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The 3rd International Yellow River Forum on Sustainable Water Resources Management and Delta Ecosystem Maintenance

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Editing Committee of the Proceedings of the 3rd International Yellow River Forum on Sustainable Water Resources Management and Delta Ecosystem Maintenance

Welcome

I, On behalf of the Organizing Committee of the 3rd International Yellow River Forum (IYRF) on Sustainable Water Resources Management and Delta Ecosystem Maintenance and the conference host, Yellow River Conservancy Commission (YRCC), warmly welcome you all over the world to Dongying to attend the 3rd IYRF.

Yellow River Conservancy Commission hosted the 1st and 2nd IYRF successfully in Zhengzhou in October of 2003 and October of 2005, respectively. The central theme of the 1st IYRF is "River Basin Management" and the 2nd IYRF is "Keeping Healthy Life of the River", which got high response and big support from water field around the world. We still remember, on the plenary and technical sessions of the past two forums, delegates carried on wide exchanges and discussions, which showed their latest research achievements sufficiently and analyzed the experiences of river harnessing and river basin management from different aspects. We collected all the valuable viewpoints and advanced experiences presented on the forum into proceedings, which promote the river basin management to keep healthy life of the river and scientific research etc. actively.

The central theme of the 3rd IYRF is sustainable water resources management and delta ecosystem maintenance. It is developed into eight sub – themes: (1) sustainable water resources management and basin ecosystem construction; (2) delta ecosystem protection and maintenance; (3) delta ecosystem and delta development modes; (4) strategies and practices on keeping healthy life of rivers; (5) river engineering and river ecology; (6) regional water resources allocation and interbasin water transfer; (7) water right, water market and water – saving society; and (8) high – tech application in modern basin management and its development trend. The Conference also arranges 18 special sessions jointly hosted by YRCC and the international well – known organizations as follows: Sino – Hispanic Water Forum; Sino – Dutch the 8th Joint Steering Committee; EU – China River Basin Management Programme; WWF – Integrated River Basin Management Forum; GWP High – level Forum on Sustainable Water Resources Management and Delta Ecosystem Maintenance; Sino – Norwegian Seminar on Sustainable Water Management; DFID – Special Session on Water and Soil Conservation; Yellow River Basin CPWF Workshop; EURO – INBO Special Session; Sino – Italian Cooperation Project on Environmental Protection; GWSP Session: Global Climate Change and

Water Resources Risk management of the Yellow River Basin; Sino – Dutch Project: Environmental Flow and Environment Protection for River Delta & Sino – Dutch Environmental Flow Training; Sino – Dutch Cooperation Project on "Satellite Based Water Monitoring and Flow Forecasting System in the Yellow River Basin"; Special Session of International Centre of Excellence in Water Resources Management (ICE WARM) Maximising the Benefits of Professional Development Activities; Post – evaluation Session on UNESCO – IHE – YRCC Professionals Training Program; Water Resources Allocation in China; Water Engineering Construction and Management in River Basins; and Management and Safety for Water Supply.

At present, about 800 experts and scholars from 64 countries and regions have registered for participating in the Forum and submitted more than 500 papers. After examined by the Scientific Committee, more than 400 papers are collected into the proceedings of the 3rd IYRF. Compared with the past two forums, the content of the 3rd forum is more abundant and the form of sessions is more multiform. The Conference will omni – directionally show the achievements on water conservancy of China and the Yellow River basin management, deeply discuss the focus and crux of river basin management, and hope to develop a mechanism for international cooperation and exchange more widely.

I am sure that with the effort of the Advisory Committee, the Organizing Committee, the Scientific Committee and all of the representatives will benefit from the conference in the professional field, and have a good time in Dongying. I believe that your experiences exchanged and your good suggestions for sustainable water resources management and delta ecosystem maintenance in the conference will influence the management of Yellow River and other river basins in the world actively in future.

Finally, I hope the 3rd IYRF be successful; hope the conference make a strong impression to every participant; and hope every participant be in good health and have a pleasant stay in Dongying.

Li Guoying
Chairman of the Organizing Committee, IYRF
Commissioner of Yellow River Conservancy Commission, MWR, China
Dongying, China, October 2007

Foreword

The International Yellow River Forum (IYRF) is a great event in water field, also a good chance for scientists who are engaged in river basin management, hydraulic research and management to exchange and discuss the river basin management and the science of water.

The 3rd IYRF is held on October 16 ~ 19, 2007 in Dongying, China. The central theme focuses on: Sustainable Water Resources Management and Delta Ecosystem Maintenance. The central theme involves the following eight sub – themes:

A. Sustainable water resources management and basin ecosystem construction;

B. Delta ecosystem protection and maintenance;

C. Delta ecosystem and delta development modes;

D. Strategies and practices on keeping healthy life of rivers;

E. River engineering and river ecology;

F. Regional water resources allocation and interbasin water transfer;

G. Water right, water market and water – saving society;

H. High – tech application in modern basin management and its development trend.

Eighteen special sessions jointly hosted by YRCC and relevant governments and well – known international organizations are arranged on the 3rd IYRF as follows:

As. Sino – Hispanic Water Forum;

Bs. Sino – Dutch the 8th Joint Steering Committee;

Cs. EU – China River Basin Management Programme;

Ds. WWF – Integrated River Basin Management Forum;

Es. GWP High – level Forum on Sustainable Water Resources Management and Delta Ecosystem Maintenance;

Fs. Sino – Norwegian Seminar on Sustainable Water Management;

Gs. DFID – Special Session on Water and Soil Conservation;

Hs. Yellow River Basin CPWF Workshop;

Is. EURO – INBO Special Session;

Js. Sino – Italian Cooperation Project on Environmental Protection;

Ks. GWSP Session: Global Climate Change and Water Resources Risk Management of the Yellow River Basin;

Ls. Sino – Dutch Project: Environmental Flow and Environment Protection for

River Delta & Sino – Dutch Environmental Flow Training;

Ms. Sino – Dutch Cooperation Project on "Satellite Based Water Monitoring and Flow Forecasting System in the Yellow River Basin";

Ns. Special Session of International Centre of Excellence in Water Resources Management (ICE WaRM) Maximising the Benefits of Professional Development Activities;

Os. Post – evaluation Session on UNESCO – IHE – YRCC Professionals Training Program;

Ps. Water Resources Allocation in China;

Ar. Water Engineering Construction and Management in River Basins;

Br. Management and Safety for Water Supply.

The preparation work for the 3rd IYRF was started after the 2nd IYRF. Since the Bulletin one was released, more than 500 papers have been submitted by about 800 decision – makers, experts and scholars from 64 countries and regions. Through the examining of the Technical Committee, more than 400 papers are collected into proceedings, including 322 papers are put into the following six volumes:

Volume I: including 52 papers under the sub – theme A

Volume II: including 50 papers under the sub – theme B and C

Volume III: including 52 papers under the sub – theme D and E

Volume IV: including 64 papers under the sub – theme E

Volume V: including 60 papers under the sub – theme F and G

Volume VI: including 44 papers under the sub – theme H

After the forum, Volume VII and VIII will be published, including about 100 papers. Total more than 300 papers are selected to present in 77 technical sessions and 5 plenary sessions.

We appreciate the generous supports of the co – sponsors, especially Dongying Municipal Government of Shandong Province, Shengli Petroleum Administrative Bureau of China, EU – China River Basin Management Program, Yellow River Water & Hydropower Development Corporation (YRWHDC), Comprehensive Development Bureau of MWR, Yellow River Wanjiazhai Water Multipurpose Dam Project Co. Ltd, Ministry of Environment of Spain, WWF (World Wide Fund for Nature), UK Department for International Development (DFID), Global Water Partnership (GWP), World Bank (WB), Asian Development Bank (ADB), Challenge Program on Water and Food (CPWF), International Network of Basin Organizations (INBO), National Natural Science Foundation of China (NSFC), Tsinghua University (TU), China Institute of Water Resources and Hydropower Research (IWHR), Nanjing Hydraulic Research Institute (NHRI), International Economic

Technical Cooperation and Exchange Centre of MWR (IETCEC, MWR).

We also would like to thank the members of the Advisory Committee, the Organizing Committee and the Scientific Committee, and all the authors presented in the proceedings for their outstanding contributions.

We sincerely hope that the publication of the proceedings of the 3rd IYRF will give an active impulse to the sustainable water resources management and delta ecosystem maintenance.

Shang Hongqi
Secretary General of the Organizing Committee, IYRF
Dongying, China, October 2007

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River Engineering and River Ecology(II)

River Engineering and River Ecology

(Ⅱ)

New Technology for Bank Protection *

Chen Hui and ***Yang Zeming***

Shengli Oilfield Water Supply Company, Dongying, 257000, China

Abstract: Putting materiel like straw into service for river course improvement is a kind of innovation in the application of engineering materiel, which brings us many benefits, such as convenience of drawing materials, lower cost and shorter time of construction, which is superior to the traditional way. The testing results proved that, adoption of the straw sleepers for bank protection is feasible and economical.

Key words: straw sleepers *, trial works, river improvement

1 Preface

The Yellow River, with heavy sediment – laden water, is famous for its "easy siltation, frequent breaching, and more migration" in history. The Yellow River Delta is one of the most prosperous zones in China, and with the promotion of petroleum strategic status and the need for the development of this area, the requirements for the stability of the river course become more and more important.

River control works mainly consists of river training and bank protection works. For the sake of stability of the river course, a large amount of blocks, willows and netting cages, are deposited in the dash place – generally named "root rock" in the drainage area of the Yellow River. Rich sandiness in the lower reaches of the Yellow River, together with its torrential and changeful flow result in a consequential movement of "root rock", even putting life in danger in flood season. In accordance with statistic, 60% expenditure was paid for the refit and the reinforcement work of "root rock", and the investment is enormous. Especially with the price growth of gasoline, a raise in the price of stone has reached to 90 yuan/m^3 in the area of the Yellow River Delta, which directly leads to rapid engineering cost growth. Thus, Innovation in the engineering materiel has practical value.

The former Yellow River Govern Office of Shengli Petroleum Administration Bureau had made quite a few tests in researching the substitution materiel by making use of local resources. In the years of 2004 and 2005, they had carried out the test by using straw sleepers before flood season. The result showed that this innovation is successful and valuable.

2 The introduction of the test mentioned above in 2004

2.1 Background of the test

During the period of an exceptionally serious flood in autumn in 2003, the flux of over 2,000 m^3/s kept at Lijin station for up to 50 days, which made a sharp change of the river course. Movement of 14 km to the lower part of river made No. 1 ~ 4 dams which replaced the previous No. 11 ~ 16 dams as the principal part to face the great flood. When we made a site investigation before the flood season in 2004, the ends of the Nos. 1 ~ 2 dams had completely been destroyed. There are no a protection above No. 1 dam , the highest part of project, directly facing main current of flood, as a result, beach bank collapsed about the length of 300 m and width of 150 m.

Qingsan River Control Project, as a part of the 1st stage work for the Yellow River Water Route Plan, was finished in 2001 according to our plan. Therefore, the continuation of building was not

* The straw sleepers: a kind of material which form is like "sleeper" which is filled up with straws completely and can be used in the river course improvement.

taken into consideration in the 2nd stage plan. So the sharp change of the Yellow River in the two years is beyond our expectancy. Therefore, it is necessary to make forceful measures to prevent the project from damage, such as short – time protection in the upper reaches.

2.2 Comparing trial project schemes

There are three schemes: the earth – rock dam, willow sleepers and straws for bank protection. After the comparisons made on a 300 m long project section in terms of several factors such as investment, construction period, convenience of material drawing and necessary emergency fund, we found out the straws for bank protection is the best one because of the following advantages: low cost, easy to draw materials and convenience for construction.

Table 1 Comparing the key elements of the three schemes

Number	Projects	Budget (yuan)	Cons – truction period	Getting material	Preparation (yuan)	Notes (m)
1	Earth – rock dam	1,500,000	2 months	Cost is comparatively high because of land purchase to gain materials.	300,000	300
2	Willow sleepers as protection for banks	1,000,000	1 month	Natural forest is rare, so willow material is not easy to gain	50,000	300
3	Straws as protection for banks	500,000	15 days	Straws are easy to gain because many cotton fields is around the project	50,000	300

2.3 Arrangement of the trial project

The length for testing is to be 300 m because of two reasons: one is that the upper reaches of the project collapsed about 300 m; the second is that it is the first time to carry out the kind of project. The location (the part with solid lines) of the project is shown in Fig. 1.

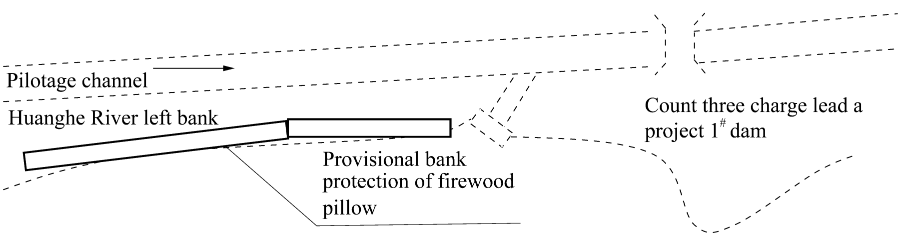

Fig. 1 Sketch for Qingsan River Control Project

2.4 The structure of the trial project

2.4.1 The structure of sleepers

There are two kinds of sleepers: one is the sleeper filled up with straws completely and we call them straw sleepers❶ for short; the other is the sleeper filled up with straws and five bags of earths that weighs 5 kg each and we call them mixed sleeper❷ for short. Both of them are 3 m long and circular, with a diameter of 0.4 m each, bound with iron wire.

2.4.2 The design of engineering

According to the design of the project, dig a slot in dry land and the slot bottom is 3 min width, bottom elevation 3 m and both internal and external slopes are 1:1. "Mixed sleepers" are placed in T order in the bottom and "straw sleepers" are placed in T order when digging inside slope. Press them tightly and fill up the gap with the hydraulic excavation machine. (the crest elevation being 6.1 m)

2.5 Implementation of the project scheme

Since there is no any experience available for reference, the project manager, together with the unit in charge of construction turned over the details and made the following project scheme.

"Straw sleepers" are made in dry land. Firstly, dig a slot, with dimensions of 0.4 m × 0.4 m × 3 m, in dry land. Secondly, place the five pieces of 10# iron wire, which length is 5 m, according to the requirement. Thirdly, fill up the slot with straw sleepers and press them tightly at the same time. Finally, tie them well and bring them out from the slot bottom. Each ' straw sleeper" is 0.4 m^3, and weight is about 50 kg. The project needs 9 layers of straw sleepers and each layer needs 750 straw sleepers. Both kinds of the sleepers are made at site in dry land. The diameter is 0.4 m, and the length is 3 m. Nine pieces of iron wire are used to bind those sleepers. The dimension of each "mixed sleeper" is 0.4 m^3, and weight is about 95 kg. We place one layer of mixed sleepers and the layer need 750 mixed sleepers. In sum, we need 369,900 kg straw sleepers and 5,460 kg iron wire and 3,000 weave bags.

The discharge at Lijin station of the Yellow River measures 150 m^3/s or so, and Qinsan water level is about 2.80 m when the project was under construction in dry land. From lower reaches, every 50 m, as a subsection of the project, are under construction. First place a layer of mixed sleepers and 3 parts of every sleeper is connected with iron wire. Then place the second layer of straw sleepers and connect them. We connect each layer each other in order to make them unity. And work like this in turn. We drive one 1m long wooden pile of 15 cm in diameter in every 5 m when working in the first layer, in order to prevent sleepers from gliding into the River. The wooden pile is left 0.3 m on soil and tightly bound with the sleepers on its sides.

At the site we have carried out statistics on the time and materials used for each procedure during construction, for the details see Table 2.

2.6 Experimental effect and analysis

2.6.1 Inflow of flood period in 2004

The third runoff and sediment regulation started on June 20, 2004 when the discharge kept in 2,500 ~ 3,000 m^3/s and the detailed conditions of water and sediment and water level are presented in Table 3. The flood water remains longer this year, compared with that of last year. The major current flows along the left side and goes upstream to No. 1 and 2 dams of Qiansan Training works. The water face of No. 1 dam is directly against the major current, both major and secondary currents

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❶ The sleeper filled up with straws completely and we call them "straw sleeper" for short.

❷ The sleeper filled up with straws and five bags of earths and we call them "mixed sleeper" for short.

rush to the temporary revetments and the water level in front of the dam approaches 6.0 m.

2.6.2 Evaluation on the new technology of bank protection

The project was completed on June 7, 2004. Despite the flood lasting for 115 day, the new technology of bank protection plays a very important role and reaches the aims of: ① the project wasn't destroyed by flood; ② the banks are very well protected.

Table 2 The record of consuming materials of Qinsan provisional protection project

Time: March 30, 2004
Place: Qingsan project site
Notes: Every dimension 0.4 m^3, two people make the straw sleeper and the mixed sleeper together The steps include filling up, pressing and placing the sleepers

		Straw pillow	Mixed pillow
Day work of manpower	Fill up soil		5 minutes
	Enclosing		5 minutes
	Pave iron wire	5 minutes	6 minutes
	Fill up straw	20 minutes	20 minutes
	Tie sleepers	6 minutes	6 minutes
	Carrying sleepers	2 minutes	2 minutes
	Transporting	5 minutes	5 minutes
	Have a rest	6 minutes	6 minutes
	Sum	0.47 work day/m^3	0.57 work day/m^3
Amount used of iron wire		10# Iron wire $5\times1.8+1.8$ m 1.68 kg/m^3	10# Iron wire $9\times2+1.8$ m 3.08 kg/m^3
Amount used of straw sleeper		125 kg/m^3	108 kg/m^3
Weave bag			4

There are many engineering means to arrive at the objective of protecting banks, but the new technology, that is, using straw sleeper, has much more advantages than others: ① Lower cost than traditional methods, such as stone and willow being easy to gain and simple construction of the project. ② Compared with building the head dam in the centre of the river(if continuing building), the new technology is safe. ③ It is necessary and timely to carry out the project because the water of the Yellow River becomes richer and richer year by year since 2000. ④ The new technology of bank protection sink as a block if the its base is washed off, while the riprap protected bank needs rearrangement and supplement of stones if the event occurs.

After flood season, we inspected the project and found out some problems: ① The whole project sunk 50 cm and both ends of the project are destroyed by about 30 m. All of these show that the project as a trial needs to be improved in the future.

2.7 Suggestion and application prospect

As a trial, the project needs improvement in design and construction: ① We should consolidate the ends of the project, such as adopting the straw sleeper and mixed sleeper, adjusting the order of sleepers, increasing the quantity and length of wooden piles, increasing the number of iron wire. ② Fill up with sleepers much deeper in the dam and adjust the proportion of the straw sleeper and the mixed sleeper to make the project more stable. ③ The project needs to have sufficient freeboard.

Judging from the successful experiment, the new technology is feasible and deserves popularization. ① It can be used in emergency case because the material is easy to gain. ② It can be used to protect slope better than reeds.

Table 3 Statistical graph of flowing water level in 2004

Date	Rate of flow of Li jin station (m^3/s)	Sand amounts of Lijin station	Water level of Lijin station(m)	Qingsan water level(m)
June 18			12.03	
June 19	761		12.46	
June 20	1,130		12.38	5.75
June 21	1,760	16	11.96	
June 22	1,600	10.9	12.56	
June 23	1,040	16.7	12.98	5.85
June 24	1,980	16.1	13.19	6.15
June 25	2,490	16.9	13.23	6.22
June 26	2,660	16.9	13.26	6.30
June 27	2,680	18.7	13.26	6.33
June 28	2,700	16.1	13.29	6.3
June 29	2,700	13.21	3.22	6.3
June 30	2,600	13.61	3.22	6.28
July 1	2,550		12.7	6.28
July 2	2,560	14	11.94	5.96
July 3	1,840	8.44	11.8	
July 4	910	5.18	11.75	
July 5	630	4.64	11.69	
July 6	620	4.16	11.92	
July 7	628	4.36	12.94	5.7
July 8	1,000	14.5	13.1	6.05
July 9	2,390	14.9	13.12	6.14
July 10	2,610	13.2	13.16	6.26
July 11	2,630	12.8	13.28	6.4
July 12	2,520	14.8	13.36	6.4
July 13	2,600	14.8	13.39	6.45
July 14	2,740	20	13.36	6.54
July 15	2,810	19.6	13.19	6.58
July 16	2,770	14.5	12.27	6.36
July 17	2,500	8.26	11.9	5.65
July 18	1,270	4.26	11.76	

Date	Rate of flow of Li jin station (m^3/s)	Sand amounts of Lijin station	Water level of Lijin station(m)	Qingsan water level(m)
July 19	905	3.84	11.67	

3 Introduction of Qingsan Project as trial in 2005

The project in 2005 aims at repairing the destroyed parts of the Qingsan protection project in 2004 and further extension of 120m upstream. In consideration of the previous experiences, we took effective measures to consolidate the two ends of the project by adopting the mixed sleepers.

After its completion, the project successfully withstood testing of man – made flood peak in water and sediment regulation and autumn flood in 2005.

4 Conclusions

The area of Yellow River estuary is abundant in cotton straw resource and low – price human resources. The new technology using the straw as the major materials costs far less, is easy to construct and repair, and at the same time benefits the local economy and provides new effective ways to increase the income of the cotton grower.

Optimal Allocation of River Pollutant Emission Rights Based on Two – level Mode

Huang Xianfeng, ***Shao Dongguo*** and ***Gu Wenquan***

State Key Laboratory of Water Resources & Hydropower Engineering Science, Wuhan University, Wuhan, 430072, China

Abstract: Aiming at the research status and existing problems of pollutant emission rights allocation, a two – level allocation mode based on water functional areas is put forward. At the view of the ecological and environmental protection and water resources sustainability, a multi – objective optimal allocation model is established for river pollutant emission rights, which takes economic benefit optimization and water quality optimization as its objective functions, and concentration, total quantity of the pollutants, allocation equality as constraints. The model is applied in Jushui River. Practical results and conclusions are obtained, which proves validity and applicability of the model and provides scientific gist for River Environmental Protection Agency.

Key words: river pollutant emission rights, two – level allocation mode, optimal allocation, water functional areas, equality

1 Introduction

River pollutant emission rights have been studying since 1960s. Dales, a American scholar, first defined them as the rights that obliges emit contamination to environment under the law. In fact, emission rights refer to the usufruct of the environment capacity resources. With the development of the economy, water environment becomes worse and the contradiction among dischargers stands out. The emission rights allocation is a main method for solving the problem and also a good way to harmonize the environmental protection and economic development. Only the emission rights is allocated reasonably based on finite resources, can the understanding of dischargers and society to water resources usufruct be enhanced. It is also in favor of managing water resources by economic measures and forcing the environmental protection work. So it has an important significance for optimal emission rights allocation.

With the increasing labefaction of river environment, people pay more and more attention to the allocation of river pollutant emission rights (RPER). It refers to the initial allocation, which is the precondition and foundation of exchange in market economy. In 1970s, the Environmental Protection Agency of America began to use the emission rights allocation policy in the atmosphere and river pollution management. A complete set of allocation system has been built, which focus on bubble, offset, banking and netting. It provides tremendous economic benefit and obvious environmental protection effect for America in the pass 30 years more. In China, with the Temporary Measures of Water Pollutant Emission License Management promulgated in 1988, and the total pollutant quantity control program carried out in 1996, the RPER has been studying entirely. Some provinces such as Zhejiang Province and Jiangsu Province are in an attempt to take the allocation of RPER to commodity management. Wang Qingeng has studied the initial allocation in total quantity control areas. The reality and equality of the allocation are realized by introducing "equal – right function" and "equal – right discharge', and an emission rights allocation model is built. Li Shoude has built a multi – objective decision – making model based on the economy optimization, equality and producing continuity.

At present, the allocation of RPER has some problems as follows: ① Simple consideration on the minimization of integrated treatment fee, which causes the water environment capacity to function fully. The dischargers would emit pollutants as possible as they can under the goal control of environment quality. ② Allocation is based on actual emission amount only, which encourages the behaviors of dischargers. It is a punishment to the cleaning producers. ③ The pollutant emission standard is just controlled by concentration, which ignores the effect differences of the different exterior environment such as weather, terrain, hydrology on the pollutant's different absorbing ability and decomposability. ④ Without the consideration on the partition characteristic of river water functional areas (WFA). Different WFA have different request for water quality. But the present allocation mode does not take it into account. It falls short of the actual condition of social development.

Based on the analysis upwards, this paper is in an attempt to build a multi – objective allocation model of the RPER with the two – level allocation mode. It considers not only the economy objective but also the water quality objective, which can remedy the shortage of the present emission rights allocation.

2 A two – level allocation mode for river pollutant emission rights

The Chinese Ministry of Water Resources had organized related organizations and institutes to accomplish the partition of WFA all over the country from 1999 to 2000. In different WFA, the water quality management goals are different. The partition of WFA provides guarantee for realizing the reasonable exploitation, efficient protection, integrated treatment and scientific management of water resources, and accelerating the sustainable development of economy and society. So the allocation of RPER should take the characteristics of WFA partition into account. Pollutant emission allocation schemes are provided which have economy and water quality optimization from the whole river layout based on the WFA water quality management goal.

The two – level allocation mode of RPER is that allocation from River Environmental Protection Agency (REPA) to water functional areas, then from water functional areas to dischargers, which can be seen in Fig. 1. The REPA ascertains the RPER based on the status of the river pollutant emission, the condition of economy and technology, the level of pollutant treatment, the future social development programming, the water environment capacity characteristics of the river itself and the pollutant total quantity control demand of the upper – level river. The RPER are distributed to the WFA, and then to the dischargers. In each distribution process, it should have some surplus so as to profit the river environmental protection and the sustainable utilization of the water resources and to reply to influence of the uncertain factors in the development of society and economy.

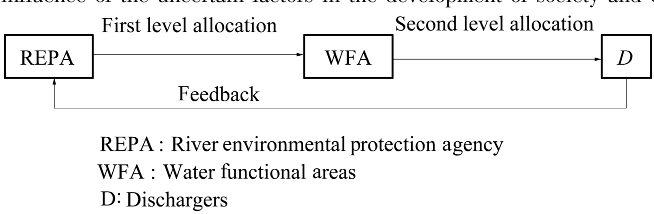

Fig. 1 The sketch of two – level allocation mode for river pollutant emission rights

3 Optimal allocation model of RPER

3.1 Modeling idea

Considering on the characteristics of WFA, the RPER should adopt two – level allocation mode. From the control scale of the whole river layout and in the guarantee of economy development and water quality management goal, it should attain economy optimization, water quality optimization and surplus water environment capacity as possible as it can to satisfy the sustainable interests of water resources. Economy optimization and water quality optimization are two contrary objectives. The optimal allocation model of RPER is to find the balance point between them with mathematical programming theory and methods.

To harmonize the economy development and the environmental protection, concentration control and total quantity control should both be the constraints in the allocation model of RPER. For a specific river, the concentration control values can be attained by the water quality goal of the WFA combining with the Environmental Quality Standards for Surface Water (GB 3838—2002). The total quantity control values can be attained by the calculation of the water environment capacity of WFA.

The equity of allocation should be considered also. The allocation can not be the same for all. It should consider the contribution level of the dischargers to the economy development. For the dischargers of larger contribution level, the emission rights should be allocated more. Furthermore, the critical discharging amount should be also taken into account. Each discharger has a lower and an upper limit.

With the considerations upwards, the paper takes economy optimization and water quality optimization as the two objectives, and the concentration control, total quantity control of pollutant, the equity of allocation and the critical discharging amount as the constraints. A multi – objective optimal allocation model for RPER is built to calculate the programming pollutant emission amount of each discharger and then realize the integrated optimization of economy and environment of the river basin.

3.2 Objective functions

3.2.1 Economy optimization objective

Economy optimization: considering the minimization of the integrated treatment fee.

$$\min EP = k_1 Q^{k2} + k_3 Q^{k2} \eta^{k4} \tag{1}$$

where, EP refers to the integrated treatment fee of the whole river (unit: 10,000 yuan RMB); Q refers to the disposal discharge of the out – standard pollutants (unit: L/s); η refers to the removal rate of the pollutants (unit: %); k_1, k_2, k_3 and k_4 refer to the proportion parameter of the disposal cost, the proportion parameter between the disposal scale and the removal rate cost, the index parameter between the disposal scale and the disposal craftwork cost and the index parameter of the removal rate cost respectively, which can be attained by the data analysis of the investment expenses of the urban sewage plants and the practical conditions of the river.

3.2.2 Water quality optimization objective

Water quality optimization: considering the maximization of the water environment surplus capacity.

$$\max WEC = W - \sum_{i=1}^{m} \sum_{j=1}^{n_i} W_{ij} \tag{2}$$

where, WEC refers to the water environment surplus capacity (unit: t/a); W refers to the river pollutant emission rights ascertained by the REPA based on the integrated consideration of various factors (unit: t/a); W_{ij} refers to the programming pollutant emission amount of discharger j in water functional area i (unit: t/a); n_i refers to the number of dischargers in water functional area i; refers to the number of WFA.

3.3 Constraints

3.3.1 Concentration control constraint

Concentration control constraint mainly considers that the programming concentration of the pollutants is controlled in the water quality management goal of the WFA.

$$B_{i0} + \sum_{j=1}^{n_i} B_{ij} \leqslant C_{is} \tag{3}$$

where, B_{i0} refers to the concentration contribution value of the upper background concentration effecting on the lower control section in water functional area i (namely the value of concentration transfer function) (unit: mg/L); B_{ij} refers to the concentration contribution value of the discharger j effecting on the lower control section in water functional area i (regarding the point pollution and the non - piont pollution as dischargers) (unit: mg/L); C_{is} refers to the water quality management goal in water functional area i (unit: mg/L).

3.3.2 Total quantity control constraint

The total quantity of dischargers in WFA is controlled within the water environment capacity of each water functional area. The total programming emission quantity of all water functional areas can not exceed the total emission right of the river.

$$\sum_{j=1}^{n_i} W_{ij} \leqslant W_i \tag{4}$$

$$\sum_{i=1}^{m} W_i \leqslant W \tag{5}$$

where, W_i refers to the water environment capacity of water functional area i (unit: t/a). Formula (4) and formula (5) have the meaning that allocation amount of the lower level can not exceed the upper level. Initial allocation of the emission rights can have some surplus so that it is propitious to the environmental protection and sustainable utilization of water resources.

3.3.3 Equity constraint

The summation of squared margin of the programming emission amount to the equal initial emission rights and the mean emission amount in recent years of all dischargers is controlled in a certain proportion of the actual emission amount.

$$(W_{ij} - W_{eij})^2 + (W_{ij} - \overline{W}_{ij})^2 \leqslant (\lambda W_{ij}^0)^2 \tag{6}$$

where, W_{eij} refers to equal initial emission rights of discharger j in WFA i, which can be calculated by the economy development contribution ratio of the discharger to the functional area multiplying the programming emission amount of the functional area (unit: t/a); $\overline{W}_{ij}$ refers to the mean emission amount in recent years (unit: t/a); W_{ij}^0 refers to the actual emission amount (unit: t/a); λ refers to a amend coefficient ($0 < \lambda < 1$), which is to control the summation of squared margin of the programming emission amount to the equal initial emission rights and the mean emission amount in recent years of all dischargers within a certain proportion of the actual emission amount. Smaller means more obvious equity.

3.3.4 Critical discharging amount constraint

Considering the producing continuity of the discharger and future economy development programming level, the emission rights of the discharger is constrained by critical discharging amount. The lower bound mainly considers the producing continuity, which can be ascertained by the minimum emission amount in recent years. The upper bound is weighed by the maximal emission amount in recent years which can by ascertained by the social and economic factors and the cutting potential of dischargers.

$$W_{ij}^L \leqslant W_{ij} \leqslant W_{ij}^U \tag{7}$$

where, W_{ij}^L refers to the minimum emission amount of discharger j in water functional area i (unit: t/a); W_{ij}^U refers to the maximal emission amount of discharger j in water functional area i (unit: t/a).

4 Application examples

Jushui River locates in the northeast of Hubei Province, the south root of Dabieshan Mountain, north bank of the Yangtze River. It is a first level branch river of the Yangtze River. The main river is about 165 km long and the watershed area is about 4,302.8 km^2. With the development of economy, a large amount of contaminations have poured into the river straightly. The water quality becomes increasingly worse. So it is very important to allocate rationally the emission rights for harmonizing the economy development and environmental protection. Jushui River has six first – level WFA and four second – level WFA in total. For the first – level WFA, they are partitioned to second – level WFA. The specific partition can be seen in the Water Functional Area Partition in Hubei Province. The results of first – level WFA of the main river can be seen in Table 1.

Table 1 Results of first level water functional areas in main Jushui River

Areas	Names	Scope			Water quality goal
		First section	Terminal section	Length (km)	
A_1	Source protection area	Source	Huangtugang Town	32.5	Ⅱ
A_2	Upper reservation area	Huangtugang Town	2 km supper Macheng hydrologic station	34.5	Ⅱ
A_3	Exploitation area in Macheng County	2 km supper Macheng hydrologic station	Minjiaji Town	9	
A_4	Reservation area from Minjiaji to Sandian	Minjiaji Town	1.5 km supper Xinzhou Water Plant	58.5	Ⅲ
A_5	Exploitation area in Xinzhou District	1.5 km supper Xinzhou Water Plant	0.5 km slower Xinzhou Water Plant	2	
A_6	Reservation area from Xinzhou District to Tuanfeng County	0.5 km slower Xinzhou Water Plant	Tuanfeng County	28.5	Ⅲ

After simplification, there are 11 dischargers both sides of the river bank. The arrangement of the first – level WFA and dischargers can be seen in Fig. 1.

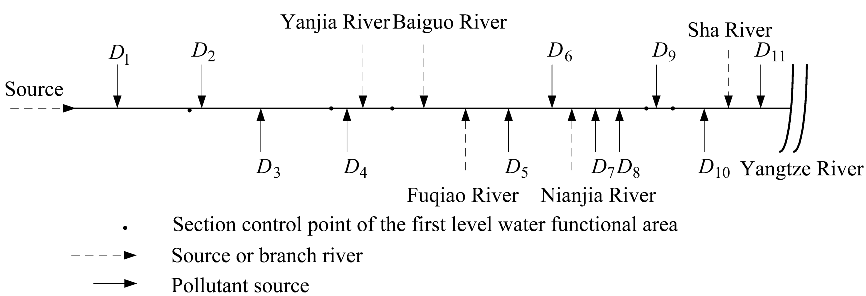

Fig. 1 The arrangement sketch of the first – level WFA and dischargers in main Jushui River

Because the water quality management goal of the pollutant discharging control area in the second – level WFA is not required in our country, the paper ascertains the value by the lower second – level water functional area. If the lower area is the transitional area, it is ascertained by the reversing of the one dimension water quality transfer equation. Otherwise, the lower section concentration of the pollutant discharging control area is equal to the water quality of the next water functional area. The concentration control goal of each water functional area can be ascertained like this. The background concentration and the concentration contribution value of the pollutant emission concentration to the lower control section can be ascertained according to the method mentioned in reference. The total quantity control goal of each functional area can be ascertained with the calculation of water environment capacity based on the pollutant concentration control goal. The programming emission amount is the sum of water environment capacity in each functional area. The equal initial emission rights in each functional area can be calculated by multiplying the economy development contribution ratio of the discharger and the programming discharging amount in the water functional area. The economic contribution ratio is the function of the economy tax contribution, economy developing scale contribution and the labor employment contribution. The critical discharging amount can be ascertained by the actual discharging amount in recent years.

The paper takes COD as the study object. A multi – objective optimal allocation model for RPER in Jushui River is built. By the analysis of the sewage plant in the middle – lower Yangtze River, the parameters of the k_1, k_2, k_3, k_4 can be evaluated as 4.437,9, 0.661,7, 44.323,9 and 4.999, the η can be evaluated as 0.5. It is a multi – objective nonlinear model. There are many studies about the solution methods. In the paper ideal point method in the multi – objective programming theory is adopted. The idea of the method is as follows. There are objective functions in the multi – objective optimal model. For each objective function, $f_i(x)$, we confirm a target value f_j^0, where $f_j^0 \leqslant \min f_j(x)$ $(j=1,2,\cdots,p)$. We mark the ideal points as:

$$f^0 = (f_1^0, f_2^0, \cdots, f_p^0)^{\mathrm{T}} \tag{8}$$

Then, the question is to solve the single objective optimal problem:

$$\min_{x \in S} \| f(x) - f^0 \|_\alpha \tag{9}$$

In the example, the shortest distance ideal point method is adopted, which is $\alpha = 2$.

According to pollution status, economy and technology level, the future development programming, the water environment capacity of Jushui River itself and the total quantity control request of the Yangtze River to Jushui River, the pollutant emission rights of Jushui River is 6,654.87t/a. Using the model mentioned above to allocate the pollutant emission rights of Jushui River, the result can be seen in Table 2 and Table 3. The results are compared with the model mentioned in reference who builds a multi – objective decision – making model based on the economy optimization, equality and produce continuity. In reference, economy optimization is the main objective and the others are subordinate objectives. But in the model mentioned in this paper, the economy optimization weighted by the minimization of the integrated treatment fee and water quality optimization weighted by the maximization of the water environment surplus capacity are the two equal objectives. The results of the two methods can be seen in Table 3.

Table 2 Allocation results of RPER in WFA using the model mentioned in this paper

Areas	Upper background concentration (mg/L)	Lower control section concentration (mg/L)	Actual emission amount (t/a)	Allocation results (t/a)
A_1	1.0	1.2	332.96	556.18
A_2	1.2	1.6	691.39	877.36
A_3	1.6	3.2	1,853.00	1,736.90
A_4	3.2	2.8	2,737.90	1,273.00
A_5	2.8	3.7	965.35	919.03
A_6	3.7	3.9	1,663.80	1,292.40

It can be seen from Table 3 that the total RPER of dischargers is 5,043.52 t/a, the integrated treatment fee is 3,919,100 yuan RMB, the water environment surplus capacity is 1,611.35 t/a and the surplus capacity ratio is 0.242. But according to the reference, the total RPER of dischargers is 5,207.30 t/a, the integrated treatment fee is 4,886,600 yuan RMB, the water environment surplus capacity is 1,447.57 t/a and the surplus capacity ratio is 0.218. Comparing with the two methods, the total allocation quantity of RPER by the method mentioned in this paper is fewer, the integrated treatment fee is less, but the water environment surplus capacity is more, so the economy objective and water quality objective are better. The reason is that under the two – level allocation mode about the allocation of RPER, the WFA has conditionality on the pollutant concentration and total quantity of the dischargers. The allocation incarnates reposefulness and equity and inclines to rationalization. But for the allocation model without considering the WFA, the results are not uniform, which will cause the water environment capacity to function fully and the integrated treatment fee higher. So the model of this paper is an effective model which is in favor of controlling and managing the whole water environmental, solving the emission contradiction in different areas, between upper and lower position, harmonizing the economy development and environmental protection, and guaranteeing the sustainable utilization of water resources.

Table 3 Result of pollutant emission rights allocation in dischargers using two methods

Dischargers	Distance from estuarine (km)	Lower bound (t/a)	Upper bound (t/a)	Actual emission amount (t/a)	Results of this paper (t/a)	Results of reference (t/a)
D_1	162	266.36	399.55	332.96	383.01	395.66
D_2	131	249.30	373.95	311.63	352.88	373.09
D_3	114	303.81	455.71	379.76	379.76	442.42
D_4	93	922.39	1,383.60	1,153.00	976.65	974.59
D_5	72	335.83	503.74	419.78	419.84	489.37
D_6	68	321.97	482.96	402.46	402.56	455.29
D_7	60	163.25	244.87	204.06	212.01	212.64
D_8	55	130.54	195.81	163.18	165.64	163.18
D_9	29	772.28	1 158.40	965.35	919.03	850.27
D_{10}	20	284.00	426.00	355.00	406.84	402.17
D_{11}	8	310.21	465.31	387.76	425.30	448.62
Sum		4,059.94	6,089.90	5,074.94	5,043.52	5,207.30

5 Conclusions

Pollutant emission rights allocation is the premise and foundation of bargaining in market economy. It is a dynamic system engineering which integrates economy, society, environment, projects and so on. The author takes the water functional areas partition into the pollutant emission rights allocation, puts forwards a two – level allocation mode that from the River Environmental Protection Agency to water functional areas, then to the dischargers. Combining the water functional areas with water environmental protection is propitious to whole water environmental management. Upon these, a multi – objective optimal allocation model is built which takes the economy optimization and water quality optimization as the two objectives, and concentration, total quantity, equality and critical emission amount as the constraints. The model characterizes the complex of pollutant emission rights, enriches and develops the theory and methods of pollutant emission rights, and is propitious to harmonize environmental protection and economy development, and has an extensive application foreground. Because the optimal allocation of river pollutant emission rights should consider not only the function of River Environmental Protection Agency, but also the Department of Water Resources Management, it need further research for the optimal allocation of river pollutant emission rights under the uniform management of water quality and quantity.

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Calculation of Ice – jam Backwater in Haibowan Reservoir of Yellow River

Lei Ming [1], ***Rao Suqiu*** [2], ***Zhang Zhihong*** [1], ***He Shunde*** [1] and ***Gao Zhiding*** [1]

1. Yellow River Engineering Consulting Co., Ltd.
2. Hydrological Bureau, YRCC, Zhengzhou

Abstract: A method of calculation of ice jam backwater is put forward by reference of bed – load transport theory and the calculation result of ice jam in the reach between Yanguoxia to Liujiaxia of the Yellow River. The characteristics of experiential parameters with boundary condition are presented via calibration the ice jam water surface profile of Wanjiazhai reach, based on mesaured data. The ice jam water surface profiles of Haibowan reservoir is forecasted.
Key words: ice jam, Haibowan Reservoir, the Yollow River

1 Introduction

Ice jam is a serious ice regime in the river of North China, which is formed generally during ice flow and frozen – up. In the natural river, ice jams occur generally at the points of channel curve or slope from steep to gentle. The channel slope toward upstream from reservoir head is steeper and flow velocity high. The downstream freeze – up first at the gentle slope. Some of slush ice sink at the head edge of ice cover and jam to backwater, then the ice cover extends toward upstream. The ice jam can be formed easily during these processing.

There are three stages, formation, stabilization and decay, during the ice jam process. It is called a stabilization stage when the velocity, slope and discharge sectional area keep steady longer time during the ice jam homeostasis. The water level is smooth with little fluctuation and it is high water level duration in this period. The steady reach is located the middle of ice jam and the highest water level occurs in this reach. These characteristics of ice jam are practically significance for deriving the highest water level and surface profile of ice jam during steady stage.

The methods of calculation of ice jam backwater include mainly probability statistics, hydraulics with experiential equations and analogy estimation with reference of backwater data in similar channel. Probability statistics need steady observed ice jam data for long time. Based on the hydraulics characteristics, the hydraulics method approximates the experiential correlation of mean velocity, discharge and water surface width, in which the experiential coefficients need calibration using observed data of ice jam at the reach. The analogy estimation can give only highest backwater level generally without the location and water surface profile of ice jam. In this research, two kind of experiential equations of hydraulics that is used to calculate in Liujiaxia reach are studied. The experiential coefficients and some parameters have been analyzed with reference of hydraulics method and result based on ice floe carrying capacity. The ice jam backwater surface profile was forecasted at Haibowan Reservoir without observed data through calculating that at Wanjiazhai reach with observed data.

2 Principal and method of calculation

The calculation research of ice jam between Yanguoxia to Liujiaxia reach put forward two methods based on Alturning river channel morphology and ice floe carrying capacity. Both of the methods need experiential formulas calibrated with observed data of ice jam. The validation using observed data at Wanjiazhai reach proved that the ice jam water surface profile expected is more difference with observed one and it is difficult to calibrate the channel morphology coefficient in first method. The second method can give good result through calibrating experiential coefficients of mean velocity, discharge and water surface width in steady ice jam reach using observed data of 3 years at Wanjiazhai reach. The acceptable fit of ice jam water surface profile between measurements and computations is 0.3 m to 0.5 m. Reference to some literatures, ice jam steady degree is the function of resistance which depends on river width, channel slope, and river bed resistance. The analysis of experiential coefficients show that it is a positive correlation with mean channel slope in the reach and negative correlation with the width of cross section in Yanguoxia and Wanjiazhai reaches. It offers a method for selection of experiential coefficients reasonably in calculation of ice jam at Haibowan reservoir head.

Reference of sand – load moving concept, based on observed ice jam data the formula can be calibrated with mean velocity of cross section, discharge, and width of water surface.

$$V = \beta \frac{Q^{0.35}}{B^{0.36}} \tag{1}$$

Combined Manning formula and flow continuity equation:

$$Q = HBV \tag{2}$$

where, Q is discharge with highest water level during ice jam. H is water depth of cross section. B is the width of water surface. V is mean velocity. β is experiential coefficient.

The steps of calculation of ice jam backwater surface profile should be as following.

Step 1. The correlation function is set up using β of Yanguoxia and Wanjiazhai and mean channel slope in the reach. In calculation of ice jam of Haibowan reservoir head, using the original and 20 years later mean slope in the reservoir head reach, β can be pointed originally, then trial calculation follows to select appropriate value of β in Table 1.

Table 1 Experiential coefficients in calculation of ice jam backwater

Reservoir Name	Mean slope(%)	β
Yanguoxia	0.17	0.71
Wanjiazhai	0.085	0.58
Haibowan (Original channel)	0.05	0.50
Haibowan (20 years later after reservoir running)	0.022	0.45

Step 2. The amount of frazil and mean discharge during freeze – up are estimated based on flow forecasting or design frequency of discharge.

Step 3. The location of the head and the end of ice jam are determined originally. The head can be located where mean velocity of cross section is about 0.3 ~ 0.4 m/s. The end location can be estimated according the morphology and flow velocity, generally located where steep slope, large velocity and hydraulics condition change less after ice jam downstream.

Step 4. Partition ice jam reach and selection siutable roughness of ice cover and river bed, the synthetic roughness nc can be calculated.

$$n_c = \left(\frac{n_b^{\frac{3}{2}} + n_i^{\frac{3}{2}}}{2}\right)^{\frac{2}{3}}$$

where, n_b is roughness of river bed, and n_i is roughness of ice cover.

According to experience, n_c affects not ice bottom of ice jam backwater but the water level only. The Larger is n_c, the larger is water surface slope and the higher is backwater level in ice jam cross sections. The ice volume expected increases correspondingly. The synthetic roughness is 0.05 and one of head part is 0.03 in the calculation of ice jam in Haibowan reservoir head.

Step 5. Combined formula (1) and formula (2), the velocity and water surface width in each cross section can be calculated separately.

Step 6. The steady water surface slope among cross sections can be calculated with formula:

$$j = \frac{V^2 n_c^2}{R^{\frac{4}{3}}}$$

where, n_c is synthetic roughness, R is hydraulics radius of cross section, and j is slope of steady water surface of ice jam.

Step 7. Ice jam backwater level of each cross section is derived from the water level at the head assumed and steady slope of water surface toward upstream.

Step 8. The thickness of ice jam at each cross section can be derived from ice jam backwater level minus the steady water level under ice cover.

Step 9. Ice volume can be calculated based on ice jam thickness at each section and compared on the forecast or design frequency or observed data. Repeat step 3 to step 8 until the ice volume expected is close to the observed one.

3 Result of calculation

The ice jam backwater was calculated at Haibowan reservoir head with the morphology data 20 years later after the reservoir running and initial condition with 1,076 m of storage level and 869 m^3/s of discharge which is once each 20 years at Shizuishan during freeze – up. The ice jam head was assumed at gorge outlet where is 11 km far away from the dam, and the end was located the cross section from narrow to wide. Fig. 1 shows the ice jam profile.

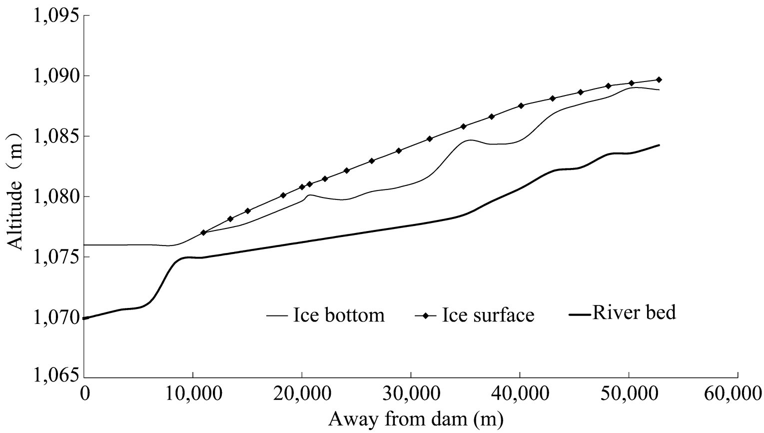

Fig. 1

4 Analysis of result

4.1 Examination the reasonability of ice jam shape

The ice jam shape at gorge reach of Yellow River should be like a trapezium or a triangle according to analysis of steady ice jam data at the reservoir heads of Yanguoxia, Wanjiazhai and Tianqiao. The ice jam shape expected at Haibowan reservoir head should be similar as the case. The reasonability of ice jam shape should be check – up as following.

4.1.1 The location of ice jam head and end

The location of ice jam head should be considered synthetically the conditions as following. Firstly, assumed the ice stops initially at the cross section with 0. 3 m^3/s of mean velocity. Secondly, natural channel slope goes gentle abruptly. Last one is trial calculation. It should be selected that backwater most serious and near upstream in the effected area when some range of reach can be selected according to the channem condition. The end location should be selected the place with gentle slope toward upstream and the hydraulics conditions change difficultly with ice jam backwater downstream, or the cross section with narrow and deep goes to wide and shadow, and same hydraulics conditions.

4.1.2 The water level and rise range at the cross section of initial rising abruptly at ice jam head

The water level at the cross section of initial rising of ice jam head can effect on the ice profile calculated and the reasonability of result directly. The elevate of head front is joint to backwater curve of reservoir downstream, but due to ice block the backwater profile can rise 1 m than in open flow duration. Water level of ice jam head should be selected by trial calculation and adjust.

4.1.3 Analysis on variety of water surface slope

The water slope is gentle at ice jam front and the joint of water surface and ice cover in reservoir downstream is smooth. The slope at top section of ice jam head is steep and close to or larger than the slope of river channel. The slope was selected with reference to the simulation of ice jam case at Wanjiazhai reach in 3 years of 1998 ~ 2000. The slope at the middle and end of ice jam body is near or less than the slope of river channel. It is coincident for the ice jam water surface profile slope and river channel slope at initial time and 20years later after Haibowan reservoir running.

4.1.4 Reasonability of ice kam shape caculated

There is no case to refer to ice jam shape after reservoir operates 20 years yet. It was considered sufficiently in the calculation that deposition in reservoir affected on ice jam feature. Firstly, considering to the slope gentle at reservoir head backwater, the experiential coefficient was less than the beginning of reservoir running. Secondly, the ice jam head was assumed to move 8.1 km toward downstream. Lastly, the slope of total ice surface was adjusted gentle, the length of ice jam increased, and ice volume increased much more but the ice supply condition is also satisfied basically.

4.2 Analysis of result reasonability

(1) Reasonable control each step of calculation to make sure the probability of result appearance. Each parameter in calculation, including experiential coefficient, location and water level and rise range at cross section initial rise, segment synthetic roughness and ice volume, and so on, was selected with reference to actual cases in similar river reach and observed data of hydrological and meteorologic conditions at this reach to make sure the reasonability of result.

(2) Consideration of the maximum ice thickness of ice jam body. The maximum ice thickness of ice jam body is 4.65 m at initial time of reservoir set – up and 3.05 m after it filled up 20 years later. It shows that the slope of river channel goes gentle after fill up, the flow velocity is smaller than with the conditions of same discharge and cross section profile, and the capacity of frazil sinking decreases. So the ice thickness should decrease.

(3) Examination mean flow velocity of cross section with ice jam backwater. Reference to the result of ice jam calculation at Yanguoxia and Wanjiazhai reservoir area, the mean flow velocity at cross section with ice jam backwater should be 0.3 ~ 1.2 m/s, and the channel slope is positive correlation with mean flow velocity. The mean flow velocity is positive correlation with synthetic roughness of cross section, then the mean velocity and ice jam backwater profile can be derived by trial computation with adjustment of nc. The mean velocity at each cross section was expected about 0.6 m/s in the calculation of ice jam at Haibowan reservoir head that is thought reasonable.

(4) Examination the total ice volume in calculation of ice jam body. Based on the historical data during frazil period at Haibowan reach for 21 years of 1968 ~ 1988, the maximum frazil ice volume is 56 million m^3. Analysis shows that ice from upstream can supply the volume enough for ice jam at the beginning of reservoir operation with short length ice jam, but it is not enough 20 years later after reservoir running because channel slope goes gentle, ice jam lengthens and ice volume reaches to about 66 million m^3. It is considered that the border ice volume can reach to 10

million m^3 which can supply for ice jam. It is thought that the ice volume of calculation is close to design value and match with the ice jam feature.

5 Conclusions

This paper presents the ice jam backwater of calculation method with ice carrying capacity, reports the experiential coefficients β calibrated with the datameasured in the field, derives the correlation between coefficient and channel mean slope, cross section width, and synthetic roughness. some new experiences for forecast ice jam backwater profile at the river reach obstained.

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Study on Influence of the Sludge in Lijin Reservoir on Water Quality of Lijin Water Plant

Yan Hongbo

Water Company of Shengli Oilfield

Abstract: By analyzing the impact of water quality and sludge in Lijin Reservoir of Lijin Water Plant, an assessment has been made. The findings indicate that the reservoir owns the water of good quality, so there is no need to remove the sludge in it in a short period, resulting in the economization in operation, maintenance and dredging of the reservoir.

Key words: Lijin Reservoir, water source, sludge, study

General situation: Lijin Reservoir is located about 4 km northwest of Lijin County, Dongying City, and 150 m east of Gongjia Arterial Canal, extending 3.3 km from north to south and 2.2 km from east to west. It stands like quadrilatereral and covers an area of 7.8 km^2 (see Fig. 1). It is designed with a storage capacity of 2.0×10^7 m^3, water depth of 3.5 m. It was put into operation in January of 1992 to shoulder the task of water supply to the Lijin Water Plant. Because of no deslting basin for sediment deposition, the muddy water directly flows to the reservoir, making serious sedimentation on its northeastern corner. From the Summer of 2006, the turbid degree of the Lijin Water Plant is much higher than 1.0 NTU. The reason for that was investigated and it is believed that is the rich nutritious sludge at the bottom of the reservoir, and it is proposed to clear out the sludge. For looking for this reason, the study on the affect of the sludge of the reservoir on water quality has been carried out in the paper.

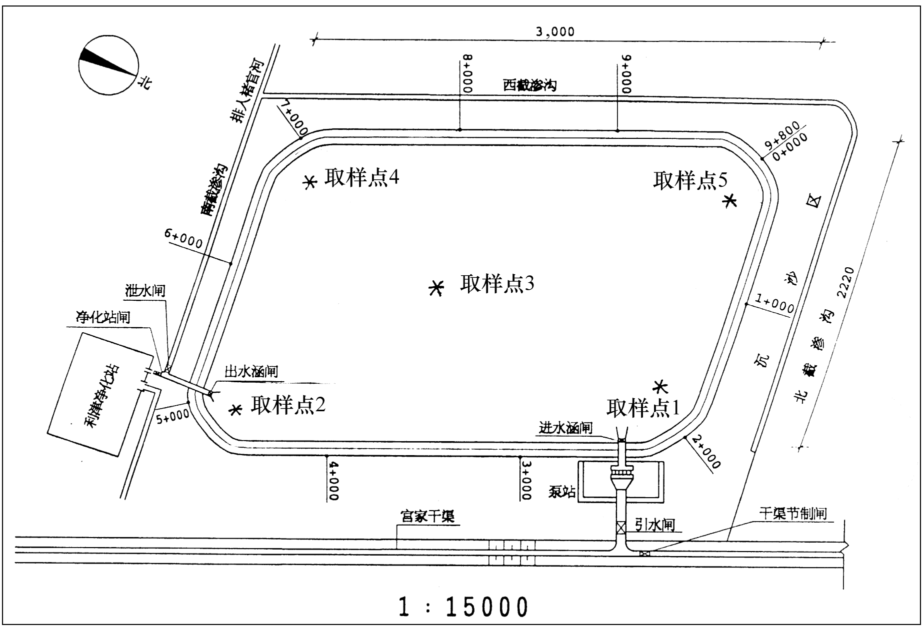

Fig. 1 Picture of each water sample product

1 Alternative study

In September of 2006, the samples of water and sludge were taken from 4 corners of the east, south, west and north and center of the Reservoir. For avoiding the affect of dykes and dams on sampling, the locations are arranged 50 m to 80 m away from dam (see Fig. 1). The number of sludge samples is five, and each water sample was got from three different levels, i. e. upper, middle and lower, respectively. The lower level of water sample is taken 0.5 m above the bottom of the reservoir, totaling 15 water samples. The testing results of TP, TN, NH_3N, algae, COD_{Mn} etc. for water samples and organic content of sludge are used for analyzing the sludge impact on water quality.

2 Test results analyses

2.1 Analysis of rich nutrition of Lijin Reservoir

The eutrophification of water body means the process of water quality worsening due to much content of N and P, the ability of water body production going up, and abnormal reproduction of phytoplankton. In general, the water with COD_{Mn} above 7.10 mg/L, TP above 0.11 mg/L, transparency above 0.73 m, is recognized as eutrophification that is a normal pollution phenomenon.

2.1.1 Analysis of testing results of TP, TN and COD_{Mn}

The average of TN of water samples is 1.67 mg/L, 39% more than 1.20 mg/L, and the averages of three levels for all positions account for 1.766 mg/L, 1.614 mg/L, and 1.624 mg/L respectively, the water body is generally assessed to be eutrophification, with an exception of TN at the southeast corner where it averages in 1.06 mg/L, less than 1.20 mg/L. COD_{Mn} of all locations are at low side, and average in 3.356 mg/L, 3.274 mg/L and 3.212 mg/L respectively, belonging to non – eutrophification, this is favorable for the water plant operation.

2.1.2 TP analysis

The average of TP is 0.054 mg/L, nearly 50% of the standard (0.11 mg/L), and the average of TP in the northeast corner amounts to 0.077 mg/L that is less than 0.11 mg/L, but the TP in lower level of the northeast is 0.12 mg/L, 0.09% more than the standard, that was because the raw water newly entered into the reservoir so that there was no time for it to develop into living organisms. The TP in southeast outlet accounts for 0.04 mg/L, less than 0.11 mg/L, and that of the rest water samples is lower than 0.11 mg/L. According to the overseas research data on reservoir ecology, the absorptive ratio of N and P by phytoplankton is 7.2∶1. This may differ by a big margin if limitation exists. The critical ratio of N and P is 10∶1. Forsberg decided these action by comparison of N and P between substratum and N and P of tiny forms of plant and animals living in lakes. The testing results show that the value between TN and TP is 17 ~ 59, more than 12, from which a conclusion can be drawn that P containing in the reservoir water acts as a limited factor to restrict phytoplankton and algae.

2.1.3 Algae analysis

According to the testing results made for algae: the number of algae growing in the center of the reservoir measures 8,255,700, 10,416,100 and 6,635,500 per liter in a order of lower layer to the upper, with an average of 8,435,767/L, that reveals that the number of algae is not high.

3 Analysis of sludge impact on water quality

Water samples' analyses indicate that there are 4 places where TP content is higher than that of middle and upper layers, accounting for the reservoir water at both upper and middle layers being better than that of the lower layer. The average of COD of northeast, southeast, center, southwest and northwest of the reservoir measures 3.4 mg/L, 3.22 mg/L, 3.12 mg/L, 3.35 mg/L and 3.32 mg/L respectively, only showing a tiny difference among 5 points. The part of reservoir in northeast is silted up seriously, its COD is more than the others. The COD of part of southeast and southwest of the reservoir was being less than the others, but the difference of COD of part of southeast and southwest of the reservoir is less than that of northeast. That means sedimentation exerts little effect on water quality. In accordance with the testing results from drying of sludge samples, the organic matter in the sludge averages in 9.56%, while those at the reservoir outlet is 8.18%, indicating that in the sludge is lower.

4 Conclusions

The aforesaid analyses show that the water quality at southeast of the Lijin Reservoir is better than the rest, that is to say, the raw water provided to the water plant is not at the state of eutrophification, but that in northeast, northwest, southeast and center is of eutrophification. There is almost no differences of COD at all 5 locations, no matter what thickness of the sludge is, displaying that the sludge will exert minor impact on the water quality, so the sedimentation on the Lijin Reservoir may not be cleaned out in a short time.

The dredging for the reservoir, on the basis of the testing and analytical results, has not been performed. As for the turbid degree of the Lijin Water Plant being more higher, the parameters for technique of the water plant has been regulated and controlled. By now, the turbid degree of the Lijin Water Plant has been controlled bellow 1.0NTU so that the aim of providing excellent water to the people has been reached.

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Study on the Yellow River Micropolluted Water Treatment for Shengli Oilfield

Liu Xin

Shengli Oilfield Water Supply Company, Dongying, 257099, China

Abstract: As the condition of the Yellow River water became more and more polluted, exceptional difficulties were brought about to the Shengli Oilfield in the lower reaches of the Yellow River. The paper expatiated on the successful experiences of the Shengli Oilfield in treating water by adopting some measures Such as pre – oxidation, dissolved air flotation, enhanced coagulation and two – stage filtration to illustrate their feasibility.
Key words: pre – oxidation, flotation, enhanced coagulation, two – stage filtration

1 Introduction

Shengli Oilfield, located in Dongying City in the lower reaches of the Yellow River, mostly relies on the water supply from the Yellow River for industrial production and daily life. From 1970 to 1999, Shengli Oilfield constructed 11 large and medium – sized reservoirs and 110 small reservoirs, with the total reservoir capacity of 450 million m^3, diverting the Yellow River water. Because the salinity of shallow groundwater of the oilfield area is high, unsuitable for drinking and irrigation, and the deep groundwater contains fluorin and iodine that exceeds the limi, the Yellow River water becomes an only water source for Shengli Oilfield. However, according to the regular monitoring conducted by the environmental supervision department, the water quality of the Yellow River in recent years has made significant changes. The main changes express in some water quality indexes exceeding the limit of Class Ⅳ water standard specified in "Surface Water Environmental Quality Standard", and the main factors include COD, potassium permanganate exponent, ammonia nitrogen and volatile phenol. The main causes of pollution are the point pollution by the urban industrial wastewater and domestic sewage and the surface pollution by agricultural waste water in the upper and middle reaches. The pollutants pumped into the Yellow River have exceeded the capacity of the water environment. According to the detection made by an authoritative department, the total amount of sewage pumped to the Yellow River sharply increased from the average of 20 million t at 1980s of the last century to the average of 40 million t at present, the emissions of chemical oxygen demand is nearly 140 million t every year and nearly 140,000 t of ammonia nitrogen, gonging beyond more than one – third and 2.5 times of the bearing capacity of the water environment of the Yellow River, the phenomenon of sub – standard quality is widespread. The organic contamination of drinking water in some areas is becoming more serious, the safety of drinking water problem has appeared.

2 Reservoir water quality survey

As the Yellow River water contains much sediment and is polluted seriously, the large, middle and small reservoirs that constructed by the Shengli Oilfield have played a major role. After the water drawn from the Yellow River has sand deposited and self – purification in the reservoirs, the water quality has improved significantly. But there still exist COD, nitrogen and algae, and $KMnO_4^-$ index exceeds criterion.

Table 1 The water companies of excessive inventory of raw water reservoir

Serial number	Water source name	Appraisal number	Exceeds figure	Indexes exceeding criteria
1	Gengjing	30	1	TN (3.99 mg/L)
2	Xin'an	30	2	COD_{Cr}(26.1 mg/L), TN(1.95 mg/L)
3	Guangnan sand exportation	30	5	Fe (0.49 mg/L), COD_{Mn} (7.21 mg/L), chloride (671 mg/L), COD_{Cr} (30.3 mg/L), Six prices chromium(0.067 mg/L)
4	Guangbeisand exportation	30	2	TN(5.41 mg/L), Fe(0.31 mg/L)
5	Minfeng2#	30	2	TN (2.61 mg/L), Fe(0.36 mg/L)
6	Minfeng4#	30	1	N (1.27 mg/L)
7	Chunhua	30	1	TN (2.44 mg/L)
8	Lijin reservoir	30	1	TN(1.14 mg/L)
9	Guhe reservoir	21	3	Chloride (328 mg/L), TN (1.19mg/L), pH (9.28)
10	5# Reservoir	21	2	Chloride(428 mg/L), TN (1.07 mg/L)
11	Gudong Reservoir	21	1	TN (1.56 mg/L)
12	Gudao1#	21	2	COD_{Cr}(22.3 mg/L), TN(1.75 mg/L)
13	Gudao 2#	21	2	TN (1.32 mg/L), COD_{Cr}(24.5 mg/L)

Note: Project standard value: TN (1.0mg/L), COD_{Mn} (6 mg/L), COD_{Cr} (20 mg/L), Fluoride (1.0 mg/L), chloride (250 mg/L), Mn(0.1 mg/L), Fe(0.3 mg/L), TP(0.05 mg/L), Sulfide(0.2 mg/L), Volatility phenol (0.005 mg/L), Six prices chromium(0.05 mg/L).

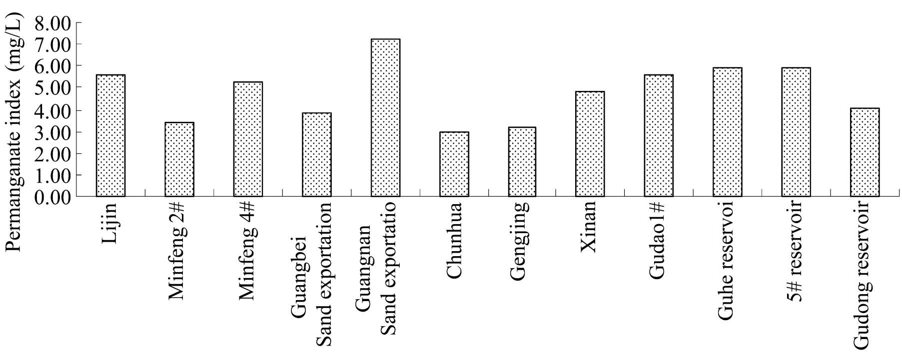

Fig. 1 Permanganate index of water supply company in July

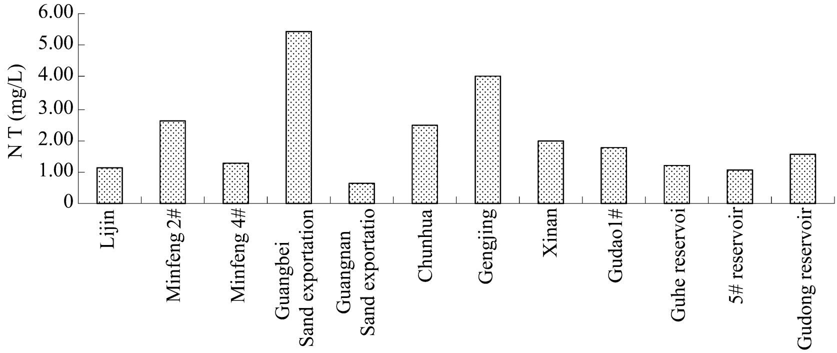

Fig. 2　TN of water supply company in July

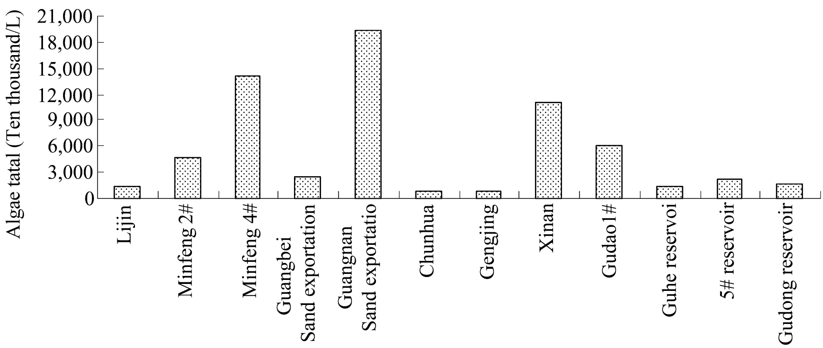

Fig. 3　Total algae of water supply company in July

3　Improvement of water treating procecure

In order to offer the safe drinking water that meets the "Urban Water Supply Quality Standard", in addition to a conventional process, we adopt some new steps as pre – oxidation treatment, dissolved air flotation, enhanced coagulation, two – stage filtration. Now I will expatiate the methods to deal with the micro – polluted water by the Binnan Water Treatment Plant and No. 1 Xin'an Water Treatment Plant affiliated to the Shengli Oilfield Water Company.

The Binnan Water Treatment Plant owns a reservoir that pertain to a shallow surface water reservoir, with an average water depth of 3. 5 m, and storage capacity of 20 million m^3, and a purification station with the water treatment capacity of 50,000 m^3 per day. This plant still uses the first generation of water purification process (coagulation – sedimentation – filtration – disinfection) as shown in the following.

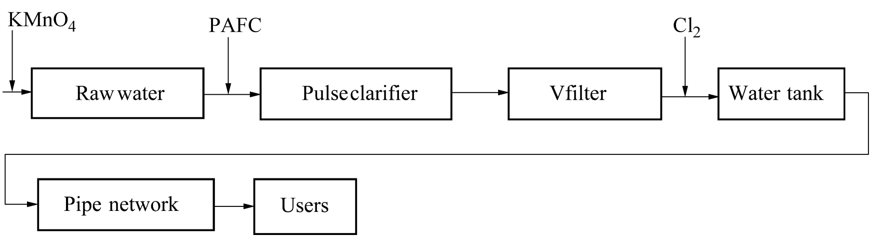

Fig. 4　The of water treatment procedure

As the technology drops behind, the Binnan Water Treatment Plant mainly takes two steps, i. e. pre – oxidation and enhanced coagulation, to deal with the original water.

3.1 Pre – oxidation

The long period of reservoir water cycle and shallow water level cause eutrophication of water bodies and fast growth of the float grass, as a result, the content of algae reaches 19.79 million per liter and the total nitrogen is sub – standard. It is typical micro – polluted water because of the index of raw water, thus, the conventional treatment process is very difficult to handle. We tried two alternatives of potassium permanganate pre – oxidation and pre – chlorination. After commissioning, the best dosage of potassium permanganate and chlorine are 1.5 mg/L and 1.0 mg/L. Coagulant used PAFC produced in Zibo Coagulant Plant, adopting dosage of 34 mg/L. The results are shown as follows:

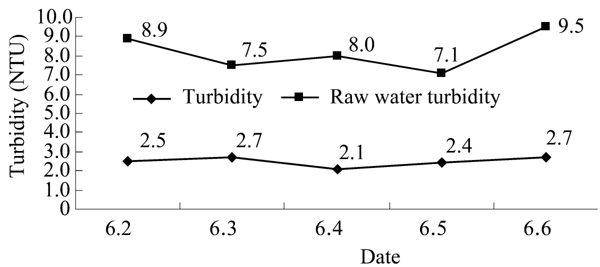

Fig. 5 PAFC

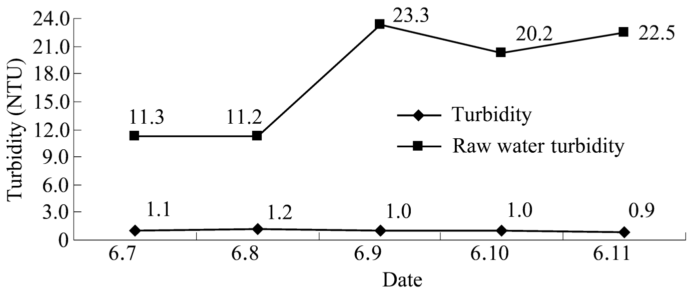

Fig. 6 Cl_2 + PAFC

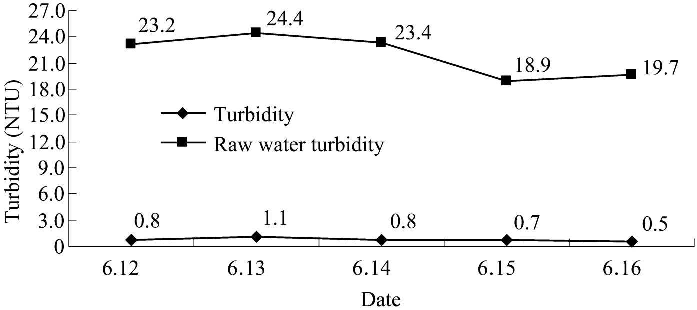

Fig. 7 $KMnO_4$ + PAFC

The results above reveal that adding PAFC and $KMnO_4$ is the best method. Since then we mainly debug these two pharmaceutical dosages to control the water turbidity below 1.0 NTU.

3.2 Enhanced coagulation

As the raw water was eutrophicating and the organic pollution became more serious, moreover, the processing facilities were outdated, limited to conventional treatment, and the temperature continued to rise in August, in order to ensure the quality of water, the Binnan Water Treatment Plant has adopted the enhanced coagulation method to deal with water since August 2006. Limited by technology, the only way to use is to continuously increase the dosage, which can make the suspending sludge bigger and achieved good results. Nevertheless, it can not keep the water with turbidity below1.0 NTU, so the Water Supply Company has planned to make over the plant in 2007.

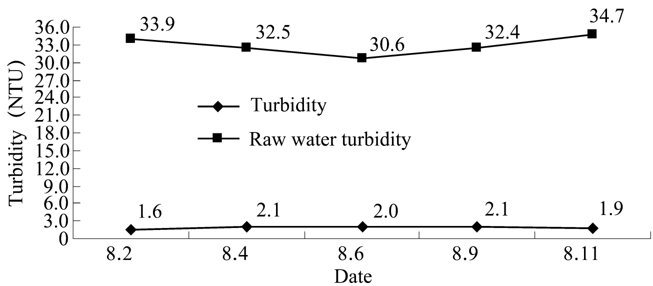

Fig. 8 PAFC (40 mg/L)

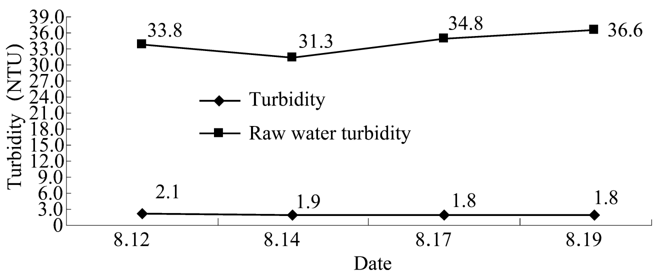

Fig. 9 PAFC (55 mg/L)

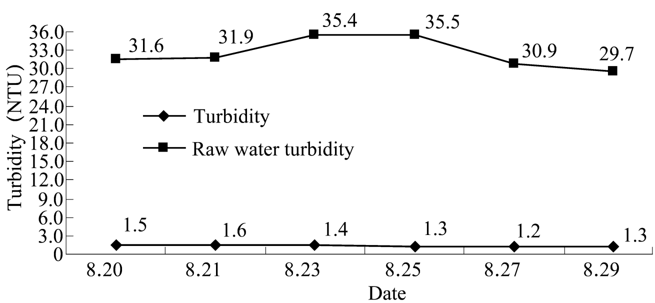

Fig. 10 PAFC (65 mg/L)

The Xinan Reservoir, belonging to Shengli Oilfield Company, is a semi-underground stripshaped plain reservoir, the average water depth is 4.0 m, the design capacity is 20 million m^3, the characteristics of the raw water is low turbidity, high algae, and the turbidity is less than 20 NTU. The algae content is higher than the standard, in order to deal with such kind of water, the Water Company positively explored new technique, new technology and its application to improve the conventional treatment process of No. 1 Branch of the Xin'an Water Treatment Plant with water treatment capacity of 50,000 m^3 per day. In August 2006, they changed pulse clarifier and siphon filter into air – floating filter with movable backwashing cover and flap filter, the transformation was successful, and solved the problem of water treatment fundamentally, and saved a large amount of coagulant.

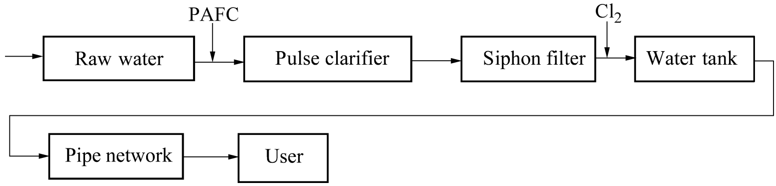

Fig. 11 The process flow before transformation

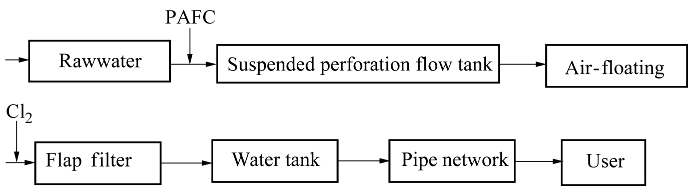

Fig. 12 The process flow after transformation

3.3 Getting rid of algae with air – floating

The higher content of algae requires choosing a more effective process of air floating, that is designed with the following material parameters:

Reactor tank: We adopted suspended perforation flow tank and reinforced concrete structures, the single group of flow tanks measures 11.35 m × 6.25 m in plan, and each tank is divided into 10 cases, connected by the orifices between them, water flows gradually between cases, in order to form a swirl flow, the intake hole and outlet hole in each case are laid out in a staggered way to let water whirl. The design flow of cases drops from 1.0 m/s to 0.1 m/s. Total head loss of the tank is about 0.3 m.

In order to automatically release sludge outside, the bottom of reactor tank is equipped with sludge perforated tubes. There are two DN100 manual butterfly valves and two DN100 pneumatic butterfly valves in the single tank. Two sludge pumping stations are set on each side of the reactor tank.

Flotation: The size of the area of contact dissolved gas is 10.90 m × 1.25 m, the release of dissolved gas is TV – release of dissolved gas, a single group (27,500 m^3 pre day) set up 44 release of dissolved gas, a total of 88 of two groups; the air compressor is Z – 0.2/7 – air compressor, the amount of ventilation is 0.20 m^3/min, and the maximum pressure is 0.7 MPa; the dissolved gas tank is fill – pressure spray bottles dissolved gas tank, and the material select stainless steel, the air vessel is TR – 10 – air vessel which diameter is 1,000 mm, the work pressure is 0.2 MPa, the water flow is 2,262 ~ 3,533 m^3/d. The reflux ratio is controlled in 5% ~ 10%, the reflux pump is Omega 80 – 370A – pump, diameter impeller is 340 mm, the lift is 37 m and the flow is 10^7 m^3/h. The raise velocity of the contact chamber is about 23.4 mm (the generally accepted is 10 ~ 20 mm). Due to the limitation of the original pool size, the raise velocity is excessive; the staying time in contact tank is about 120 s. In order to automatically pump sludge to

outside, there set sludge perforated tubes at the bottom of reactor tank.
effect comparison between the flotation and algaecide:

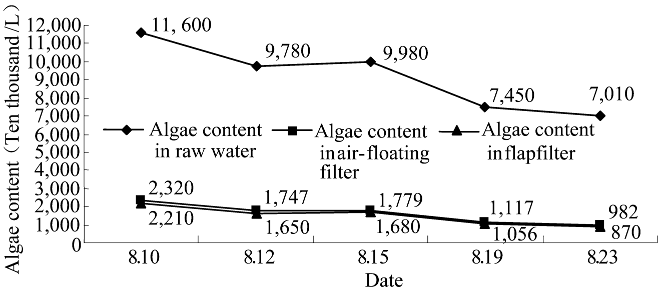

Fig. 13 Effect contrast of gas floats for eliminating the algae

3.4 Two – stage filtration

3.4.1 Movable hood backwashing filter

The size of single movable hood backwashing filter is 10.4 × 15.05 m, being divided into 60 cases, a total of 120 of two groups, the size of single case is 1.60 × 1.35 mm.

The single – water backwashing is adopted, with the design strength of backwashing of 15 L/(s · m^2), the flow of backwashing pump of 116.6 m^3/h, the lifting range of 4.4 ~ 5.2 m, and the backwashing time of 4 ~ 8 h, those shall be adjusted according to the actual situation.

The thickness of supporting layer is 100 mm, and the filtering media layer is 700 mm.

3.4.2 Flap filter Section

Filter area of single flap filter: $F_{single} = 4.75 \times 5.80 \times 2 = 55.1\ (m^2)$

Total filter area: $F_{total} = 55.10 \times 6 = 330.6\ (m^2)$

Normal filtration rate: $V_{normal} = 6.93$ (m/h)

Water washing intensity: $q_{water} = 13 \sim 15$ L/(s · m^2)

Gas washing intensity: $q_{gas} = 15$ L/(s · m^2)

Supporting layer and filtering media layer: the upper layer is ceramist, its diameter is 1.6 ~ 25 mm, and 0.7 m thick; the lower layer is quartz sand, its diameter is 0.9 ~ 1.35 mm, K80 is 1.4, and 0.8 m thick; the diameter of gravel in the supporting layer is 2 ~ 12 mm, laid out in three layers of different grain sizes, with a total thickness of 400 mm.

After the transformation of the No. 1 Branch of Xin'an Water Plant, because of using movable hood backwashing filter and flap filter, the water quality produced by the plant can be well ensured, and the detailed effect comparisons are shown as follows (Adding aluminum chloride polymerization for 65 coagulant mg/L).

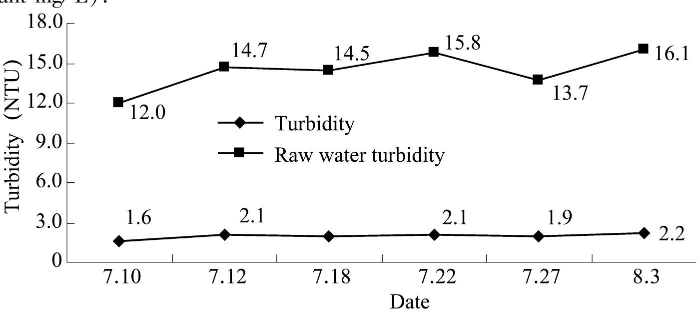

Fig. 14 Pulse clarifier + siphon filter

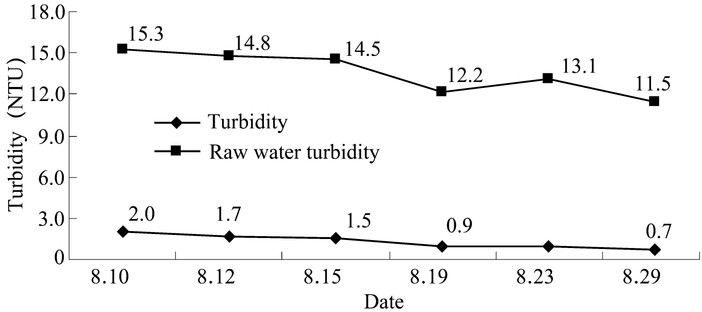

Fig. 15 Air – floating filter + flap filter

The results showed that to change the pulse clarifier and siphon filter into air – floating filter with movable backwashing cover and flap filter displayed a distinct advantage to algaecide, basically eliminated the impact of algae on the water, so two – stage filtration made the water produced by the plant to be kept below 1.0 NTU.

4 Conclusions

Based on the aboven tables and figures, it can be seen that the effective measures to treat micro – polluted water refers to pre – oxidation, first, followed by flotation algaecide, enhanced coagulation, sedimentation stratosphere, finally, implementation of multi – stage filter (activated carbon filter, bio – ceramic filter, sand filters and other combinations). Now, the movable hood backwashing process of Shengli Oilfield Water Company will be used in transformation of the Guhe Water Treatment Plant and Binnan Water Treatment Plant.

Since the Ministry of Construction promulgated "Urban Water Quality Standard" on June 1, 2005, the Shengli Oilfield Water Company vigorously began to implement the standard to increase the quality of research topics. In addition to conventional treatment, the pre – treatment processing and extensive processing have been added, and innovative management carried out for various facilities for coagulation, sedimentation and filtration to ensure the safety of drinking water. With regard to the turbidity, chlorides, Ammonia and other targets specified in the State Water Quality Standards that will soon be issued, we have already achieved good results.

Study on the Yellow River Wetland Ecosystem Restoration in Henan Province

Wang Tuanrong

Henan Academy of Forestry, Zhengzhou, 450008, China

Abstract: According to the characterisuics of the Yellow River wetland and the ecological system in Henan Province, it is put forward that the targets about the wetland ecosystem in the Yellow River in Henan is to construct a healthy ecosystem and provide sustainable resources for people. The ecological restoration measures are to protect water supplies and primary phytocoenosiums, in the same time, they also help artificial breeding of primary phytocoenosiums, introduce and develop salt – tolerant economical plants, and the measures of the ecosystem restoration are to establish wetland protection measures and management mechanisms, launch positively wetland research, and set up a number of wetland reserve areas and wetland park.

Key words: the Yellow River, wetland, ecosystem, restoration Hennan

"The Convention on Wetlands" defines that wetland is natural or artificial, permanent or temporary marsh, peat lands or water zone, with stationary or mobile, fresh, brackish water, or salt water, including the ebb over 6m deep waters. Marshes, peat, salt marsh, wet meadow, lakes, rivers, the stagnation storage area, the estuary delta, reservoirs, ponds and paddy fields and the ebb over 6m deep sea areas all belong to the wetland areas. Wetlands, land and the sea are called the three large ecosystem that has a close relationship with the survival, proliferation and development of mankind. It has the most natural biodiversity landscape and ecological environment and also one of the most important environment of the humanity's survival.

1 General situation of the Henan wetland

The Yellow River wetlands located in the northern part of the Henan Province, extending from the west of the Yangjia village, Lingbao City, to the east of Zhangzhuang village, Puyang city, involving 25 counties (districts) such as Sanmenxia City, Luoyang City, Jiyuan City, Jiaozuo City, Zhengzhou City, Kaifeng City and Puyang City. At present, there are "the Yellow River Wetlands National Nature Reserve". "Zhengzhou Yellow River Wetland Nature Reserve" and "Kaifeng Liuyuankou Wetland Nature Reserve".

1.1 Plant resources

The Yellow River wetlands in Henan Province located in the juncture of the northern subtropical and temperate, with rich flora and fauna complex, according to the survey, the Yellow River wetlands have vascular plants of Species 598, Section 284, Branch 80, of which 38 species are woody plants, 560 herb species. There are 18 Section, 41 Species aquatic plants of 62 Section 557 Species terrestrial plants, the dominant subjects are Gramineae, Compositae, Legume, sedge, Chenopodiaceae and Rosaceae. Particularly, there are many rare plant species in the Yellow River wetlands, Henan Province, such as Swainsonia salsula. Poliploid hay, Round fruit hay, Mustard salt etc. Phytoplankton is mainly algae, there are at least 124 Species, 71Sections, 37 Brands, 8 Phyla in this area, diatoms and Chloros constitute the majority of these plants.

1.2 Animal resources

There are 175 species of birds, Subject 16, Section 42, of which, 26 duck Section which accounts for 14.9%, 16 species of accipitridae, accounting for 9.1%, 11 species of herons, 6.3%, Snipes 10 species, accounting for 5.7%, gull Section 8, accounting for 4.6%, 8 species of crow, 4.6%, other branches of 96 accounting for 54.8 percent, mainly include bird Branch, Crane Division, dove, Woodpecker and Crake Branch River kingfishers, storks Branch, cuckoo family, and Yan Branch, Bailaoke, cousins Branch, tits out, madam etc. Animals are relatively lack of resources, only 22 species, Subject 5, Section 8, Rodents which more, accounting for 13 species, belonging to 2 Subject 4 Section. Amphibians and reptiles are 10 species, 2 subjects, 5 sections. 437 species of insects, Subject 13, Section 108 mainly concentrate in the Lepidoptera, Coleoptera, Homoptera, Odonata. Subject 5 insects account for 75.3%. Black stork, white stork, the birds, white shoulders birds, the great bustard, hooded cranes, herons, red – crowned crane, the Pallas's Sea Eagle, White – tailed Sea Eagle are the first state preserved animals, while there are 31 species of birds (such as swan and Nayang) that enjoy the second grade of protection, also including animals, mammals otters, giant salamander and other amphibians. Fish are valuable copper fish, the Yellow River carp and some of high economic value of migratory fish such as eel.

1.3 Wetland types

The wetlands of the Yellow River in Henan are composed of artificial wetlands, river wetlands, lakes wetlands and marshes wetlands. The wetland above the Xiaolangdi Reservoir is mainly artificial wetland, below it is river wetland. The Xiaolangdi Reservoir, at its early operation stage, will store water as its main objective, therefore, wet area increases dramatically, then after it is up to the required level, it will be operated in the mode of storing clear water while discharging the muddy that will make the wetland area relatively stable. Wetlands area increases in winter and spring, and decreases in summer and autumn. The flood season and the mode of operation of the reservoir affect river wetlands below the dam, increasing wetland area in flood season, reducing the area in winter and spring.

2 Wetland characteristics

2.1 Ecosystem diversity

The Yellow River wetland not only has the characteristics of river wetlands, but also with the features of ponds and marsh wetlands. It includes the river ecosystem, river lowland ecosystem, flood ecosystem, marsh ecosystem, forestland ecosystem, farmland ecosystem, the corridor ecosystem, and so on, so the Yellow River wetland has the features of ecological system diversity.

2.2 Species diversity

According to the survey, there are 743 species of plants, including lower plants algae 124 species 8 phyla; 619 species 302 sections 93 brands of higher plants (including four varieties), 867 species of animals, including 175 species of birds, 22 species of mammals, 437 species of insects and 63 species of fish, 143 other animal species. So, the wetland is characterized of biological diversity.

2.3 The importance of location

The Yellow River wetlands are in the transition zone between the middle reaches and the lower reaches of the Yellow River, and also in the transition zone between the eastern plains and western hilly Henan and the Loess Plateau. Wetlands have both canyon landscape and vast shoals. The large numbers of migratory birds have a stopover in Henan, or stay in winter, the location is very important.

2.4 The vulnerability of the ecological environment

The Yellow River wetlands located in China's inland, with large population in the surrounding area and the large environment pressure. Currently, near the southern and northern shores of rivers and tributaries there are many mining industries established that cause the river pollution, in addition to the quality of water in the main stream of protected areas and non – cadmium ion of ammonia, the rest indicators are of III standards, even more than the standard V – minus in some of the tributaries. Due to drought in recent years and unplanned use of water, the lower Yellow River have been drying up. If we do not strengthen the protection of protected areas, the ecological environment of wetlands would be seriously damaged.

3 The objectives, principles and measures of the ecological restoration

3.1 The objectives of the ecological restoration

The goal of ecological restoration is to repair and construct a healthy ecosystem, provide mankind with the sustainable use of resources. These mainly include:

(1) To realize surface stability of the ecosystem.

(2) To restore vegetation and soil and guarantee the vegetation cover and soil fertility.

(3) To increase the species composition and bio – diversity.

(4) To realize the restoration of biological communities, and improve the productivity and sustainability of the ecosystem.

3.2 The principles of the ecological restoration

The principles of the ecological restoration can be summed up in three aspects as natural, aesthetic and socio – economic technology, with the stresses on abidance by natural law and human action, and requiring appropriate technology, economical feasibility and social accept.

3.3 The measures of the ecological restoration

3.3.1 Appropriate water supplies

The Yellow River wetlands subject to semi – arid, semi – humid monsoon climate, natural precipitation is not high, also uneven distribution of rainfall, recurrence rate of over 60% of annual precipitation; Drought, windy and large quantity of soil evaporation in spring and autumn. The Yellow River is the main source of fresh water. To ensure the healthy and good ecological functions of wetlands, it is necessary to supplement water in the dry season. The key measures are to increase vegetation coverage and reduce soil evaporation, improve soil structure, increase moisture holding capacity of soil, store more water in rainy season and makeup water in dry season, and regulate water of the Yellow River as to ensure the river without dry – off.

3.3.2 Protection of primary phytocoenosiums

Many primary phytocoenosiums grow in the Yellow River wetlands, such as sedge wetland plants, eleusine indica community, reed bring water plants, lotus community, floating plant with pondweed and community, and submerged plant community types. With the feature of strong adaptability, it plays an important role to the health and ecological functions of the wetlands. However, as human activity intensifies, these primary phytocoenosiums are subject to damage to varying degrees, such as over – grazing, land reclamation etc. , leading to the rate of vegetation cover lowering. Therefore, we must take strict measures to protect primary phytocoenosiums.

3.3.3 Artificial breeding of primary phytocoenosiums

To protect primary phytocoenosiums in the same time, in order to enhance vegetation cover, we also need to update the original vegetation artificial breeding. Under natural conditions, plant breeding is slow and poor growth. By adopting updated artificial breeding measures, plant breeding coefficient can greatly enhance.

3.3.4 Introduction of economic development and use of salt – tolerant plants

In order to mobilize the enthusiasm of the masses to protect wetlands, to reduce the excessive reclamation of wetlands and under the premise of protection of primary phytocoenosium, salt – tolerant economy plants can grow in the land with better soil conditions. Species selection will have to consider the ecological benefits, and econmic benefits as well, so, fraxinus velutina, mulberry, willow structure, big fruit medlar, dates, pears, peach etc. , maybe the choose, as a result, the ecological environment can be improved and a certain economic benefits obtained. Great efforts are made to build a vegetation system and enlarge the vegetation cover.

4 Ecosystem restoration countermeasures

4.1 Establish sound policies and management mechanisms to protect wetlands

Wetland policy is the key to improve the wetland protection by establishing the policy of limiting the action of threat to the ecological system of wetland, to coordinate the relationship between wetland reserve and regional economic development. We should encourage formulation of the economic policies conducive to protect the wetlands from damage and sustainable use of wetland resources, and effectively combine water resources with wetland protection, and explore the development and utilization of wetlands compensation for the use of valuable ecological restoration and management. A leading group shall be set up for the Yellow River wetland in the Henan Province to unify and coordinate the inter – agency in wetland protection. Through inter – departmental joint operation, it is speeded up the decision – making to develop and promote a comprehensive consideration of wetland functions and values as well as the natural productivity and biodiversity.

4.2 To focus on protection and to establish a group of Wetland Nature Reserves

According to the Yellow River in Henan wetland conditions and the main problems, we must expeditiously implement the "Henan Wetland Protection Project Planning" prepared jointly by the eight ministries or commissions, and approved by the departments of the provincial government, strive to do preliminary work in the "11th Five – year Plan" period, to promote "Zhengzhou Yellow River Wetland Nature Reserve" and "Kaifeng Liuyuankou Wetland Nature Reserve" to the National Wetland Nature Reserve, and to establish Shangqiu Wetland of the Old Yellow River, and Yuanyang, Fengqiu, Changyuan and Wenxian of four provincial wetland nature reserves along the Yellow River. These wetlands have significant value and been seriously threatened, so should be protected as soon as possible.

4.3 Establish wetland park and explore a new mode for wetland protection and rational exploitation

In recent years, Jiangyan City, Jiangsu Province, based on biodiversity conservation and development of wetlands, has combined the protection of wetlands and development of tourism, it not only creates a virtuous cycle of the ecosystem, and also makes tourism become the wetland eco – tourism brand, creating a new mode of wetland resource protection and development, which attracts a great attention by the local and national governments. Learn from the experience of Jiangsu, Henan provincial forestry department has recently agreed and approved to establish the Xinyang Lianghekou Wetland Park. This is the first settlement of a wetland park in Henan. The Yellow River wetlands must study these successful experiences in the establishment of the Yellow River Wetland Park. Wetland protection well combines with the development, giving full play to the wetland ecological, economic and social benefits.

4.4 Speed up the repair and reconstruction of degraded wetland ecosystem

Firstly, based on surveys of wetland resources, the degraded wetlands are analyzed and evaluated to find out the reasons of degradation and to further make out ecosystem restoration plan for different types of degraded wetlands. Secondly, the combination of national and provincial key ecological projects, the policies for returning farmland to forest (lake, swamp, beach and grass) shall be actively implemented. Natural wetland area shall be restored as soon as possible to improve the status of the wetland environment and to restore the ecological system. Thirdly, focus on the key points, regional implementation of policy and steady progress. To ensure the ecological security of the Yellow River, which focuses on the Sanmenxia – Luoyang mesa of Loess Hills area, the Taihang Mountains and along the Yellow River, accelerate returning lands for farming to forestry and grass, closing hillsides to facilitate afforestation and herbage beaches for nourishing, and restore the wetland environments on both sides of the Yellow River. Wetlands reclamation is entirely forbidden on the depression and swampy area outside the Yellow River and on the old Yellow River wetland.

4.5 Actively carry out the wetland research

The delay of scientific research has seriously impacted scientific protection, utilization and development of the wetlands in the Yellow River in Henan Province. Therefore, we should actively organize research institutes, universities, scientists to jointly tackle the theoretic and technical problems, such as appearance and evolution law of the wetland, ecosystem structure and function of wetland, reconstruction and repair of technical studies, wetlands impact on human activities.

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Study on the Mode of the River Channel Shrinking in the Lower Yellow River *

Wang Weihong*, *Chang Wenhua* and *Zuo Weiguang

Yellow River Institute of Hydraulic Research, Yellow River Conservancy Commission, Zhengzhou, 450003, China

Abstract: The wandering reach of the Lower Yellow River has been continuously shrunk over the recent 20 years, which brings great threat to flood prevention. In order to find out the cause and the pattern of the watercourse shrinking, the movable bed physical model experiment was carried out. The result reveals that the development of watercourse shrinking changes with different water – sediment conditions. It can be classified into two categories, according to the position of deposition, of "concurrently silting of bank and channel" and "centralized channel deposition". Meanwhile, there is also a phenomenon called "deposition without shrinking". Because watercourse shrinking is a complicated development process, whether the watercourse shrinks or not should be judged by such essential factors as the area of the wetted cross – section and the mean elevation of the main channel's riverbed and so on, with the exception of the breadth depth ratio of the cross – section.

Key words: river channel shrinking, concurrently silting of bank and channel, centralized channel deposition, Lower Yellow River

Watercourse shrinking is a complicated course and has specific development mode. With studies on shrinking mode of watercourse in the Lower Yellow River it can not only provide practical demand on watercourse improvement, but also have important meaning in enriching the scientific content of riverbed evolvement. Through the method of physical model experiment it is regarded as experimentation object for wandering reach in the Lower Yellow River and initially studies shrinking mode of watercourse.

Experimental study indicates that common effect with watercourse shrinking is to reduce the capacity of wetted cross – section in the river trough and continuous increase of water level in the same flux, but in the definite boundary condition, the riverbed shrinking mode according to runoff – sediment condition is different. Besides, according to the analysis on observation data in the section of archetypal fix position, it is different for watercourse shrinking form of different river type and reach.

1 Shrinking mode with different runoff – sediment condition

It is modulating course of the Babao and Laitongzhai reaches in the experiment in 1994 flood season at same year topographical condition, shown as Fig. 1 ~ Fig. 3. It can be seen that they were all compound river channel initially, with relatively shallow channel and low riverbed. The main river channel became narrow obviously, especially in the later stage, the main channel width changed from 4,000 m to less than 1,000 m, in which there occurs peak flood equal to 4,100 m^3/s and sediment concentration equal to 32.2 kg/m^3. Meantime river bed rises tremendously such as river bed in the Babao section increasing 1 m. It absolutely accords to the character of watercourse shrinking in the former, which explains that river channel is in the process of shrinking in the runoff – sediment condition. Because the bankfull flood of 1994 made the two sections shrinking to a

* The first special subject, named as "Repairing object and studying countermeasure of reach form in the Lower Yellow River", in the 8th problem of the 11th Five – Year Plan of National Key Technologies R (D Program of China.

single channel. Then transverse swing becomes slowly and it never occurs compound channels or double channels in the experiment, but the altitude of river bed is still as high as usual. Breadth depth ratio was decreased in the initial time such as breadth depth ratio of the Laitongzhai turn 80 $m^{1/2}$/m to 20 $m^{1/2}$/m in the initial month of the flood season. Breadth depth ratio in the section is relatively steady whether flux decrease or increase. In a word it is named the mode of concurrently silting of bank and channel that it occurs for bank and channel deposit parallel", several channels becoming single channels, little river channel changing" and average altitude of river bed rising in the course of watercourse shrinking in the runoff – sediment condition that it contains bankfull flood and high sediment concentration, which character is bank and channel deposit up together, main river channel becoming narrow and shallow, river bed changing highly".

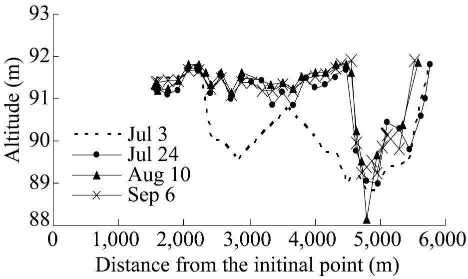

Fig. 1 Babao section addition

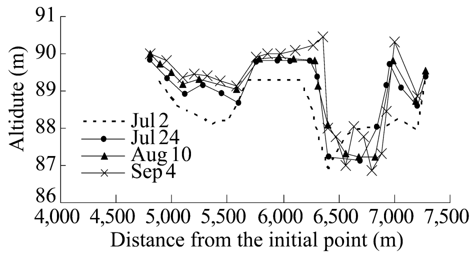

Fig. 2 Laitongzhai section addition

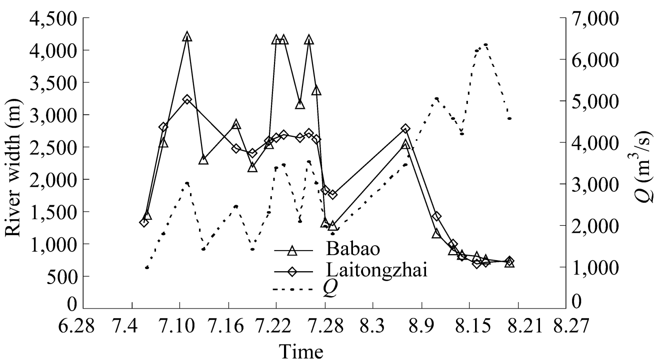

Fig. 3 Width change graph in the condition of 94's flood

It is the change course of river width, breadth depth ratio of the section, the area of wetted cross – section of the main river channel and average altitude of the river bed in flood season of 1988, shown as Fig. 4 ~ Fig. 7. It indicates that width and breadth depth ratio decrease in flood season, and become balanced after one and half months in the runoff – sediment condition in 1988. The area of wetted cross – section of main river channel varies between the maximum and minimum, but the variation of the area of wetted cross – section in the same flux is small in the flood season. The average altitude of river bed before the flood season is a little lower than after the flood season. Watercourse was deposed and the deposition is 4.4×10^7 m^3 in this time. So we can consider it as deposition but not shrinking. From the course of runoff – sediment condition of flood season in 1988 we can know that peak flow (the peak discharge is 6,719 m^3/s) and the time period in which the flux is higher than 4,000 m^3/s is 15 days despite sediment concentration is high in this year (the maximum is 169 kg/m^3), so river bank deposit is relatively more than river channel, from modulating course of the cross section, which forms the bed – making mode of depositing but not shrinking.

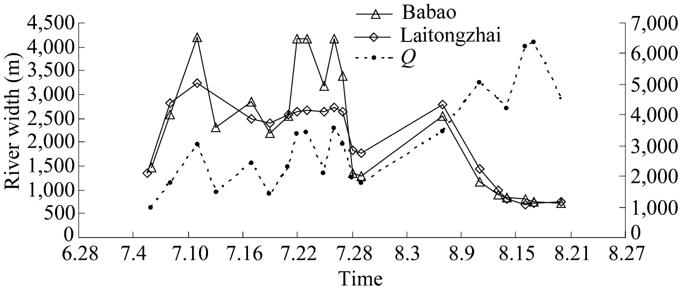

Fig. 4 Width change in flood season in 1988

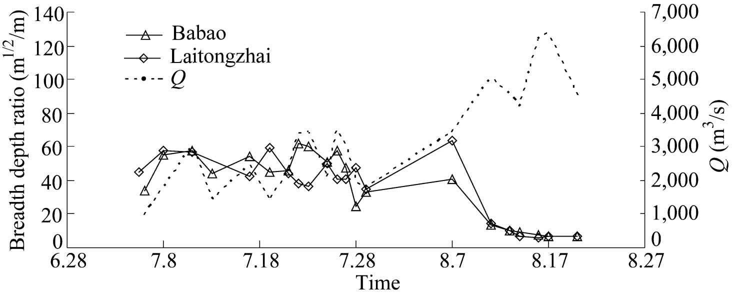

Fig. 5 Width depth ratio change in flood season

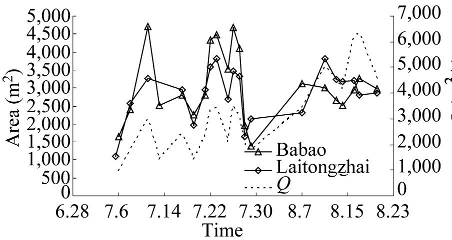

Fig. 6 The area of wetted cross – section changein flood season in1988

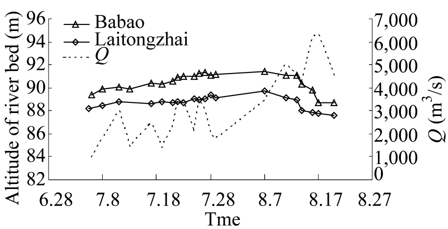

Fig. 7 Average altitude change of main channel in flood season in1988

Where, in Fig. 4 and Fig. 5 Babao is the Babao section, Laitongzhai is Laitongzhai section and Q is flux.

It occurs seriously shrinking in the watercourse in the runoff – sediment condition of 1991s because the landform is that after the flood season of 1988s. In the runoff – sediment condition of 1991s, river width is similar to 1988s, but breadth depth ratio in the Babao and Laitongzhai sections rises 1.5 times bigger than those of 1994s. At the same time the main area of wetted cross – section reduces in the large extent such as the area of wetted cross – section in the Babao section reducing 1,028 m^2, the area of wetted cross – section in the Laitongzhai section reducing 757 m^2, which is basic character of river shrinking. The reason is lack of large flux course in the flood season of 1991 when flood peak discharge was only 2,000 m^3/s but with relatively heavy sediment concentration, and incoming water – sediment coefficient is above 0.02 $kg \cdot s/m^6$. In a word, it was deposited in the main river channel, creating the shrinking mode of deposition centralized in the main channel, shorted form centralized channel deposition.

Where in Fig. 6 and Fig. 7, Babao is the Babao section, Laitongzhai is Laitongzhai section and Q is flux.

Moreover, from variation of breadth depth ratio in the different shrinking modes we can find that breadth depth ratio rises or reduces despite of being in the shrinking mode, which can prove that the breadth depth ratio is not the necessary factor for judging watercourse shrinking.

2 Modulating character of section in the shrinking course

Experiments indicate that modulating of cross section is relatively complicated. Modulating trend of cross section is subject to the shrinking mode of the watercourse. Cross section of watercourse becomes narrow and deep for the "bank and channel deposition" mode, which trend is obvious with rising of coming sand coefficient, that is to say, breadth depth ratio($\sqrt{B}/H$) of cross section reduces with it.

When coming sand coefficient is over 0.05 kg · s/m^6 the changing extent of $\sqrt{B}/H$ becomes slow, but for the "centralized channel deposition" mode, river width change little while river bed rises obviously, section becomes narrow and breadth depth ratio rises. accordiug to menting above we can find that the bigger coming sand coefficient is, the more river bed rises, and the more section area cut down. Accordingly breadth depth ratio of cross section rises with the increasing of coming sand coefficient (see Fig. 9).

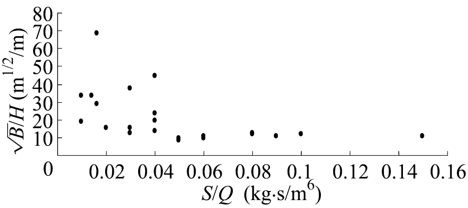

Fig. 8 Relation between incoming water – sediment coefficient and channel morphology coefficient in "flood plain and main channel deposition" mode

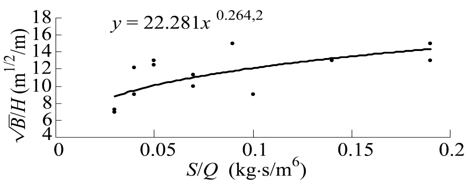

Fig. 9 Relation between coming sediment coefficient and channel morphology coefficient in "centralized channel deposition" model

From the actually measured data we can find that the area of wetted cross – section reduces with the increasing of coming sand coefficient (see Fig. 10). In Fig. 10 there are related images between section area and coming sand coefficient in the flood season in the Huayuankou and Aishan sections, from which the area of wetted cross – section trends to the reducing with the increasing of coming sand coefficient. Coming sand coefficient reflects the relation of Q and S. When coming sand coefficient is small, average flux is big, and sand carrying capacity is strong, but transported sand is relatively little, beneficial to the channel scouring and with larger area of wetted cross – section, and vice versa. As shown in Fig. 11, it is the relation between the coming sand coefficient in the flood season and area change before and after the flood season in the four stations of the Lower Yellow River, from which we can see that the relation is similar to the section area in the Huayuankou station, that is to say, variety of flux section area closely relates to the coming sand coefficient, with the increasing of coming sand coefficient the area variety is smaller than zero and watercourse begins to shrink. It ought to point out that it is different for crisis coming sand coefficient between washing and deposition.

Where, in Fig. 10, Huayuankou is the Huayuankou section and Aishan is the Aishan section In Fig. 11, Huayuankou is the Huayuankou section, Jiahetan is Jiahetan section, Gaochun is the Gaochun section and Sunkou is the Sunkou section.

Studying the experiment we can also find that watercourse shrinking is tracking to the runoff – sediment course, which is in the course of dissociation runoff – sediment condition the course of watercourse shrinking is correspondent to the time of runoff – sediment course in which watercourse

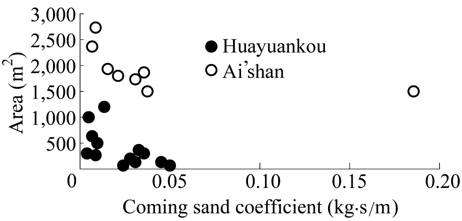

Fig. 10 Relation between coming sand coefficient and coefficient and the area of wetted cross – section

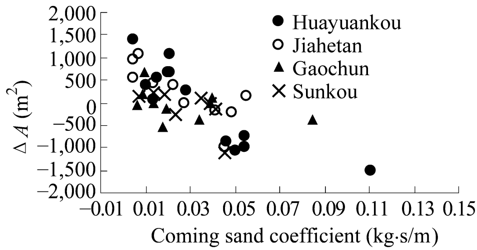

Fig. 11 Relation between coming sand variety in the section area

shrinking is relatively stable. Fig. 12 shows the changing course of the area of wetted cross – section in the condition of discharge equal to 1,000 m^3/s and 2,000 m^3/s in the runoff – sediment course of 1994s, from which the area of wetted cross – section lessens continuously with the flux course and becomes stable after one and half months, increasing stage of river bed is concentrated on the first month with increasing over 1m, subsequently, river bed is in the modulating course of tiny rising and reducing. In Fig. 13 it is changing course of average elevation of river bed in the main river channel in the runoff – sediment series of 1991s, from which river bed rises quickly and becomes stable in the initial time of the first flood. It indicates for the modulating course of ratio from breadth depth ratio in the main river channel of the runoff – sediment course in the 1994s and 1991s, from which river bed adjusts quickly in the first flood peak and becomes stale in the tiny range regardless of increasing or reducing.

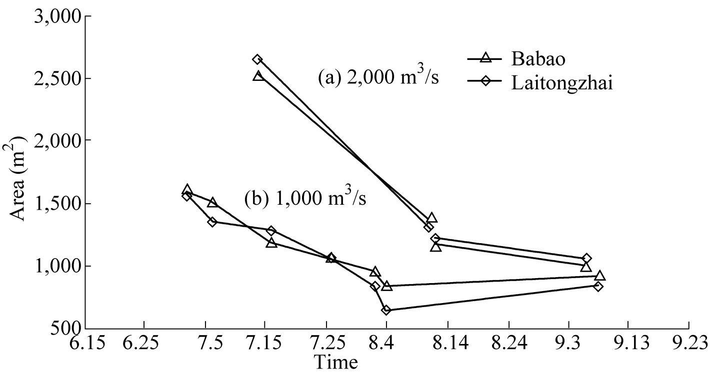

Fig. 12 Modulating course of section area in the 1994s runoff – sediment series

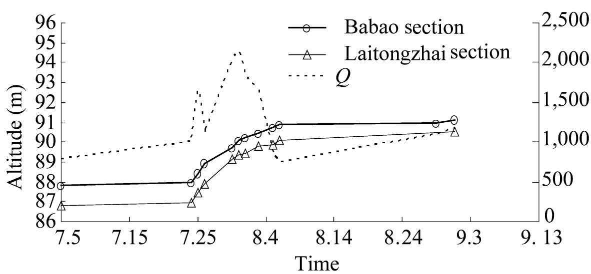

Fig. 13 Modulating course of average altitude in the main channel of 1991s flood

Obviously, under varying runoff and sediment conditions in the experiments, the river channel shrinking normally develops quickly, mainly occurring in the initial stage of flood season. That is to say, for a certain varying runoff and sediment course, watercourse shrinking does not need a lot of time to finish. Therefore, varying runoff and sediment course is leading for molding effect of watercourse shrinking.

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The Sustainable Management Research on Combating Water Pollution in the Yellow River Basin *

Xu Hui and ***Zhang Dawei***

Lanzhou University, Lanzhou, 730000, China

Abstract: The water pollution in Yellow River Basin tends to be serious. The water environment becomes worse and worse, which has impacted the local social economy development and the sustainable management of the whole basin. This paper, based on the theories of global changes, riverbasin sustainable management and intergrated ecosystem management, as well as the characters and facts of riverbasin, discussed the way of realizing the sustainable management of the Yellow River Basin and pointed out it's necessary to evaluate the validity of the present control system, it may be more effective to adjust the management mechanism under present system and the system design should consider its comprehensive nature and the long – term characteristic.

Key words: the upper – middle Yellow River Basin, water pollution prevention, sustainable management

The Yellow River, located between 96°E ~ 119°E and 32°N ~ 42°N, with a length of 1,900 km from East to North, and a width of 1,100, km from North to South, and the river basin area of 795,000 km^2 (42,000 km^2 area of inland water is included), is the second largest river in China, and the important water supply source in the Northwest and North of China. It provides water for itself and the irrigation areas within its lower river reaches, which holds 15% arable area, 12% population, and more than 50 large – medium sized cities. Meanwhile, long distance water transfer to outside regions is also being conducted. Therefore, the Yellow River plays an important role. However, due to its special condition, the irrigation and water conservancy infrastructure being weak, and lack of effective management, it has long been considered as one of the most difficult rivers to be dealt with in the world. Especially, after the entry of the 21st century, with the rapid growth of population and accelerated development of economy, new conditions and problems as follows have emerged in the Yellow River Basin which is originally vulnerable in ecological environment: ① pollution exceeds allowable limitation and problems of ecological environment caused by flow depletion and social development are more and more serious; ② the deterioration of water environment aggravates the contradiction between demand and supply for water resources and so on. The analysis based on the "Chinese Environment Report" published in the last 15 years shows that the Yellow River has always been in the forefront among the seven biggest rivers in China either in terms of the proportion of river length with IV class or even worse water quality in the evaluated river length, or in terms of order of composite pollution – discharge index. The inspection of the implementation of "Law on Combating Water Pollution", made by the Standing Committee of the National People's Congress, the People's Republic of China, from May 8, 2005 to the late May of 2005, showed that the most seriously polluted rivers in the seven water systems are the Hai River, the Liao River, the Yellow River and the Huai River, and this is the first time for the Yellow River to exceed the Huai River as far as the pollution is concerned.

The problem of water pollution in the Yellow River Basin is related to not only itself, but also the relationship between human being and river basin, and other diversified aspects including society, politics, economy, law, international relationship and people's ideas, especially, the characteristics possessed by the self – development of human being. Thus, as far as the combating

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water pollution in the Yellow River Basin is concerned, it is more important to apply scientific management than the engineering approaches. Based on global changes, theories of sustainable river basin management and ecosystem management, subject to the characters and facts of it, how to realize the sustainable development in the Yellow River Basin has been discussed in the study.

1 Water pollution in the Yellow River Basin

The industries along the Yellow River Basin have long been following the development patterns characterized by low input, high consumption and severe pollution. From the mid – term of 1980s to the beginning of 1990s, enterprises with severe pollution developed quite fast and caused the pollution source increasing. However, the water pollution control obviously lagged behind. What's more, the water quality is further deteriorated due to the aggravating conditions of agricultural pollution and domestic sewage pollution in recent years. The analysis on the relevant documents published between 1990 and 2004 shows that the amount of waste water of the river basin has increased from 3.26 billion m^3 to 4.4 billion m^3, with an increasing rate of 35%. The analysis, based on typical years, on the variation trend of water pollution in the Yellow River Basin in the last 20 years (Li X L, etc., 2004) indicates that the water quality of the Yellow River is in a tendency of obviously worsening, the wastewater discharge is increasing, the proportion of domestic sewage increases to nearly 30% in 2000 from 20% at the beginning of 1980s ; the discharge of major pollutant such as CODCr increases to 1.5 million t from 450,000 t at the beginning of 1980s, which has increased more than twice and far beyond the loading capacity of the Yellow River's water environment. It is shown in the relevant documents that the water quality of mainstream of the Yellow River has aggravated from being uniformly better than IV class in 1980s to over 60% river length being worse than IV class. Moreover, more than 30% river length is in V class or lower than V class since 2001 (Fig. 1).

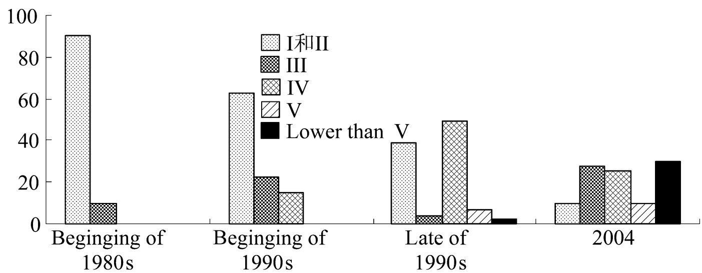

Fig. 1 The proportion of different water quality in the river length in the last 25 years (revised according to diagrams by Li X L, etc.)

It is shown (Wang D F, etc., 2003) that the main pollutants in the mainstream are ammonia nitrogen, cadmium, lead, etc. In Gansu reach of mainstream and Inner Mongolia reach, such pollutants as petroleum and heavy metal are even found to have exceeded allowable standard (Qian Y, etc., 2004). The main pollutants in the estuaries of the Yellow River are ammonia nitrogen, volatilizable phenol, permanganate index, Biochemical Oxygen Demanded in five days (BOD_5), dissolved oxygen, nitrite nitrogen and so on. Meanwhile, the underground water quality declines in some regions where the surface water seriously polluted is taken for irrigation, and the concentration of pollutants are in the tendency of increasing year after year due to the severe condition of surface water pollution.

The source of polluted wastewater in the Yellow River Basin mainly originates from six estuaries flowing through large – medium sized cities, namely, the Huangshui River, Dahei River, Fen River, Wei River, Luo River, Dawen River and mainstream, namely, from reach of Liujiaxia to reach of Huayuankou, which accounts for more than 80% in the total volume of waste water in the river basin. What's more, the polluted wastewater is concentrated at the reaches of large – medium sized cities in 10 and upper – middle reaches of the Yellow River, including Xining, Langzhou, Yinchuan, Hohhot, Taiyuan, Baoji, Xianyang, Xi'an and Luoyang, which accounts for 40% in the total volume of river basin. Therefore, the prevention and control of water pollution in the upper and middle reaches of the Yellow River should be the most important.

2 The sustainable management research on water pollution control in the Yellow River Basin

2.1 The sustainable management research on water pollution control in the Yellow River Basin

A lot of experiments and researches to manage the Yellow River have been done in the last half century. In recent years, the study on the water pollution mainly concentrates on the following aspects: ① characteristics of water pollution and its factor analysis, including the impact exerted by one reach on the other reach and so on; ② the measurement and analysis of water pollution; ③ controlling method and model construction of water pollution; ④ application of new technology and methods such as computer simulation technology, artificial neural system simulation, GIS, game theory, scenario analysis method; ⑤ management theory and countermeasures in the prevention and control of water pollution, such as conflict management in the river basin, integrated management in the river basin, sustainable management in the river basin, legislative management in the river basin, countermeasures and strategy research on combating water pollution in the river basin. Although the river basin management legislation in China began relatively late, rapid progresses have been made. In 1995, the State Council enacted the first regulation of combating water pollution in river basin, namely, "Interim Regulations Concerning the Prevention and Control of Water Pollution in the Huai River Basin". In 1997, the 8th meeting of the Standing Committee of the People's Congress of the Xinjiang Uygur Autonomous Region promulgateed the first local regulation concerning the management of water resource in river basinss in China, namely, "Regulation concerning the Water Resource Management in the Tarim River Basin". In 2002, the management system characterized by integration between the river basin management and regional management was established in the revised "Water Law of the People's Republic of China". Since the 21st century, China has begun to introduce the ideology of Integrated Ecosystem Management (IEM), tried to establish a sustainable integrated management framework, characterized by cross department, industry and region. Ecosystem approach has been gradually adopted in the biodiversity protection in China, the establishment of "Chinese Biological Diversity Protection Action Plan" being the proof. Moreover, the ideology of ecosystem approach was carried through in the "National Ecological Environment Protection Program" issued in 2000. Although the conception of "River Basin Ecosystem Management" is not formally put forward in laws, regulations, relevant policies and documents, China has conducted a great deal of researches and projects aiming at small watershed management. It should be pointed out that in recent years, managers and researchers have been striving to introduce and learn the ideology and methods concerning the river basin ecosystem management, summarize valuable experiences, and explore methods to realize expected objectives in practice. The representative projects include integrated river basin management conducted by the research team subordinated to the Chinese Council for International Cooperation on Environment and Development, 2002; environmental planning and management research team subordinated to Chinese National Programs for Science and Technology Development (863, 973), 2003; International Yellow River Forum in 2003 and 2005; EU – China Workshop on Integrated River Basin Management in 2005; the Sino – Dutch Water Resource Management Innovation Seminar in 2006. It should be pointed out that in recent years, some foreign scholars have shown a keen interest in research on the management of water resources in the Yellow River Basin. For example, the research on the control of erosion and sedimentation in the Yellow River Basin (Robinson, A. R. 1981) and the impact imposed by human activities on the management of water resources in the Yellow River Basin (Zdzislaw Kaczmarek, 1998). Especially, two sessions of International Yellow River Forum held in 2003 and 2005 have provided a huge platform for exchanges and communications of ideas and information. The above – mentioned achievements laid a foundation for theory basis and support for practices in the research on sustainable management combating water pollution in the Yellow River Basin.

Generally speaking, we have developed some basic views as follows:

(1) Lacking of unified management mechanism is one of the important reasons for water pollution in the Yellow River. So, a new management mechanism needs to be established;

(2) The factors including society, economy, natural conditions and social elements should be taken into consideration in the process of prevention and control of water pollution in the Yellow River Basin. Laws and regulations should be improved. Inter – regional and trans – departmental cooperation and coordination should be strengthened;

(3) The market adjustment on waste water bearing capability under the national resources administrative system should be applied in the process of combating water pollution;

(4) It is hard for the existing achievements to be persistent in managing of the Yellow River, due to lacking of scientific management mechanism, no effective legislative guarantee, no favorable regulating mechanism and incentive mechanism;

(5) The ecological protection should adhere to the goal of rationality of structure, good function, and integrality of ecological process; realize the transition from single element to multi – element management; change management from administrative region to river basin system; have unified management of life and non – life system; have scientific management based on ecological monitor and researches. Efforts should be made to integrate human activities into the coordinated management of ecosystem.

2.2 International management research of combating water pollution in river basins

All international management of combating water pollution in river basins have experienced the process of decentralized management, unified management, integrated management and sustainable management, in which, some typical cases and relatively perfect theories have been formed. For example, Congress of the United States passed the bill of exploiting water resources in the Tennessee River Basin and establishing Tennessee Valley Authority, the earliest unified management institution of river basin in the world, which generated good results. After the World War II, many countries formulated unified management scheme on water environment of river basins. The Thames River in the United Kingdom and the River Rhine in Europe are another typical examples in the control of water pollution. The unified management on river basin emphasizes the river basin as a unit to manage resources and environment, systematically considering such issues as environmental protection and management, sustainable utilization of resources, benefits distribution among stakeholders, public participation in the decision – making process of resource management, navigation, electricity generation, and tourism. In 1990s, with the presentation of sustainable management theory, the river basin management entered into a new phase of development. It was Gardiner (1993) who first put forward the integrated management on river basin with the goal of sustainable development of river basin. Brebbia C. A (2002) thought the main problems confronting the management activities on water resources were accelerating demand for water resources from human kind and threatening supply of water resources because of water pollution, waste of water resources and climatic change. "Sustainable Management" comprehensively takes measures of administration, law, education, economy, science and technology with the purpose of social, economic and environmental sustainable development. Compared with the unified management, the goal of sustainable management is more definite, the meaning is more abundant. With the development of river basin ecology and enrichment of practices, the river basin management focuses on the management on ecosystem. Generally speaking, it is the strategy involving the integrated management on the elements such as water, land, gas, biology and so on; it admits that humankind and its cultural diversity are the important components in the ecosystem; suitable management methods should be adopted to deal with the complexity and dynamic of ecosystem to solve the problem in insufficient realization of ecosystem functions. The concept of ecosystem management changes humankind from disordered utilization and passive adaptation to the nature, to implementing active ecological restoration and scientific management (Ma KM, Fu BJ, etc., 2004), generally accepted in the international social and resource environment field. It was at the 5th session of the conference of the contract parties with "Convention on Biological Diversity" that No. V/6 resolution was passed, and five guidelines and twelve principles on Ecosystem Management (EM) are proposed, which provides important direction for the further implementation of EM. The project of "Study on Hubbard Brook Ecosystem" was the earliest research aiming to develop a kind of detailed, comprehensive study on the structures and functions of ecosystem, which concentrated on how the specific small river basin works. In 1992, U.S. Forest Service announced that the agency would be moving to an "ecosystem approach" for the management of the national forests. It was the first government agency in the United States, and perhaps in the world, to officially adopt an ecosystem approach to natural resource management. The river basin ecosystem management, based on the ecosystem management and the whole conditions in river basin considered, rationally utilizes and protects various resources and environment, with the purpose of maximization of comprehensive benefits and sustainable development in river basin (Qiu L, etc., 2004). To summarize the researches, the river basin ecosystem management should include but not be limited to the contents as follows: ① pay attention to the features of river basin ecosystem; ② comprehensively consider environment and development of river basin to realize the sustainable development; ③ strengthen institutional capability building, including cooperation, coordination and communication; ④ adopt adaptive management; ⑤ the human value plays an important role in realizing the goal of river basin management; ⑥ take multidisciplinary approaches; ⑦ apply adjusting approaches including administration and market; ⑧ legal management; ⑨ information building; ⑩ enact long – medium term plans and evaluate the implementation of plans. Many scholars tend to show partiality on river basin ecosystem management (Mitchell, 1990; Boon, Dixon J A, Easter K W, 1991; Gardiner J L, 1993; Harper & Ferguson, 1995; Ewing B, 1997; Miguel A M, Chenoweth J L 2001; Laine A, 2002; Grayman W M, 2003; Hagebro C, 2004; Steven H W, 2005).

Although the idea of resource management from the macroscopical point of view in river basin was gradually accepted and familiarized by people as early as in 1950s, the goal of river basin integrated management still remains unachieved. The researches attach importance to technical measures. As far as cross – disciplinary, especially natural and social science is concerned, the international researches are relatively more than that in China. However, as far as management mechanism is concerned, the research lacks considering factors as follows: features of water environment in different regions and economic structure; application of integrated measures; the features of different regions and situation of boundaries; with different regional features and boundary conditions; systematic characteristics of river basin and global changes. Meanwhile, because of "non – structurization" or "semi – structurization" system, the water resource system of river basin is not only involved with natural ecosystem relating to water, but also keeps close relationship with economy, society, humanity and regulations. Therefore, it is necessary to adopt a kind of dynamic management mechanism in combating water pollution in the river basin, do further researches on lots of relevant regularities and find out innovative mechanism and measures.

Similarly, combating water pollution in the Yellow River Basin should be implemented through the integration of many measures. In order to realize sustainable management on combating water pollution in the Yellow River Basin, it is necessary to attach importance to the background of global changes; the environmental change in the river basin, climatic change, ecological coupling and prediction for future short – scale trend; the integration between natural and social science; integrated mechanism taking diversified benefits and different regional features into consideration. It is high time to conduct interdisciplinary researches with the construction of water environment in the Yellow River Basin.

3 Issues needed to be paid attention to in the study on sustainable management on combating water pollution in the Yellow River Basin

Owing to different natural and social conditions, further researches should be investigated on the prominent problems in the Yellow River Basin. The researches listed as follows deserve to be paid attention to.

3.1 Capacity evaluation study on the current relevant management policies

It is indispensable to conduct evaluation over resources and environment – related policies and plans. In practice, some countries or local authorities conduct surveillances and evaluations on the implementation of some policies and laws. However, the standardization of evaluation is insufficient. Usually, the evaluation is done from the view of fact, namely, only implementing effect of policies is concerned, neglecting whether the policies complies with science of ecosystem, namely, the value of policies. Researches on this aspect in China are quite insufficient. To overcome the inertia of the existing benefits and system, it is necessary to evaluate the existing relevant management polices, make corresponding revisions and improvement. Therefore, we can choose major factors relating to the river basin management as indexes for evaluation. The factors include natural attribute of river basin, development level of social economy, urbanization level, population distribution, resource structure, industrial structure, characteristics of water quality, main polluting factors, relevant laws, regulations and policies, levels of pollution treatment, financing, public participation, role of women, application of local knowledge, extent of information publication, authority differentiation of relevant organization and so on. It is also necessary to choose key polluted cities and their radiation regions, conduct evaluation and comparison on the basis of one – to – one correspondence, comprehensively evaluate enlightenment and insufficiency in the existing management policies.

3.2 Comparative study on management patterns of river basins both at home and abroad

The study on cases of river basin legislation is often put forward like this: Alfirst, learn at abroad and experiences, practices then, find weaknesses and insufficiency existing in the management pattern in China, finnally, put forward to what should we do. However, such researches usually neglect system verification on the social and natural background, systematic and dynamic survey on the changes of systems based on background changes. So, the localization of systems, degree of adoption and operability of proposals in practices are negatively influenced. Thus, it should be prioritized to establish environmental management approaches and policies that are both socially and ecologically acceptable (Derek, 1996). Therefore, some typical river basin management patterns such as river basin management pattern in Tennessee valley (TVA), Murray – Darling River Basin Management (ICM) pattern, coordinated management pattern with participation from multiple departments in UK (CCM), and water pollution management pattern in the Huai River Basin of China should be selected in the future researches. Gomparison and analysis should be conducted on relevant legislations at different period of time within the same river basin while comparison and analysis should be conducted on relevant legislations that are similar with an objective of legislation and regulated objects in different river basins. As a consequence, characteristics, strongpoint and weakness concerning the changes of these patterns, failures and experiences from practices, enlightenments to the prevention and control of water pollution in the Yellow River Basin can be obtained.

3.3 Discussion on patterns of sustainable management on water pollution control in the Yellow River Basin

Owing to the importance of construction of institutional capability, especially, the future river basin integrated management institution must possess the authority in terms of coordinating and managing behavior of the stakeholders within the river basin (Hopper, 2000), the paper set the institution as main line, and put forward the sustainable management pattern in the prevention and control of water pollution in the Yellow River Basin (the pattern is shown in Fig. 2), with the purpose of exploring the realization of the river basin ecosystem management. Due to the reason that it will be more effective to adjust the management system under the existing framework, the general strategy is to strengthen cooperation between institutions under the precondition that the terms of reference possessed by the existing institutions remain unchanged. What's more, it is necessary to enable more stakeholders to participate in the protection of the river basin to facilitate the absorption of local knowledge by means of establishing advisory committee, and ensure the scientific characters in deciding relevant affairs within the river basin. Specifically speaking, the first thing needed to be done is to establish the advisory committee for river basin ecosystem management, which should be composed of stakeholders such as representatives from the government departments, industry, experts, public inclusive of women. It is also necessary to integrate cross – discipline knowledge and discuss the river basin affairs on a diversified perspectives basis, which comprises the formulation, revision and detailed implementation plans of relevant laws and policies, formulation and implementation approaches of long and medium term plans on the river basin, environmental impact assessment on the construction of key projects. As a consequence, the above – mentioned measures shall provide scientific basis for the central government in decision – making process and provide important reference basis for the detailed implementation conducted by local governments, which shall lay a solid foundation for the realization of sustainable development within the river basin. The advisory committee for river basin ecosystem management provides direct advisory opinions for the central government, monitors and evaluates the formulation of measures for river basin management. Meanwhile, the central government timely feeds back the adoption of advisory opinions and other problems existing in the river basin management affairs to the advisory committee for river basin ecosystem management. The organizational structure at each level of governments remains unchanged. The central sector is mainly responsible for the formulation of integrated river basin plans and incentive policies, coordination of balance among various stakeholders, promotion of cooperation among stakeholders, macroscopically controlling the goal of river basin sustainable development, directing and monitoring the implementation of measures for river basin management on the local basis. The local sector, on the other hand, following the industrial layout and division of regional functions formulated by the central sector, is responsible for the formulation of detailed enforcement regulations, implementation of relevant laws and policies with the local social and ecological factors taken into consideration.

3.4 Exploring the permanent effective mechanism and approach for the prevention and control of water pollution in the Yellow River Basin

The design of system must be comprehensively considered for long. The exploration of permanent effective mechanism and approach for the prevention and control of water pollution should integrate systems, measures, laws and management patterns.

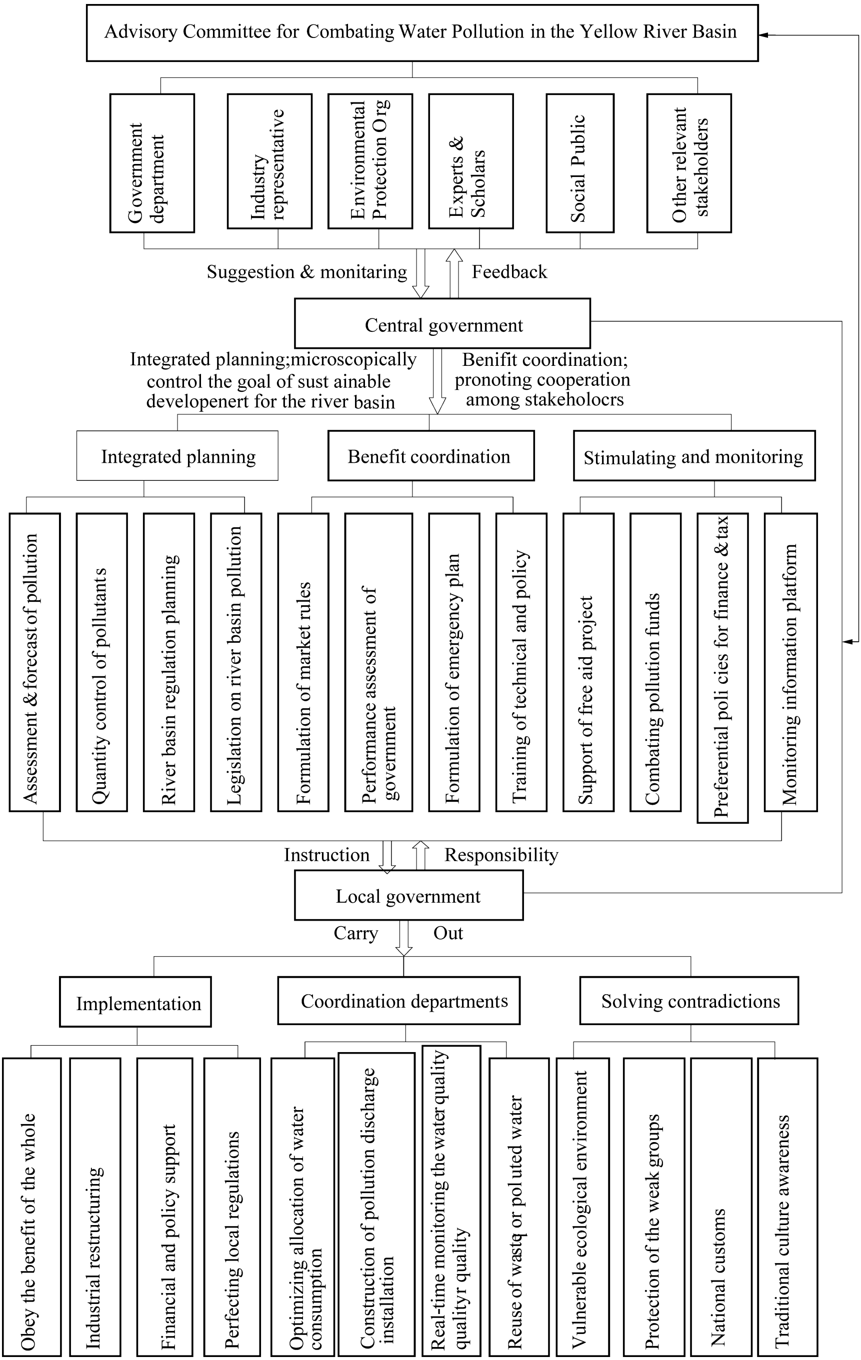

Fig. 2 Diagram of management pattern on water pollution control in the Yellow River Basin

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Research on Flood Control Mechanical Technology with Larger Geocontainers

Zhang Baosen[1], ***Wang Zhenyu***[2], ***Wang Zili***[1,3] and ***Deng Yu***[1]

1. Yellow River Institute of Hydraulic Research of YRCC, Zhengzhou, 450000, China
2. Flood Control Office of YRCC, Zhengzhou, 450000, China
3. Water Conservancy and Electricity Institute of Hohai University, Nanjing, 210098, Cina

Abstract: This paper introduced a new mech a nilized wrecking technology with larger geocontainers applied to flood control, and summarized its development process. Dynamics of larger geocontainers declined in water was dealt with and their stability against scouring and friction was analyzed as well, which provided a theoretical basis for the material selection, structure design and manufacture of geocontainers. A larger geocontainer under itself load can be tightly attached to riverbed so that it is suitable for filling up washout pits in a river and can replace such traditional wrecking methods as cages with stone, willows pillow, jackstone and large netting cage to stabilize dam foot, which is very beneficial to river protection and dam urgency. We developed larger geocontainers with volume from 10 to 12 m^3, with the aid of dump trucks, excavators, bulldozers and loaders to carry out mechanical stuff, transport, jackstone, and it takes only ten minutes to finish the stuff work. This new technology was applied in the test of Caiji 54 th and Wang'an 14 th dam of Lankao County in the Lower Yellow River in 2004, producing a good result. This technology provides a new way for flood control in the area short of rocks and possesses high value in application and popularization.

Key words: larger geocontainer, mechanization technology of rush repair for flood control, geosynthetics, wrecking technology, the Yellow River

1 Introduction

In thousands of years, people living along the Yellow River have obtained very rich flood control experiences during their struggle against flooding of the Yellow River. According to water and sediment characteristics, they have used the local materials and invented many flood control means, such as cages with stone, willow pillow, jackstone and large netting cage, etc. The application of such materials and technology formed the basic methods of the Yellow River flood control which has produced great effect on flood control and rush repair, nevertherless, they are still being important flood control measures recently. With developing of technology and economy, more than twenty specialized flood control teams have been set up in the lower Yellow River, equipped with large sized machinery such as dump trucks, excavators, bulldozers and loaders, which enhance their abilities in rush repair for flood control. Nowadays, the application of fiber netting cage and geosynthetics has brought great change in flood control, which has evident virtue as saving manpower, accelerating flood control speed and reserving materials easily etc. In order to solve how to organize rush repair in special situations such as lack of stones or short of stone supply because of rainy season, the paper puts forward flood control technologies with larger geocontainers. Larger geocontainers with the volume from 10 m^3 to 12 m^3 are successfully developed, they can be mechanically stuffed, transported, thrown with dump trucks, excavators, bulldozers and loaders. It only needs ten minutes to finish the stuff work. These materials were tested in Caiji 54th dam and Wang'an 14th dam of Lankao County in the lower Yellow River, which were subjected to 2,800 m^3/s flood during water and sediment regulation. In addition, the test of transportation and jackstone of larger geocontainers is analysed in water in Fengqiu Shunhejie 13 th dam.

2 Stability analysis of larger geocontainers

2.1 Stress analysis for larger geocontainer in sinking

2.1.1 Geocontainer state

The geocontainer, after filled and compacted by mechanical equipment, can reach the maximum density of about 1,470 kg/m^3, and a maximum water – content coefficient of about 24%. Normally, the sand in the container has a higher porosity and the density is between 1.15 g/cm^3 and 1.33 g/cm^3. As thrown into water, the geocontainer will go through a series of complex changes. The geocontainer is soaked tardily, the soil inside exhausts gas slowly and is saturated gradually, meanwhile its mechanical property would change considerably.

2.1.2 Stress state of larger geocontainer thrown to water

Thrown to water by dump trucks, the geocontainer is mainly subject gravity and friction drag of the hoppers. When the car hopper slopes down to 45° ~ 50°, the geocontainer will immediately slide out itself, and the badly designed geocontainer would be broken up because of violent impact force. Generally, they will kneel down to the ground. Besides, if the geocontainer is not dumped directly at the right position, it will be pushed forward by excavators and bulldozers to its final position (see Fig. 1 and Fig. 2). These forces must be considered when designing the structure and selecting materials.

Fig. 1 Geocontainer pushed by a bulldozer

Fig. 2 Geocontainer pushed by an excavator

2.1.3 Stress state of larger geocontainer entering into water

There are two kinds of stress states: ① being slided down from bank slope; ② being sunk down in water. During sinking, it endured the same stress as stone except its smaller density. When larger geocontainer is thrown into water, the air in it will gather at its top and forms the ballonets (see Fig. 5 and Fig. 6) that will bring buoyant force and affect the sinking and stability of larger geocontainer. During sinking, the larger geocontainer mainly endures gravity, buoyancy, slope friction drag, circumfluence resistance, and hydrodynamic pressure, which constitutes a resultant force that decides sinking time and displacement. Messrs Geng Mingquan and Song Dongpo have done experiments to study the stability. Moreover, the larger geocontainer offsets are affected by current velocity and water depth. The more rapid the current velocity is, the bigger offset the larger geocontainer is. And the more deep the water depth is, the bigger offset the larger geocontainer is.

2.2 Stability analysis of shock resistance of geocontainers

If the air in geocontainer is taken into account (compactedness is 0.7 ~ 0.8, calculated by geocontainers' size and its filling soil amount), the looser the earth is, more air in it, so it is more porose. If the air – out capability of the geocontainer is poor, its floatage will be strong, for its gas is difficult to be discharged. As a result, the geocontainer will be unstable. Consequently, the materials chosen to make geocontainers should be feasible to exhaust gas. The soil should be compacted before filled into geocntainers to reduce the air containing in it and increase buoyant force.

2.3 Friction stability analysis of geocontainers

To keep the underwater geocontainers in friction stable is very important. The adopted friction coefficient shall be smaller of the following: the friction coefficient among geotechnical materials and the friction coefficient between geotechnical materials and soil. In total, the friction coefficient between geotechnical materials and soil is bigger, while the coefficient between geotechnical materials is smaller. In geocontainer's underwater construction, the stability of the geocontainer is highly dependent on parameters such as current velocity, scour hole's formation, geocontainer's state, geocontainer's placement strength. In the condition of speedy proceeding, the underwater construction will be stable when the geocontainer is static at an angle after it is destabilized for a certain time.

3 Structural Design and wrecking method of larger geocontainers

3.1 Structure and dimension

The dimensions of a larger geocontainer is 4.5 m × 2.4 m × 1.3 m, determined by the car hopper dimension of a dump truck. The geotextitile is determined by the qualifications: strength, deformation rate, hydraulic permeability, air discharge and soil saving in the process of rush repair. If they are produced with weaved fabric and compound geotechnical materials (200 ~ 250 g/m^2), a 5 cm – wide reinforcement band is demanded at 1m intervals in order to reinforce geocontainers strength. See Fig. 3 and Fig. 4; while, hemp ropes or chemical fibre rope bound at 1m intervals are used for containers of non – woven fabrics to reinforce geocontainers strength.

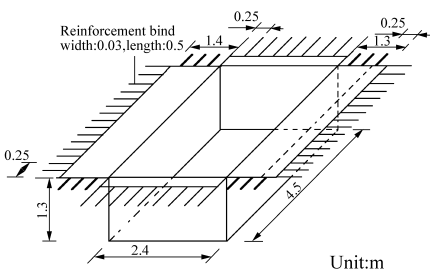

Fig. 3 Structure and size of lager geocontainer

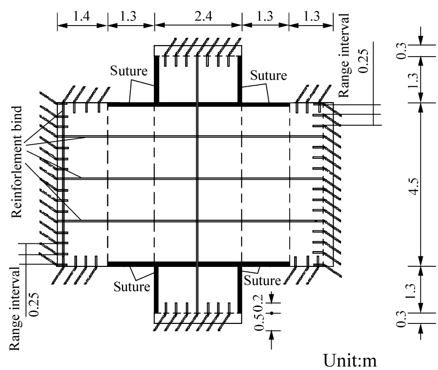

Fig. 4 Developed representation of larger geocontainer manufacture

3.2 Rush repair method and characteristic of larger geocontainers

Mechanized rush repair with larger geocontainers means to make big packets of a certain shape and volume from geotechnical composite materials, which are filled with loose soil and other materials, cooperated with loaders, excavators and dump truckes, to do mechanized rushing repair in flood control. The methods and characteristics of rush repair with larger geocontainers are as follows: Larger geocontainers are assembled in dump trucks with charging cranes and digging machines, which meets mechanical work requirement of dump trucks. The empty pockets can be pre – sewn and stored conveniently. As the material can be quickly transported to a danger spot, quickly loaded and pitched in an emergency, larger geocontainer has the following advantages:

(1) Convenient transport, simple manipulate and quick rush repair, comprehensive applicable domain: throwing in ship, at bank, by hand or by machine.

(2) No restriction on soil quality, so it can be obtained on site and replace of jackstone in some cases.

(3) substitute for willow and stone fascines, in favor of eco – environmental protection.

Fig. 5 Larger geocontainers as brought on the site from the factory

Fig. 6 Mechanical cast loose soils

The essential of mechanized rush repair with larger geocontainers is that it separates the geocontainer processing site from the throwing stie, avoiding the limitation of small work site in traditional rush repair technology, realizing the assembly line work, and increasing the efficiency of rush repair.

4 Analyze the rush repair effect of larger geocontainers

4.1 Experimental result of throwing large geocontainers in underwater execution of Caiji 54 th dam and rush repair of Wang'an 14 th dam of Lankao County proves that

(1) Reasonable site arrangement can accelerate mechanized work. The number of dump trucks can be determined by the operated cycle time of distance and digging mechanics, following the principle of minimize the number to guarantee the maximum productive rate at the least minimum cost. For example, 50 m underwater execution, a D85 bulldozer, 3 excavators and 10 ~ 12 dump trucks are the most effective teamwork.

(2) 10 m^3 large geocontainer can solid stand in water and perform on the condition that the water depth is about 4 m ~ 6 m and the measured discharge velocity is less than 1.0 m/s. See Fig. 7 and Fig. 8.

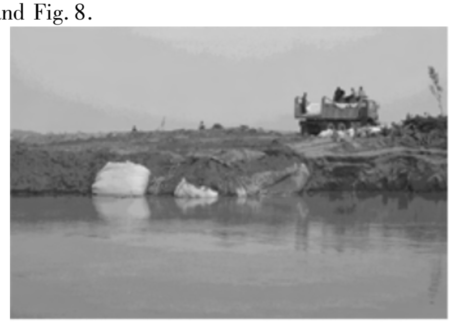

Fig. 7 Underwater execution of large geocontainer

Fig. 8 Resisting current scour of large geocontainer

4.2 Experimental results of throwing large geocontainers in 13th dam underwater execution of Shunhe road of Fengqiu reveal that

(1) Earth – filled woven fabric large geocontainer can't form stable mass in the condition that the water depth is about 8 ~ 10 m and the measured discharge velocity is 1.5 m/s, large stream impacts dam. The mainly reason is that the strength of throwing larger geocontainer is related to current scour. The velocity of one 10 m^3 geocontainer per 25 ~ 35 minutes couldn't satisfy the requirement of underwater execution.

(2) Most larger geocontainers were cracked at upper commissure and soil lost sharply when woven fabric larger geocontainers were thrown, so that the efficiency is low. The air in container can't be ejected underwater for the reason that permeability of the woven fabric is too poor, the geocontainer is subject to biger buoyancy forces, the pulse – on velocity is low and the scour resistance is feeble.

5 Conclusions

The materials selection, structure, size, manufacture and mechanized loading, transportation and throwing etc. of larger geocontainers are solved through the experiment. The following conclusions and suggestions have been obtained on the basis of the experimental results:

(1) The mechanized rush repair of larger geocontainers, embodying the principles of high strength, high efficiency, factory processing and mechanization work, has many advantages and development potential. This method presents new technical support for flood control and rush repair work.

(2) To solve low strength and be liable to crack when thrown, this paper introduces the method of binding larger geocontainers with reinforcement band or string.

(3) With the characteristic of soft deformability, the larger geocontainer is fit for filling up washout pits. It can tightly attach to the riverbed under its load, and is beneficial to the stability of underwater base dam and advantage the rush repair work of stream groin.

(4) Larger geocontainers with volume from 10 m^3 to 12 m^3 are successfully developed, and experimental results reveal that 10 m^3 geocontainers have good applicable effect.

(5) It is very complex to estimate the stability of underwater geocontainers. It can be determined by water – depth, current velocity condition, and execution technology. It is suggested that the stability and execution technology should be further analyzed, tested and investigated.

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Discussion on Permeable Groynes

Zhang Cuiping[1], ***Zhang Suocheng***[2] and ***Yang Dalian***[3]

1. Yellow River Institute of Hydraulic Research, YRCC, Zhengzhou, 450003
2. Yellow River Conservancy Commission
3. Hydrology Bureau of Yellow River Conservancy

Abstract: This paper summarizes the development of permeable groynes, compares the functions and characteristics of permeable groynes and impermeable groynes, and suggests the appropriate location to construct permeable groynes in the Yellow River.
Key words: permeable groynes, channel regulation, river trainning works

1 Permeable groynes

Groynes vary greatly with their structure, appearance and action on stream flow. Groynes are classified by the construction method and material, i. e. permeable or impermeable. It is clearly that the construction material is different just by the terms of permeable groynes and impermeable groynes. At the same time, the permeable groynes differ with the impermeable groynes on the influence on the flow. Permeable groynes slow down the current while impermeable (solid) groynes deflect the current (Becksteak, 1975).

Permeable groynes are often made of piles, bamboos or timbers, which allow flow to pass through the space between the piles. When the current flows through the permeable groynes, the flow energy will be absorbed partly. So the flow velocity will be locally reduced and then the sediment transport capacity. As a result, the sedimentation will occur near the permeable groynes. In this way an eroding bank may be stabilized or a river branch could be closed.

2 Development of permeable groynes

2.1 Types of permeable groynes

Fig. 1 shows the structure of a permeable groyne in the early years (Nedeco, 1959). A permeable groyne consists of a row of clumps of two to three piles connected by horizontal beams and crossings. To prevent the scour between and downstream of the groynes, a mattress is sunk before the pile are driven. The size of the mattress depends on the water depth and current speed between the piles. The scour can extend 20 ~ 30 feet upstream and 30 ~ 50 feet downstream from the axis of the groyne and it will be larger at the river – side end of groyne.

Experience on the Mississippi shows (Fig. 2) that gradually many permeable groynes converted into impermeable one due to the sedimentation (Nedeco, 1959). Fig. 3 shows permeable groynes constructed of bamboo and timber. Fig. 4 shows a pile row of permeable groynes field in Bangladesh (Wal, 2001). At present, permeable groynes can also be constructed of steel piles or reinforced concrete piles, which are driven into the riverbed and the flood plain, consisting of a single pile row or of several rows (Fig. 5). Recently, an innovative groyne, combination of solid and permeable groynes (Fig. 6), is proposed and some researchs on what is the effect have been done (Wal, 2001) (Reduan, 2002).

2.2 Function of permeable groynes

Permeable groynes are used as the river training works to serve the following functions:

(1) Creating a slack flow with the object of silting up the area in the vicinity.

(2) Protecting the river bank by keeping the main flow away from.

(3) Contracting a wide river channel, usually for the improvement of water depth for navigation.

2.3 Influence of permeable groynes

Permeable groynes allow flow to pass through the piles but at the same time the flow velocity is dampened.

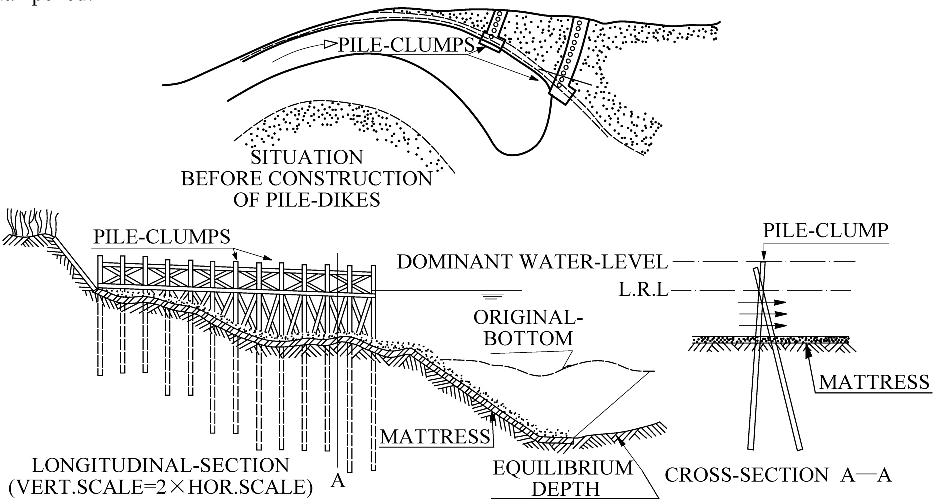

Fig. 1 Construction of a permeable groyne (pile clumps) (Nedeco, 1959)

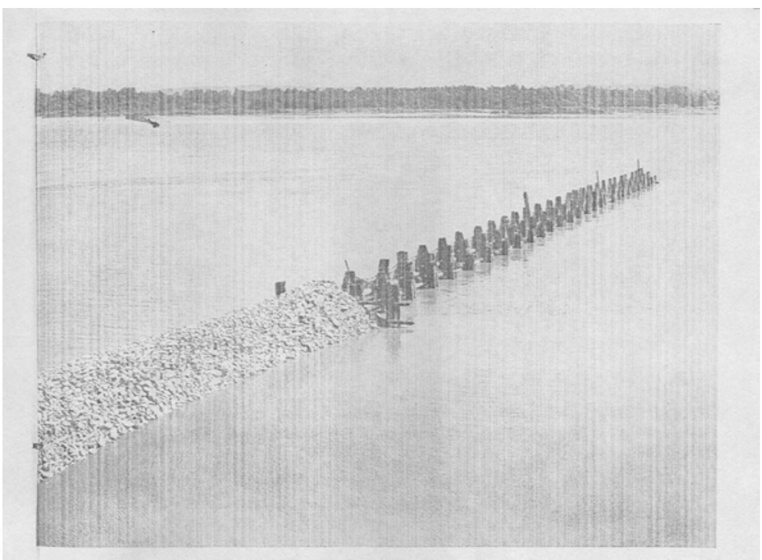

Fig. 2 Pile dike in the Mississippi River (Nedeco, 1959)

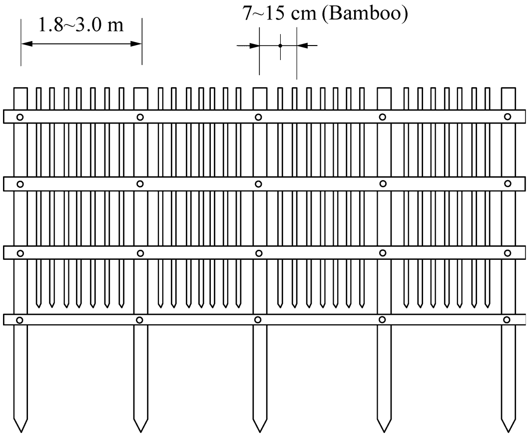

Fig. 3　Typical section of permeable groyne used in Bangladesh (Alam and Faruque, 1986)

Fig. 4　Pile row in a pilot project along the Brahmaputra River in Bangladesh, 1996 (Wal, 2001)

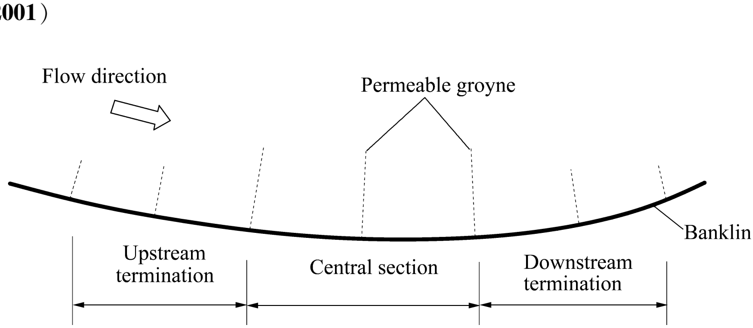

Fig. 5　Schematic layout of permeable groyne field (Guidelines and design manual for standardized bank protection structures, Bangladesh, 2001)

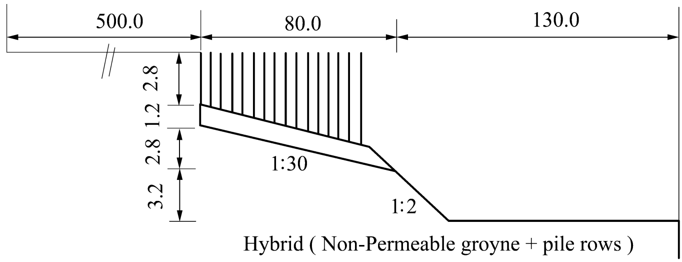

Fig. 6 Shape of innovative groyne (Reduan, 2002)

Thanks to a smaller blocking area, permeable groynes (e. g. needle groynes shown in Fig. 7) usually work under lower hydraulic load. A part of flow passes through the spacing between piles which do not produce or at least reduce the circulation zone below the groyne.

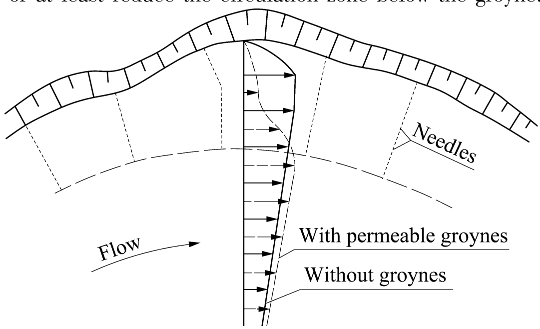

Fig. 7 Change in mean velocity distribution due to permeable groyne (Przedwojski, 1979)

2.4 Advantage and disadvantage

The advantages of permeable groynes are as follows.

(1) Many kinds of material, for example, piles, bamboos or timbers, etc. can be used to construct the permeable groynes. It is facility to construct permeable groynes with local material.

(2) Control flow pattern in the permeable groynes field. Permeable groynes (Fig. 8) can control the flow patterm reasonably and make the flow parrel to the bank line in the groyne field. Properly spacing of the groyne will enhance the effect of several permeable groynes on the reduction of the flow velocity near the bank. Permeable groynes orientation or head configuration are of minor influence regarding hydraulic performance and stability of the structures.

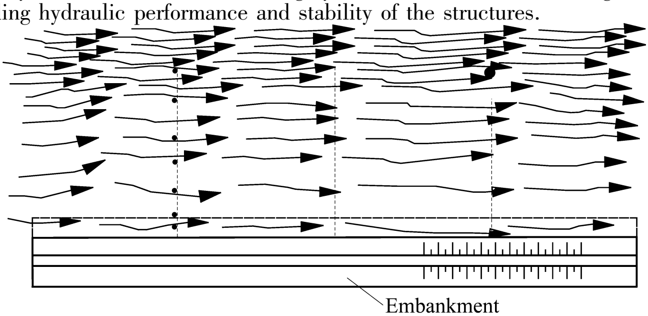

Fig. 8 Flow pattern in a series of permeable groynes (Guidelines and design manual for standardized bank protection structures, Bangladesh, 2001)

(3) In submerged permeable groynes field, turbulence is less significant than that in the impermeable groynes. Submerged permeable groynes are preferable to submerged impermeable groynes for protection of property along the bank since the former do not create turbulent and eddy conditions as strong as the latter. However, these groynes are effective only in rivers which carry heavy suspended loads (Central Board Of Irrigation and Power, 1989).

The disadvantages of permeable groynes are:

Permeable groynes are not strong enough to resist shock and pressure from debris, floating ice and logs. Moreover these groynes will become semi – permeable or even non – permeable by the floating debris collected against the face.

Permeable groynes are not suited if the river training works is to confine a river to a defined channel. Permeable groynes cannot be used effectively for training the river along a desired course by attracting, deflecting or repelling the flow in a channel unless the permeability is low.

The effect of permeable groynes on the concentration of the flow was less than that of impermeable groynes (Nedeco, 1959).

2.5 Suitable locations of constructing permeable groynes in the Yellow River

Based on the function and effect of permeable groynes and situation of river training in the Yellow River, more suitable location of constructing permeable groynes are pointed out as follows.

Permeable groynes can be constructed in the straight stretch and the convex bank of the channel to contracting a wide main channel of the Yellow River.

Transverse permeable groynes are more suitable for protection of levees of flood defense.

Permeable groynes can be used for some temporary river engineering in the Yellow River, for instance, blocking the second branch.

3 Experiences with permeable groynes in the Yellow River

3.1 General information of permeable structure and groynes in the Yellow River

The field experiment about permeable structure was carried out in 1979 in the Yellow River. As a pilot project, one permeable groyne was created at Dangdaba in the lower reaches of the Yellow River in 1987. The groyne consisted by 100 concrete piles, with an overall length of 104 m. The diameter of the piles is 0.55 m, and the internal width is 0.55 m or 0.40 m. The permeabilities are 50.0% and 42.1% (Li, 2003).

Besides impermeable groynes, permeable structures are constructed at the downstream termination of impermeable groynes field (Fig. 9), with one – row piles. The piles were arranged along the direction of flow in the river and at the alignment of the channel regulation. It can be called as longitudinal permeable dike.

According to the results of physical model, a few permeable structures have been made in recent years, with diameter 0.8 m, internal width 0.4 m, and the permeability 33% (Chen et al., 2003).

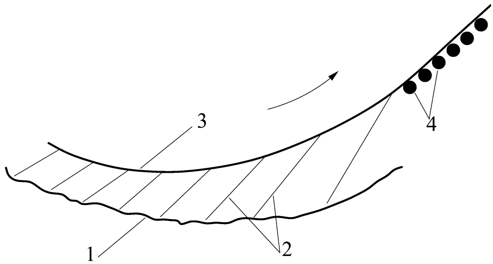

Fig. 9 Permeable structures in the Yellow River

1—Natural bank of the river; 2—Impermeable groyne field;
3—The alignment line of channel regulation; 4—The pile of permeable structure

3.2 The research results of permeable structures

In order to optimize the permeability, a physical model has been carried out at Institute of Hydraulics Research, YRCC (Tian & Wang 2000). The plantform of permeable structures is shown in Fig. 10 and the parameters used in the test are shown in Table 1. The study found out the following results (Yao et al., 2003):

The local scour is formed along the row of piles, and the deepest scour is near the pile (Fig. 11).

The deepest local scour is about 20 m near the pile at the river side. The larger the permeability is, the smaller the local scour is.

Under the same flow conditions, the larger the permeability is, the faster the deposit rate behind the piles is.

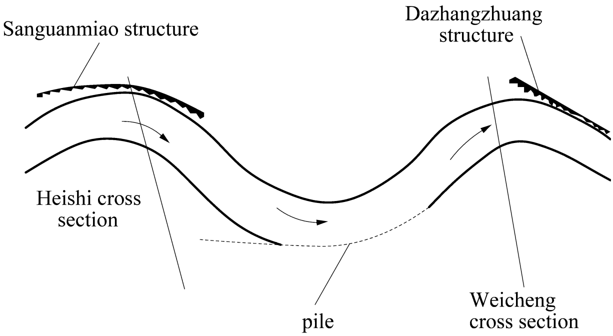

Fig. 10 Layout of permeable structure (Yao et al., 2003)

Table 1 Parameters used in test

Diameter of pile (m)	Internal width (m)	Permeability (%)
0.8	0.3	27
1	0.5	33
1	0.75	43

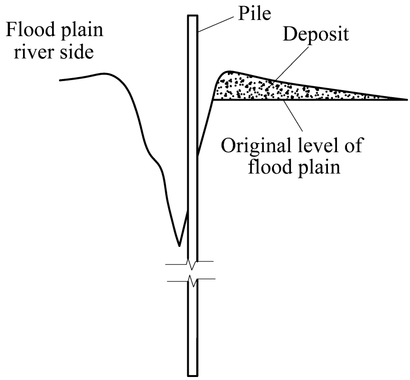

Fig. 11 Sketch on scoured hole near the pile at permeable structure (Yao et al., 2003)

3.3 Comparison between the permeable structures in the Yellow River and permeable groynes

The permeable structures in the Yellow River are different from the permeable groynes in other rivers. The layouts are different. One row piles are adopted in the Yellow River along the regulated line, and the axis of permeable structures parallels the flow line (Fig. 10). The permeable groynes in other river are perpendicular to the flow line, and normally several rows permeable groynes works together. For example, guidelines and design manual for standardized bank protection structures (Ministry of Water Resources: Water Resources Planning Organization, Government of Bangladesh. 2001) point out that the standard layout of a groyne field consists a central section with a series of at least 3 groynes similar in composition and length plus an upstream and downstream termination with shorter groynes (with decreasing length), in order to cope with a possibly developing reaches upstream embayment and to smooth out the transition between protected and unprotected reaches downstream from the groyne field (Fig. 5).

The function is not same. The main function of permeable groynes in Bangladesh is bank protection, but permeable structure in the Yellow River is trainning the main flow.

The permeability is different. The permeability p of a groyne is defined by the ratio of open (non – blocked) area to the total area, which can be expressed by the quotient of the internal width s and the distance e between the axis of two adjacent piles ($p = s/e$). Different layouts determine the different permeabilities of permeable groynes and permeable structures in different rivers or countries.

The permeabilities of permeable structure in the Yellow River wihic are 50% ~ 30% are smaller than that in the other rivers. Guidelines and design manual for standardized bank protection structures (Ministry of Water Resources: Water Resources Planning Organization, Government of Bangladesh. 2001) recommend the permeabilities of permeable structures are 50%, 60%, 70% and 80% from the first pile near the embankment to last pile in the river for the standardized groyne structures. The permeabilitiy decreases towards the embankment. This layout can achieve a gradual transition from the non – blocked to the partially blocked river cross – section and create a more or less flow resistance from the head to the root (when allowing for bank parallel flow lines)

4 Discussions

More studies have to be done to find out where and whether permeable groynes are a realistic alternative for the traditional groynes in the Yellow River. The comparison between impermeable groynes and permeable groynes should be carried out and some studies on economical aspect also have to be done. To permeable groynes itself, many parameters should be optimized under the very particular situation of the Yellow River, such as the spacing of groynes, the permeability of groyne, etc.

5 Conclusions and recommendations

Permeable groynes can be constructed in the straight stretch and the convex bank of the channel to narrow the channel width of the Yellow River. Transverse permeable groynes are more suitable for dyke protection. Permeable groynes can also be used for some temporary river engineering in the Yellow River, for instance, blocking the second branch, etc.. Permeable groynes cannot be used effectively for training the river along a desired course by attracting, deflecting or repelling the flow in a channel unless the permeability is vrey low. Further more field and model studies on permeable groyne and innovative groyne in the Yellow River are recommended.

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A Study on Yellow River Mainstream Line Feature Extraction

Zhang Haichao[1], **Duan Feng**[1], **Zhang Yanning**[1], **Liu Xuegong**[2] and **Han Lin**[1,2]

1. Institute of Computer, Northwestern Polytechnical Univ ersity, Xi'an, 710072, China
2. Info rmation Center of Yellow River Conservancy Commission, Zhengzhou, 450004, China

Abstract: Mainstream line is significant for the Yellow River situation (regime) forecasting and flood control. An effective mainstream line feature extraction method is proposed in this paper. Considering the characteristics of tiny spectrum discrepancy between the area of mainstream and non – mainstream, the conversion method of using between – class scattering degree as projection index is proposed. After maximizing the between – class discrepancy to obtain effective information components for classification, skewness coefficient is utilized to describe the feature of mainstream line based on the statistical distribution discrepancy indicating in the components of maximum between – class scatter for the area of mainstream and non – mainstream. Experimental results indicate the effectivity of the proposed approach in mainstream line detection. The results of case computation indicate the proposed approach can extract the location of mainstream line automatically with higher accuracy.

Key words: remote sensing, feature extraction, mainstream line, between – class scatter matrix, skewness coefficient

1 Introduction

Mainstream line is the one with the maximum velocity among the streams of the River, flowing insurgently and flushing greatestly on the embankment. To determine the location of mainstream of the river is important for guiding the forecasting of river regime variation, river training, flood control decision and planning. The traditional method to detect mainstream line is performed manually, using velocity detection apparatus transversely in the river, this method is time consuming, laborious as well as highly uncertain. Remote sensing technology offers us a better way to detect river mainstream line using multispectral images . There have been some efforts to account for the interpretation of mainstream line in multispectral image. The extraction of mainstream line based on remote sensing image is relatively difficult and less studied so far. Usually, remotely – sensed image is affected by various complicated reasons, the acquired spectral feature is very difficult to be used to describe the formation of substance exactly. In addition, because of the tiny spectral feature differences between the mainstream and non – mainstream areas, the traditional spectral analysis method is difficult to use in practice. To solve this problem, this research starts from seeking the effective projecting direction to maximize the difference, and then extract the features of mainstream line.

Projection based on Between – class Scatter *Matrix*: Using W to denote a $n \times 1$ unit vector, the main idea of projection could be described as follows: the $n \times m$ observation matrix is projected to W via the transformation formula $Y = W^{\mathrm{T}}X$, obtaining a $m \times 1$ column vector Y. The criterion for choosing W is to improve the divisibility of the data set after projection. That is to find a series of optimum directions for projections satisfying the orthonormal conditions and maximize the following criterion formula:

$$J = \frac{W^{\mathrm{T}}GM}{W^{\mathrm{T}}W} \tag{1}$$

Using G_t、G_w、G_b to denote the total scatter matrix, within – class scatter matrix and between – class scatter matrix separately, then:

when $G = G_t$, it is the PCA transformation. It maximizes the total scattering degree after projecting the observing matrix in W direction. But maximizing the total scattering degree can not guarantee obtaining desirable results while classifying. Because the directions discarded by PCA have the probabilities of discriminating different classes(as showed in Fig. 1).

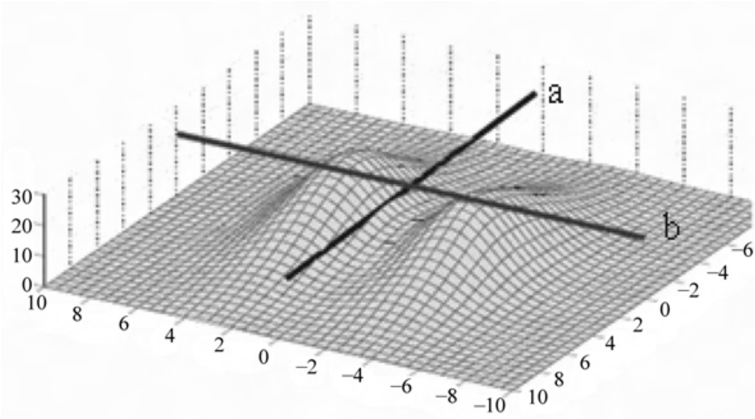
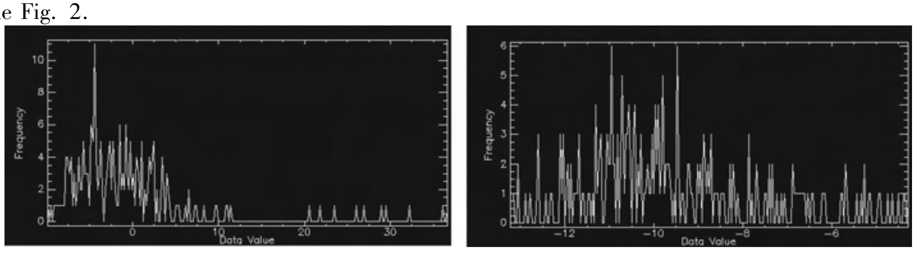


Fig. 1 The impartible direction (a) in which total scattering degree is maximal

If the within – class scattering effect could be eliminated, namely, let $G = G_b$, the result of classification should be improved. In this algorithm, choosing between – class scattering degree as the index for projection offers the first component as the most effective component for classification, which assembles the most effective information for classification.

2 Mainstream line feature description

Traditional multispectral image analysis method is base on the spectral analysis, identifying the targets through their spectrum. But in practice, such a simple classification method which only uses spectra can not satisfy the expectations. After analyzing on the first component image generated from the above projection algorithm, a feature of the mainstream line is extracted: the localized histogram of the mainstream area is skewer than that of the non – mainstream area. This is depicted vividly in the Fig. 2.



(a) (b)

Fig. 2 The histograms of an area of one segment of the river in the first component. Fig. 2(a) is the mainstream area, Fig. 2(b) is the non – mainline area

It can be described statistically using the skewness coefficient. Skewness coefficient is a third – order statistic which reflects the uniformity of the data distribution, whose formula is:

$$Skewness = \frac{1}{n-1} \sum_{i=1}^{n} (x_i - \bar{x})^3 / (SD^3) \qquad (2)$$

where, SD is the standard deviation. $Skewness = 0$ reflects the state is identical to normal $Skewness > 0$ distribution; indicates the peak value on the left, $Skewness < 0$ indicates the peak value on the right. The larger the absolute value of skewness, the skewer the distribution. This feature can be used to determine the location of mainstream line by using a series shapes of histogram on transect of the river.

Applications and results: We made an application of our algorithm to verify its practicability and precision. The algorithm was applied to detect mainstream line in a multispectral image of the Yellow River. The image used was obtained from LandSat5 TM on May 10, 2004. We masked the non – river areas to focus only on river areas. An image of the data set is illustrated in Fig. 3. The line in Fig. 3 is the mainstream line manually marked by the Yellow River Conservancy Commission experts.

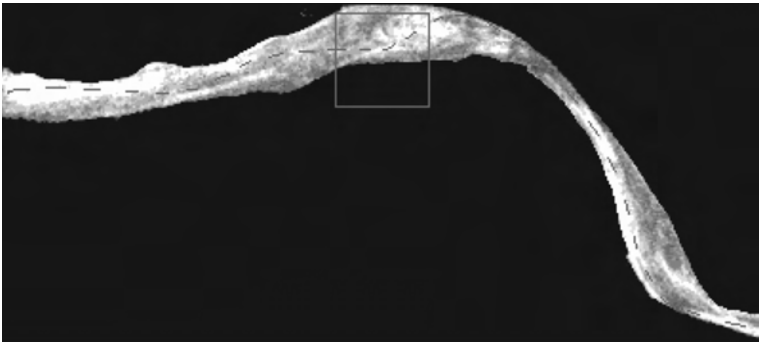


Fig. 3 A masked segment of the Yellow River (Band 4)

Spectral samples were selected for mainstream line and non – mainstream line area based on manually marked mainstream line, then the between – class scatter matrix could be constructed and used as generating matrix G_b to perform the projection conversion. Fig. 4 illustrates the first component obtained after applying the projection algorithm. We calculated skewness of the first component using a 3×3 spatial window, and marked Y – coordinate of the positions where the skewness was maximal on the image from column to column, then an average value was calculated for every 3 neighboring rows.

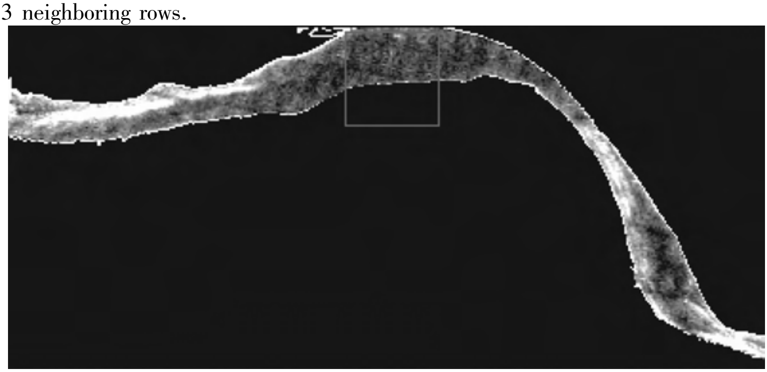


Fig. 4 The first component obtained after projection

The final segmented image result using white points gained an image, as showed in Fig. 5 in contrast with the original images. As could see from comparison, the positions of the mainstream line detected were in the flow path generally, proving this method for detecting mainstream line is practical.

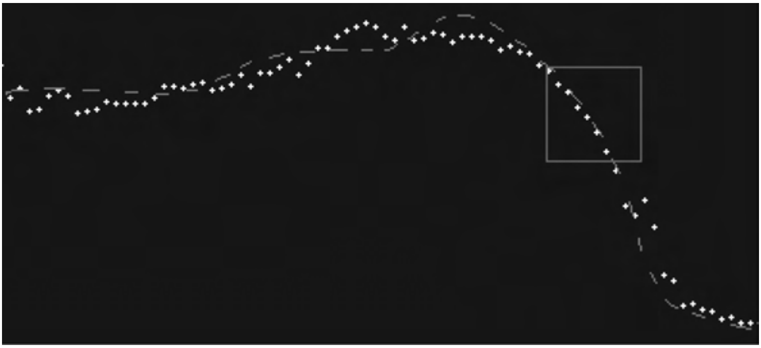


Fig. 5 The averaged maximal skewness position for the segment of the Yellow River

This algorithm was applied to other segments of the Yellow River, and the results are illustrated in Fig. 6.

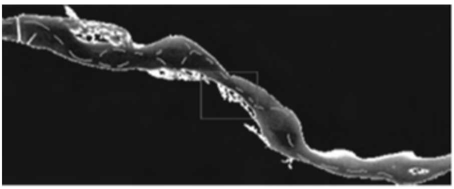


Fig. 6 Other segments of the Yellow River and the experimental results

3 Conclusions

In this paper, we proposed an effective scheme to detect mainstream line areas in multispectral images. The between – class matrix is used as the generating matrix to perform the projection, aggregating the effective factors for classification; then the skewness is selected as the feature to discriminate the mainstream line. As the algorithm has the characteristic of localization and relativity, the result is strong in robustness.

Acknowledgements

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The Investigation on Equilibrium River Width in Alluvial River

Zhang Min [1,2], ***Li Yong*** [1], ***Wang Weihong*** [1], ***Hou Zhijun*** [1] and ***Luo Liqun*** [1]

Yellow River institute of Hydraulic research, Zhengzhou, 450003, China

Abstract: Hydraulic geometry of alluvial river is of fundamental importance in river training, channel desiging and river managing. The alluvial river width is a focalization and difficulty in academe. There are a lot of different viewpoints of Chinese and foreign researchers. Existing knowledge is reviewed, and it's advantage and disadvantage were pointed in this study. And then our new research was demonstrated. The alluvial equilibrium river width is correlated with discharge, sediment concentration, and especially the longitudinal slope. The plane shape is also influenced by discharge, sediment contraction and slope. The empirical equation about equilibrium hydraulic geometry and plane shape are obtained in this study by the simple physical model.

Key words: alluviation, river, equilibrium, river width

1 Introduction

The Lower reaches of the Yellow River is an active accumulation river. The river channel is wandering and shallow. The river width decreased obviously (Qian Ning, 2003. 9) since 1986 with the change of water and sediment conditions (Chen Jianguo. et al., 2004. 12; Shen Guanqing. et al., 1996). The varition of river cross section is a fateful factor for flood discharging and sediment transporting (Li Yong. et al., 2000). For many years, plenty of investigations have been carried out on the river bed developing of the alluvial channel in the main stream and tributaries of the Yellow River. General speaking, many previous investigations focused on the cause of the change of the water and sedimate, the aggradation and degradation of the river channel, but less investigations were performed on the rule of changing of the river width, especially on the equilibrium width of the river. The equilibrium river width is an abstract concept, an ultimate objective, a value in the ideal condition, also a trend of longtime development.

2 Review of existing investigations on equilibrium river width

The initial study was about the steady river width topic (Атунин, C. T., 1957, 4) instead of equilibrium width. The empirical equation of steady river width is as follows:

$$B = A_1 Q^{0.5} J^{-0.2}$$

here B is the channel width, A_1 is the stability coefficient, Q is bankfull discharge, J is the longitudinal slope, the observed data is in Russian river. At the same time, Атунин, C. T. give a concept of steady river width: There is no shallow, branching in bed – building stage, and the hydraulic geometry relationship is as follows:

$$B^m = KH$$

where: H is the flow depth, m, k are constants, m is 0.5 in Russian river, K is 8 ~ 16, the average value is 10.

Mai Qiao wei (Mai Qiaowei, 1995) calculated the stability coefficient from Qin – Chang to Qian – zuo station in Lower Yellow River according to equation (2). The conclusion was that the Lower Yellow River upwards Gao – cun station was attribute to wandering river channel, the characteristic of Sun – kou, Li – jin and Qian – zuo station was attribute to lower river channel, Ai – shan, Luo – kou and Yang – fang station belonged to mountain river channel. Obviously, it can't solve the problem about the Lower Yellow River's pattern, so can't solve the problem of river cross section, because the equation (2) was concluded from plain river with low sediment concentration or mountain river with coarse sediment, but the sediment concentration is high in the Yellow River.

J. H. Mackin (1948) mentioned the equilibrium river was that the longitudinal slope was adjustment enough to reach a certain velocity for the transport of the incoming sediment. The equilibrium river is a balance system, its special characteristic is that the balance will be broken if any control factor alter, the system will soon absorb the infection of the change. Qiang Ning considers it was not correct to give prominence to the effect of the longitudinal slope prominent.

Qian Ning(Qian Ning, 1982) has noted that the alluvial river was an open system . The substance and energy were constantly exchanged between this system and outside. It is possible that there are still some varieties of the components even the system has got equilibrium. Because the factor of catchment were complexity and multiplicity, the sediment from upstream channel is not equal to the capacity of sediment transport, the channel must be erosion or sedimentation, so there are always aggradation or degradation in the alluvial river. On the other hand the self – adjustment of the alluvial river was always toward the way that can stop transmutation.

Regime theory is the earliest concept about balanceable cross section. Leopold and Maddock considered it is the index corelation between the discharge and the cross section, the value of the coefficient and index can be obtained from the large number of practice data. Afterward, the influence of the discharge concentration and the grain diameter were considered into the formula. The formula were widely applied because all of them were found with practice data and they were easy to used, it was used widely. It can be used when the natural condition was similar, or else not.

Mechanics theory assume the channel is straight, secondary flow can be neglected, sediments are non cohesive and don't vary with the river bed. The theory was based on a fluid momentum balance to obtain the local boundary shear stress and a stability criterion for sediment particles that make up the channel perimeter. Recently, the hydrodynamics – soil mechanics method which is founded with mechanics theory is developing. In this method, the aggradation and degradation are calculated by hydrodynamics model, then the stability of the bank is analysised by the soil mechanics – model.

The extreme hypothesis theory developed rapidly on balance river – width research after 1960s. The theory of maximum sediment transport assumes that the river adjust its slope and geometry – shape until it come to new balance, in other words, the river will adjust its width continuously until the rate of sand transporting becomes biggest under the given discharge and slope. The theory of maximum sediment transport is same to the theory of minimum slope. The river – width, depth of water and slope can be gained with the stream continuum equation, the sediments transportation equation, the stream resistance equation.

The maximum friction theory assumes that the riverbed is flat at the beginning. The stream will destroy riverbed and it will become unevenness after it flow away. At the same time, the friction of boundary will increase. The cross section will go to steady, till the friction become maximum, The theory of maximum sediment transport rate assumes that an alluvial channel adjusts its slope and geometry to maximize its transport capacity. In other words, for a given discharge and slope, the width of a channel adjusts itself to give a maximum transport rate. There are several other theories, such as hypothesis of minimum activity, theory of minimum Froude Number, theory of minimum energy dissipation rate, etc. All of above theories show the investigation on the equilibrium river width have got a further step, however, they are still not good enough to be applied on the alluvial channel in practice.

3 The new idea of equilibrium river width

The river – width and cross section will adapt to the condition of discharge, sediments and boundary and keep stabilization if they don't vary. In other words, there will have specifically equilibrium river – width in a given discharge, sediments and boundary after longtime adjustment. The equilibrium width is likely to keep short time on actual river or the equilibrium won't appear forever, but the river – width must continually approach balance. At present, we don't know the crucial conditions that determines the equilibrium river – width. But we know that the discharge, sediments and slope must determine homologous river geometry.

3.1 Physical model results of cross section

The physical model was conducted in a 160 m long, 20 m wide outdoor open space. The longitudinal slope of three river reach were 3‱, 2‱ and 1‱. They are connected orderly by diversion flume. The discharges were 800 m^3/s, 1,500 m^3/s, 3,000 m^3/s, 4,000 m^3/s and 5,000 m^3/s. Each flux with about 3 sediment concentration, the sediment concentration was from 12 to 240 kg/m^3, it was all 16 combinations.

The variety of incoming water and sediment concentration and boundary condition was decisive to the adjustment of river cross section, on the other hand, the latter was adapt to the former, and then to discharge the flood and transport the sediment. The river cross section was already adapted to the changeless incoming water and sediment for a long time adjustment, and then the river cross section was equilibrium. The empirical formula of equilibrium river cross section was obtained form the physical model:

$$B = 2.18Q^{0.95}S^{-0.45}J^{0.44} \tag{1}$$

where: B is river width (m), Q is discharge (m^3/s), S is sedimentation (kg/m^3), J is the longitudinal slope (‱). The observed data is close to the calculated data, as shown in Fig. 1. The relativity coefficient is 0.91.

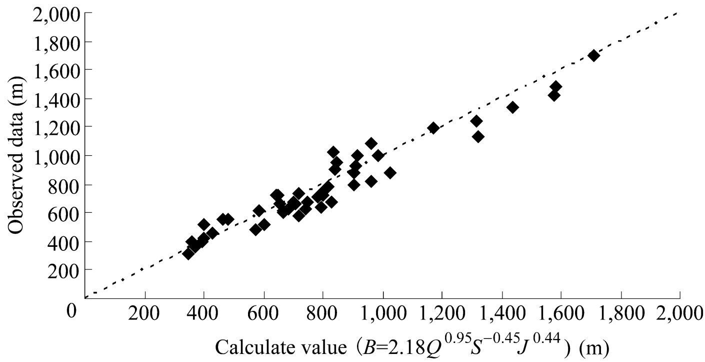

Fig. 1 The comparison of obseved data to calculated data of Eq. (1)

And the formula of area was:

$$A = 2.5Q^{0.9}S^{-0.145}J^{0.07} \tag{2}$$

Here A is area of cross section (m^2). The observed data is close to the calculated data, as shown in Fig. 2. The relativity coefficient is 0.92.

It can be obtained that the higher of discharge, the more likely river width will increase, the area will also increase. The higher of the sediment concentration, the more likely the river width and area tend to be smaller in the same discharge. The higher of longitudinal slope, the more likely that river width tend to be smaller.

3.2 Physical model results of plane shape

The erosion and sedimentation was decided by the incoming water and sediment, the local erosion and sedimentation lead to the river cross section change, and the cross section change leads to plane shape change, so the sinuosity、bend radius and main current oscillation amplitude are variation.

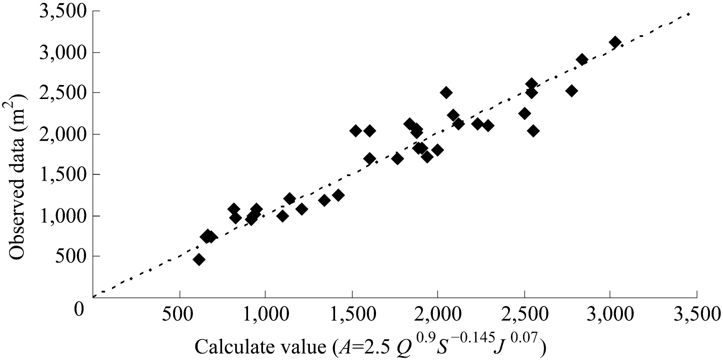

Fig. 2　The comparison of obseved data to calculated data of Eq. (2)

The Fig. 3, Fig. 4 and Fig. 5 illustrate how the sinuosity, bend radius and main current oscillation amplitude vary for different longitudinal and discharge. In the same longitudinal slope, the higher of discharge, the more likely the sinuosity tend to be smaller, the more likely the bend radius and the main current oscillation amplitude tend to be larger. The effect of discharge to sinuosity was obvious. The longitudinal slope also was a decisive factor to the sinuosity, bend radius and main current oscillation amplitude.

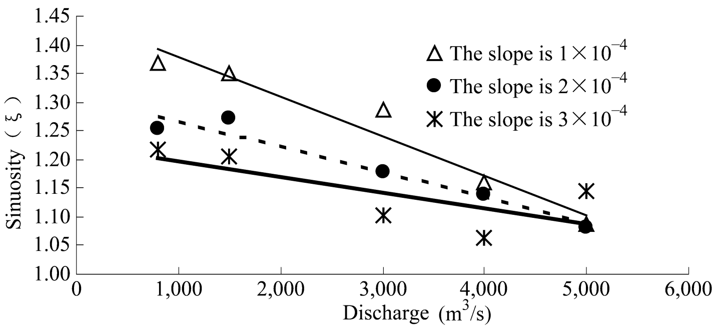

Fig. 3　The relationship between sinuosity and discharge

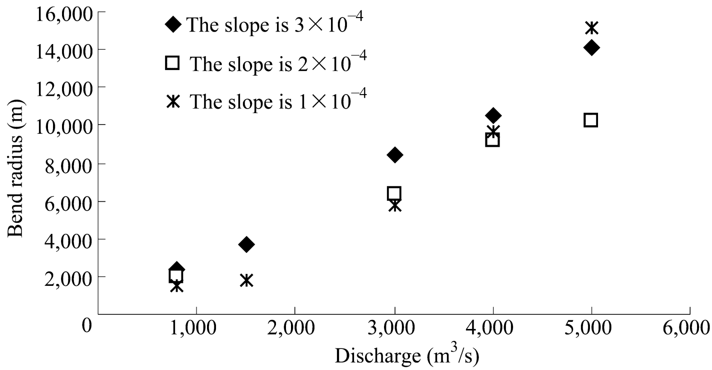

Fig. 4　The relationship between bend radius and discharge

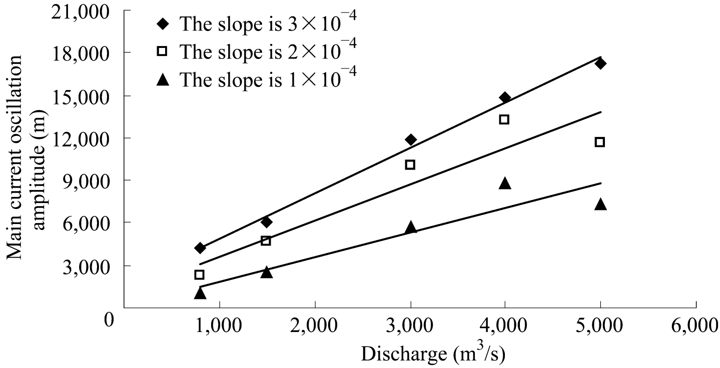

Fig. 5　The relationship between main current oscillation amplitude and discharge

The empirical formula about the sinuosity, bend radius and main current oscillation amplitude in equilibrium river was shown as follow:

$$\xi = 2.85Q^{-0.1}J^{-0.14} \tag{3}$$

$$R = 0.52Q^{1.14}J^{0.52} \tag{4}$$

$$\Phi = 0.68Q^{1.07}J^{1.4} \tag{5}$$

Here the ξ is sinuosity, R is bend radius and Φ is main current oscillation amplitude. The observed data is close to the calculated data, as shown in Fig. 6, Fig. 7 and Fig. 8. The relativity coefficient is 0.9, 0.96, 0.95.

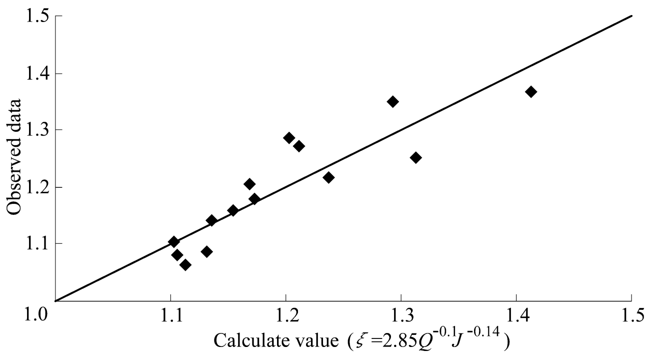

Fig. 6　The comparison of observed data to calculated data of Eq. (3)

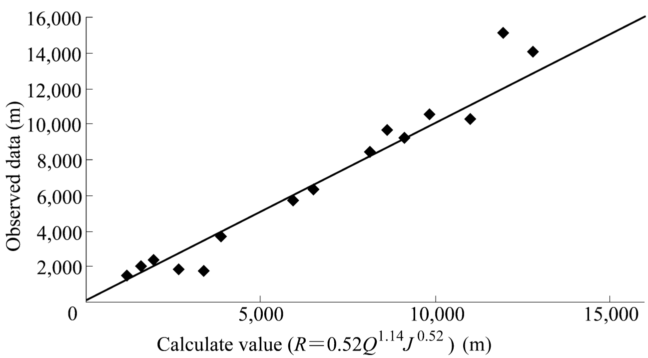

Fig. 7　The comparison of observed data to calculated data of Eq. (4)

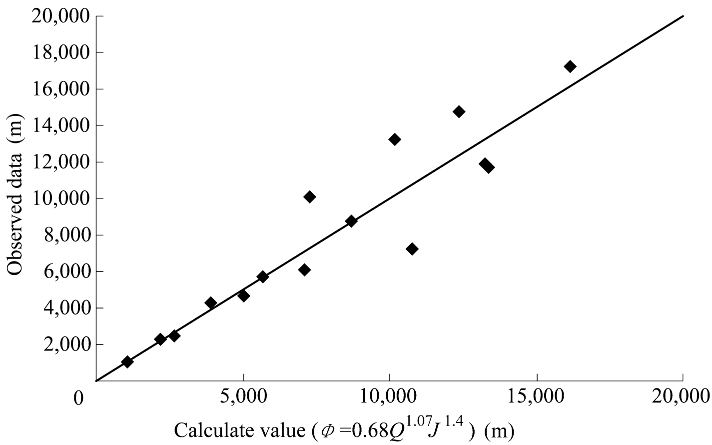

Fig. 8 The comparison of observed data to calculated data of Eq. (5)

4 Conclusions

Based on the data of the physical model in the unchanged water and sediment condition, it research shows that discharge, sediment concentration and longitudinal slope are the factors to influence the mophology of the cross section. The effect of discharge was largest to river width, with a exponent of 0.95, the second was longitudinal slope, finally the sedimentation. The area is also increased with the discharge increased, but the effect of longitudinal slope is not evident. To the river plane shape, there are also obvious regulations: the higher of the discharge, the more likely that the sinuosity tend to be smaller, the more likely the bend radius and the main current oscillation amplitude tend to be larger; the smaller of the longitudinal slope, the more likely that the sinuosity tend to be smaller, that the more likely the bend radius tend to be smaller, and the main current oscillation amplitude tend to be smaller.

The empirical formula of the equilibrium river cross section and plane shape is referenced to the Yellow River harnessing and programming. For example, if the discharge is 1,000 m^3/s, sediment concentration is 15 kg/m^3 in long time in Shandong reach (longitudinal slope is 1‱), and then we can conclude that the river width is about 450 m. Finally the physical model provides enough varification data to other equilibrium theories.

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Serious Deposition in the Lower Yellow River Channel and Countermeasures

Zhang Yanjing, ***Hu Chunhong*** and ***Wang Yangui***

International Research and Training Center on Erosion and Sedimentation, Beijing, 100044, China

Abstract: The runoff and sediment in the Yellow River show a decreasing trend in recent years, but sedimentation become more serious, especially in main channel. The sedimentation causes river channel shrinking , river bed rising, and flood discharge capacity decreasing for the same water level continuously and seriously, threatening the flood control safety of the lower Yellow River. The analysis results show that the continuous sedimentation in the Lower Yellow River channel can be attributed to the water and sediment variations of the Yellow River, such as the continuous low water and high sediment concentration, a longer flood duration, a lower average flood discharge, a higher sediment concentration in flood, more floods with high sediment concentration, and more floods from upper coarse sediment area. Some other causes for the continuous sedimentation include river channel shrinkage by production levee, the extensior of the Yellow River in estuary area, etc. Countermeasures for controlling sedimentation in the Lower Yellow River channel, such as soil and water conservation works, river channel training, water flow and sediment regulation by reservoirs, sediment diversion, river channel dredging, river course shortening in estuary area, etc. are also discussed in this paper.

Key words: the Lower Yellow River, channel deposition, perched river, sedimentation control

1 Introduction

The Lower Yellow River is from Tiexie to Lijin, with a total length of 800 km and an area of about 4,000 km^2 (Fig. 1), belong to an alluvial channel. The Lower Yellow River can be classified as three river channel patterns, i. e, the wandering reach from Tiexie to Gaocun, with a width – depth ratio ($\sqrt{B}/H$) of 20 to 40; the transitional reach from Gaocun to Taochengbu, with a width – depth ratio of 8. 6 to 12. 4; and the meandering reach from Taochengbu to Lijin, with a width – depth ratio of 2 to 6.

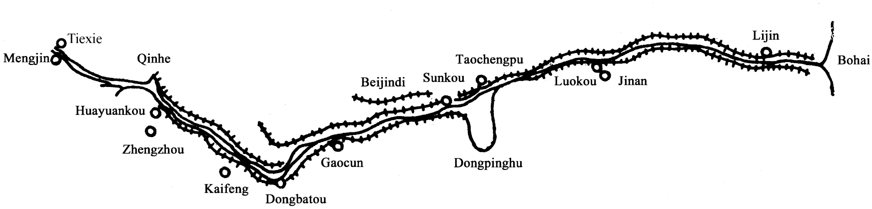

Fig. 1 Plan view of lower Yellow River

The existing Lower Yellow River was formed in different historical periods, mainly in two periods, namely, the natural deposition period form 1855 to 1960 and the period after completion of Sanmenxia Reservoir since 1960.

Table 1 shows annual runoff and sediment load in the Lower Yellow River in different periods. After the completion of Sanmenxia Reservoir in 1960, due to sediment trap, the sediment content in the Lower Yellow River has been declined obviously for the detention of the Reservoir. During the period of Nov. 1985 to Oct. 1999, the annual runoff and sediment load in the Lower Yellow River were 27.8 billion m^3 and 0.764 billion t, respectively, and in the period of July 1919 to June 1985, the annual runoff and sediment load in the lower Yellow River were 46.4 billion m^3 and 1.56 billion t, respectively. Compared with those before 1985, the annual runoff , sediment volume, sediment concentration in the lower Yellow River channel after 1985 decreased by 40.1% , 51% , and 18.2% ,respectively, which shows that even though the runoff and sediment volume decreased remarkably, the sediment concentration almost kept unchanged.

Table 1 Characteristics of flow and sediment for different periods

Periods	Annual runoff (10^9 m^3)	Annual sediment load (10^9 t)	Annual sediment concentration (kg/m^3)	Maximum flood discharge at Huayuankou (m^3/s)
Jul. 1950 ~ Jun. 1960	48.0	1.795	37.4	22,300
Oct. 1960 ~ Oct. 1964	57.3	0.603	10.5	9,430
Oct. 1964 ~ Oct. 1973	42.6	1.63	38.3	8,480
Oct. 1973 ~ Nov. 1980	39.5	1.24	31.3	10,800
Nov. 1980 ~ Oct. 1985	48.2	0.97	20.1	15,300
Oct. 1985 ~ Oct. 1999	27.8	0.764	27.5	7,000
Jul. 1919 ~ Jun. 1985	46.4	1.56	33.6	

Owing to low flow and high sediment load, unbalanced water and sediment, and wide and shallow channel of the Lower Yellow River, a large amount of sediment have been deposited in the channel, making the channel bed rising year after year and the lower Yellow River becoming a perched river. Furthermore, influenced by the operation of Sanmenxia Reservoir and production dikes along two banks, the secondary perched river between the two banks has been formed, its channel bed is higher than the flood – plain outside the production dikes, making the situation of flood control more serious. At present, the whole lower Yellow River has become a two – graded perched river, of which the "highly perched" reach is over 300 km long. The river bed elevation of the lower Yellow River channel is commonly 3 ~ 5 m higher than that of the ground behind the river, the maximum is 10 m. Researches on channel deposition cause and its countermeasures are important for the flood control and the regulation of the Yellow River.

2 Deposition features of the Lower Yellow River

2.1 Continuous deposition

Since 1950s, the lower Yellow River channel has been kept in continuous deposition. The amount of sedimentation and the deposition rate are listed in Table 2. Table 2 shows no obvious decreasing tendency of sedimentation with the decrease of runoff and sediment load. Due to clear water discharging from Sanmenxia Reservoir in the period of Oct. 1960 to Oct. 1964, and the high water and low sediment load in the first five years of 1980s, the river channel was scoured, with an annual scouring amount of 573 million t and 96 million t for the two periods, respectively. In all the other periods, the river channel was silted, with annual deposition amount of 198 million t to 426 million t, the deposition rate was larger than 15.93%. Especially during the period of 1985 to 1999, due to continuous low water flow and sediment load, the deposition rate was as high as 29.58% ,which was 1.9 times of the average annual deposition rate of 15.55 %. With regard to the amount of water and sediment inflow, the deposition of the river channel has been aggravated obviously since 1985.

Table 2 Average annual sedimentation and deposition rate in the lower Yellow river channel in different periods

Item \ Period	July. 1950 ~ Jun. 1960	Oct. 1960 ~ Oct. 1964	Oct. 1964 ~ Oct. 1973	Oct. 1973 ~ Nov. 1980	Nov. 1980 ~ Oct. 1985	Nov. 1985 ~ Oct. 1999	July. 1950 ~ Oct. 1999
Average annual sedimentation (10^6 t)	360	-573	426	198	-96	226	188
Deposition rate (%)	20.06	-95.00	26.13	15.93	-9.94	29.58	15.55

Note: "+" denotes deposition, "-" denotes scour.

2.2 Continous deposition and rising of the channel bed

The scour and deposition conditions in the years of 1950 to 1993 are listed in Table 3. For these 43 years, except the final result of scour in the reach from Tiexie to Huayuankou, all the other river reaches were silted and the average annual deposition thickness was 0.04 ~ 0.09 m; especially in the years of 1986 to 1993, the channel bed rose greatly, reaching to 0.09 ~ 0.28 m. It can be seen that, since 1950, in spite of the variation of water and sediment inflow condition and operation of Sanmenxia Reservoir, the river channel was scoured or silted alternately, but the final result was that channel bed was raised, especially after 1986.

Table 3 Scour and deposition thickness in different periods **Unit: m**

Period	Tiexie—Huayuankou	Huayuankou—Jiahetan	Jiahetan—Gaocun	Gaocun—Aishan	Aishan—Likou	Likou—Lijin
1950 ~ 1960	1.15	0.57	0.97	0.96	0.14	0
1960 ~ 1964	-1.91	-1.15	-1.31	-1.62	-0.59	-0.49
1964 ~ 1973	0.69	1.42	2.16	1.73	2.30	3.25
1973 ~ 1980	-0.45	0.02	0.15	0.46	0.29	0
1980 ~ 1985	-0.54	-0.62	-1.0	-0.36	-0.49	-0.54
1986 ~ 1993	0.69	1.27	1.50	1.50	2.24	1.01
1950 ~ 1993	-0.37	1.51	2.47	2.85	3.89	3.23
Annual mean (1986 ~ 1993)	0.09	0.16	0.19	0.19	0.28	0.13
Annual mean (1950 ~ 1993)	-0.01	0.04	0.06	0.07	0.09	0.08

Note: "+" denotes aggradation, "-" denotes degradation.

2.3 Serious deposition in the main channel

Owing to the decreasing trend of water and sediment inflows in the lower Yellow River, the plain - flooded chances became smaller, sediment was mainly silted in the main channel. The scour and deposition of the river channel for the period of 1950 to 1999 are listed in Table 4. It can be seen from Table 4 that, in the period of 1950 to 1960, sedimentation mainly occurred on the floodplains, which accounted for 77% of the total, and only 23% in the main channel; in the period of flood detention and sediment release of Sanmenxia Reservoir from Nov. 1964 to Oct. 1973, the transversal distribution of sedimentation was changed radically. Because of the flood peak reduction, the released flow had a low portion of bankfull discharge but carried a large amount of sediment, resulting in siltation mainly in the main channel, which accounted for 67% of the total, and only 33% on the floodplains. The average annual deposition in the main channel was 294 million t from Nov. 1964 to Oct. 1973. In the years of 1986 to 1999, for the successive low water flow and sediment load, the main channel was seriously deposited. The sedimentation in the main channel was 159 million t, which accounted for 70.4% of the total.

Table 4 The measured deposition and erosion amount in the main river channel and deposition ratio

Item	Amount of deposition or erosion (10^6 t)					
	July 1950 ~ Jun. 1960	Oct. 1960 ~ Oct. 1964	Nov. 1964 ~ Oct. 1973	Oct. 1973 ~ Oct. 1980	Nov. 1980 ~ Oct. 1985	Nov. 1985 ~ Oct. 1999
Whole section	361	-578	439	181	-97	226
Main channel	82		294	2	-126	159
Percentage of the main channel(%)	22.7		67.0	1.1	129.9	70.4

Note: "+" denotes deposition, "-" denotes erosion.

Since 1986, not only the transversal distribution of sedimentation has changed a lot compared with that in 1950s, but also the amount of sedimentation in the main channel increased greatly. In the years of 1986 to 1999, the annual sedimentation was only 63% of that in 1950s, but the amount of sedimentation in the main channel was 1.6 times of that in 1950s.

2.4 Channel shrinkage and reduction in flood discharging capacity

The river channel kept silting and withering in recent years, thus the medium - flow channel has been narrowed seriously. The variations of channel width of wandering reaches from aerial photogrametric data are listed in Table 5. Since 1980s, owing to long - term effect of small discharge and much lower frequency of effective bed - forming discharge, the channel width of the lower Yellow River for medium flow reduced to less than 2 km in 1996, which were only 40% to 70% of that in 1950s.

Table 5 Variations of channel width of lower Yellow River **Unit: m**

Reach	Year			
	1956	1972	1982	1996
Tiexie—Huayuankou	2,806	3,252	3,000	1,937
Huayuankou—Jiahetan	3,742	3,644	3,079	1,555
Jiahetan—Gaocun	2,890	2,707	1,451	1,207

The variations of flow area under bankfull water stage can be used to reflect the development and shrinkage of the river channel. The variations of flow cross section under bankfull water stage along the river course in 1986 and 1994 are shown in Fig. 2 (a). Compared with 1986, except individual cross section, most of the cross - sections were contracted in 1994, many of which were less than the half of that in 1986. Variations of flow cross section with time under bankful water stage for the Mazhai cross - section in the wandering reach and Datianlou cross - section in the transitional reach are shown in Fig. 2 (b). It is obvious that the flow cross section under bankful water stage for both cross - sections has a withering tendency.

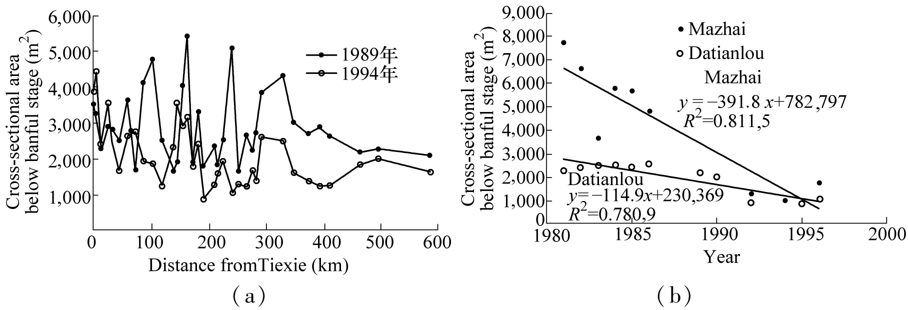

Fig. 2　Variation of flow area under bankfull water stage

Sedimentation and shrinkage of the channel resulted in continuous reduction of bankful discharge. Variations of bankful discharge of the river channel are shown in Fig. 3, which changed from 6 000 m^3/s in 1980s to about 3,000 m^3/s in 2003, even to 2,000 m^3/s for some reaches.

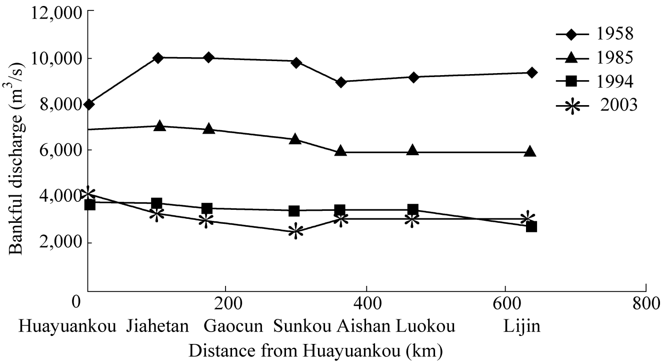

Fig. 3　Variations of bankful discharge of Lower Yellow River

Bankful discharges in 1985, 1994 and 1996 are listed in Table 6. Since 1985, the bankful discharge reduced rapidly, up to 1996 the average bankful discharge in the upper wandering reach of Gaocun reduced to 1/2 or less than 1/2 in 1985.

Table 6　Variations of bankful discharge of lower Yellow River　Unit: m^3/s

Year	Huayuankou	Jiahetan	Gaocun	Sunkou
1985	6,800	7,600	6,900	4,300
1994	3,700	3,700	3,500	3,400
1996	3,500	3,160	2,800	3,300

Sedimentation and shrinkage of the river channel and a sharp reduction in bankful discharges aroused a sharp decrease in flood discharging capacity, the low flow overflowing the bank, and the medium – low flow bringing about a big flood disaster.

2.5　Formation of secondary perched river

Since 1980s, owing to dry climate and excessive use of water resources by human activities, the water amount entering the Lower Yellow River reduced sharply. In addition, for the flood peak reduction and flood detention by Sanmenxia Reservoir, overland flows reduced, sediment was mainly silted in the main channel, and comparably smaller on the floodplains. Besides, since 1958, a lot of production dykes were built on the floodplains, which contracted the flood channel and influenced the water and sediment exchange between the main channel and floodplains, consequently, large amounts of sediment deposited in the main channel between the dykes, the so – called secondary perched river with the channel bed being higher than floodplains which are themself higher than the ground behind the embankments was emerged.

According to the analysis of 13 measured cross – sections in Oct. 2001 from Gaocun to Sunkou, only 3 cross – sections' average channel bed elevations were a little lower than those of floodplains, all the other 10 cross – sections' average channel bed elevations were higher than those of floodplain. The maximum elevation difference between channel bed and floodplain was as large as 4.5m, and the transversal slopes of the floodplain were 0.38‰ to 2.3‰, which were 2.6 to 15.5 times of the average longitudinal river slope.

At present, the Lower Yellow River has completely become a secondary perched river, and comparably serious 'high – perched' reaches are 300 km long. The elevation of the Lower Yellow River channel bed is generally 3 to 5 m higher than that of the ground behind the levees, the maximum is 10 m. The average elevation of the river channel bed is 20 m higher than the urban ground of Xinxiang City, 13 m higher than that of Kaifeng City, and 5 m higher than that of Jinan City. The elevation of the Lower Yellow River channel is still kept in rising, generally 0.05 ~ 0.1 m in a year. In this situation, once a big flood occurs, the river regime will be changed greatly and a transversal or oblique current happens easily, increasing the danger of levee breaking. Under the medium and normal floods, the transversal and oblique branch rivers are easily formed, causing flood discharging along the main levee, threatening the safety of the main levee, and worsening flood control situation. The channel morphology of the Lower Yellow River may be in the most dangerous state in history, and flood control of the Lower Yellow River has come to the crucial situation.

3 Cause of serious deposition

3.1 Low water flow and high sediment load as well as high sediment concentration

According to the measured data at Huayuankou gauging station in the years of 1950 to 2000, the long – term average annual sediment load was 1.05 billion tons, which ranked first in the world, but the long – term average annual runoff was only 40.4 billion m^3. The average annual sediment concentration was 26.4 kg/m^3. The runoff and sediment load of the Yellow River is in an extreme unbalanced state. At the same time, there is a big reduction in runoff yield in the watershed, and the annual runoff after 1970s was apparently smaller than that before 1970s. Since the mid – 1980s, the annual runoff has shown a rapid decline tendency. Affected by climate, hydraulic projects, and soil and water conservation measures, the annual sediment load also reduced rapidly (Fig. 4). Attention should be paid on that, since the mid – 1980s, although the sediment load decreased, the sediment concentration remarkably increased (see Table 1), which aggravated channel sedimentation.

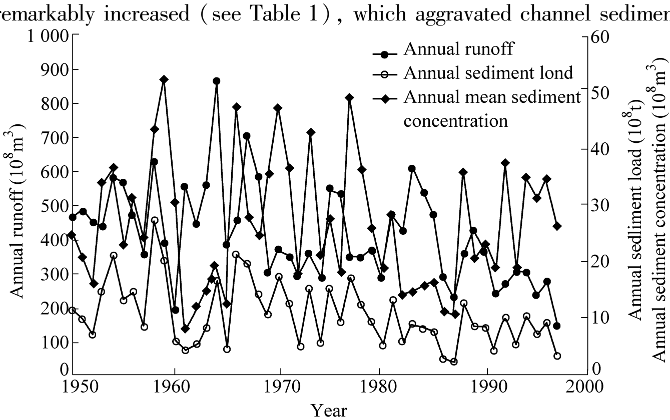

Fig. 4 Changes in annual runoff, sediment load, and average annual sediment concentration

3.2 Hyperconcentrated floods

Since the mid – 1980s, the occurring frequency of hyperconcentrated flows has increased. Floods with sediment concentration larger than 300 kg/m^3 occurred at Sanmenxia station in the years of 1988 to 1989, 1992, 1994 and 1996, respectively. The channel – shaping function by hyperconcentrated flows for the Lower Yellow River channel has greatly be strengthened.

Although the hyperconcentrated flow lasted a short time, the sedimentation caused by it is quite serious. Table 7 gives the amount of deposition during 11 hyperconcentrated flows in the years of 1950 to 1983. The 11 floods lasted 104 days, and the total runoff and sediment load for the 11 floods accounted for only 2% and 14% of the total runoff and sediment load in the period of 1950 to 1983, respectively, but the sedimentation amount accounted for 54% of the total sedimentation for the same period.

Table 7 Details for hyperconcentrated flows in the years 1950 to 1983

Period	Maximal sediment concentration at Sanmenxia station (kg/m^3)	Huayuankou station: Maximal discharge (m^3/s)	Huayuankou station: Coefficient of oncoming sediment (kg · s/m^6)	Runoff (Billion m^3)	Sediment load (Billion ton)	Amount of sedimentation (Billion ton)	Intensity of deposition (million ton/d)
Aug. 18 ~ 25, 1953	716	6,790	0.045,2	1.98	0.35	0.231	28.80
Aug. 26 ~ Sept. 2, 1953	412	8,410	0.043,6	2.1	0.351	0.150	18.80
Sept. 2 ~ 9, 1954	590	12,300	0.017,9	4.75	0.838	0.488	61.00
July 23 ~ 29, 1956	444	6,500	0.033,8	2.06	0.313	0.210	30.00
Aug. 6 ~ 12, 1959	397	7,680	0.043,9	2.70	0.531	0.265	33.20
July 25 ~ Aug. 5, 1969	435	4,500	0.070,9	2.16	0.463	0.335	27.86
Aug. 4 ~ 17, 1970	620	4,040	0.114	2.63	0.830	0.554	39.70
July 25 ~ 30, 1971	666	5,040	0.073,2	1.08	0.247	0.200	33.30
Aug. 28 ~ Sept. 7, 1973	477	5,890	0.058,8	3.17	0.740	0.302	26.26
July 4 ~ 15, 1977	589	8,100	0.052,4	3.45	0.802	0.454	37.80
Aug. 3 ~ 12, 1977	911	10,800	0.058,6	3.09	0.887	0.582	58.20
Total				29.17	6.350	3.770	
July, 1950 ~ June, 1983				1,482	46.20	6.99	
Percentage of hyperconcentrated flow (%)				2.0	13.7	54	

3.3 Floods coming from coarse sediment area

Table 8 lists the amount of scour or siltation of several sediment grain sizes in the river channel from Sept. 15 of 1960 to Oct. 31 of 1990. In the rleach of Tiexie to Gaocun, the amount of coarse sediment with grain size larger than 0.05 mm accounted for 61% of the total sedimentation in flood seasons, 100% in non – flood seasons, and 94% in a year. In the Lower Yellow River channel, the amount of coarse sediment with grain sizes larger than 0.05 mm accounted for 55% of the total deposition in flood seasons, 100% in non – flood seasons, and 82% in a year. It is obvious that the river channel was mainly deposited by coarse sediment of larger than 0.05 mm.

Further researches showed that, coarse sediment silted in the river channel mainly comes from several regions, they are: the area between Hekou town and Longmen, Malian river valley 1 Beiluo river valley and the upper reach of Jinhe river, namely, the coarse sediment area of about 0.08 million km^2 of Jinhe river. The average sediment concentration of flood from coarse sediment area was commonly over 150 kg/m^3. Although floods coming from the coarse sediment areas are only

10% of all floods, the deposition caused by them accounted for 40% to 60% in all floods. Floods from the coarse sediment area are the dominating factor causing serious deposition in the river channel.

Table 8 Contents of various sediment sizes in amount of scour or siltation from Sept. 15 of 1960 to Oct. 31 of 1990

Period	Grain size (mm)	Total amount of scour and siltation in river channel (10^6 t)			Percentage of sediment grain size larger than 0.05mm in amount of deposition (%)		
		Tiexie—Gaocun	Gaocun—Lijin	Tiexie—Lijin	Tiexie—Gaocun	Gaocun—Lijin	Tiexie—Lijin
Flood season	<0.025	458	458	916			
	0.025 ~ 0.05	1,276	-242	1,034			
	0.05 ~ 0.1	1,930	-332	1,598	60.67	13.76	55.24
	>0.1	745	63	809			
	Total	4,409	-52	4,357			
Nonflood season	<0.025	-1,155	44	-1,111			
	0.025 ~ 0.05	-1,134	725	-409			
	0.05 ~ 0.1	-463	703	240	100.00	51.48	100.00
	>0.1	0.70	113	183			
	Total	-2,682	1,585	-1,097			
All-year	<0.025	-697	503	-195			
	0.025 ~ 0.05	141	483	625			
	0.05 ~ 0.1	1,467	371	1,838	94.18	35.68	81.91
	>0.1	816	176	992			
	Total	1,727	1,533	3,260			

Note: "+" denotes deposition, "-" denotes scour.

3.4 Small discharge duration increased largely

Since 1970s, the small discharge duration has increased greatly, and the channel - forming function of small discharges has been strengthed. In the years of 1950 to 1986, the most frequent discharges of 2,000 ~ 3,000 m^3/s lasted averagely 30 days a year, the discharges from 3,000 to 4,000 m^3/s and from 4,000 to 5,000 m^3/s also appeared quite often. While in the years of 1986 to 1996, the most frequent discharges reduced to 500 ~ 1,000 m^3/s, and lasted averagely 38 days a year, and the flood discharge larger than 3,000 m^3/s appeared only 5 days a year.

Owing to water diversion along the river course and channel storage function, the duration of large discharges reduced along the river course, but the duration of small discharges of 50 to 500 m^3/s and less than 50 m^3/s increased. This shows that the lower the location along the river course is, the weaker the bed - forming function of large discharges is, and the comparatively stronger the bed - forming function of small discharges is. Fig. 5. gives duration change of smaller discharge (<50 m^3/s) and larger discharge (>1,000 m^3/s) at Lijin station in the Lower Yellow River during the past years. The smaller discharges (<50 m^3/s) almost did not appear in 1950s and 1960s. They began to appear after 1970s, and increased with time after 1970. The accumulated days of smaller floods (<50 m^3/s) increased to 50 to 60 days in a year over the period from 1970 to 1990, and rapidly to about 150 days after 1990. The accumulated days of larger floods(>1,000 m^3/s) rapidly reduced since 1970s, from about 200 days in 1950s and 1960s to about 60 days in 1990s.

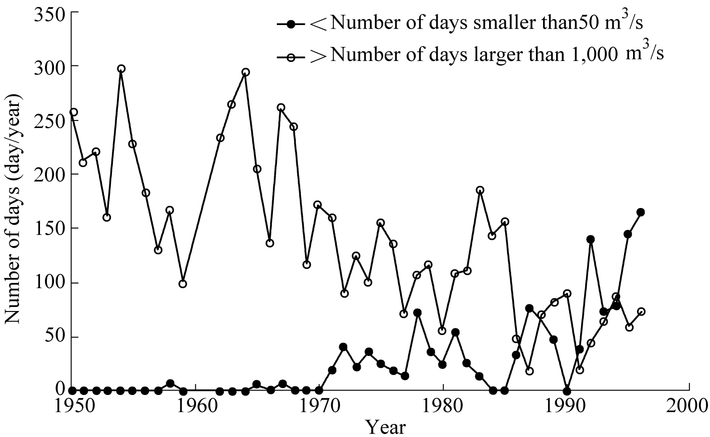

Fig. 5 Change in duration of different discharges at Lijin Station

3.5 Great changes in flood processes and flood discharge as well as sediment concentration

In recent decades, the duration of flood was prolonged, the average flood discharge reduced greatly, and the sediment concentration of flood increased. All these aggravated sedimentation in the main channel. In the years of 1950 to 1997, 398 floods happened in the Lower Yellow River, among which 100 floods happened in the years of 1986 to 1997. Among 398 floods, there were 33 hyperconcentrated floods with maximum sediment concentration larger than 300 kg/m^3, 48 low sediment – concentrated floods with average sediment concentration smaller than 10 kg/m^3, and 317 common floods. Table 9 gives water flow and sediment features of all floods. The sediment inflow coefficient in Table 9 is a ratio of sediment concentration to water discharge. It can be seen from Table 9 that after 1986, the amount of runoff and sediment load in every flood reduced, but the flood duration increased. The average flood discharge reduced greatly, but the sediment concentration and sediment inflow coefficient increased. This kind of variation in flood processes on one hand, reduced the main channel scour by large floods, on the other hand, aggravated the main channel, sedimentation owing to an increase in sediment inflow coefficient.

Since 1976, the flood peak discharge has a reducing tendency. Fig. 6. shows the variation of flood peak discharge at Sanmenxia and Huayuankou stations during the past years. Since 1976, the flood peak discharges at Sanmenxia station have gradually reduced. From 1976 to 1995, except a very large flood peak in 1982 due to the local inflow, the flood peak discharges at Huayuankou station still presented a decrease tendency.

3.6 Flood channel narrowed by production dykes

Since 1958, production dykes have been widely built on the floodplains of the river channel. The dykes narrowed the flood channel, aggravated the sedimentation of the river channel, influenced the exchange of water and sediment between floodplains and channel, and made a large proportion of sediment deposited in the main channel between production dykes. Consequently, the sedimentation increased in the channel, reduced on the floodplain, and the situation of secondary perched river was aggravated.

Table 9 Details of flow and sediment of all floods in Lower Yellow River

Flood grade	Period	Number of floods (d)	Duration	Runoff (10^6 m^3)	Amount of sediment load (10^6 t)	Discharge (m^3/s)	Sediment concentration (kg/m^3)	Sediment inflow coefficient ($kg \cdot s/m^6$)
Common flood	1950 ~ 1997	317	12.5	2,485	112.9	2,402	45.4	0.018,9
	1986 ~ 1997	77	13.2	1,578	87.8	1,651	55.7	0.033,7
Hyperconcentrated flood	1950 ~ 1997	33	12.9	2,310	377.2	2,388	163.3	0.068,3
	1986 ~ 1997	12	16.1	2,242	315.3	1,786	140.6	0.078,7
Low concentration flood	1950 ~ 1997	48	18.9	2,473	9.4	1,801	3.8	0.002,1
	1986 ~ 1997	11	31.0	2,002	12.2	791	6.1	0.007,7
All	1950 ~ 1997	398	13.3	24.69	1.224	2,329	49.6	0.020,1
	1986 ~ 1997	100	15.5	17.02	1.068	1,573	62.7	0.039,8

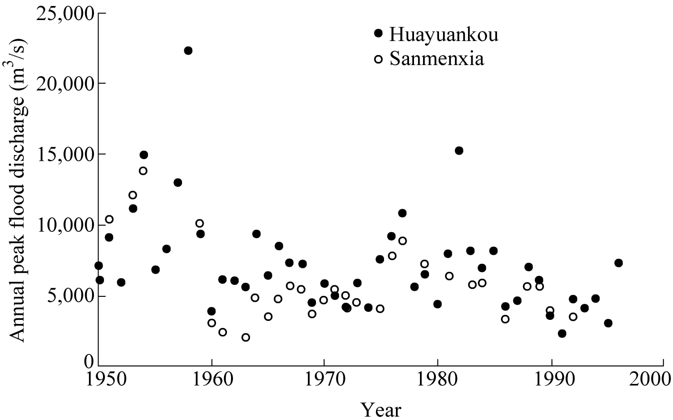

Fig. 6 Change in flood peak discharges at Sanmenxia and Huayuankou Stations

3.7 Extension of the Yellow River Mouth

Extension of the Yellow River mouth results in the rise of erosion base level, raises water stage, and causes retrogressive deposition in the channel, which aggravates deposition in the river channel to some extent.

4 Strategies for controlling sedimentation in the Lower Yellow River

4.1 Soil and water conservation works

Soil and water conservation works should be strengthened in the middle and upper Yellow River area to reduce the amount of sediment entering into the Lower Yellow River. The deposited sediment in the Lower Yellow River mainly comes from the sediment yield area with abundant and coarse sediment in the middle Yellow River basin. This area features broken topography, steep slopes and deep gullies, centralized rainstorms, severe water and soil loss . But the existing criterion for water and soil conservation is low, and the future task is very arduous. Practices show that water and soil conservation works, such as silt – detaining dam construction, afforestation, are one of the essential measures to reduce sediment entering into the Yellow River. Through adopting comprehensive countermeasures of engineering, biologic and cultivation mode improvement etc. , the aims to alleviate soil erosion and reduce sediment entering the Yellow River could be achieved.

4.2 Channel regulation

Channel regulation work can strengthen the Lower Yellow River's boundary and control its main stream. Through constructing flood – plain control and protection works, such as embankment, buttress and bank revetment, to regulate the middle flow channel, confine the meandering range, control the main stream and river regime, decrease the occurring probability of transversal current and oblique current and rolling current, the aim of protecting flood – plain and bank can be achieved. Besides, according to the characteristics of meandering channel, wide and shallow cross – section, longer middle and small discharge duration, the groyne construction along the channel bank can be carried out to narrow and deepen river channel. The adopted channel regulation measures will remarkably increase sediment carrying capacity of the Lower Yellow River during flood periods, transporting more sediment into the sea and alleviating sedimentation in the Lower Yellow River.

4.3 Regulation of water flow and sediment load by reservoirs

Water and sediment should be regulated timely to enlarge flood cross – section and reduce deposition in the Lower Yellow River. In order to control floods and sediment loads effectively, it is meaningful to carry out regulation of water flow and sediment load, construct main projects inceasingly, build a regulation system of water flow and sediment load, ultimately form an integrated regulation system composed of Longyangxia Reservoir, Liujiaxia Reservoir, Daliushu Reservoir, Qikou Reservoir, Guxian Reservoir, Sanmenxia Reservoir and Xiaolangdi Reservoir to enhance the artificial flood and sediment load control capability.

From July, 2002 to July, 2004, three tentative flow and sediment regulations in the Yellow River were carried out, a total of 260 milion t sediment was transported into the sea, the whole river channel was scoured, and the flood discharge capacity increased from bellow 2,000 m^3/s to 3,000 m^3/s, effectively alleviating sedimentation in the Lower Yellow River . Since 2005, the water and sediment regulation have been formally put into practical application.

4.4 Diversion of sediment and desilting

Sediment diversion and desilting to reduce sediment load of the Lower Yellow River can not only alleviate the deposition of the river channel, but also decrease the extension rate of the river mouth, so it can be served as an essential measure for the Lower Yellow River regulation and harnessing. Especially, in combining with large scale projects on the upper and middle Yellow River, constructing desilting area in a planned way, the multiple purposes of sediment pile – up, soil quality improvement, and levee stabilization will be realized.

4.5 Channel dredging

River channel dredging can deepen and widen the severe deposited main channel and move out coarse sediment of 0.025 ~ 0.05 mm to silt the levee, reducing height difference between river channel and levee foot and rising ground. Dredging has some role in increasing river channel discharge capacity, alleviating sedimentation in river channel, decreasing river bed rising, controlling floods, protecting dikes. Sediment dredging in some estuaries has certain successful experiences. It is an important auxiliary measure to alleviate river channel sedimentation and control flood. While the dredging measure is adopted, attention should be paid to re – silting in dredged river channel. The dredged sediment should be properly treated and pollution by sediment should be prevented.

4.6 Shortening river course to the sea

Because the extension of the river mouth leads to rise in longitudinal profile of the river channel, it is necessary to adopt some measures to decrease the extension rate of the river mouth. The concrete measures include choosing a river mouth with comparatively deep water, steep bank slope and strong sea current, and altering the river course in a planned way to shorten the channel.

4.7 Diversion of seawater to scour the river mouth

Seawater would be transferred from Laizhou Bay to Lijin reach of the Yellow River to scour the river channel downstream Lijin and to move more sediment into the sea by salted – turbid density flow. It is expected that the headward erosion as a result of lowered base level will alleviate sedimentation in the river channel upstream Lijin.

5 Conclusions

According to above analyses, the main reason for the heavy deposition, channel shrinkage, and flood carrying capacity reduction of the lower Yellow River in recent decades is the variation of the runoff and sediment load process since 1986, such as the continuous low water flow and high sediment concentration, a large increase in flood duration and a large decrease in water discharges as well as an increase in sediment concentration, hyperconcentrated floods, floods originating from source area of coarse sediment, great changes in flood processes and flood discharge as well as sediment concentration. Other subsidiary reasons include construction of production dykes narrowing flood channel and the extension of the Yellow River mouth. Up to the present, strategies for sedimentation control in the Lower Yellow River, such as soil and water conservation works, regulation of flow and sediment load by reservoirs, diversion of sediment and desilting, dredging in channels, shortening flow path to the sea have been adopted and taken effect. Deposition of the Lower Yellow River is still very serious and may not be eliminated easily due to many influencing factors. With the improvement of understanding of mechanism of flow and sediment and the development of science and technology, some new technology and methods such as diversion of seawater to scour the Lower Yellow River should be taken into considerations to mitigate the deposition of the Lower Yellow River more effectively.

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Research on the Effect of Dams on Water Environment in Huai River Basin

***Zhang Yongyong*[1], *Xia Jun*[2,1], *Wang Gangsheng*[2], *Zhao Changsen*[2] and *Jiang Yan*[2]**

1. State Key Laboratory of Water Resources and Hydropower Engineering Science, Wuhan University, 430072
2. Key Laboratory of Water Cycle and Related Land Surface Processes, CAS, Beijing, 100101

Abstract: The effect appraisal on water environment and aquatic ecosystem subject to dam construction is one of the hotspots in the world. Taking the Huai River Basin as an example, a distributional SWAT hydrologic model and a water quality – quantity model in the paper have been firstly developed as the basis. Three cases, i. e. with dams and pollution, without dams and with pollution, and with dams and without pollution, have been designed to contrast the water quality variation process of the dams on the Shaying River and Bengbu Dam on the main Huai River. The contribution of the dams and polluting discharge to the Huai River in the year of the status (1999) has been quantitatively computed for the first time. The results would provide a scientific basis to antipollution and joint operation of the dams in terms of water quality and quantity regulation.

Key words: dams, water pollution, contribution, Huai River Basin

1 Introduction

The research of the dams' effect on river ecology and environment is not only a new task in the watershed management in our country; but also is one of the worldwide hotspots and difficulties. According to the 1998's statistics of the International Commission On Large Dams (ICOLD), there are about 48,000 large dams in the world that includes 22,000 dams in China, accounting for 46% approximately. The dam construction brings about huge benefits in water supply, irrigation, flood prevention, electric power generation, etc. and promotes the socio – economy development as well. However, along with excessively exploited water resources, a great mass of dams constructed have intensified rivers pollution, biodiversity degeneration and so on. The negative effect of dams on ecology and environment has been becoming more prominent day by day. Therefore, in view of appraisal of the relations between dams and eco – environment correctly, a large number of people protest against construction of the dams in such developed countries as the USA, thus, 1,440 dams had been removed in the USA during 1995 to 2000 (Yu &Shi, 2005).

The Chinese government has been paying more attention to the Huai River's pollution at all times. In 1994, the government promised to make the water clear in the Huai River by 2000, but the pollution is still very serious so far. Besides the excessive discharge of pollutants to the river, the construction of a large number of dams should be another major cause. At present, there are 5,400 large and middle sized reservoirs and more than 4,200 dams and sluices in the Huai River Basin. Those dams and sluices have slowed down flow velocity, reduced their self – purification capacity and river runoff and aggravated the water body pollution of rivers. What is more, the majority of the gates are closed to store water in a dry flood season, as a result, abundant sewage water from living and production would get together in front of the gates to create polluting mass of high concentration, which easily results in outburst polluting accidents when the gates are opened first time to release flood water in flood season, such accidents as the 1994 and 2004's heavy pollution accidents taken place in the Huai River. In March 2005, the State Council Office instructed to earnestly appraise the operation and management situation of the existing dams on the Huai River. In October of the same year, Vice – Premier Zeng Peiyan emphasized in the Huai River basin water pollution controlling meeting that we should carry out the eco – environment assessment earnestly for the hydraulic projects to be built, and should appraise on the operation and management situation of the existing dams. In November, Suo Lisheng, the vice – minister of the Water Conservation Ministry, expressed his opinion that it was necessary to appraise the existing dams at the Ecological Effects of Hydraulic Project Operation Forum (Suo,2005).

Currently, the influence appraisal of dams is only limited to some unilateral research, i. e. obstructing navigation(Li &Chen, 2003; Lin, 2005), reducing pollutant bearing capacity(Suo, 2005; Yuan, 2004), influence on fish migration and biodiversity and so on(Yu &Shi, 2005; Zhou, 2005;Wang & Dong, 2006; Li, 2006;Yang, 2006; Huang, 2006). All researches are not in the basin scale for the appraisal. In addition, most research is based on qualitative descriptions instead of concrete quantification. In this study, the Huai River Basin is taken as an example, and a distributional SWAT hydrologic model and a water quality – quantity model are chosen as the foundation for the first time to appraise the effect of dams on the rivers water quality process and preliminarily quantify the contribution of the dams to the Huai River pollution (in 1999). This findings is expected to provide the scientific basis for antipollution and union dispatch on water quality and quantity.

2 The integrated appraisal model

The integrated appraisal model of dams to water environment is established by combining a distributional SWAT hydrologic model of coupling dams in the Huai River Basin with a conceptual model of adjacent dam's water quality and quantity. Based on the water quantity and water quality parameters calibrated according to the data of the typical year(1999), the SWAT model is utilized to stimulate flow discharge of rivers, runoff yield of sections, the water abstracted by human being's activity and water storage variation of river course and reservoirs for both cases of with and without dams, all of which will be the input of the water quality model for simulation of river water – quality concentration change. Finally the contribution of dams and pollutants to the Huai River will be studied.

2.1 The distributional SWAT hydrology model for coupling dams

The SWAT is a distributional hydrologic model of powerful physical mechanism, developed by the Agriculture Research Bureau under the American Agriculture Ministry. And it has been applied widespread in Canada and the North America (Fontaine, T. A., et al., 2002). In China, Wang Z. G. (2003,2006), Liu C. M. (2003,2006) applied SWAT to the Hei River, Hai River and Yellow River. The SWAT model is well established for its flexible operation, powerful functions and good suitability for the complex hydrologic simulation and the water resources management in big river basins.

The hydrologic cycle in the Huai River Basin has been severely disturbed by the excessive dams' construction. Therefore, the dams influence should be taken into consideration when developing the Huai River Basin distributional hydrologic model. SWAT model provides the reservoir simulation function, which considers the reservoir as an independent unit to be added to the corresponding sub – basin. It is very convenient to simulate the influence of the reservoirs on the regional hydrologic cycle. The dam also can be treated as a reservoir, with a similar method. The distributional hydrologic model of coupling dams for the Huai River Basin is constructed on the ARCVIEW SWAT2000 interface.

2.2 The adjacent dams' water quality and quantity conceptual model

Taking the river section between two adjacent dams for computing (see Fig. 1), the water quality – quantity conceptual model of section i will be:

$$\begin{cases} \Delta V_i = (Q_{i-1} + Q_{i-2} - Q_i)\Delta t + R_i - q_i \\ C_i = \dfrac{(Q_{i-1}C_{i-1} + Q_{i-2}C_{i-2})\Delta t + R_i C_{R_i} + W_i}{q_i + \Delta V_i + Q_i \Delta t + K_i V_i} \end{cases} \tag{1}$$

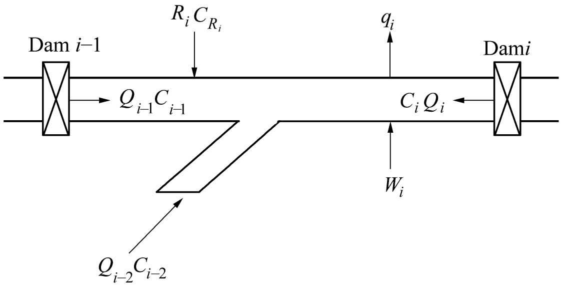


Fig. 1 Balanced water quantity and quality relationship between any two adjacent dams

where: Q_{i-1}, C_{i-1} are the flow and water quality concentration at the lower reaches of dam $i-1$, respectively. Q_{i-2}, C_{i-2} are the flow and water quality concentration from the tributary, respectively. If there is no tributary in the river, Q_{i-2}, C_{i-2} shall be 0. Q_i, C_i are the flow and water quality concentration at the upper reaches of dam i, respectively. R_i is inflow from the section, while C_{R_i} is the non point pollutant concentration. q_i is the water withdrawing quantity. V_i is the storage volume. ΔV is the variable storage volume. K_i is the degradation coefficient in section i. W_i is the total point pollutant received in section i. The model is deduced in detail by Xia J. et al. (2005). The degradation coefficient K_i relates with the flow for the same computing section, $K_i = \alpha_i Q_i^{\beta_i} + \gamma_i$, where α_i, β_i, γ_i are the degradation parameters of section i.

Because of the observed data for non point pollutant unavailable, the non point pollutant concentration C_{R_i} should be calibrated. Suppose that: C_{R_i} is a multiple of C_i, viz. $C_{R_i} = \eta C_i$, the amount of non point pollutant is quite variable between flood season and non – flood season. So when simulating the concentration of NH_4 – N and COD_{Cr}, the parameters α_i, β_i, γ_i, η are divided into two groups. During the non – flood season, C_{R_i} is less than C_i, viz. $\eta \leqslant 1$, while during the flood season, C_{R_i} is more than C_i, viz. $\eta \geqslant 1$. GA algorithm method is selected for the parameters calibration (Duan et al. 1994; Wang & Xia 2005).

2.3 The effect appraisal indices of dams on river environment

The effect of dams and pollutant on rivers environment in the Huai River is analyzed by contrasting the water quality process under three different cases, with dams and pollution (11), without dams and with pollution (01), and with dams and without pollution (10).

2.3.1 The effect appraisal index of dams

$$\eta_{\text{dams}} = \sum_{i=1}^{12} (C_{11} - C_{01}) / \sum_{i=1}^{12} C_{11} \times 100\% \tag{2}$$

where: η_{dams} is the effect appraisal index of dams. C_{11}, C_{01} are water quality concentration for the cases of with dams and pollutant (11), and without dams and with pollutant (01) respectively. NH_4 – N and COD are selected as the water quality index. If $\eta_{\text{dams}} < 0$, $\sum C_{11} < \sum C_{01}$, it indicates that the dams will be helpful to reduce water polluting concentration. If $\eta_{\text{dams}} > 0$, $\sum C_{11} > \sum C_{01}$, it means that the dams will aggravate worsening of water quality. If $\eta_{\text{dams}} = 0$, $\sum C_{11} = \sum C_{01}$, it means that the effect of dams on water quality is not obvious.

2.3.2 The effect appraisal index of pollutant

$$\eta_{\text{pollution}} = \sum_{i=1}^{12} (C_{11} - C_{10}) / \sum_{i=1}^{12} C_{11} \times 100\% \qquad (3)$$

where: $\eta_{\text{pollution}}$ is appraisal index of antipollution to water quality. C_{10}, C_{11} is water quality concentration for the cases of (11) and (10). Normally, $\eta_{\text{pollution}} \geqslant 0$.

2.3.3 The contribution of dams and pollutant to water quality

$$\varepsilon_{\text{dams}} = \frac{\eta_{\text{dams}}}{\eta_{\text{dams}} + \eta_{\text{pollution}}} \qquad \varepsilon_{\text{pollution}} = \frac{\eta_{\text{pollution}}}{\eta_{\text{dams}} + \eta_{\text{pollution}}} \qquad (4)$$

where: $\varepsilon_{\text{dams}}$, $\varepsilon_{\text{pollution}}$ are the contribution of dams and pollutant to water quality, respectively. If $\eta_{\text{dams}} < 0$, the pollutant discharge is the main reason of the river pollution, viz. $\varepsilon_{\text{dams}} = 0$, $\varepsilon_{\text{pollution}} = 1$. If $\varepsilon_{\text{dams}} < \varepsilon_{\text{pollution}}$, the effect of dams on river quality is less than that of pollutant discharge. If $\varepsilon_{\text{dams}} > \varepsilon_{\text{pollution}}$, the effect of pollutant discharge on river quality is less than that of dams. If $\varepsilon_{\text{dams}} = \varepsilon_{\text{pollution}}$, the effect of pollutant discharge on river quality equals to that of dams.

3 The integrated appraisal of dams to river environment in Huai River Basin

The Shaying River, with the largest flow discharge and most severe pollution among the tributaries of the Huai River Basin, is selected as an example to be analyzed for the dams' effect on the river environment. As the Shaying River brings more than 60% pollutant to the Huai River, it is named "the barometer" of the Huai River. Since 1980's while it has brought about abundant water quantity to the main river, Shaying River has been polluted seriously, and the main pollutant exceeds the water quality standard more than several dozens times, even hundred times. Pollution accident occurs unavoidably. In this study, the Shaying River is divided into eight computation sections, viz. Zhaopingtai Reservoir—Baiguishan Reservoir —Mawan Dam —Luohe Shahe Dam—Shahe Zhoukou Dam—Huaidian Dam—Fuyang Dam—Yingshang Dam—Fantaizi, of which seven dams on the Shaying River and Bengbu Dam on the Huai River will be the key points for study (Fig. 2 and Table 1).

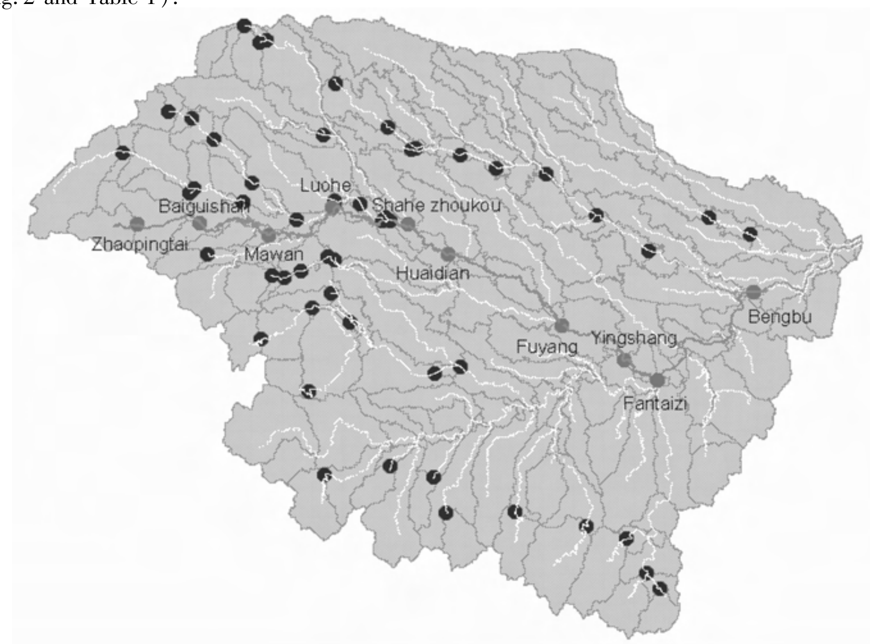


Fig. 2 The research reaches and dams in Huai River Basin

Table 1 The water quality goal of the water function zones at the Shaying River

Dams and Reservoirs		Water function zones	Water quality(mg/L)		
Upper section	Lower section		Class	NH_4-N	COD_{Cr}
Zhaopingtai	Baiguishan	Water protection and utilization zones of river source	Ⅱ	0.5	15
Baiguishan	Mawan	Utilization zone	Ⅲ	1	20
Mawan	Luohe	Utilization zone	Ⅲ	1	20
Louhe	Shahezhoukou	Utilization zone	Ⅲ	1	20
Shahezhoukou	Huaidian	Utilization zone	Ⅲ	1	20
Huaidian	Fuyang	Utilization zone	Ⅲ－Ⅳ	1	20
Fuyang	Yingshang	Utilization zone	Ⅲ－Ⅳ	1	20
Yingshang	Fantaizi	Utilization zone	Ⅱ－Ⅲ	1	20
Fantaizi	Bengbu	Utilization zone	Ⅱ－Ⅲ	1	20

3.1 The effect of dams on river water quality

This paper takes Baiguishan Reservoir on the Shaying River source and the Fuyang floodgate at the lower reaches as examples to expatiate the effect of dams on the Shaying River water quality.

3.1.1 Baiguishan reservoir

The flow hydrogragh with and without dams for Baiguichan Reservoir as shown in Fig. 3.

At present, water quality of the Baiguishan Reservoir is polluted by NH_4-N that is lower than Class Ⅲ for its water functioning zone, as shown in Fig. 4. Comparing water quality(C_{01}) of non－dam with that of having dams (the present situation), the concentration of NH_4-N and COD_{Cr} changes a little in the flood season, but remarkable in non－flood season. The concentration of NH_4-N increased 2% and the concentration of COD_{Cr} increased 28% in the whole year. The reservoir is favorable for the water quality concentration improvement.

In order to meet the water quality goal, the concentration of NH_4-N and COD_{Cr} can be reduced 92% and 20% respectively by controlling the pollutant discharge.

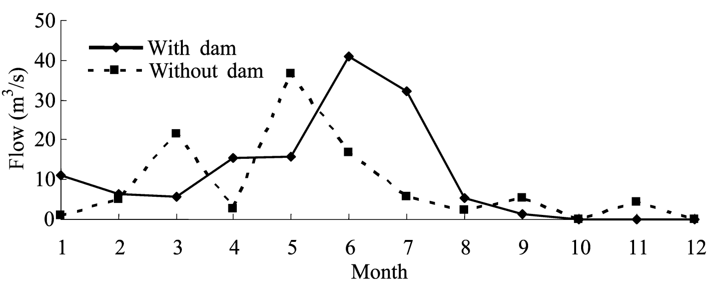


Fig. 3 The flow hydrograph with and without dams for Baiguishan Reservoir

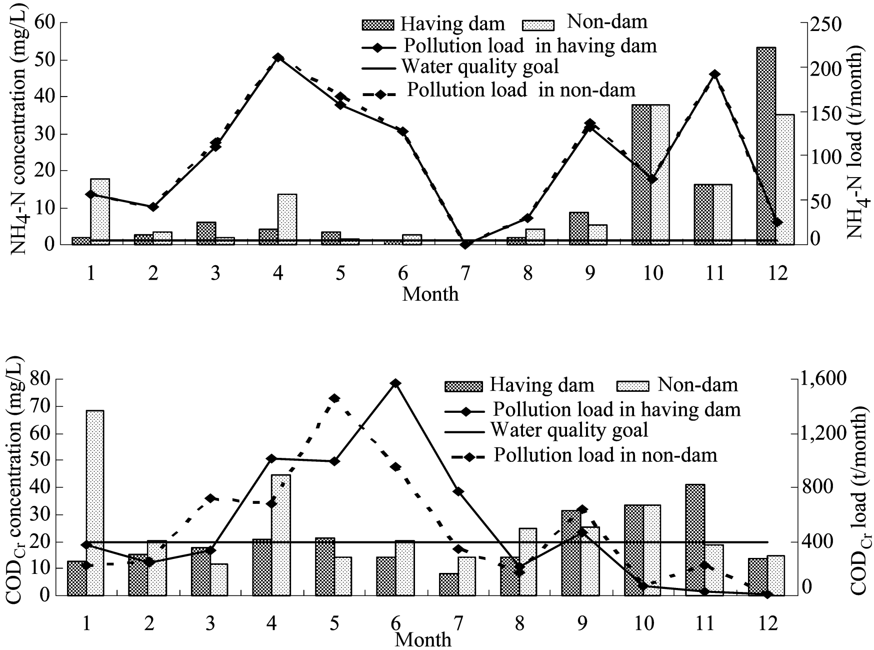
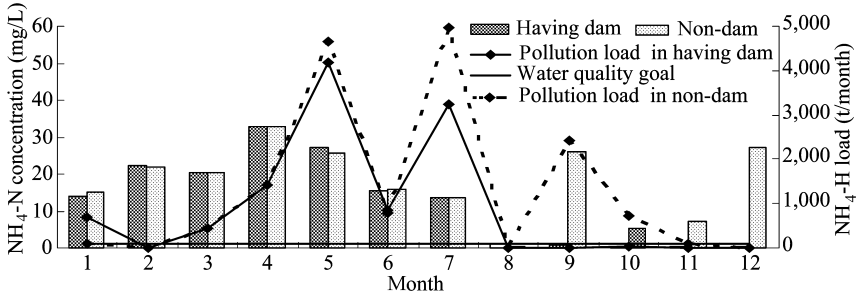


Fig. 4 The concentration hydro graph of NH_4-H and COD_{Cr} with and without dams for Baiguishan reservoir

3.1.2 Fuyang gate

At present, water body at the lower reaches of the Fuyang dam is being polluted seriously (Fig. 5). Comparing C_{01} with C_{11}, the concentration of NH_4-N and COD_{Cr} change a little from June to July. But from August to the end of the year when the gate is closed, the sewage from the upper reaches generates no influence to the water body at the lower reaches (Fig. 6). The concentration of NH_4-N increased 42%, with little change of the concentration of COD_{Cr} in the whole year. Therefore, the concentration of NH_4-N and COD_{Cr} will reduce 93% and 37% by controlling pollutant discharge, respectively.



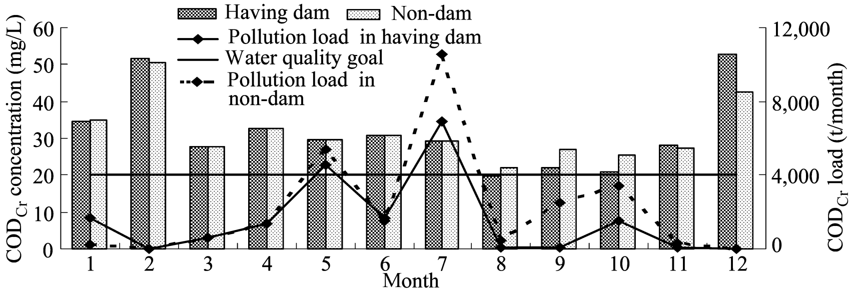


Fig. 5 The concentration hydrograph of NH_4-N and COD_{Cr} with and without dams for the Fuyang Dam

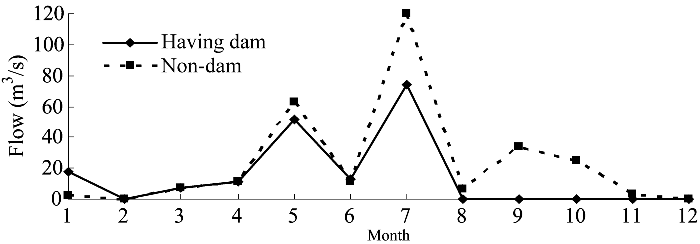


Fig. 6 The flow hydrograph with and without dams for the Fuyang dam

The results of all the researched dams on the Shaying River are shown in Table 2 and Fig. 7, Fig. 8.

Table 2 The effect of Shaying River dams and pollutant discharge on water quality

Dams	NH_4-N (%)		COD_{Cr} (%)	
	η_{gate}	$\eta_{pollution}$	η_{gate}	$\eta_{pollution}$
Baiguishan	-2.0	97.0	-28.0	20.0
Mawan	13.0	71.0	8.0	28.0
Luohe	-19.0	66.0	-5.0	20.0
Shahe Zhoukou	8.0	89.0	9.0	47.0
Huaidian	-10.0	96.0	10.0	49.0
Fuyang	-42.0	93.0	0	37.0
Yingshang	23.0	96.0	4.0	45.0
Bengbu	15.0	83.0	6.0	43.0

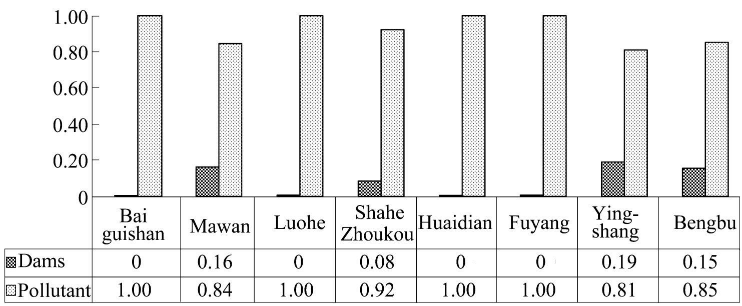
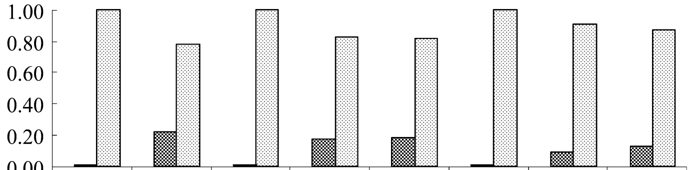


Fig. 7 The contribution of dams and NH_4-N discharge to water quality of the dams on the Shaying River



	Baiguishan	Mawan	Luohe	Shahe Zhoukou	Huaidian	Fuyang	Ying-shang	Bengbu
Dams	0	0.22	0	0.17	0.18	0	0.09	0.13
Pollutant	1.00	0.78	1.00	0.83	0.82	1.00	0.91	0.87

Fig. 8 The contribution of dams and COD_{Cr} discharge to water quality under dams in the Shaying River

4 Conclusions

The researches carried out herein above can draw the following conclusions:

(1) The effect of dams on the Huai River water quality shows a close relationship with the hydrologic circumstance. The excessive dam construction on the Huai River has changed hydrologic cycle there, and the dam storage and operation have remarkably changed the flow volume and velocity. With opening gates, both flow velocity and quantity of the river would be great, otherwise, the both would be small. The water body self – purification capacity and the environmental capacity have a close relationship with flow and velocity of rivers. The dams substantially reduce the water body self – purification capacity and the environmental capacity.

(2) The effect of dams on the water quality in the Huai River Basin tremendously varies in different area. At the upper reaches of the Shaying River where the reservoir enjoys plentiful water and fast velocity, the water quality is relatively good, and the dams are helpful to improve the rivers environment. But at the middle and lower reaches, with the increase of water quantity, the dam stores water and reduces the flood peak. Comparing with the water quality of non – dam, both the quantity and velocity of flow for the case of with dams are less, so is the degradation coefficient, so, the existence of dams have intensified river pollution.

(3) Comparing antipollution with dams' effect to the Shaying River water quality. At the upper reaches, the dams are helpful to improve the water environment, whereas, the excessive discharge of pollutant is the main cause of the river pollution. But the pollution in the middle and lower reaches is mainly caused by the both, however, regarding to the dams in different areas and the different water quality indices, the effect of two factors are different. Overall, the excessive pollutant discharge is the main reason, and the contribution ratio is in the range of 0.7 ~ 1.0, taking Mawan, Shahe – Zhoukou, Yingshang and Bengbu dams for instance. For the dams with a great quantity of sewage mass flocked at its upstream, such dams as Luohe, Huaidian and Puyang can trap sewage water so that the water quality worsening of the lower reaches can be alleviated.

Massive hydraulic engineering construction of the Huai River Basin has obviously contributed to the water environment contamination the pollution. In order to improve the Huai River environment and realize the objective of making the Huai river water clear in 2010, except for reducing pollution discharge, adjusting industrial structure, etc., more attention should be attached to the scientific dispatching of dams for both economic and eco – environment interests.

This paper integrates the distributive hydrologic model with the water quality model, and has analyzed the role the dams play in water environment. That is the first time to take the watershed hydrologic cycle as the foundation and the quantitative analysis of dams influence on water pollution in the Huai River Basin. Although the appraisal method is simple, the system is not completed yet and remains to be improved.

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Atrophy of Tail Channels and its Effect on Traveling of Flood in the Yellow River Estuary

Zhang Zhihao and ***Hu Chunhong***

China Institute of Water Resources and Hydropower Research, Beijing, 100044

Abstract: Aiming at the problem of atrophy of tail channels after the variation of flow and sediment in the Yellow River estuary, using the methods of field data analyse and theoretical study, the characteristics and mechanism of atrophy of tail channels in the Yellow River Estuary is searched, and its effect on traveling of flood is probed into. Researchful results show that the degradation and aggradation, longitudinal profile, cross section of tail channels experienced readjusting processes, the new evolution characteristics are put up; the variation of flow and sediment molds the atrophic configuration of tail channels, atrophy of tail channels influences the ability of transporting flow and sediment in reverse, which develops the atrophy of tail channels badly; owing to the atrophy of tail channels, the water level of flood elevates, the flood becomes smooth, the flood transmitting time increases, its effect on traveling of flood is very disadvantage. Using the methods of regress analysis, a criterion index of tail channels is erected. It provides referenced use during the process of harnessing the atrophy of tail channels in the Yellow River Estuary.

Key words: the Yellow River Estuary, atrophy of tail channels, mechanism of the evolution, traveling of flood, a criterion index

1 Introduction

The Yellow River Estuary is the end – result of the Yellow River's flow and sediment, which is the influx area of river and sea and is very important composing part of Yellow River basin. The variation of flow and sediment has been appearing in the Yellow River Estuary since 1986, and the tail channels have experienced complicated response processes. Meanwhile, the characteristic of atrophy of tail channels is most outstanding. With the forming and developing process of atrophy of tail channels, the safety of prevent or control flood is threatened greatly in the Yellow River Estuary, so the research of atrophy of tail channels is becoming a new problem needed to be solved urgently in the Yellow River Estuary. By resorting to field data analyse and using the methods of contrast analyse and theoretical study, the characteristic of atrophy of tail channels in the Yellow River Estuary is opened out, the mechanism of atrophy of tail channels is analyzed deeply, its disadvantage effect on traveling of flood in the Yellow River Estuary is searched. Finally using the methods of regress analysis, a criterion index of tail channels is erected, which provides referenced use during the process of harnessing the atrophy of tail channels in the Yellow River Estuary.

2 The characteristics of atrophy of tail channels

2.1 The characteristics of degradation and aggradation

Fig. 1 is the process of variation of degradation and aggradation at Lijin—Qing7 reach. By analyzing, the characteristics of degradation and aggradation change are as follows: ①Absolute value of aggradation minishs, extend of degradation and aggradation decreases, and aggradation spends more time. ②Except adjustive stage of channel from 1996 to 1997 since the channel changed its route at Qing8 section, characteristic of annual distributing of degradation and aggradation was that flood season and non – flood season were both aggradation. ③ Characteristic of transverse distributing changed. The main channel was degradation and bottomland was aggradation before

1986. Both the main channel and bottomland were aggradation after 1986, and degradation and aggradation happened mainly in the main channel since 1986.

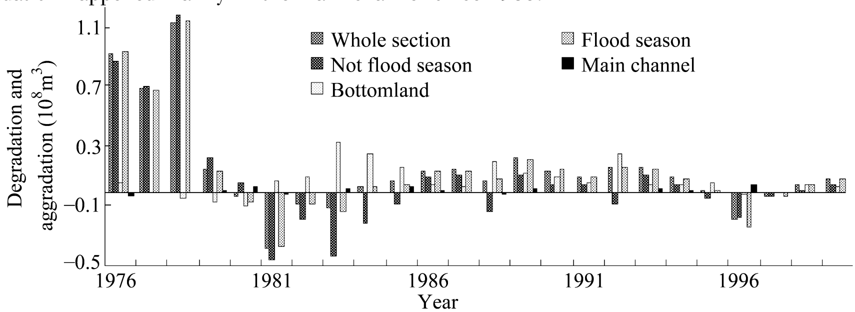

Fig. 1 Variation of annual erosion and deposition in Lijin – Qing7 reach

2.2 Adjustment of longitudinal profile

3,000 m^3/s surface slope of reaches are protracted at the Fig. 2 by analyzing, at the reach from Lijin to Yihaoba affects by the aggradation along the channel, its longitudinal slope increases slowly. Longitudinal slope adjusted complexly as the reach from Yihaoba to Xihekou was affected by aggradation along the channel and toward the source. Longitudinal slope of the reach from Xihekou to Shibagongli increases early, then decreases lastly, which reflects the influence of aggradation along the channel becomes less and the influence of aggradation towards the source takes up a main station. The reach from Shibagongli to Dingzilu is affected by the influence of aggradation towards the source, its longitudinal slope diminishes. The longitudinal slope of the reach from Lijin to Dingzilu is 0.98‱ in 1988, it is 0.95‱ in 1995, so the adjustive trend of longitudinal slope becomes soft during the process of atrophy in the tail channels.

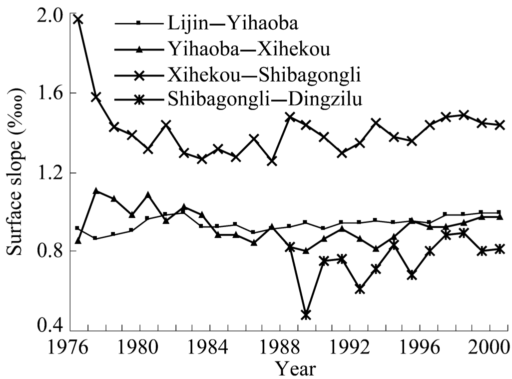

Fig. 2 Variation of 3,000 m^3/s surface slope of tail channels in the Yellow River Estuary

2.3 Variation of morphology of cross section

During the atrophy of tail channels, variation of morphology of cross section is the most direct. Fig. 3 is the variation of morphology of Qing3 section, which shows: ① Main channel become narrow, aggradation is grave, and the area of passing flow decreases; ② The most serious part of aggradation lays on the deepest spot of channel, breadth depth ratio of cross section becomes large, and the channel forms a dish; ③ Aggradation mode of channel atrophy is "welt aggradation".

Concretely, one side of bottomland seldom aggrades, another side aggrades a large tender bottomland; ④ Main channel aggrades new bottomland lip on the tender bottomland, which is spreaded with a lot of sediment. The opportunity of overflowing becomes little at the bottomland surface that is apart from the main channel, whose aggradation reduces. So it becomes low – lying, transverse slope of bottomland increases obviously.

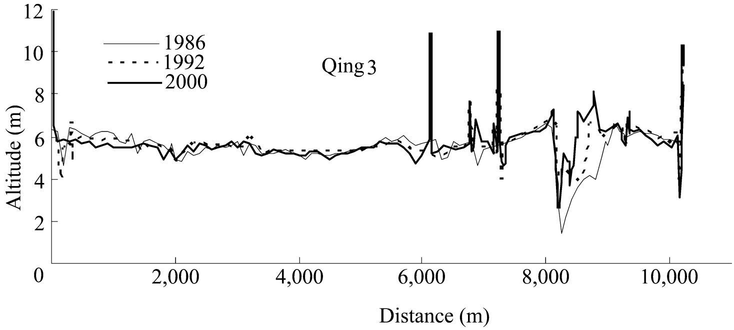

Fig. 3 Variation of typical cross section of tail channels in the Yellow River Estuary

3 The mechanism of atrophy of tail channels

Because different characteristics of variation of flow and sediment act on tail channels, it will bring diverse response. With the continual decrease of annual flow and sediment, the ability of channel's transporting flow and sediment decreases. The decrease of flow and sediment of flood season in a large – scale results in the loss of ability of well self – adjustment of tail channels. As coupling drive of river and sea decreases, the ability of transporting sediment to sea is also lower. The responses mentioned above are that variation of flow and sediment makes the ability of transporting flow and sediment of channel change, it breaks up the primary relative balanceable state of degradation and aggradation of channel, then channel develops toward a new balanceable state of degradation and aggradation. When the old balance is broken up and the new balance is rebuilding, the characteristics of degradation and aggradation of channel will change. This change causes adjustment of lognitudinal and transverse direction. Longitudinal slope becomes slow, and transect becomes atrophy. With the build of new balance of degradation and aggradation, tail channels gradually atrophy. Flow and sediment decay successively, the ability of transporting flow and sediment still decreases, and the temporary balanceable state of degradation and aggradation will be broken up, tail channels will continue to atrophy too. Besides the condition of flow and sediment, continual atrophic lognitudinal and transverse section reduces the ability of transporting flow and sediment of channel, and the channel atrophy is further. It is a badly cycle, channel is more atrophy, the ability of transporting flow and sediment is more lower, channel is more serious atrophy. Fig. 4 summarizes the forming and developing process of atrophy of tail channels in the Yellow River Estuary.

4 Atrophy of tail channels affects traveling of flood

4.1 River circumstances become worse, bottomland falls badly, controlling of engineering weakens

Transverse river power weakens because of variation of flow and sediment which conduces imbalance of transporting sediment of cross section. On one hand, transverse river power can not carry a great deal of sediment to realize transverse transporting, a new big bottomland is formed on one side, On the other hand, transverse river power can not scour the other bottomland to supply transverse transporting sediment, the other side of main channel is not degradation and aggradation, so aggradation of tail channels is "welt aggradation". The mode of welt aggradation brings swing of main channel of tail channels, the river circumstances becomes worse. Some projects lose the function of controlling the river circumstances, freaky river curve appears in some reachs. According to the river circumstances observation of "96 · 8" flood, variation of the river circumstances of tail channels is obvious. Dynamical axes of mainstream moves, tail channels keep to evolution the rule of "one curve changes, all curves change". So mostly projects anear the mainstream formerly are not anear mainstream again, bottomland that is not anear mainstream formerly falls badly. Maximal change of the river circumstances is the reach of Shibahu thereinafter, the flow lean to the left side of Shibahu engineering formerly, now it leans to the right side of Shibahu engineering. The change above brings the chain – reacting: the flow moves adown the Hulin engineering, the bottomland underside the Hulin engineering falls in, the flow move up the Balian engineering, the bottomland up the Balian engineering fall in badly, the flow move up the Qing3 engineering, the flow moves southerly in Dingzilu engineering, the left bottomland of Cha2 section anear the river mouth falls in 500 m long, freaky "S" river curve appears in this reach. The river circumstances of tail channels becomes worse, it brings the bottomland falls in easily, the controlling function of engineering can not exert normally, and its action of controlling the river circumstances weakens obviously.

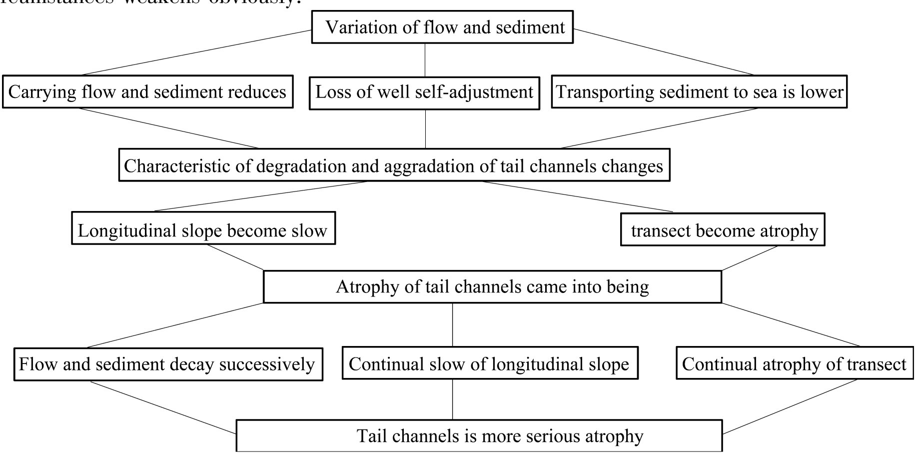

Fig. 4 Sketch of forming and developing process of atrophy of tail channels in the Yellow River Estuary

4.2 The water level of same discharge of flood elevates largely

According to Consecutive equation of current and Maning resistance formula, the formula below can be derived.

$$Q = A \times V = \frac{1}{n} B J^{\frac{1}{2}} h^{\frac{5}{3}} \tag{1}$$

When the discharge of main channels rises from Q_1 to Q_2, elevatory value is as follows:

$$h_2 - h_1 = h^{\frac{3}{5}} B^{-\frac{3}{5}} J^{-\frac{3}{10}} \left(Q_2^{\frac{3}{5}} - Q_1^{\frac{3}{5}} \right) \tag{2}$$

Analyzing formula (2), when the discharge is the same, elevatory value of the water level of main channels increases along with the shorten of breadth of main channels, it increases along with the increase of resistance of riverbed. The tail channels are atrophy, the breadth of main channels shortens largely, the adjustment of bed form of main channels results in the increase of resistance of riverbed of tail channels, so the water level of same discharge of flood elevates up consequentially. Fig. 5 is the variation of water level of 3,000 m^3/s discharge of the tail channels. With the variation of flow and sediment since 1986, the water levels of four stations named by Lijin, Yihaoba, Xihekou and Dingzilu of the tail channels has been constantly elevating, and the elevating extent is big. From 1986 to 1995, the elevating height of the water level of 3,000 m^3/s discharge of four water level stations are 1.46 m, 1.73 m, 1.34 m and 1.43 m, the elevating rates are 0.15 m/a, 0.17 m/a, 0.13 m/a and 0.14 m/a. After 1996, effected by the degradation trace to the source as a result of changing channels at Qing8 section and the degradation of flood season, the water level along the tail channels has declined, and later shows a tendency to increase year after year. Because the water level of the same discharge of flood elevates largely, the degree of disaster of same discharge of large – scale flood will increase. For medium – sized and small flood, the situation of traveling of flood has undergone tremendous changes. The medium – sized and small floods that could not bring the disaster before 1986, but they can bring big disaster after the atrophy of tail channels. "Small flood bring large disaster" is formed, the safety of prevent or control flood is threatened badly.

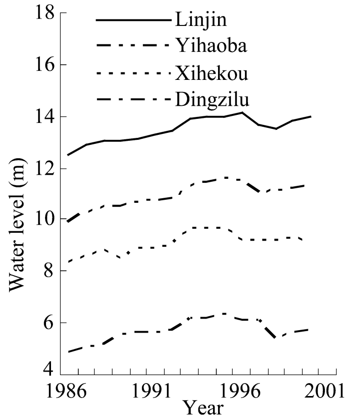

Fig.5 Variation of water level of 3,000 m^3/s discharge of the tail channels

4.3 The decrease of peak discharge is obvious, the flood becomes smooth

Table 1 is the statistics of typical characteristics of three cross section of tqhe tail channels in the Yellow River Estuary. By analyzing it, from 1986 to 2000, the breadths of the main channel of three typical cross section have narrowed from 142 to 525 m, the aggradation depth of the main channel of three typical cross section are 0.27 ~ 1.03 m. Because of the atrophy of tail channels, the cross section area of passing flow of main channels reduces greatly. Thereinto, Wangjiazhuang section reduces by 898 m^2, Zhujiawuzi section reduces by 1,081 m^2, and Qing3 section reduces 1,296 m^2. So the more the cross section close to the river mouth, the greater losses of the area of passing flow of main channels is. The area of passing flow of cross section reduces greatly, the bank – full discharge Q_p decreases obviously. By analyzing the measured data, when the flood peak discharge Q_m is less than the bank – full discharge of channel, during traveling process of the flood in main channel, even if the flood becomes smooth, the decrease of flood peak discharge is not big. Once the flood peak discharge exceeds the bank – full discharge of channel, the floodplain happens. The bigger the flood peak discharge is, the bigger the decrease of flood peak discharge is. After the tail channels is atrophy, the bank – full discharge reduces badly, the floodplain probability of the same discharge of flood increases, the floodplain happens encountering medium – sized and small flood, the decrease rate of flood peak discharge Q_m/Q_p increase affirmably. So by reason of atrophy of the tail channels, the decrease of flood peak discharge of tail channels is big during flood transmitting, the flood become smooth badly.

4.4 The flood transmitting time increases consumedly

The atrophy of tail channels makes the flood smooth obviously, the transmitting speed of the flood will be influenced by all means. In the meantime, because the flood of floodplain decrease, the roughness rate of floodplain increases obviously with the miscellaneous grass cluster, the flood transmitting time becomes longer. Because tail channels becomes atrophy, the transporting flood ability of main channels toboggans, the area of passing flow of main channels is only about 1,000 m^2. Under the condition of tail channels, the floodplain probability of the same discharge of flood increases, flood peak discharge puts down badly, flood wave gradient is small, velocity of flow is slow, and the flood transmitting time becomes longer necessarily. At the same time, because the resistance of bottomland increases, the velocity of flow of bottomland is less than the velocity of flow of mail channel, and that declining water of bottomland happens in the process of falling water, the declining water of bottomland piles up the process of falling water after the flood peak, another process of flood peak comes into being. The peak discharge exceeds the first flood peak discharge, and the second flood peak makes the flood transmitting time increase consumedly. Take "96 · 8" flood as an example, the discharge of flood peak was 3,200 m^3/s at Lijin station, the water level was 14.12 m. The floodplain happened along the tail channels, according to locale observation, the average velocity of whole section was 0.5 ~ 0.9 m/s at Lijin station, which only occupied 1/3 ~ 1/2 ratio of the average velocity of the same discharge before 1986. The flood transmitting time was 27 hours from Lijin station to the sea, which was 1.5 ~ 2.2 multiples of the transmitting time of the same discharge before 1986.

4.5 Transverse river and oblique river appear easily, the danger of flow anear bank increases

According to the process of atrophy of Qing3 section in Fig. 4, main channel aggraded new bottomland lip on the tender bottomland, which spreaded with a lot of sediment. The opportunity of overflowing became less at the bottomland surface that was apart from the main channel, its aggradation reduced, so it became low – lying, and transverse slope of bottomland increased obviously. Table 1 is the statistics of typical characteristics of three cross section of the tail channels in the Yellow River Estuary. Transverse slope of bottomland of Wangjiazhuang section was 1.2‰ in 1986, which increased to 1.4‰ in 2000. Transverse slope of bottomland of Zhujiawuzi section was 0.97‰ in 1986, which increased to 1.03‰ in 2000. Transverse slope of bottomland of Qing3 section was 2.7‰ in 1986, which increased to 3.1‰ in 2000. So with the development of the atrophy of tail channels, transverse slope of bottomland of majority sections are far bigger than longitudinal slope, the large – scale floods come at this situation in the Yellow River Estuary. The river circumstances will change acutely, transverse river, oblique river and roll river appear easily, and the safety of bank is threatened. Even when small flood comes, the appearance probability of transverse river and oblique river is big too, and the danger of flow anear bank increases. For example, the discharge of "96 · 8" flood peak was only 3,200 m^3/s at Lijin station, the length of flow anear bank was 54 km, the water depth was 0.5 ~ 2.5 m, the bank of Yellow River Estuary was faced with the danger of burst at any time, and the situation of prevent or control flood was very grim.

Table 1 Typical characteristics of cross section of the tail channels in the Yellow River Estuary

Name of section	Year	Breadth B(m)	Depth H(m)	Area A(m^2)	Transverse slpoe J(‰)
Wangjiazhuang	1986	493	3.79	1,868	1.2
	2000	351	2.76	969	1.4
Zhujiawuzi	1986	796	3.79	3,017	0.97
	2000	603	3.21	1,936	1.03
Qing3	1986	950	2.25	2,138	2.7
	2000	425	1.98	842	3.1

5 A criterion index of atrophy of tail channels

During the variation of flow and sediment, the characteristics of atrophy of tail channels stood out greatly in the Yellow River Estuary. The security of prevent or control flood was threatened by the developing of atrophy of tail channels. The government attached importance to the atrophy of tail channels. Channels dredging put in practice time after time since 1986. It has an effect on the mitigating of atrophy of tail channels. A index is needed as the controlling standard in process of channels dredging.

The most characteristics of atrophy of tail channels was that the area of passing flow lost badly. Choosing the variable $\Delta A_i/\bar{A}$ of Linjin section to express the atrophy of tail channels of I year, ΔA_i is the difference between the area of passing flow of i year and the area of passing flow of $i-1$ year at Linjin section, $\bar{A}$ is perennial average of the area of passing flow at Linjin section. A The main factors that affected atrophy of tail channels are the flow and sediment and the boundary condition. A formula as follows is erected by using the method of regression,

$$\frac{\Delta A_i}{\bar{A}} = 0.02\left(\frac{Q}{\bar{Q}} \cdot \frac{\bar{\rho}}{\rho} \cdot \frac{\bar{d}_{50}}{d_{50}}\right)^{-0.57}\left(\frac{\sqrt{B}}{H}\right)^{0.49} \tag{3}$$

Its correlative coefficient $R = 0.82$, which indicates that the pertinence of this formula is all right. Analyzing the formula (3), the variable $\Delta A_i/\bar{A}$ is in inverse proportion to the condition of flow and sediment, the condition of flow and sediment is good, the degree of atrophy of tail channels is light, the condition of flow and sediment is bad, the degree of atrophy of tail channels is serious. The variable $\Delta A_i/\bar{A}$ is in direct proportion to breadth depth ratio $\sqrt{B}/H$. When channels are wide and shallow, the degree of atrophy of tail channels is serious; when channels are narrow and deep, the degree of atrophy of tail channels is light.

The variable $\Delta A_i/\bar{A}$ reflects the percentage of lost area of controlling cross section of tail channels in i year. The flow and sediment keeps continual attenuation in successive years, the atrophy of tail channels has a process of aggravating accumulative development year after year. So a criterion index of atrophy of tail channels named T_n is imported, its mathematical expression is as follows,

$$T_n = \sum_{i=1986}^{n} \frac{\Delta A_i}{\bar{A}} = \frac{A_i - A_{1986}}{\bar{A}} \tag{4}$$

Physical meaning of T_n is accumulative total percentage of lost area of cross section of tail channels from 1986 to No. n year. Analyzing the variational process of T_n (Fig. 6), the atrophy of tail channels aggravated continually from 1986 to 1995, the worst year was 1995, its area of passing flow lost 50 percentage. Influenced by degradation of trace to the source arose from changing route at Qing8 section in 1996, the area of passing flow resumed a certain extent, but atrophy of tail channels is still grave. The year distributed of T_n is 0 year under the beeline $T_n = 0.2$; the year distributed of T_n are 3 years between the beeline $T_n = 0.2$ and $T_n = 0.3$, it is 20 percentage of total of years in Fig. 6; the year distributed of T_n are 9 years between the beeline $T_n = 0.3$ and $T_n = 0.45$, it is 60 percentage of total of years in Fig. 6, the year distributed of T_n are 3 years above the beeline $T_n = 0.45$, it is 20 percentage of total of years in Fig. 6. According to the distributing characteristics of these points, the process of atrophy of tail channels can be divided into four phases as follows:

(1) $T_n < 0.2$, the atrophy of tail channels had not come forth;

(2) $0.2 \leqslant T_n < 0.3$, the atrophy of tail channels was coming forth and growing;

(3) $0.3 \leqslant T_n < 0.45$, the atrophy of tail channels developed continuously;

(4) $T_n \geqslant 0.45$, the atrophy of tail channels was sever.

At the same time, it offers a controlling standard to harness atrophy of tail channels. When T_n reaches 0.2, the atrophy of tail channels was coming forth, we should strengthen observation and keep a weather eye on the continual development of atrophy of tail channels. When T_n reaches 0.3, we should use engineering measures to alleviate atrophy of tail channels under the allowable condition. When T_n reaches 0.45, we must use synthetical measures to alleviate atrophy of tail channels.

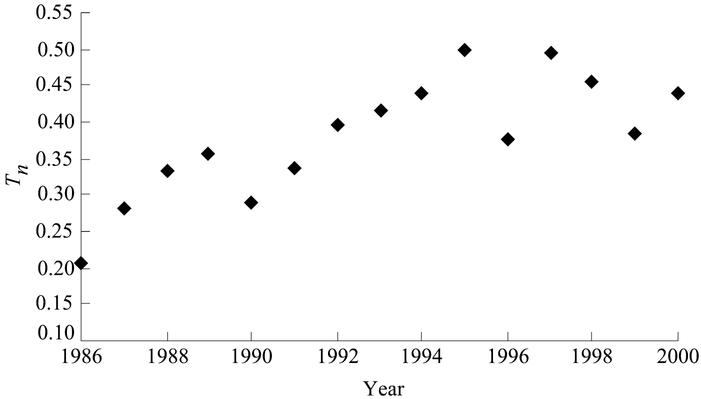

Fig. 6 Variational processes of criterion index T_n of atrophy of tail channels

6 Conclusions

(1) With the variation of flow and sediment in the Yellow River Estuary, the tail channels experienced complicated response processes, meanwhile, the characteristics of atrophy of tail channels are most outstanding. In order to adapt to the variation of flow and sediment conditions, the degradation and aggradation, longitudinal profile, cross section of tail channels experienced readjusting processes since 1986, the new evolution characteristics are put up. The longitudinal atrophy mode of tail channels follows the rule of third power curve aggradation, the transverse atrophy mode reflects that the atrophy of tail channels of cross section is the process of froming and developing.

(2) As a result of atrophy of tail channels, the river circumstances become worse, bottomland fall in badly, the controlling of engineering weakens. For traveling of flood, owing to the atrophy of tail channels, the water level of flood elevates, the flood becomes smooth, the flood transmitting time increases, "small flood brings large disaster" is formed. With the development of the atrophy of tail channels, transverse slope of bottomland of majority sections is far bigger than longitudinal slope, transverse river, oblique river and roll river appear easily, the danger of flow anear bank increases. So the atrophy effect of tail channels on traveling of flood is very disadvantage, and the safty of prevent or control flood is threatened badly in the Yellow River Estuary.

(3) Variation of flow and sediment debased the ability of transporting flow and sediment, it molded atrophic hydraulic geometry configuration of channel, this configuration affected the ability of transporting flow and sediment, it pricked up the atrophy of tail channels, this is a bad cycle, tail channels is more atrophy, the ability of transporting flow and sediment is lower, channel is more serious atrophy. The tail channels dredging put in practice time after time, a criterion index T_n is needed as the controlling standard in process of Channels dredging. Physical meaning of T_n is accumulative total percentage of lost area of cross section of tail channels from 1986 to No. n year. According to the distributing characteristics of T_n, choosing 0.2, 0.3, 0.45 as the values of T_n, these can be used as the control limit points during the harnessing of atrophy of tail channels.

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Observation Research on River Works Downstream of the Yellow River

Zheng Limin, ***Hou Aizhong*** and ***Chen Weiwei***

Yellow River Institute of Hydraulic Research, Zhengzhou, 450003, China

Abstract: The observation items, instruments and techniques of river works downstream of the Yellow River have been building step by step in the long term of flood controlling process. Along with the realization of modern flood controlling goals in the Yellow River, a serious of problems were arisen from the observation on river works such as the fewer routine items, the immature techniques, and the lack of scientific management. On the basis of analyzing the present observation status of the river works, this paper puts forward the necessary items to be carried out at present, the relevant techniques and instruments, and tries to find out a well – functioning mechanism for standardization of the river works observation in the Yellow River.

Key words: Yellow River, observation, instrument, techniques, management

1 Introduction

The Yellow River flood is a kind of non – frequent natural phenomenon, and all kinds of flood – control works is not used frequently. Implementing project observation can promptly obtain the project utilization condition and the engineering change rule accurately, examine security, stability as well as rationality of the flood – control works, accumulate data for safe running and scientific utilization of the flood – control works and provide the scientific basis for realizing the project benefits. At the same time, through the accumulation of prototype observatory data, the engineering design theory, the computational method and the design indices can be validated to make sure that the design is accurate and reasonable so as to increase the design level of the river works.

2 Present status of the river works

The river engineering system of the Yellow River including embankments, river works, culverts and sluices, is formed gradually in the long – term flood prevention process. After the founding of the nation, the embankments and vulnerable spots, as the main barrier against the Yellow River flood, has been constructed in a large – scale and the achievement which attracts worldwide attention has been acquired. A relatively perfect river flood – control system has been set up, which has played a huge role in flood prevention of the Yellow River.

The Lower Yellow River stretches 878 km, and the section from the Mengtsing Baihe town to Kenli Yuwa mainly depends on the embankment to restrain flood except for the mountainous ridges of the section before Henan Zhengzhou railroad bridge on the right bank and the section between Shandong Liangshan Shilipu to the Jinan Songzhuang. The length of the Yellow River left embankment is 718.7 km, and right bank is 604.8 km.

2.1 Levees

The Yellow River levee project, as the most important portion of the lower river flood prevention system, was first built in the Spring and Autumn Warring States Period, and continuously constructed in all the dynasties since the Qin and Han. At present it altogether has various kinds of embankment of 2,285.115 km, in which 1,368.342 km is for the main stream, 312.868 km for detention basins, 199.320 km for tributaries and 247.340 km for others. The total length of defended embankment is 1,952.810 km, and the undefended dike is 332.205 km.

There are big differences in the construction quality in the Yellow River dike project and there are many latent dangers because the foundations of most of them are gravel layers with strong water percolation. Since the foundation of new China, the downstream dangerous levees have been repaired and reinforced in a large scale three times successively. Although in the reinforcement an attention has been paid to construction of dikes or increase of foot bedding to extend the infiltration path, there are still many dangerous situations such as water piping and cave – in collapses in flood season because of the long dikes to be protected and excessive quantities of work to be handled over completely. Under the condition of high water level in flood season, the flushed pits and deep pools formed after dike breaches in the past become weak links that easily develops into such major dangerous situation as seepage, infiltration, leakage, landslide and even dam breach.

2.2 River works

The river course of the Lower Yellow River is a world famous "suspension river", and the flooding water in flood season does extremely serious harm, which is always the key point of flood preventing. Dam, spurs and shore protection projects are built in so – called "vulnerable spots" where major current flows against. The embankment downstream of the Yellow River altogether has 207 vulnerable spots of various kind where 6,265 of the dam, spurs and shore protection works have been built, with the total length of 394 km, including 134 vulnerable spots, 5,248 dams, spurs and shore protection of 308 km in length, or 17% of the total in the main dikes of the Lower Yellow River. There are 94 river protection works against main current rolling and 301 dams. The LAower Yellow River has provided with 204 training works to protect the banks, and 3,793 dams and spurs of 346 km in length. The improvement of the river course has played remarkable roles in protecting the embankment security, controlling the river outlet, expanding river course flood discharge ability, developing the local economy and so on.

2.3 Water diversion culverts and sluices

The Yellow River downstream embankment has completed 99 water diversion culverts and sluices. The Yellow River water diversion irrigation areas, mainly distributed below the Qin river, involve 21 cities and more than 60 counties (cities, regions) of Henan and Shandong provinces, and the design irrigated area is 3,327,000 hm^2, in which the effective irrigated area is 1,611,000 hm^2. They have promoted the industrial, agricultural and economical the healthy development, and guaranteed water use by the people living on both banks along the Yellow River and flood prevention security. The Yellow River water has become the prop water source, and a lifeblood of the city's economy development along the river, which holds the pivotal function in the economical development.

In order to cope with the Yellow River catastrophic flood, YRCC completed detention basins such as North Jindi and Dongping Lake in the Lower Yellow River, and proposed the flood prevention goal of "water diversion, defending, free discharge and populace safety", and constructed 12 floodgates, and reduced the downstream flood prevention pressure greatly.

3 Observation status of the river works

The observation on the river works along the Yellow River is at subordinate position for a long time, comparing with the progress of the national relative observation standard, the observation items carried out project are quite few, and the observation facilities and techniques are backward. The project observation is performed by man – power primarily, resulting in heavy labor intensity, low technical content and poor quality of results. The off – carriage instrument is crude, the instrument disposition and the observation frequency cannot satisfy the standard, which does not adapt with the present management development situation.

3.1 Observation items

The observation data for the status of river water and works is not comprehensive. The river information mainly depends on the eye view to trace the plan, the root stone information is obtained by artificial grope, the water level information uses the primitive water level staff. The observations of most items have not followed the specifications, even if some items have been observed, their instrument precision, observation method and termination condition merely met the specified requirements.

The observation on the river works performed presently includes the items of dam subsidence, superficial, big cross section and root stone survey, the dike cave – in, river regime survey, ice slush and so on. The majority of culverts and sluices apply water level and discharge relations, i. e. to calculate flow discharge through the water level. Only a few administrative units conduct silt content and buoyance and pressure observation.

3.2 Observation instruments

The observation instruments used has low technicality, and the quantity of them is at low side as well, so the project observation is in long – term stagnation and in low level repetition situation, which created the present status of low technical threshold, old observation facility, and serious damage. The existing observation instruments are mainly as follows: level, altazimuth, draft, telescope, current meter, tape measure, hidden danger investigation and so on.

3.3 Observation management

In the observation on the river works, the administrative units are badly short of specialized observation persons, and the problems of incomplete management system and of no standard management exist, especially for the daily observation items, only a few administrative units carried on the preliminary statistical analysis to the observation record material and reorganized the filing – up.

4 New observation techniques

The construction of "Digital Yellow River" proposed the new request for the project observation construction. In recent years, such instruments as self – recording gauge, laser range finder, underwater television system of ultrasonic wave automatic imaging instruments and project CT have been introduced or developed. They changed the traditional condition of backward survey method, low precision and long duration in river course relief displacement, and the fast precision measuring goal in some river section was achieved.

The newly – introduced instruments have characteristics of high automaticity, accurate data, reliable safety, and have provided the new method for the project observation, which has played a vital role in the project observation. These observation methods strengthen the observed data's timeliness greatly, and provide accurate, prompt and direct – viewing information, and reduce the manual working load on spot, and provide the first material to guarantee the project's safe operation.

4.1 Real – time remote supervisory system of dangerous situation in the culverts, sluices and training works

The Xinxiang Water Conservancy Bureau developed a long – distance supervisory system for culverts and sluices in 1999. This system can control the culverts and sluices in a long distance directly through the network transmission system so that long – distance or short – range monitoring can be realized. This achievement has been already popularized throughout the entire river basin.

The real – time monitoring system of dangerous situation in Yellow River "vulnerable spot" controlling and guiding project, was installed and put into use in Yuanyang in July, 2003. Based on the reality of the dangerous situation in the Yellow River "vulnerable spot" controlling and guiding project, the system adopts imagery processing technology and sensor technology, and has realized functions of prompt discovery of dangerous situation, auto – alarm, real – time long – distance monitoring and surveillance. This system uses the independently developed root stone position transmitter to conduct real – time monitoring on root stone's displacement of dams or spurs.

4.2 Zhongmou wireless auto – alarm system of dangerous situation in training works

Zhongmou Yellow River Water Conservancy Bureau developed the wireless auto – alarm system for vulnerable spots and training works. This system is an alarm device equipped with magnetism sensing, water sensing, pulse launch and microcomputer imaging. It doest not require setting up of wire, and the survey launching device can survey collapse, cave – in, displacement and landslide of the works, and has the security function at the same time. It is convenient to carry and easy to install, and its alarm distance can reach about 5 km.

4.3 Optical fiber diffraction grating monitoring in controlling and guiding project in the Yellow River Lao Tian'an

Henan Water Conservancy Bureau, jointly with Tsinghua University and Taiwan Hsinchu Jiaotong University, implemented a dike monitoring project at Lao Tian'an training works, Wuzhi county. Using the merits of distributivity, high sensitivity and high stability of optical fiber diffraction grating, the continuous digital monitoring of dam distortion near river spot was performed, and the insufficiency of traditional dam shore observation and survey method were overcome. The entire project consisting of 9 sets of 4 kinds of monitoring instruments such as the optical fiber diffraction grating stratum distortion monitor system, vibrating stratum distortion monitor system and the resistance promulgation stratum distortion monitor system and so on, monitors and analyzes upstream slope, dam head, dam slope and root deformation.

4.4 Embankment hidden defect survey

Yellow River Engineering Consulting Co, Ltd. (YREC) has developed the MIR – IC overlapped high density electric logging device. The company first proposed the new understanding of boundary "gathering flow" from basic theory aspect, revised the depth formula of unusual body (crack, space) in the semi – infinite spatial theory, and established the theoretical basis of small unusual body detection in embankment through direct – current electrical method. It has consummated the electronic resistivity cross section method in the method technology, and has introduced the high density resistivity method to survey dike crack and cavern, expanded unidimensional survey in the traditional direct – current electrical method to two – dimension, and solved the problems in crack position, crown burying depth, trend and so on, and caused the crack, the empty survey technology to be more perfect. It enhanced the functions from mere localization to the localization, qualitative gauge, image formation and partial quotas. It changed the traditional partition test to roll test continuously, and changed the trapezoid coverage to rectangular coverage.

4.5 Informationization of Mengjing water level observation

Mengtsing Water Conservancy Bureau installed the contact electron draft at dam 12 Tiexie vulnerable spot in April, 2003, which enabled the entire river system possible to grasp the newest water level change in the first time at Tiexie dangerous work, and realized data sharing in common. In July, 2004, Mengtsing Water Conservancy Bureau installed DJ – 99WG (YRT) telemetering electron draft again at dam 5 in Baihe. It turned out that the draft measuring error was small, and the performance was stable. The data message was entered into the network, resulting in being economical, quick, precise and highly effective in water level observation.

5 The Yellow River project observation goal

River course project observation is of an important method to accumulate information for the scientific and technical development of the engineering structures along the dikes. According to the project safety and running management needs, Dike Project Management Design Standard SL171—96, Ministry of Water Resources River Dike Project Management General Rule SLJ703—81 and the Ministry of Water Resources Dam Project Management General Rule (1990), the Yellow River downstream river course project observation should include the observations of subsidence, flow pattern, river regime change, river bed flushes and silt, the river bank cave – in, displacement, wave, ice and so on. The dike project observation should develop the basic observation project such as project deformation, the infiltration, the water level, the superficial observation and so on. Water diversion culvert and sluice project observation should develop the observations of flux, silt content, water level, osmotic pressure and the settlement.

5.1 Basic observation items

Basic observation items include subsidence, displacement; saturation line of dike body; water level, superficial observation and so on. Through observations of the river course project, we can grasp its change and working condition, so as to guarantee the project security, to accumulate materials and improve the management.

The river course project observation duty is monitoring water and flow conditions, the project change and the working condition, and grasping the change rule of the water state and the project, so as to provide the scientific basis for the management and utilization. The observation work should maintain the systematic characteristic and the continuity, and accord to the stipulated items, the frequency and the time. The observation results must be real and accurate, and the precision has to conform to the stipulation.

The intervals of flood prevention observation should be up to the utilization situation stipulated according to the standard. It requests to observe all the maximum values and the minimum values of deformation when in utilization. If the management time taken is long, and the building change situation is stable and its change rule is grasped basically, the observing intervals may be lengthened suitably.

5.2 Special observation items

Special observation items are established due to the adverse effects of the Yellow River embankment environmental factor, aiming at guaranteeing the river course project security and integrity and convenient river drainage, making full use of the river course and the dike project to safeguard the industrial and agricultural production, and the lives and properties of the people along the Yellow River. The Yellow River course project observation must accord to the requirements of safe operation of the river training works on the Yellow River, and carry on the observations such as water level, seepage, subsidence, displacement, superficial observation, water depth, river change, big cross section, beach cave – in, dike fallout, root stone missing, ice slush, floodplain, wave and so on.

The location of observation points should reflect the project running situation, and the observation cross section and positions should be chosen in the dam sections with good coverage and representative, and the project observation profile should be arranged at the sector that has the dominant character and special change in engineering structure. As for complex projects, observation items and profiles can be added properly if necessary.

5.3 Reorganization of observed data

The project observation should be executed according to the standard, each observation must be recorded and promptly analyzed to make sure that the precision conforms to the requirement. In the observation process, we should inspect that whether the operating method conforms to the requirement, whether each examination result is within allowable offset, whether observed value conforms to the precision requirement, and whether the data recorded is accurate, clear and complete.

The key point of the observation data reorganization is the accuracy verification of primitive observation data. Whether it has unusual value should be judged. The data should be complete, with clear textual research, reliable data, integrated graphs, unified specification and complete explanation. The data need to be fully preserved, each kind of observation and analytic results shall be put on file before the end of March after the preliminary analysis and reorganization of the last year's project observed data has been carried on. The archive will be examined and printed every five years.

5.4 The project safety appraisal

Carrying on the appraisal on the safety of the river training works will lay a foundation for observation management, and provides the data and the basis to the project security evaluation and the maintenance management. The Yellow River downstream river course project situation is complex, and there are many hidden defects, the hydrogeological conditions and distribution randomness of the hidden defects vary a lot along the route. The establishment of the safety evaluation criteria and the assessment method in the Yellow River project system can provide the theoretical basis and technical support for the river course management and the maintenance.

The safety appraisal is a special inspection and safety valuation to a river course project, and is policy – making basis to carry on the service, the reinforcement, or the reconstruction to the river course project. Through the safety appraisal on the river training works that exist many defects, the recession of river course project function can be effectively declined and the flood prevention safety and normal opeartion can be guaranteed.

6 Observation items and the instrument standard

In order to satisfy the need of the Yellow River flood prevention administrative bureaus to carry on the normal observation, the observation instruments should fulfill the needs of advancement, the environmental adaptability, the long – term run, being able to realize automation data acquisition and so on. The configuration of the observation facility should conform to the principles of effective, reliable and economical reasonable. Through the suitable configuration of the equipment and the improvement of observation technology and reading method, we can realize the technology and the equipment modernization in the Yellow River conservancy works, and obtain the reliable observed data.

6.1 The items that should be established

The items to be observed shall cover dike body subsidence, the hidden danger investigation, seepage, vulnerable spots and levees cave – in, displacement, river regime, water level, root stone and so on; the big cross section of river course, the root stone survey, dike fallout, project displacement, water level and so on; ice slush, flux, silt content, osmotic pressure, water quality, water level and settlement, crack observation.

6.2 Basic off – carriage instrument should be provided

According to the characteristics of the Long Yellow River dike defense line, and simultaneously considering the Yellow River observation personnel's technical level, the county water conservancy bureau should be facilitated with off – carriage instruments listed in as Table 1.

Table 1 The configuration standard of medium county water conservancy bureau

Instruments	Unit	Quantity	Instruments	Unit	Quantity
S3 level	set	3	Mapper	set	2
J2 theodolite	set	3	Self – recording tide gauge	set	5
Camera	set	5	TGSY – osmometer	set	1
Pick up camera	set	2	Differential resistance pore pressure cell	set	2
Telescope	set	5	Measure ship	set	2
GPS	set	1	Topology all station	set	1
DISTO – classic^3 laser ambulator	set	2	SYS1 – 2 ultra – sonic depth finder	set	2
LJX – 1 portable current and flow instrument	set	3	ZDT – I intelligent dike incipint fault detecor	set	1

7 Concluding remark

The observation on the river works on the Yellow River, by rational layout of information gathering points, should carry on gathering, storage, retrieval, display and analysis of the related projects, and relate the hydraulic engineering observation data to the spatial position straightly, providing the powerful technical method for the water conservation information visualization and expression, and realizing the data transmission modernization.

Along with the arrival of wide band network, the water conservation information transmission will speed up greatly, and the real – time and smooth dynamic video become reality, which will provide the foundation for the visualization of hydraulic engineering observation information. We should establish a safeguard system of the Yellow River conservancy works observation instrument configuration, and enhance the project observation management and supervision, and above 60% of the important observation project equipments should catch up with the international level of the end of 1990s, by 2008, among which the high – tech products should occupy about 10 percent. By 2010, the former number would be 100 percent and the latter number would be 20 percent.

The Yellow River conservancy works observation should take the computer technology as the core and promote the comprehensive automation management level. Depending on the scientific modern water conservation concept, the highly effective reasonable management system, the advanced reasonable service flow and technical method, and the high quality professional troop and comprehensive resources conformity, we can boost the Yellow River project observation modernization process.

Study on Automatic Operation of Large Water Transfer Canal System *

Yao Xiong[1], **Wang Changde**[1] and **Fan Jie**[2]

1. School of Water Resources and Hydropower, Wuhan University, Wuhan, 430072, China
2. Design Institute, Changjiang Water Resources Commission, Wuhan, 430010, China

Abstract: The middle route of the South – to – North water transfer project is the longest open channel of China. It has a flat slope and a large design discharge, but lacks necessary in – channel water storage. For the purpose of supplying accurate amounts of water on demand at the right time, automatic operation techniques are necessary. The controlled volume operation method and a new style of water level plus discharge controller for large water transfer project were studied and a simulation model including siphons, aqueducts, and off – takes was constituted. As an example, the simulation of automatic operation of the emergency section of South – to – North water transfer project was carried out and the results showed that the controlled volume method of operation can optimize the water storage of the canal system which is particularly suitable for large water transfer canal systems with complex operation conditions. The results and conclusions provide a technical foundation for the automatic control and management of large scale water transfer canal system especially the South – to – North water transfer project.

Key words: automatic operation, controlled volume operation method, South – to – North water transfer project, simulation

1 Introduction

Interbasin water transfer is crucial for the regions of northern China where water shortage has been a great issues. The South – to – North water transfer project begins from the headwork of Taocha to the Tucheng lake of Beijing through 1,276 km canals. Because of the complexity of water supply target and the lack of necessary in – channel storage, it is necessary to implement canal automatic operation, which can improve the operation of canal system to ensure water transfer security, and improve water division efficiency, in order to supply adequate amount of water at the right time, reduce the costs of operation and management.

An effective canal automatic control system must choose an appropriate operation method according to its hydraulic characteristics and functions. The method of operation directly affects the canal regulation volume of water and has a great influence to the canal operation stability. The basic methods of operation are constant downstream depth, constant upstream depth, constant volume and controlled volume operation method, which are identified based on the location of the canal pool water surface pivot point. The controlled volume operation method is the most flexible method which is particularly suitable to the large water transfer system with the complex conditions of operation. But it needs to use the suervisory control system and to design complex software according to the special system circumstances, so the this method is the most difficult one to implement, and the research and applications in this area are relatively less. The operational criteria can be satisfied by managing the water volume contained in one or more canal pools using the controlled volume operation method. The pool water surface may raise and fall. In fact, the water surface pivot point is of relatively little importance for controlled volume method. Operational flexibility primarily is

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restricted by water level fluctuation limits. Based on controlled volume method, the gate controller and control algorithm for the automatic operation of large water transfer canal system were studied. A large water transfer canal system simulation model including siphons, aqueducts and off – takes was constituted and the simulation of automatic operation of the emergency section of South – to – North water transfer project was carried out as a typical case using controlled volume operation method.

2 Unsteady flow in open channel

Canal system often transits from one steady flow state to another steady state, the flow state in the canal will be gradually changed which is described as unsteady flow during the process of this transient. Because the shape of most canals is a regular prism and the canal cross sections often have little change or keep uniform in one canal pool, we use the Saint – Venant equations to describe the one – dimensional unsteady non – uniform flow in open channel[4].

(1) Continuity equation

$$B\frac{\partial z}{\partial t}+\frac{\partial Q}{\partial s}=q \tag{1}$$

(2) Momentum equation

$$\frac{1}{gA}\frac{\partial Q}{\partial t}+\frac{2Q}{gA^2}\frac{\partial Q}{\partial s}+\left(1-\frac{BQ^2}{gA^3}\right)\frac{\partial z}{\partial s}=\frac{q}{gA}(v_{qs}-v)+\frac{BQ^2}{gA^3}(i+M)-\frac{Q^2}{A^2C^2R} \tag{2}$$

where: B is the width of canal water surface(m); z is the water surface elevation(m); t is the time (s); Q is the discharge(m^3/s); C is the Chezy coefficient; s is the distance along the canal(m); q is the inflow along the canal side($m^3/(s \cdot m)$); g is the gravitational acceleration (m/s^2); A is the cross – sectional area (m^2); v_{qs} is the flow velocity along the canal axes (m/s); R is the hydraulics radius (m); v_s is the average flow velocity along canal axes of the canal side in – flow (m/s), which is usually ignored; i is the canal bottom slope (m/m); and $M=\frac{1}{B}\frac{\partial A}{\partial s}|_h$, for a prism – shaped canal, $M=0$ or $\frac{\partial A}{\partial s}|_h=0$.

The preissmann implicit scheme is widely adopted as the numerical solution method of Saint – Venant equations for its fine characteristics such as high accuracy, unconditional convergence. In this method, the s—t plane of solution domain is divided into regular rectangular net, then using the difference quotients to approach the partial derivatives of dependent variables (Z and Q), the discrete equations can be deduced on each grid. By adding equations for the upstream and downstream boundary conditions of each canal pool, it has $2N$ equations for $2N$ variables. Combining all the $2N$ equations, we can get large – scale sparse nonlinear equations which can be solved by double elimination method (recursion method).

3 Method of operation

3.1 Pool operation alternatives

The method of operation is based upon the location of the canal pool water surface pivot point. The pivot point is the location within a canal pool at which the depth remains constant while the water surface slope varies. The basic methods of operation are constant downstream depth, constant upstream depth, constant volume and controlled volume operation.

A constant upstream depth is maintained by pivoting the water surface at the upstream end of the canal pool in constant upstream depth operation. The canal banks must be horizontal to accommodate the zero – flow profile, so the construction costs is too expensive for large water transfer canal system.

Constant downstream depth method of operation-where in the water depth at the downstream end of each canal pool remains relatively constant. The canal can be sized to convey the maximum steady flow and the steady state water depths should never exceed the normal depth for the design flow rate. The canal freeboard can be minimized, thus reducing the construction costs, but it reacts slowly to the changes of downstream water demand.

The pivot point locates at the middle of the water surface profile within the constant volume operation method (Fig. 1). A relatively constant volume in each pool is maintained by pivoting the water surface about a point near the mid – pool as the flow changes from one steady state to another. The main advantage of this method is the ability to quickly change flow conditions in the entire canal system. The disadvantage of constant method of operation is the additional canal bank and lining required at the downstream end of each pool, however the additional height required is only about one – half that required for constant upstream depth operation.

Using the controlled volume operation method, the operational criteria can be satisfied by managing the water volume contained in one or more canal pools (Fig. 2), unlike the constant volume operation method which should keeps the volume in canal pool constant. The pool water surface may raise and fall. In fact, the water surface pivot point is of little importance for controlled volume method. Operational flexibility primarily is restricted by depth fluctuation limits. So this method is considerably suitable for the large water transfer canal system with large canal prism cross – section. The authors select this most flexible operation method as the method using in mathematic module construction and simulation.

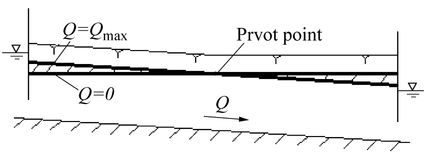

Fig. 1 Constant volume operation method

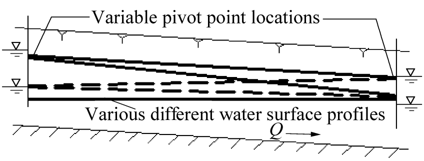

Fig. 2 Controlled volume operation method

3.2 Algorithm of controlled volume operation method

The water level in canal pool can raise and fall under controlled volume operation method. But there are still water level constrains in order to avoid overtopping the canal bank and satisfy water division along canals. For a multi – reach canal system all canal pools have its lowest water level limit Z_{min} and highest water level limit Z_{max}. The controlled water level YT is a non – constant value which changes with the off – take water intake and the downstream water demand. The controlled volume operation algorithm is designed as follows:

(1) Firstly, Judge the status (supplementing or consuming) of the canal system according to the flow rate of the headwork and the total flow rates of downstream and off – takes.

(2) Find out the pools with water volumes that can be changed according to the water level constraints. If there is no pool with adjustable water volume, the canal system will be operated by conventional method of operation to maintain the balance of canal system.

(3) If there are pools with adjustable volumes between the lowest water level limit Z_{min} and highest water level limit Z_{max}, figure out the adjustable volume of each pool and sum up the total regulation volume.

(4) Distribute the flow rate difference of inflow and outflow of the canal system to the upstream gate of each pool from the downstream to upstream according to the proportion of the adjustable volume to the total regulation volume. Calculate the opening height of gate value according to the new flow rate through the upstream gate of each pool. The canal system comes into the process of volume adjustment because of the difference of flow rate turned into and out of each pool.

(5) After the buffering and regulating of water storages, the canal system reaches the water level limits with non – adjustable volume. Then accommodate the opening height of gate again from the downstream to the upstream to match inflow and outflow. The canal system ultimately operates based on constant volume.

The simultaneous check gate operating technique should be adopted to ensure that gate real time response to the changes of the flow rate. Adjusting all canal check gates simultaneously can establish a new steady – state flow in the canal system in the shortest time just as the single pool.

4 Automation model of canal system operation

4.1 Frame of the canal automation system

The entire canal automation simulating system is composed by six modules as follows: the steady flow calculation module, the feed – forward control module, the PI control module, the calculation module for opening height of gate, the calculation module for the discharge through the gate and the unsteady flow calculation module (Fig. 3), these six modules tie up close and affect mutually to realize the controlled volume operation target together.

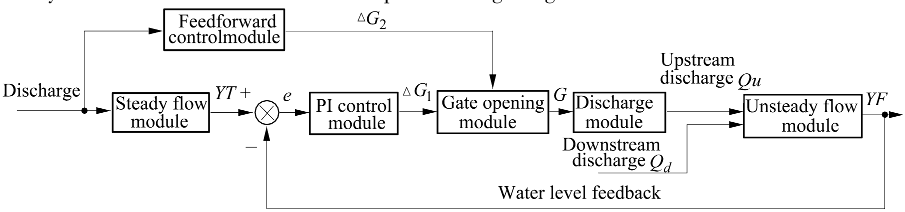

Fig. 3 Canal automation system

4.2 Compound controller

The controller of the canal system is a combination of feed – forward control of discharge and feed – back control of water level which both produce increments of the opening height of gate[6]. The output of the controller is the linear superposition of the two increments, of course, this output value should meet the constrains of gate static bandwidth and fastest hoist – speed of the gate as the ultimate input of the gate hoist equipment.

The feed – forward control of discharge uses the flow rate as input instead of the water level. The basic principle can be represented as follows: we can get the flow rate through the gate from the algorithm of the controlled volume operation method and the water levels in the front of the gate and behind the gate by the unsteady flow calculation module. Now the opening height of gate can be reverse deduced by the formula as follows:

$$Q = C_d G_k b \sqrt{2gh_0} \tag{3}$$

where: Q is the discharge through the gate (m^3/s); G_k is the opening height of gate (m); b is the gate width (m); h_0 is the gate upstream water depth (m); C_d is the discharge coefficient which has different value for free flow and submerged flow.

The increment of the opening height of gate $\Delta DG1$ can be gained by the comparison between opening height of gates of two continuous sampling times.

$$\Delta DG1 = G_{k+1} - G_k \tag{4}$$

where: G_k is the opening height of gate of sampling time k; G_{k+1} is the opening height of gate of sampling time $k+1$.

Feed – back control uses water level differences as the input. The controlled water level YT changes with the flow rate difference of the inflow and outflow of the pool. Suppose the variation of the controller water level caused by volume adjustment in one sampling time is Δh, the controlled water level can be updated. It is no longer a constant target but changing with Δh.

$$\frac{dV}{dt} = Q_u - Q_d \tag{5}$$

where: V is the water volume in one pool that is the function about the controlled water depth $V =$

$f(h)$; Q_u is the upstream discharge; Q_d is the downstream discharge.

The real time feed – back water level YF corresponded to the controlled water level YT is a weighted value of upstream water level and downstream water level which get from the solutions of the Saint – Venant equations[7].

$$YF = K \times YF1 + (1 - K) \times YF2 \tag{6}$$

where: K is the weight factor of upstream water level $YF1$ and downstream water level $YF2$. The value of K is smaller, the pivot point gets closer to the downstream of the pool.

The water level difference is the outcome controlled water level YT minus feed – back water level YF. The increment of the opening height of gate $\Delta DG2$ can be gained by PI incremental algorithm as follow:

$$\Delta DG2 = K_p \Delta e + K_I e \tag{7}$$

where: $\Delta DG2$ is the output of feed – back control; K_P is the proportional coefficient; K_I is the integral coefficient; Δe is described by $\Delta e(k) = e(k) - e(k-1)$.

5 Example of simulation and results

The emergency section is the last part of the middle route of South – to – North water transfer project from Beijing, which starts at Guyun check gate, ends at a place near Beijing. The canal section runs through Hebei province whose total length is 127.298 km (Zhang Zhiming and Wen Dan, 1997). The whole canal system is divided into 13 canal pools by check gates, including 12 turnouts, 16 inverted siphons, 3 aqueducts, and many tunnels, bridges, and drainage structures. The designed inflow rate is 170 m^3/s at the beginning and 60 m^3/s at the end. The general parameters are presented at Table 1. The pools are farther divided into small parts according to the basis as follow:

Table 1 General parameters of canals

Canal No.	Sub – division number	Length (m)	Design water depth (m)	Design flow rate (m^3/s)	Bottom altitude (m)	
					Upstream	Downstream
1	5	9,759	6.00	170	70.253	70.141
2	4	22,053	5.00	170	69.991	69.032
3	4	15,177	5.00	165	68.882	67.728
4	6	19,553	5.00	155	67.578	66.475
5	3	9,234	5.00	135	66.325	66.139
6	5	25,697	4.50	135	65.989	64.935
7	3	13,198	4.50	135	64.812	64.295
8	7	27,098	4.50	135	64.145	61.486
9	4	9,717	4.50	125	61.336	60.771
10	2	14,924	4.50	100	60.621	59.920
11	5	20,829	4.30	60	59.770	58.695
12	4	14,705	4.30	60	58.545	57.849
13	8	25,314	4.30	60	57.699	56.500

Note: drop at each gate 0.15 m。

(1)The changes of canal parameters (manning roughness coefficient n; bottom slope i; bottom width b; side – slop m). The boundary of sub – division is the section where the canal parameters changes to ensure that every sub – divisions have the same parameters.

(2)The location of off – takes. It is the boundary of sub – division because the flow rate changes abruptly at those places where the water level and flow rate of the pool should meet the continuous conditions.

(3)The location of inverted siphons. The inverted siphons can not be described by Saint – Venant equations because the flows throughout the siphons are pressure flows. We simplify the siphon as a cross – section at the pool which is the boundary of the sub – divisions.

(4)The transition section in the pools. Canal and structure are usually linked by transition sections. We divide the transition section into several parts to improve the accuracy of calculation.

(5) The parts need to densify the nets. The flows of the tunnel with no pressure and the aqueducts can be described by Saint – Venant equations, but the length is relatively short, so we densify the calculation nets by taking these structures as single sub – divisions to improve the simulation accuracy.

Suppose that the canal system is fed by a constant – level reservoir whose water level is 7.0 m. To simplify the simulation, we concern only Zhongguan off – take (in fourth pool) and Tianjin main canal water intake (in ninth pool) with a scheduled flow rate changing process showed in Fig. 4, the others have zero intake flow rate and the downstream flow rate of the canal system keeps 10 m^3/s invariable. The simulation results about the target water level and the opening height of gate are showed in Fig. 5 and Fig. 6.

The simulation results illustrate that:

(1)The canal check gates can realize simultaneous operating because of the feed – forward control. During the off – take discharge changing process, the check gates rose or fell, but the gates that own off – takes participating in operation had bigger movements. The headwork check gate kept nearby the initial opening height of gate all along because the whole canal system satisfied the water demand by regulating the water volume of its own.

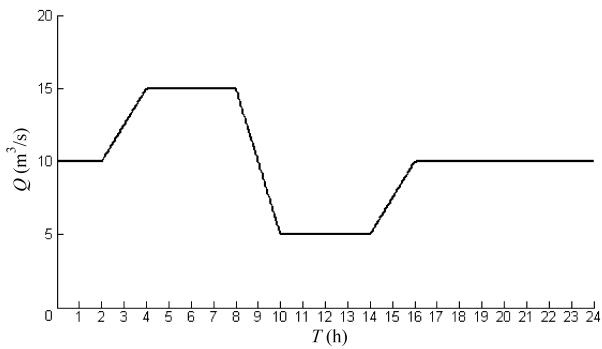

Fig. 4 Off – take discharge changing process

(2)The water level of each pool changed smoothly with the flow rate of off – takes. The target water level fell when the water volume was consuming, while the target water level rose when the water volume was supplementing. No mater the lengths of canal pools are different and the off – takes participate in operation or not, the canal system can be operated stably.

(3) The target water level at the midpoint no longer keeps relatively stable but changes smoothly with the discharge changing process. Suppose the constant volume operation is adopted for canal system operation, the pivot point at the midpoint keeps stable, while the upstream and downstream water level of the pool may fluctuate obviously. The water level transient process will be more pleasant because of the buffer storage within the canal using the controlled volume method.

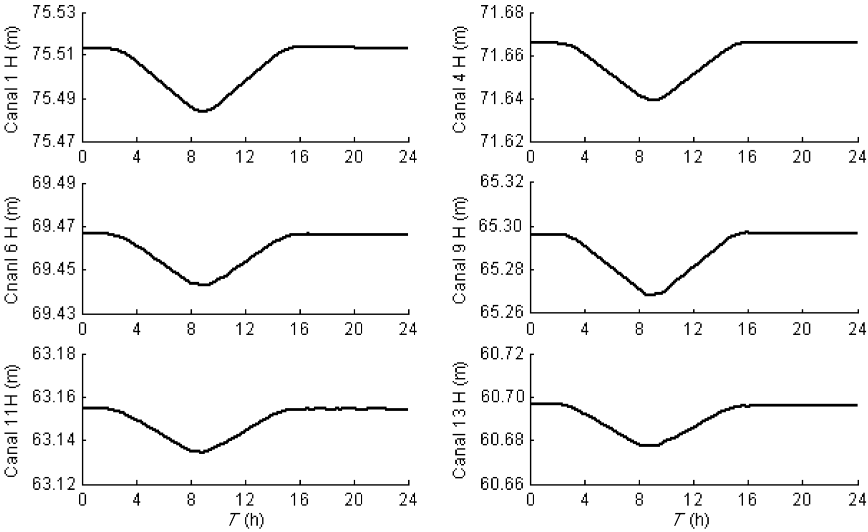

Fig. 5 Target water level changing process

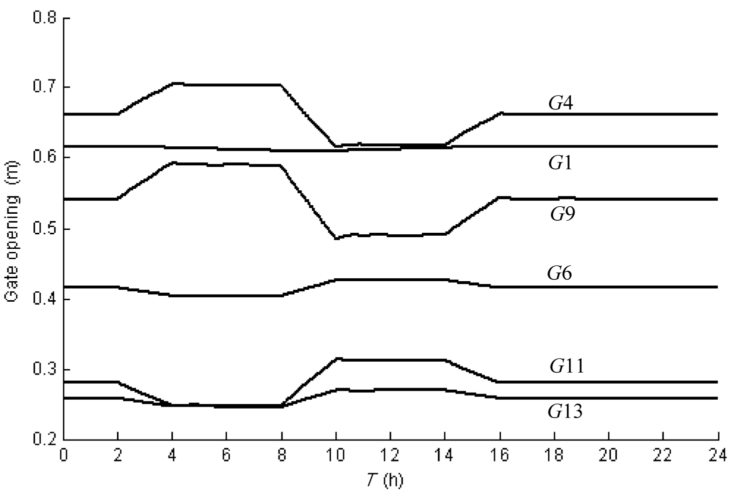

Fig. 6 Opening height of gate changing process

6 Conclusions

Inter – basin water transfer project is an important measure to overcome the uneven distribution of water resources on time and space and realize reasonable allocation of water resources. Canal automation technology can obviously improve canal system operation which is an organic combination of optimal schedule theory and automatic control technology. A simulation module of large water transfer canal system based on controlled volume operation method is developed and the simulation results of the emergency section of South – to – North water transfer project as a typical case show that a canal system operating by the controlled volume method of operation has a good flexibility to response to the water demand changes, and it has the capability to response to a wild range of flow conditions that otherwise might require the use of off – channel storage or waste – ways. The controlled volume method of operation can optimize the whole water storage of the canal system, thus transform rapid flow change at the downstream end into a gradual flow change in the upstream canal pools by using the buffer storage. As a result, the disturbance to the upper pools and headwork can be minimized. So the controlled volume operation method is particularly suitable for large water transfer canal systems with complex operation conditions.

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On Sediment Reduction by Dredging at Estuary in Lower Yellow River

Zhang Dongfang and ***Zhang Houyu***

Department of Construction and Management, Yellow River Conservancy Commission, Zhengzhou, 450003, China

Abstract: The Yellow River estuary is of weak tide, heavy sediment and constant accumulation. The continual accumulation not only resulted in eliminating the riverbed slope, but also caused headward siltation, at the same time, generating adverse influences on flood and sediment discharge. In the long future, the Yellow River will be still a sediment – loaded river, therefore, reducing sediment of the river mouth is one of the important measures to enhance the capability of sediment and flood discharge in the lower reaches. This paper firstly analyzed sediment reduction mechanism by dredging measures. On the basis of the analyses of scouring and siltation evolution of the river estuary after the dredging process twice since November 1997 to October 2001, it was demonstrated that under some conditions of water and sediment, dredging in plan in its main river channel to some extent could create scouring along the river course and headward scouring, that could effectively decrease the sedimentation on the riverbed both upstream and downstream of the dredged section, and increase its capacity in flood discharge and sediment delivery and thus it is advantageous to the current river flow in fluent and stable way.

Key words: the Yellow River, estuary, dredging, siltation, erosion

1 Riverbed evolution and water sands dynamic characteristics of the Yellow River estuary

The Yellow River estuary is a receiving area of water and sand. Compared with other estuaries, it has characteristics of much water and less sand, and tempestuously fluctuating of flood peak. The mean annual discharge of Lijin Hydrological Station is 33.24 billion m^3 since 1950, and mean sediment is 823 million. For 20 years, the water and sediment coming to the river mouth have been reduced drastically due to a large amount of water use by the lower reaches and less rainfall in the Yellow River Basin. During the years from 1986 to 2001, the mean inflow and sediment of Lijin Hydrological Station for many years were 1,377 billion m^3 and 351 million t respectively, only accounting for 27.4% of the inflow 50.15 billion m^3 and 28.4% of sediment 1.237 billion t during the years from 1950 to 1985, but the characteristics of more water and less sediment kept unchanged.

Not only does the evolution of the Yellow River estuary relate to water and sediment from the upper reaches, but also it is affected by ocean dynamic factors along coastal area, including tide, ocean current, surf, circumfluence, outpouring flow, among which, tide, ocean current and surf are the main factors. The ocean dynamic factors are relatively weak at the Yellow River estuary, it is only 1 m/s. The tide scope is small, only at 0.61 ~ 1.13 m. There is hardly tide phase. During non – flood season the tide phase is short, only at 15 ~ 30 km.

Because of water and sediment characteristics above and the ocean dynamic traits, large amount of sediment carried by the Yellow River deposed in its delta area. The estuary puts up the drastic accumulation. Delta can make land actively. Mean area of making land is more than 20 km^3 every year. Coastal line incessantly extends to outside seashore and riverbed continuously rises. When riverbed rises to some extent, flood breaks through limitations to find another way to sea through low land of delta. After that, sand beak extends and riverbed starts rising on a new basis. Evolution of the Yellow River delta embodies the seasonal circle of "deposition – extension –

fluctuation – realignment". Since 1855 the river course change took place 9 times near fan – shaped delta of the estuary. The swings of the Yellow River estuary flow course changed frequently.

Table 1 is flow pass evolution of the Yellow River estuary since 1855.

Table 1 Flow pass evolution of the Yellow River estuary since 1855

Sequence number	Change year (y · m)	Change site	Entry site of sea	Duration of flow(y)	Change reason
1	1,855.8	Tongwaxiang	Xiaoshenmiao	34	Breach in flood season
2	1,889.4	Hanjiayuan	Maosituo	8	Overflow in winter season
3	1,897.6	Lingzi village	Siwangkou	7	Breach in flood season
4	1,904.7	Yanwo	Laoguazui	22	Breach in flood season
5	1,926.7	Bali village	Diaokou	3	Breach in flood season
6	1,929.9	Jijia village	Nanwang river	5	Manmade breach
7	1,934.9	The first dam	Laoshenxiangou	20	Non – enclosure by blocking
			Tianshuigou		
			Songchunronggou		
8	1,953.7	Xiaokouzi	shenxiangou	10.5	Artificial emerge of branches
9	1,964.1	Luojiawuzi	Diaokou river	12.5	Artificial breach of dike
10	1,976.5	Western river mouth	qingshuigou	26	Artificial change of flow route

2 Necessity of dredging at the Yellow River estuary

2.1 Impact on lower reach reason by accumulation of sediment at the Yellow River estuary

Extension of estuary sedimentation results in relative lift of erosion datum plane of the estuary and abating of longitudinal grade, further aggravating riverbed rising. That is obviously displayed by the relationship between the lift of water level and length of extension of estuary deposition.

From the change of flow route from Shenxiangou in 1953 to Diaohekou in 1976, the estuary extended 25 km, the mean extension rate every year is 1.1 km/a. During this period, the water level below Lijin went up by a rate of 0.11 m/a, totaling in about 0.25 m. The two has good corresponding relation. It indicates that water level lift at Lijin station has intimate relation with sediment accumulation extension of the estuary. During 1950 to 1975, water level lift of same discharge in lower reach of Gaocun site is from 2.07 ~ 2.38 m. It is nearly as same as lift of 2.1 m of same value of 32 km of extension of estuary. During 1950 to 1990 the water Level of all stations lift up to 2.0 ~ 2.5 m, it is also near to lift value of sediment accumulation of the same period.

Therefore, sedimentation in the Lower Yellow River lifts up at the same way. Furthermore, the slopes of all river sections in the Lower Yellow River have no tempered trend. On the contrary, they have abating trends. All the river sections have the traits of sedimentation along the river source. Hence, sediment accumulation on the estuary is main reason for heavy accumulation in the Lower Yellow River.

2.2 Estuary regulation is very important to the Yellow River development and economy of delta area and environment protection

Firstly, estuary regulation directly relates to Long – term safety of the Lower Yellow River. Estuary sediment accumulation and its extension is one of reasons that result in riverbed rise and flood water level lift as well as influencing factors of flood control in the Lower Yellow River, therefore, it should view the estuary regulation as an important part of the whole Yellow River development.

Secondly, estuary regulation closely relates to durative development of economy and society of the delta area. The sources of land, floodplain, oil, gas, bittern and oceanic creatures are abundant, and its geographic location is advantageous. The development potentials are tremendous. The delta plays a great role in Bohai sea economy development circle and the Yellow River basin.

In March 2001, the fourth section conference formally listed "Environmental Economy Development of Yellow River Delta" into the "Fifth National Development Plan", and Shandong Province made it as new century project and is a new development growth point of our country. Therefore, to harness the Yellow River estuary and guarantee safety of flood control is necessary for river delta construction.

Thirdly, estuary regulation concerns with restoration of ecosystem and protection of the delta. The nature protecting wetland zone of the Yellow River which 230 km^2 in total area is the most capacious, entire and young system on the earth. And it is one of thirty wetlands that especially protected by international organization, at present it urgently needs protection.

2.3 Dredging of the Yellow River estuary is one of the important measures for estuary regulation

The key problem is how to dispose of sediment in the estuary regulation. Dredging is to dig some amount of sediment in a certain sections of the river channel, further regulating the hydraulic factor in order to adjust river trend or enhance the sediment transport capacity of the river and reduce the sediment accumulation. And it is a measure of embankment by dredging sediment. Not only dose dredging at estuary reduces river mouth sediment accumulation, but also it can produce scouring along river source, therefore, it is meaningful to reducing sediment deposition. At present the main channel below Aishan has heavily silted up, so the flood control situation is severe.

At the beginning of Xiaolangdi reservoir operation, the clear water scoured the river channel of the Lower reaches, but due to the sediment regulation above Aishan, the scouring function has been greatly reduced. It has no obvious effects yet. The sediment accumulation has been the restriction of flood control in the Lower Yellow River, whereas, at present there is hardly effective measures for sediment reducing in the reach and dredging method is one of advantageous experiment.

In addition, we may use the dredged sediment to reinforce the dike and eliminate the weak points inside the dike and enhance the capability of flood control of this reach. Therefore, it is necessary to dredge the river channel at the estuary of the Yellow River.

3 Sediment reduction analysis of dredging functions at the Yellow River estuary

3.1 The theoretical analysis of sediment reducing effect by dredging

The scope of effect analysis of sediment reducing by dredging includes the dredged reach and its upper and lower areas to some extent. As for dredging itself, the dredged sediment equals to the reduced. In a certain scope upstream of Wahesa section, dredging sediment can enlarge its water surface gradient and result in rise of sediment carrying capacity of flow and make the scouring along river source. The scouring capacity will reduce with regulation of slope till disappearance.

In respect to the reach downstream of dredging section, heavy sedimentation again reduces the sediment concentration that entered channel and causes the scouring along river source. The scouring degree will reduce with restoration of sediment concentration till vanish. Therefore, dredging sediment amount consists of two parts. One is dredged directly from river channel. This part is the main body of river sediment reducing. Another is the sediment reducing amount from scouring along river source and channel.

3.2 The dredging experiment indicates that dredging can reduce sedimentation

The started project is located at Zhujiawuzi—Qing 2 section in the estuary of Shandong Yellow River. The Zhujiawuzi—Qing 6 section is 10.89 km in length and it is the main dredged river section. The average dredging breadth is 200 m and mean dredging depth is 2.5 m. The dredged earth volume is 5.32 million m^3.

From the Zhujiawuzi—Qing 6 section to Qing 2 is 12.61 km in length. In order to dredge the river for 20 m in breadth it needs to excavate the earth volume 0.16 million m^3. the total dredged volume is 5.48 million m^3. The project was started up on the 23rd November 1997 and finished on the 2 nd Jun 1998.

Considering the influences on upper and lower reaches by dredging, we determined the Qing 6 as our research section, the measured layout maybe seen as Fig. 1.

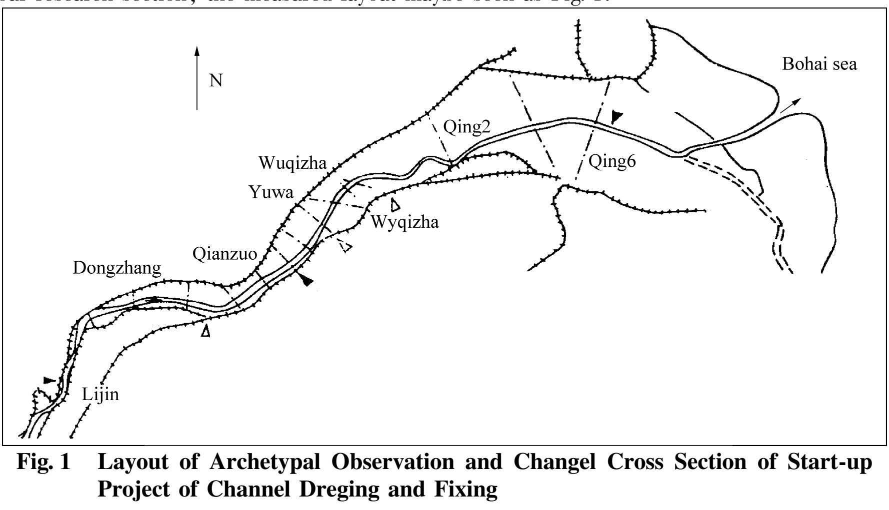

Fig. 1 Layout of Archetypal Observation and Changel Cross Section of Start-up Project of Channel Dreging and Fixing

The dredging effect can be expressed with the ratio of dredging sediment. Ratio of dredging sediment refers that the ratio of dredged volume and the sediment reducing amount under condition of same water and sediment on situation of dredging and non - dredging and can be calculated by:

$$\beta = \frac{W_{SW}}{\Delta W_{S1} - \Delta W_{S2} + W_{SW}}$$

In the equation, β refers to ratio of dredging sediment, W_{SW} refers to dredged sediment. ΔW_{S1} refers to scoured sediment under condition of non - dredge. ΔW_{S2} refers to scoured sediment after dredging at the research reach.

The sediment reducing effect can be analyzed by measured data and prototype measured ones. First is analysis of analogy. During the flood seasons in 1986 and 1998 the reach length in lower western river mouth is respectively 54.4 km and 55.5 km. The error can be negligible. The earth volume is 8.49 billion m^3 and 9.3 billion m^3, they are nearly same. The sediment is respectively 151.9 million t and 371.9 million t. The sediment in 1986 was much less than ever before. However, in the flood season of 1998 the sediment is 4.505 million m^3. It is obviously less than that of 9.48 million m^3 in 1986 flood season. It indicates that the dredging effect is apparent.

Secondly, it uses the gradient of 3,000 m^3/s as parameter at pre – flood season according to the relation between the water volume in flood season in Lijin station and Qing 6 river section. See Fig. 2. Under condition of non – dredging, the water amount at Lijin station is 10 billion m^3 and the sediment accumulation is about 6.5 million m^3. After dredging, the water amount obtained to 9.32 billion m^3 at Lijin station in flood season and sediment in the reach is 3.683 million m^3. The reduced sediment is 2.817 million m^3. Adding 5.48 million m^3 of the sediment excavated out, the total sediment reducing amount will be 8.287 million m^3, and the ratio of dredging sediment will be 0.66.

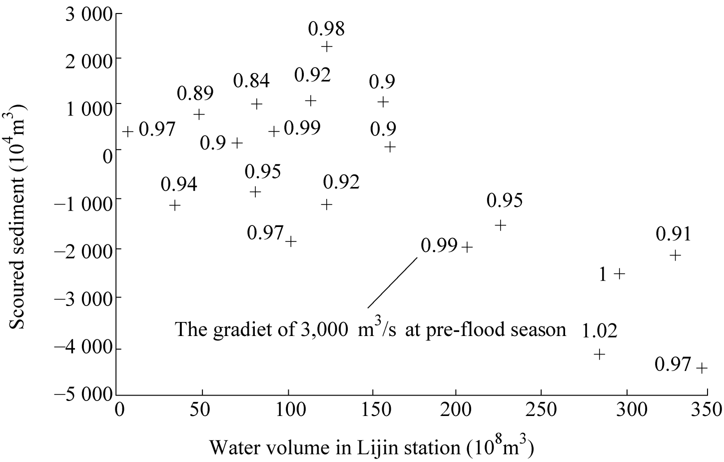

Fig. 2

We have analyzed the sediment reducing effect by physical model experiment. The model scope is from Lijin to western river mouth section. The boundary limitations are on basis of landform after flood season of 1997. We dredged in terms of started project design. The experimental water and sediment conditions are adopted according to flow and sediment course from two phases of Oct. 9 to Oct. 28 of 1995 and July 24 to Aug. 17 of 1993. Compared with prototype flow conditions the effects are similar and benefit little more. The experiment indicates that the sediment accumulation from Lijin to western river mouth is 4.102 million m^3 before dredging and post – dredging amount is 2.354 million m^3. The reduced amount is 7.228 million m^3, ratio of dredged sediment is 0.76.

To Calculate dredging effect is by means of mathematical modeling. The first modeling is to utilize 2D sediment math modeling developed by Wuhan University of Hydraulic and Electric Engineering and adopted the method of extending river and adding section. The second modeling is created by the Yellow River Institute of Hydraulic Research. The river boundary conditions are that the actual section in 1998 is for non – dredging and the original measuring section for after dredging. The water and sediment are adopted by actual process of flow conditions of Lijin station during Jun. and Oct. in 1998. The ratio of dredging sediment is respectively 0.63 and 0.85.

In conclusion, during the flood season of 1998, the ratio of dredging sediment of embankment project at narrow reach in the Lower Yellow River was about 0.63 ~ 0.85. The research result of dredging experiment in 2001 indicated that the ratio of dredging sediment was from 0.63 to 0.76, therefore, the embankment project by dredging at narrow reach in the Lower Yellow River can reduce the sediment.

4 Conclusions

It is necessary to dredge at the Yellow River estuary. Under some condition, dredging can make functions for sediment reducing. The key problem is how to design the plan of channel dredging reasonably. Reasonable plan of dredging should set importance on characteristics of water and sediment of this reach as well as practical situation of riverbed evolution. It should analyze traits of river channel type of sediment transportation. The dredging plan shall include dredging reach, section geometry of dredging, scope of sediment dredging, time of dredging and layout of dredging line and so on. It is useful to utilize dredged sediment to reinforce dike. Dredging river is a new conception in the Yellow River regulation and it needs to research extensively. The construction technology and silted – up area layout also need to be carefully studied in order to guarantee the project well implemented.

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Dam Construction and Environmental Protection

Xie Xinfang[1], ***Wang Xiaofeng***[1], ***Wang Wenshan***[2] and ***Liu Xinfang***[1]

1. Yellow River Engineering consulting Co., Ltd., Zhengzhou, 450003, China
2. Department of water and soil conservation, YRCC, Zhengzhou, 450003, China

Abstract: The contradiction between environment and development is always a focus of the international community. The progress of human civilizations necessitates the development and utilization of hydropower resources, an important way of which is to build dam. However, the construction of dams also causes adverse environmental impacts. It is our goal to properly integrate dam construction with environmental protection to benefit the human beings. This paper discusses the relationship between dam construction and environmental protection in dam construction versus environmental impacts, dam construction versus environmental management, dam construction versus environmental impact assessment, dam construction versus environmental protection area, dam construction versus environmental supervision, and, on this basis, looks into the future of environmental protection as part of dam construction.

Key words: dam construction, environmental protection, management measures, prospect

1 Introduction

Environment and development are significant issues widely concerned by the international community today. Environment is the main condition of human survival and the material base of sustainable socioeconomic development. To look for a way for sustainable development that well coordinates population, economy, society, environment and resources, not only meeting the demands of the present generation but also constituting no risks to the future generations' meeting their demands, is a goal of the common people today.

In 1970s, when the industrialized countries suddenly woke up in the face of environmental disasters, China began to pay attention to environmental issues. In 1973, the 1st national environmental working conference unveiled the campaign of environmental management in China. Subsequently, the government has completed the "Agenda of the 21st Century", which includes environmental protection into the important track of social development.

Water and hydropower projects produce great effects and benefits in transforming nature and utilizing resources properly, but also cause adverse environmental impacts. The degree of such impacts differs from one case to another, generally relating to the size of projects and the environmental sensitivity of project areas. However, most adverse environmental impacts can be mitigated/offset by appropriate measures.

2 Dam construction and environmental protection

2.1 Dam construction and environmental impacts

Water is natural resources indispensable for the living and social production of man. Along with human progress and social development, the development and utilization of water resources play a more and more important role in economic development and livelihood. In order to coordinate the imbalance distribution of water resources in time and space, achieve multipurpose utilization of water resources and meet the demands of national economic development, it is an important way to construct dams.

To construct dams and raise water levels, while producing huge overall benefits in national economic development, also inevitably result in some negative environmental effects, such as inundation of land resources, reduction of biological resources, resettlement of local residents, pollution due to "three wastes" during construction, impacts on cultural relics and landscapes as a result of reservoir impounding, and impacts on public health, water quality and aquatic. Although the ranges and factors of such impacts are different from one project to another, the production of impacts is a fact that cannot be evaded.

An active measure to get rid of the demerits and difficulties of dam construction is to conduct adequate investigations and studies before constmction, improve the design and justification of dams, and pay adequate attention to the environmental and resettlement programs of dams. In view of the built dams in China, the environmental hazards due to dam construction can be minimized so that an integrity of the economic, social and environmental benefits is achieved finally provided that practical measures are implemented, including forceful efforts in public participation and consultation, well – organized preparation and implementation of resettlement plans to maintain sustainable economic, social and ecological development in host areas and enable successful settlement, careful risk evaluation to improve foreseeability and blindness in action, and preparation and implementation of adequate environmental plans in the light of project features.

2.2 Dam construction and environmental management

Environmental management is an important way and tool of coordinating socioeconomic development and environmental protection. This term has two meanings: in a broad sense, it means management of human social and economic activities as allowed by the environmental capacity and based on environmental theories by technical, economic, legal, educational and administrative means; in a narrow sense, it means the managers' control and regulation of pollution and damages caused to the environment in the process of economic and social development, to enable the achievement of preset environmental goals and the integration of economic, social and environmental benefits.

Dams are aimed at promoting merits and abolishing demerits, to enable multipurpose use and improve the people's production and livelihood. Therefore, environmental pollution and ecological damages in the process of dam construction deserve adequate attention. Especially when economy grows rapidly today, the ever – increasing number and size of dams represent more significant adverse environmental impacts. This is demonstrated by the outstanding or remaining environmental problems in some projects. To look in the cause, these problems are largely caused by improper management, e. g. unreasonable plan and layout, no restraints on environmental protection in pursuit of maximum economic interests, while others not directly related to management can be effectively solved by adequate environmental management. Under the condition of limited economic strengths, it is greatly significant to regard the improvement of environmental management as the policy of environmental protection and to identify the process of environmental management in addition to reliance on technological progress and increase of environmental input.

2.3 Dam construction and environmental impact assessment

The environmental problems during and after dam construction can be mitigated/offset by environmental impact assessment (EIA) and environmental protection measures proposed therein. EIA means a set of methods and systems for analyzing, forecasting and assessing the possible environmental impacts due to dam construction, providing mitigating/offsetting measures, and carrying out follow – up monitoring.

In view of the work process, EIA includes 3 stages in terms of either general assessment or environmental element assessment: preparation, formal work, and report preparation.

The scope of EIA covers such main environmental elements (or items) as water environment, air environment, acoustic environment, ecological environment, public health, landscape and cultural relics. The factors, methods and levels of detail of these elements are dependent upon the level of EIA, which is determined by the project impacts, including their scope, target and source intensity.

EIA methods include the mathematical model method, physical model method, analog and comparison method, and character index method, which are used for different environmental elements according to the level of EIA and the actual conditions. Generally speaking, higher levels of EIA and more complete surveys of environmental setting result in higher accuracy of forecast and assessment.

2.4 Dam construction and scope of environmental protection

The scope of dam – related environmental protection has been limited to the preparation of EIA reports for feasibility study purposes over the years, mainly because of the separation of reconnaissance, planning and design of dam projects from construction and management, the inadequacy of laws/regulations, and the lack of understanding. As dam – related environmental protection is performed on a large scale, particularly international financial institutions – financed projects are introduced, the environmental awareness of the public is increased. The increased environmental awareness of professional persons other than those specialized in the environmental protection of water and hydropower projects, including managers and leaders, constantly enlarges the scope of environmental protection.

Environmental protection is incorporated into the whole process of dam projects financed by loans or domestic funds, including prefeasibility study, feasibility study, design, bidding and construction. While preliminary environmental examination reports are prepared in the stage of preparation, environmental proposals in the stage of feasibility study and environmental protection design in the stage of preliminary design, and submitted to superior environmental authorities for review and approval, environmental clauses are prepared and incorporated into bidding documents according to the FIDIC Conditions of Contract, project features and environmental requirements in the stage of bidding and design. This practice provides a solid basis for the preparation and implementation of environmental programs.

In the stage of construction methodology statement, environmental action plans are prepared to set the goals of environmental protection, determine the methods and contents of special environmental activities, and fix the environmental cost estimates.

In the stage of implementation, environmental management organizations are established and environmental responsibilities identified for the Employer, Engineer and Contractor, to carry out environmental monitoring, disease control and other environmental activities.

2.5 Dam construction and environmental supervision

Many adverse environmental impacts due to dam construction are caused in the construction period, so it is particulaly important to implement environmental protection measures during construction. Environmental supervision, a pioneering mode of environmental management toward this purpose, properly links with the construction of projects, reduces the time difference between identification and solution of environmental problems, mitigates the subsequent economic losses, changes after – the – fact management to process management, changes simply mandatory environmental management to a combination of mandatory and directive management, and changes inactive management to active prevention and process management.

The scope of environmental supervision mainly includes the following aspects:

To supervise the Contractor's performance of environmental clauses included in the Contract, explain such clauses, provide remedy measures for significant environmental issues, cause responsible parties to take correction measures within a specified period of time, identify and keep abreast of environmental problems during construction, provide instructions to specific environmental indicators, analyze monitoring results, and provide improvement schemes.

To participate in meetings reviewing the construction methodology statements, construction schemes and schedules provided by the contractor, make comments on environmental improvement, review the building materials, equipment lists and environmental indicators proposed by the contractor, coordinate the relationship between the employer and the contractor, handle breach of contract regarding environmental clauses, and treat claims and counterclaims in environmental aspects impartially according to contractual settlement of disputes procedures.

To take part in the interim taking over of a section/part of the works and final taking over of the all the works performed by the contractor, and cause site clearing and restoration of completed works, for the landscape to meet the applicable environmental provisions.

3 Prospects for environmental protection in dam construction

(1) The development of human civilizations necessitates the transformation of environment and the development and utilization of water resources necessitates the construction of dams. No doubt the construction of dams causes various effects on the local physical environment and social environment, some of which are desired, some are not, some are positive, and some are negative or detrimental. As our sciences and technologies progress constantly, however, we will be able to understand and implement practical measures to maximize various positive effects and mitigate/offset detrimental ones.

(2) Along with the development of water conservancy in China, the scope of dam – related environmental protection will be enlarged further. At present, it is not a common practice to incorporate environmental protection into all stages of a project. To the contrary, many large and medium – sized water and hydropower projects include environmental impact assessment and environmental design in feasibility study and preliminary design stages only, with little or no environmental protection arranged in other stages. As environmental protection systems are improved constantly, environmental protection will be certainly extended to both ends of a project: the stage of planning, including the comparison and selection of alternatives, and the stage of implementation and operation management.

The horizontal expansion of dam – related environmental protection is mainly reflected by resettlement, which is inseparable and interactive with environment. Thus, environmental protection should be carried out with due care in all stages of resettlement, including planning, site selection, physical relocation, and resettlement, to enable coordination and promotion between resettlement and environment.

(3) To depend on scientific and technological progress is probably one of the most important approaches to improve environmental protection in China. In the respect of dam – related environmental protection in China, the application of up – to – date technologies, methods and equipment represents the general trend. It is expected that an EIA database will be established for each large – sized water project in the near future and updated in line with dynamic changes, to verify the forecast environmental impacts and remedy measures and make adjustments as appropriate for the purpose of dynamic management.

(4) Dam construction will enter upon the track of sustainable development. Having experienced the course of initial elimination of hazards and later multipurpose utilization that combines the promotion of benefit with the elimination of disbenefits, China has realized the importance of sustainable development. To construct dams and conquer nature, we must first follow the "natural order of things", establish a new and harmonious relationship between man and nature, and change from simply making nature meet our demands to respecting and protecting nature. While considering the interests at present, the planning, design and construction of dam projects must consider the interests of the coming generations also. Nature will "infinitely benefit man" only if construction (transformation of nature) is combined with protection (preservation of nature).

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Discussion on Unbalanced Tender Offer

***Zhang Shengguang*[1], *Liang Haiyan*[2] and *Yu Tao*[3]**

1. Shandong Yellow River Engineering Bureau, Jinan, 250011, China
2. Yellow River Conservancy Commission, Zhengzhou, 450003, China
3. Puluo Company of Jinan Yellow River Engineering Bureau, Jinan, 250011, China

Abstract: The application and promotion of tendering and bidding is getting canonical to the Yellow River's flood control projects. The promulgation and implementation of "Cost Evaluation Norms for Bill of Quantity of Construction Works" provides a platform of an unbalanced tender offer for construction enterprises. This paper delivers a brief deseription on the background causes, manifestation, and aftereffects of the unbalanced tender offer as well as the strategies and measures for impartial and reasonable tender pricing.

Key words: tendering, tender offer, manifestation, strategies

In 1998, the Yellow River flood control projects commenced to confirm construction enterprises by tendering and bidding. With the gradual open of the construction markets, the tendering and bidding system is getting better and more canonical after long period of groping. At the same time, competition among enterprises for bidding are getting more cut – throat. The construction enterprises gain experience in the course of bidding, therefore, they often win the bidding and obtain profits by utilizing some smart bid tactics. The multiform of flood control project construction and complicacy of the valuation of project cost mak it difficult to define the project cost. Two tendencies in the public bidding course attract our attention: First, during the bidding competition, some construction enterprises maintain competitive quoting power by means of adopting an unbalanced quoted price. Second, the owner can lower the price unbridledly. Bidders are forced to accept irrational items in the bidding writing and bear entire commitments to win the bidding, which makes them unprofitable. So they won't spare to jerry – build which touch quality, safety and rate of progress negatively and compels the engineering management to be extremely passive. Now, we shall discuss on unbalanced quoted price in several aspects in the following content.

1 Background and definition of unbalanced tender offer

On July 1, 2003, the national promulgation and implementation of "Cost Evaluation Norm for Bill of Quantity of Construction Works" indicates that the construction engineering tendering contract evaluating way is changing from total price contract to unit price contract. This represents a tremendous improvement in the construction engineering bidding accounts valuation technique and provides a platform for bidders to retract engineering funds. It also increases the profits of management and unbalanced quote prices.

Compared with the normal balanced quoted price, unbalanced quoted prices are used to adjust the unit price or amount of some projects consciously on precondition of total changeless quoting. Its purpose is to take back the engineering fund as soon as possible and increase the current capital. Meanwhile, it gets extra profits from the design modification which changes the engineering work load or unit price.

2 Manifestation of unbalanced tender offer

The following is a summary of the patterns of manifestation of unbalanced tender offers: First, ambiguity or visible errors in the blueprints. Unit price of the items estimated to be amended is higher in order that it could be utilized in the evaluative modification. Second, those items that the engineering work load is estimated to increase, their unit prices are high. Third, because of the difficulty of accurate calculation of the engineering work load such as cubic meters of soil and stone project unit quoted price could be higher. Although the total quoted price isn't much affected, construction enterprises can gain more profits when the practical engineering work load is larger than that expected in the bidding. Fourth, providing the owner items in provisional prices. If the provisional price is on the low side, increasing the engineering work load intentionally can attain an extra price difference. Fifth items constructed in advance such as basic engineering, soil excavating and pile foundation, can cause high unit price, which will increase early income and turnover of capital. For the afterward items, their unit price is low.

3 Main causes of unbalanced quoted prices and their effect

The unit who invite public bidding and bidders are unitive as well as opposite. They both agree on the same cardinal point that guarantees the quality, quantity and completion of construction task on time. But they are contradicted in the engineering cost. The bidding unit pursues the project profit as much as possible. The contradiction between the owner and bidder on the engineer cost is based on the premise of unbalanced quoted price. At present, competition among construction markets get cut-throat, the owner attaches the importance of the bidder's qualification, there for the price of the economic bidding in the evaluation course directly affects whether the bidder can win or not in the bidding process. Some bidders cut off investment to seek lower prices. Meanwhile, the owner can lower the price to the greatest extent, even below the cost. This insane competitive method is a direct result of unbalanced quoted prices.

For construction enterprises, unbalanced quoted price is a kind of strategy or technique. As to the owner it results in winning the bid with a low price while balancing it with a high price, which hampers public bidding from working properly.

4 Strategies and measures for impartial and reasonable quoting

The management sector pay full attention to the cost of engineering and bidding. Quality is separated from price in cost controlling and "controlling consumption, guiding price, and pricing at the market" should be used in the valuation of supervisor mode. Calculating the floating downward scope should be used in all kinds of bidding projects. They should be controlled in rational engineering cost ranges to protect both economic rights and interests.

The owner should take effective countermeasures under the condition of fairness and to impartiality aim at unbalanced tender offers. The reasons is to polish up the bidding process, guarantee the engineering quality, increase investment benefit and protect national and public interests as well as the legitimate rights and interests of the parties involved in tendering and bidding activities. Three aspects that should be considered.

4.1 Pay full attention to preparation before bidding

The owner should handle affairs according to national stated procedures related to capital construction and avoid "three sides" projects. They should put much emphasis and capital on the preparation, especially the construction blueprint. They should evaluate the cost properly, allow rational minimum prices of awards of contracts and guarantee legal rights and interests of bidders. First, the extent and quality of the blueprint is particularly important for total prices project. Rational blueprints can reduce and even avoid design changes. According to "Public Bidding Law", precondition on the bidding enterprises' aptitude and credit standing is good, the engineering bidding should be ended in rational minimum price, but not less than the cost. The premise is to require integrated and accurate blueprint to evaluate proper cost. Second, owners should take enough time to investigate engineering price data in the market and get the latest price information. This large amount of data with prices that are difficult to confirm can be fixed temporary prices. But the temporary prices should be moderate. Meanwhile, those files including the adjustments require temporary prices to be defined. Third, inspecting the credit of the bidding unit on the spot should be required. In particular, much emphasis should be put on whether they' ve caused dissension by project balance in the previous construction engineering.

4.2 Attach much importance on bid evaluation

Firstly, a tender shall entrust some professional tending agency to work out the engineering estimatior. At present, the engineering bidding adopts the international method of evaluation according to the bill of quantity of construction works. This method is a way to form a new engineering cost forming mechanism. Reduc the engineering cost is a good way to avoid letting out pre – tender. Evaluation according to the bill of quantity of construction works can more accurately show the real engineering cost. This is a benefit to form certain engineering cost through fair competition. Moreover, evaluation of the bill of quantity of construction works is a convenient way to regulate the bidder' s evaluation acts technically, to avoid "black case work" and to make it clear to the public. Secondly, it is important to improve the proportion of economic bidding evaluation of the bid evaluation committee and ensure the evaluation time. As to unbalanced projects of the bidder' s tender offer, analyze them one by one and collect the written material. Then we should abolish the unbalanced tender offer with large amounts. Finally, the owner should organize the checkup of the bid for the winning bid and make written clarity or commitment for the ambiguous problems. Don't leave hidden problems and avoid winning the bidding with low prices while balancing it with high prices.

4.3 Put emphasis on engineering alteration and counterclaims in the implementation of the projects

Completion of the engineering is the most difficult and complicated phase. As far as the engineering is concerned, invariability is relative while alteration is absolute. As to the adjusting bill, supervising owner and construction enterprises shall calculate according to the contract as well as unitive engineering alteration auditing procedure. As for the serious unbalanced items, try to find them in time and negotiate with the construction enterprises to get them resolved during the construction, to avoid entanglement after the construction is completed. When it comes to claiming for compensation, distinguish responsibilities and offer counterclaims in time to avoid worthless loss. The management of the engineering cost shall run through the whole construction process. We should avoid attaching much importance on the rate of construction progress and quality while caring less about its cost.

In general, to win and gain markets in the impetuous competition for the construction enterprises, normal strategies and tactics is not enough. Enterprises should keep improving their management level and integrative competitive power. Moreover, they shall pay full attention to the evaluation and review in the bidding process to ensure the bidding process working smoothly, prevent serious unbalanced quoted prices from posing negative impact on construction processes.

Experiment and Research of the Impact from Sanmenxia Operational Level on Tongguan Elevation

Chang Wenhua, ***Hou Suzhen***, ***Wang Puqing*** and ***Tian Yong***

Yellow River Institute of Hydraulic Research, Yellow River Conservancy Commission, Zhengzhou, 450003, China

Abstract: By means of the physical model, 5 groups of experiments with different water levels and water and sediment conditions were carried out. The impact on lowering the Tongguan elevation caused by different water and sediment conditions and the different water levels were compared and analyzed. The test results indicate that lowering the water level in front of the dam may adjust silting location within the reservoir that is advantageous to wash out and lower the Tongguan elevation. However, compared with the water level, the favorable water and sediment conditions have a bigger influence on the Tongguan elevation.

Key words: operation mode of Sanmenxia Reservoir, Tongguan elevation, flood open discharge

1 Outline

Serious deposition occurred in the Sanmenxia Reservoir area during its initial operation stage, resulting in sharp rise of the Tongguan elevation (the water level of Tongguan cross section at flow discharge of 1,000 m^3/s) and the riverbed in the Lower Weihe River to be deposited and raised continuously, thus, the flood prevention situation became grim. Therefore, the reservoir had been rebuilt and its operational mode changed twice respectively. Since adopting "Storing Clear Water and Releasing the Muddy" in 1974, in order to reduce the influence of the operation of the reservoir to the Tongguan elevation, from 1974 to 1992, the peak water level of the reservoir at non – flood season was restricted to no more than 326 m and the average water level was 324.15 m. From 1993 to 2001, the peak water level was restricted to no more than 322 m in most years and the average water level was 321.83 m. Since 1986, as a result of the change of water – sediment conditions, there was accumulative deposition in the reservoir area below Tongguan and the Tongguan elevation constantly rose. The research indicated that the Tongguan elevation has the feature of eroding at flood season and depositing at non – flood season, but the primary factors that would affect the Tongguan elevation come from water – sediment conditions and operational water level of the reservoir. In order to further study the impact of different water levels of the Sanmenxia Reservoir and water – sediment conditions on Tongguan elevation and erosion and deposition in reservoir, the physical model experiment was carried out.

2 Test plan

2.1 Model design and verification

The model design mainly considers similar conditions of water gravity, the resistance to water flow, water flow capacity to transport sand, suspended sediment, the distortion of riverbed, the starting and raising of sediment and the river pattern. The main scale is the horizontal scale λ_L = 420, vertical scale $\lambda_H = 50$, suspended sand diameter scale $\lambda_d = 0.91$, sediment concentration scale $\lambda_s = 1.8$, the time scale $\lambda_t = 59.4$.

The model was validated through the recorded flow and sediment process from November 1991 to November 1994, the result indicates that model design can well meet the similar request of water flowing and alluvial sedimentation in reservoir.

2.2 Test condition and plan

The initiatory boundary condition of the experiment is the terrain of the reservoir area after the flood season of 2001. The volume of water and sediment was controlled according to the total volume of water and sediment at Xiaobeiganliu reach of the Yellow River, the Huaxian hydrologic station of the Wei River(branch of the Yellow River) and the north Luo River (branch of the Wei River). The outlet of the model was controlled by the water level of Sanmenxia Reservoir. The water and sediment conditions for the experiment include two series, the high flow series and the low flow series. The high flow series adopts the recorded data of water and sediment process from November 1, 1986 to October 31, 1989 while the average annual volume of water and sediment of the Tongguan hydrologic station are 29.29 bnm^3 and 0.845 bnt respectively; the low flow series adopts the water and sediment process from November 1, 1996 to October 31, 1999 and the average annual volume of water and sediment of the Tongguan hydrologic station are 19 bnm^3 and 0.57 bnt respectively. The peak water level of the Sanmenxia Reservoir during non – flood season is restricted to 318 m or 315 m and during flood season the Reservoir were open discharged in the full season or in the flood days (when the flow is over 1,500 m^3/s, otherwise, the water level restricted to 305 m). There are different compositions for five test plans shown in Table 1.

Table 1 Test plans

Test plan	Conditions of test	Plan abbreviation
1	Water and sediment of low flow, non – flood season318 m, open discharge of flood season	Low flow 318 open discharge of flood season
2	Water and sediment of low flow, non – flood season315 m, flood open discharge of flood season	Low flow 315 flood open discharge
3	Water and sediment of low flow, non – flood season318 m, flood open discharge of flood season	Low flow 318 flood open discharge
4	Water and sediment of rainy flow, non – flood season315 m, flood open discharge of flood season	Rainy flow 315 flood open discharge
5	Water and sediment of rainy flow, non – flood season318 m, flood open discharge of flood season	Rainy flow 318 flood open discharge

3 The analysis of test result

Fig. 1 and Table 2 show the process of change of Tongguan elevation and its fluctuation in different plans, from which it can be found out that there are some differences among them.

3.1 Comparing the results of different plans of different water levels under the same water and sediment condition

3.1.1 The condition of high flow

In the plan of high flow 318 flood open discharge, Tongguan elevation accumulatively raised 0.13 m in non – flood season, accumulatively dropped 1.14 m in the flood season and totally dropped 0.83 m within three years.

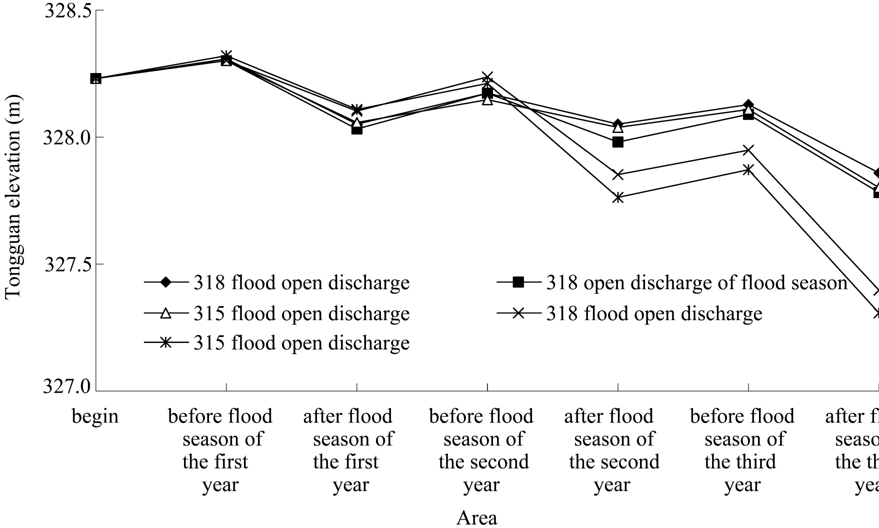

Fig. 1 The process of change of Tongguan elevation in each test

Table 2 Fluctuation of Tongguan elevation in different periods Unit: m

Plan	Low flow 318 flood open discharge	Low flow 318 open discharge of flood season	Low flow 315 flood open discharge	High flow 318 flood open discharge	High flow 315 flood open discharge
The first year non – flood season	0.08	0.07	0.07	0.07	0.09
The first year flood season	–0.26	–0.27	–0.24	–0.2	–0.21
The second year non – flood season	0.12	0.14	0.09	0.14	0.10
The second year flood season	–0.12	–0.19	–0.11	–0.39	–0.45
The third year non – flood season	0.08	0.11	0.07	0.10	0.11
The third year flood season	–0.27	–0.31	–0.31	–0.55	–0.56
Accumulative rise	0.28	0.32	0.23	0.31	0.3
Accumulative drop	–0.65	–0.77	–0.66	–1.14	–1.22
Total drop within three years	–0.37	–0.45	–0.43	–0.38	–0.92

In the plan of high flow 315 flood open discharge, Tongguan elevation accumulatively raised 0.30 m in non – flood season, accumulatively dropped 1.22 m in the flood season and totally dropped

0.92 m within three years. In non – flood season, under the peak water level 318 m, the farthest impact of backwater of the reservoir arrived at Huang Yu 34 cross section and Tongguan reach was in the natural way. When the peak water level was at 315 m, the impact of backwater was smaller than 318 m plan. Therefore, in non – flood season, the impact of operational water level of the reservoir to Tongguan elevation is smaller. In the two plans, the gap between rising of Tongguan elevation is 0.01 m. Water level dropped at flood season, so it caused regressive scouring and steep on water level, the part of sediment deposition in 315 flood open discharge plan is near to dam, and it is much easier to be scoured out the reservoir and is more helpful for scouring the reservoir. High flow 315 flood open discharge accumulatively scours 0.08 m more than high flow 318 flood open discharge and accumulatively scours 0.09 m more within three years.

3.1.2 Conditions of low flow

In low flow 318 flood open discharge plan, the total drop of Tongguan elevation within three years is 0.37 m, and in low flow 315 flood open discharge plan, the total drop of Tongguan elevation within three years is 0.43 m, which is 0.06 m more than low flow 318 flood open discharge.

Comparing low flow 318 open discharge of flood season with low flow 318 flood open discharge, at flood season, the water level in front of dam of low flow 318 open discharge of flood season is low, the gradient of water surface in the Reservoir is large, so it is more helpful for regressive scouring. The total drop of low flow 318 open discharge of flood season within three years is 0.45 m, 0.08 m more than that of low flow 318 flood open discharge.

3.2 Comparison of the same operational water level of the reservoir under different water and sediment conditions

3.2.1 Comparing of all 318 flood open discharge plans

In non – flood season, considering that the operational water level of the reservoir is the same, the differences of Tongguan elevation of all plans were mainly caused by water and sediment factors. In low flow 318 flood open discharge plan, the spring flood peaks are larger than that of the high flow 318 flood open discharge plan, which is helpful for scouring of Tongguan elevation, therefore, within three years, the Tongguan elevation of non – flood season in low flow 318 flood open discharge plan dropped accumulatively 0.03 m more than that of high flow 318 flood open discharge plan. In flood season, the flow discharge and volume of flood peak under the high flow water and sediment conditions are larger than those of low flow water and sediment condition, which are helpful for scouring of Tongguan elevation, therefore, within three years, the Tongguan elevation in high flow 318 flood open discharge plan accumulatively dropped 0.37 m more than that of low flow 318 flood open discharge plan.

3.2.2 Comparison of 315 flood open discharge plans

The drop of Tongguan elevation under conditions of high flow is much larger than that under conditions of low flow. In high flow 315 flood open discharge plan, the drop of Tongguan elevation in flood season accumulatively reaches 1.22 m, 0.56 m more than that of low flow 315 flood open discharge; the total drop is 0.92 m within three years which is 0.49 m more than that of low flow 315 flood open discharge.

3.3 Comprehensive comparison

Through comparisons among each plans, under the same water and sediment factors, it can be found out that the drop of Tongguan elevation in 315 flood open discharge plan drops 0.06 ~ 0.09 m more than that in 318 flood open discharge; under the condition of low flow, the drop of Tongguan elevation in 318 open discharge of flood season drops 0.08 m more than that in 318 flood open discharge. For the similar operational mode of the reservoir and different water and sediment conditions, the drop of Tongguan elevation under the condition of high flow drops 0.46 ~ 0.49 m more than that under the condition of low flow.

Comparing the total drop of Tongguan elevation within three years, the largest drop of Tongguan elevation takes place in the plan of high flow 315 flood open discharge, and the smallest drop is in the plan of low flow 318 flood open discharge. The drops of Tongguan elevation of high flow 318 flood open discharge, low flow 318 open discharge of flood season and low flow 315 flood open discharge are in the middle.

Under the same water and sediment factors, the lower operation water level is favorable to decrease Tongguan elevation. When the reservoir operation mode is same, the more abundant the water is, the more favorable to lower Tongguan elevation will be. Both operation of water level in front of dam and water and sediment factors have influence on lowering Tongguan elevation, but water and sediment factors are more obvious to scour and lower Tongguan elevation.

4 Conclusions

The difference of impact on scouring and lowering Tongguan elevation which is from 315 flood open discharge plan and 318 flood open discharge plan is small. The difference of impact on scouring and lowering Tongguan elevation which is from low flow 318 flood open discharge and low flow 318 open discharge of flood season is also small. In high flow flood open discharge plan, the Tongguan elevation accumulatively dropped 0.37 m more than that in low flow flood open discharge plan. So it can be concluded that the water and sediment conditions are the main factors affecting the Tongguan elevation. To lower the Tongguan elevation in large scale can not be realized only by depending on lowering the operational water level of the Reservoir. The aim to lower Tongguan elevation is to solve the problems of sedimentation and flood control in the lower Weihe River. Because of deterioration of water and sediment in Weihe River recently, only depending on lowering Tongguan elevation con not completely solve the problem of flood control. So we should speed up the pace of treatment and strengthen the search of law of river course evolution in the lower Weihe River. The problem of Tongguan elevation is complicated, although a great number of achievements have been gained, we still need to further study on inherent law, influence factors and measures to reduce of changes of Tongguan elevation.

Tendering and Tendering Agent Practice for Yellow River Hydraulic Engineering Construction Project

Li Wei and *Luo Dagong*

Henan Yellow River Construction Engineering Co., Ltd., Zhengzhou City, Henan Province, 450003, China

Abstract: The tenders and bids for engineering is an important link in the engineering construction. According to many years practice as tendering agent for Yellow River hydraulic engineering construction project, this paper introduces the tenders and bids development of Yellow River hydraulic engineering construction project, primarily concludes the characters of tendering for Yellow River hydraulic engineering construction project and discusses some problems in the tendering agent work.
Key words: engineering construction, tenders and bids, tendering agent, three systems, Digital Yellow River

The tenders and bids for engineering is the most popular and important method in the domestic engineering construction project procurement at present. As an indispensable link in engineering construction, now it has been popularized and applied in Yellow River hydraulic engineering construction, and is displaying its importance gradually. Over many years, we have always acted as professional tendering agent. Entrusted by construction unit, we have successively undertaken and completed tendering of Yellow River hydraulic engineering project for many times, accumulated amount of experience, and got better effects.

1 Brief introduction to tenders and bids development of Yellow River hydraulic engineering construction project

Early in 1982, China adopted international tender contract system on the Lubuge hydraulic power station of Yunnan province. Being long affected by planned economy, morbidity law system and construction management system, the tenders and bids for engineering wasn't extensively put into practice in China. That tenders and bids for engineering truly pressed ahead on the Yellow River hydraulic engineering construction is after Hydraulic Engineering Construction Project Management Temporary Stipulation of Ministry of Water Resource (try out) in 1995. Especially after Yangtze River flood in 1998, as dike engineering centered on large – scale flood control works began to construct and the reform of basic construction management system three systems went into depth, more and more Yellow River hydraulic engineering construction project constructions adopt tenders and bids so that it develops very rapidly. After the issuance and implementation of Law of the People's Republic of China on Tenders and Bids in 2000, tenders and bids for Yellow River hydraulic engineering construction have stepped into stage of all – round implementation and the tendering and bidding work is being standardized gradually.

2 Main characters of tendering of Yellow River hydraulic engineering construction

2.1 Powerful planning

Most of Yellow River hydraulic engineering construction projects are Public Welfare Projects, belonging to central committee water resource basic construction projects. Its construction fund is mostly from central committee investment and its implementation must pass basic construction filtration procedure project proposal, feasibility study report, etc. must be submitted to the relevant departments to review and approve and only those listed in central committee annual investment plan can be implemented. From filtration project to completion of project implementation, middle procedures are numerous. The tendering and bidding work, as a part of many procedures, is naturally well – planned. At the same time, Yellow River hydraulic engineering construction project often refers to preliminary work such as compulsory land acquisition and residence removal etc. As we know, compulsory land acquisition and residence removal influences extensively with hard work. According to state relevant stipulation, only after the completion of these works can the project possess the condition of tender and start tendering. In the practice, it's very general of each party to prepare and coordinate, then leave too little time for tendering work. At the same time, tendering work also should guarantee that post procedures carry out according to the plan, so tendering of Yellow River hydraulic engineering construction project mostly reckon the time according to the planned time of starting works, which causes that tendering of Yellow River hydraulic engineering construction project must be well planned. When to publish notice, when to accept bidding signing up, when to sell the bidding document, and when to open bid, etc. must be arranged closely and there is no flexible space. At the same time, tendering work has strict procedure and many middle links. Thus feasible plan is required to assure tendering work to be carried out smoothly.

2.2 Project with extensive involvement

On the one hand, tendering projects of Yellow River hydraulic engineering construction involves extensive areas. Those undertaken by us mainly concentrate in the downstream areas of Yellow River, originate from 4 provinces such as Henan, Shandong, Shanxi, and Shaanxi and the tenderers refer to river administration departments in 4 provinces and about 20 cities.

On the other hand, tendering project also involves extensive work content and specialty. Those undertaken by us refer to Yellow River flood control engineering construction, engineering construction supervision, engineering design, engineering investigation, environment evaluation etc, of which Yellow River flood control engineering also includes river regulation and control, levee heightening, concrete seepage interception wall, road construction, bridgework, brake and trench reconstruction and expanding.

2.3 Obvious mass quantity

Most of Yellow River hydraulic engineering construction projects are Public Welfare Projects and engineering funds are mostly from central committee investment that make known to lower levels according to annual investment program. Once annual investment program and annual engineering implementation schedule are approved, related projects will start one by one. Therefore, this brings tendering projects of Yellow River hydraulic engineering construction strong mass quantity with specific representation as including many contract lots every time. Under general situation, each tendering has 3 ~ 5 contract lots at least and 30 ~ 40 contract lots at most.

2.4 Severe competition between construction enterprises

If there are few contract lots in one tendering project—like few porridge for many monks, severe competition is very common and natural. Generally speaking, there are many contract lots of tendering and many opportunities to award of contract for construction enterprises, which will lead competition to ease up. But as for tendering of Yellow River hydraulic engineering construction, it's not true. Sometimes there are 30 ~ 40 contract lots in one tendering project of Yellow River hydraulic engineering construction. Although there are more contract lots in one tendering project, the competition among construction enterprises remains quite severe, and there may have more than 40 construction enterprises competing for one contract lot. The degree of competition is tough. That is why construction enterprises take part in tendering and bidding of Yellow River hydraulic engineering building construction so actively, on the one hand, is relevant to saturation of domestic architecture market whose present situation is few construction projects but too many construction enterprises. This is basic reason leading to severe competition. On the other hand, it's relate to the situation of enterprise itself. It's said that many construction enterprises that take part in bid had engaged in Yellow River hydraulic engineering from the times of planned economy and had close connection with Yellow River. Now, although these enterprises step into society, and participate in market competition, due to present domestic segmentation in architecture market and industrial and local protectionism, it is difficult for them to contract the projects. So these enterprises concentrate the goal and the power into the market of Yellow River hydraulic engineering construction. To some extent, this also aggravates the competition of tendering and bidding of Yellow River hydraulic engineering construction project.

2.5 High requirement on the bid evaluation experts

Although the nation has specific conditions and requirements for the bid evaluation experts, the features of tendering of Yellow River Hydraulic Engineering Project raise higher requirements for them. First of all, because the tendering generally includes many contract lots each time, coupled with many construction enterprises joining the competition, many relevant bidding documents as well as large workload, the bid evaluation job may last for a longer time. It is not so easy to finish so many comparison and evaluation in the required time. Therefore it requires the experts not only having sound health, but also having hard – working dedication spirit on work. Then, over several years, tendering of Yellow River Hydraulic Engineering Project, as a part of "Digital Yellow River" engineering construction, is gradually exploring and testing the evaluation with computer, which demands the involved experts not only having the higher professional knowledge and practical experiences, but also the skills of operating the computer. This is also the new requirement on bid evaluation experts raised by tendering of Yellow River Hydraulic Engineering Project.

3 Practice of tendering agent for Yellow River hydraulic engineering project

Our company is a professional tendering agent with grade A qualification of tendering agency for engineering construction. Since 2001, assigned by the project construction unit, we have successively undertaken and fulfilled nearly 30 batches tendering agent work of Yellow River hydraulic engineering projects. Among them, some are projects invested by central committee of CPC, and some are loan projects of Asian Development Bank, whose contents involve specialties such as the engineering construction, engineering supervision, engineering design, engineering survey, environment evaluation and so on. Over recent years, we have finished tendering of engineering projects as an agent for 450 contract lots, accumulatively winning bid amount about 3.5 billion Yuan.

According to the features of tendering work of the Yellow River hydraulic engineering projects, we should focus on such aspects of improving our concept, administrating strictly, carefully compiling the tendering documents, enhancing the evaluation work in the tendering agent process, ensuring the tendering agent work carrying out smoothly.

3.1 Improve the concept, strictly fulfill the relevant law and regulation of the state, and set up complete tendering agent work system

Because tenders and bids touch upon extensive fields and has strong political power, if the tendering agent organization wants to deal with it well and provides excellent and high efficient service, they must stick to and follow the principles of opening, equality, just and honesty, solidly establish the concept of following law, carefully study and carry out relevant law, regulation and rules of the state. Since 2000, to standardize the tenders and bids behavior, the state and some ministries like Ministry of Construction, Ministry of Water Resources successively issued several laws, regulations and rules such as the Law of the People's Republic of China on Tenders and Bids, Interim Provisions on Bid Evaluation Commission and Bid Evaluation Methods, Administrative

Measures for Bidding and Submission of Tendering for Construction Projects, Management Regulation of Water Project Construction on Tenders And Bids, Management Measures of Water Project Construction Supervision on Tenders and Bids. Carefully studying such laws and regulations not only can improve our sense of law and concept legality, but also is the foundation and basic guarantee for doing the tendering and bidding work well.

The establishment of complete regulation and system is a guarantee for the tendering and bidding work and is a future standard to improve the tendering agent daily work and management behavior. Besides the above mentioned law, regulations and rules, System and Principles on Tendering Agent, System and Principles on Bid Evaluation, System and Regulation on File Management of Tendering Agent have been successively established in light of the demands of the tendering agent work, and each system has been exercised in actual way to improve the standardization and systemization of the management work.

3.2 Compile the tendering documents carefully

The tendering document expresses the tenderers' intention. The tendering document, as the written document made by tenderers to bidders, is the most important legal document in the tenders and bids activities and the important basis for bidders to prepare their bidding documents and participate in the bidding, which not only regulates complete bidding procedure, but also raises each specific technological standards and terms of exchange to draw out the main contents of the contract. The quality of tendering document decides whether the tendering and bidding work is successful or not.

According to the features of tendering work of Yellow River hydraulic engineering project, while compiling the tendering documents, it should lay stresses on the following six aspects: ① stressing on the legal effect of tendering documents and insisting the basic principles of science, preciseness, standardization and justness. ② Clearly making out the prerequisites bidders must need. ③ Clarify the components and compiling requirements of the bidding document in order to ensure that bidders can hand over the documents qualified for the bid evaluation. ④ Clarify the evaluation standard and methods for the bidding documents in the tendering documents to ensure that they can meet the requirements for bidding documents and be published openly in the documents, no random alternation on them. All the standards and methods unspecified in the tendering documents can not be taken as basis to evaluate the bid, the purpose of which is to improve the transparency, openness and justness in the process of bid evaluation. ⑤ List the components and major articles of the contract in the tendering documents to inform the bidders of the main contents of contract after they win the bid, explaining rights and obligations of both sides. ⑥ List each technological specification for implementing the projects in the tendering documents and focus on the requirements for project quality and technology.

During the course of compiling bidding document, for assuring fairness and justice of tendering, according to stipulation of Law for Tenders and Bids, each article of tendering document should be checked to guarantee the tendering document excluding contents that exclude latent bidder so as to protect the benefits of bidder.

To guarantee tendering document tallying with actual situation of construction project, embodying the requirements of tenderer and reflecting purpose of tenderer, in the course of tendering work of Yellow River hydraulic engineering construction project, we invite related construction management department and tenderers to assign representatives or special person acquainting with construction situation to take part in compiling work of tendering document at stage of compiling tendering document, respecting the opinions and suggestions of tenderers under premises of holding principal.

3.3 Accept supervision actively and organize bid evaluation work well

Evaluation of bids is most important link in tendering and bidding activities. The center of bid evaluation work is regulating bid evaluation activity and keeping its justice. Thus, when acting tendering work of Yellow River hydraulic engineering construction project, at stage of bid evaluation, two emphases of tendering agent work are to establish legal bid evaluation institutes and to do secret keeping work well, accepting supervision of related departments during the course of bid evaluation activity.

3.3.1 Establish bid evaluation institute legally

Bid evaluation experts for tendering of Yellow River hydraulic engineering construction project are chosen randomly from bid evaluation expert bank of Yellow River hydraulic committee according to relative regulations. Selecting of bid evaluation expert is under supervision of tendering and bidding competent authorities of Yellow River committee, supervision department and representative of notarization department. List of bid evaluation experts is kept secret before determination of result of tendering.

3.3.2 Accept supervision actively and keep secret in the course of evaluation of bids

The bids evaluation work of all the public and invited tendering lots should be done in closed condition. As for the tendering and bid evaluation of Yellow River hydraulic engineering construction project, we supply service actively and do work of keeping secret well, and invite relevant function department of Yellow River hydraulic committee to appoint representatives to supervise on the spot, in addition to trust notarization institute to appoint notary to make notarization of procedure, method and result of bid evaluation, assuring bid evaluation work is done strictly according to evaluation standard and method specified in bidding document.

4 Experience and inspiration from tendering agent of Yellow River hydraulic engineering construction project

(1) Since "three systems" reform of basic construction management system is put into practice, under importance attached by leaders of Yellow River hydraulic committee and common effort of relevant department, tendering and bidding work of Yellow River hydraulic engineering construction project experiences the course of development, regulation and improvement. Enforcement of tendering and bidding work makes great promotion in developing Yellow River hydraulic engineering construction, improving enterprise technology, saving investment of engineering construction and enhancing engineering quality and benefit. As unfolding of "digital Yellow river" engineering construction, tendering and bidding management of Yellow River hydraulic engineering construction project also moves into new step. Recently, bid evaluation system by computer technology has been put into practice more and more in tendering work of Yellow River hydraulic engineering construction project, which not only can enhance the management efficiency of tendering and bidding work, but also can decrease human factors in the course of bid evaluation to assure fairness and justice of tendering and bid evaluation work.

(2) Yellow River hydraulic engineering construction project mostly belongs to central hydraulic fundamental construction project. Tendering and bidding of project covers a wide area, having great social effects and receiving attention from every aspects of society. Quality of tendering and bidding work not only determines all - round implement of follow - up work of project, but also relates to efficient use of national funds and project quality. Therefore, bidding agent enterprises must know their own responsibility, improving their sense, building all - round concept and supplying quality service to tenderers.

(3) For there are too many links in acting the tendering, involving a lot of law and regulations etc., tendering agent have to hold on principal of publicity, fairness, justice and faith, obeying law and regulation strictly, making full use of their own professional knowledge, ensuring behaviors and processes of tendering agent accord with requirements of relevant law and regulations, selecting bidder who meets the tender demand through normative behavior and operation. Thus, benefit of tendering agent as well as tenderer can be guaranteed.

(4) There are also some problems to be solved and improved in the development of tenders and bids of Yellow River hydraulic engineering construction project, such as the phenomenon that some bidding enterprises take part in bid by the onward lending of qualification in tendering and bidding for the construction. As to this, Yellow River committee takes many measures and methods to prohibit this phenomenon in the course of tendering and we also intensify the procedures such as registering and qualification assessment in the process of agent work. However, due to secrecy of the course that takes part in bid by lending of qualification, it is difficult to find problems in tendering and bidding stage. Settlement and improvement of these problems need common effort of related departments in future work.

The Water Quality Status of the Estuary of the Yellow River and its Changing Trend in the Future

Li Liyang*, *Feng Chen*, *Guo Zhen*, *Wang Zia* and *Li Hua

Yellow River Basin Water Environmental Monitoring Center, Zhengzhou, 450004, China

Abstract: Along with the theory of maintaining the healthy life of the Yellow River brought up and the rising of construction of wetland, the water quality status in Yellow River estuary and its trend of development in the future should be paid highly attention to, because in a sense the water quality status in the estuary is directly related to the continuation of the Yellow River's healthy life in the future, as well as the ups and downs of the wetland construction in the estuary. Combining the results of analysis and assessment of the water quality at Lijin Station in the Yellow River's estuary in "Yellow River basin water resources bulletin", this paper has generalized the water quality status in the Yellow River estuary at present. Further more combining the field data of mainly water quality parameters at Lijin Station from 1996 to 2005, the trend of the fluctuation of water quality at the estuary has been carried out on both qualitative and quantitative analysis by using the Seasonal Kendall trend test, which will be useful for the reference to management.

Key words: seasonal Kendall test, Yellow River estuary, water quality status, fluctuation trend

In recent years along with the theory of maintaining the Yellow River healthy life brought out and the rising of construction of wetland at Yellow River estuary, the water quality status becomes more and more important for in a sense it is direct relation to the maintenance of the Yellow River healthy life and its ups and downs of the wetland constructions at estuary. Therefore it is imperative to research the water quality status and its fluctuating trend at the Yellow River estuary.

1 Water quality status at Yellow River estuary in recent years

Presently there is only one water quality station, Lijin station, at the estuary of the Yellow River, therefore the water quality of Lijin station basically reflects the water quality of the Yellow River estuary. According to the analytic and overall assessment results of the water quality at Lijin station on 'Yellow River basin water resources bulletin' from 2003 to 2005 (see Table 1), it can be seen that on some extent the water quality has become better than before. The water quality of the estuary in 2005 belongs to class three, which has reached to the drinking water quality requirement of surface water and was better than class four of 2003 and 2004's. At the same time the organic contamination in low reach also weaken, the concentrations of the primary pollution parameters, such as chemical oxygen demand (COD_{Cr}), have decreased to the drinking water quality requirement.

From the status of every month in a year, the water quality status is different in some extent between each month. According to the assessment results of every month on 'the Yellow River basin water resources quality bulletin' in 2005, the water quality is poor at the beginning of flood season and some month of low water period (see Table 2), the over limit rate reaches 33.3 percent. The primary pollution items are ammonia nitrogen, COD_{Cr} and petroleum.

Table 1 The water quality status of the Yellow River estuary in recent three years

Year	Water period	Water quality class	Primary overproof items
2003	Low water period	Ⅳ	COD
	Flood period	Ⅲ	
	Whole year	Ⅳ	COD
2004	Low water period	Ⅲ	
	Flood period	Ⅳ	petroleum
	Whole year	Ⅳ	Petroleum
2005	Low water period	Ⅲ	
	Flood period	Ⅲ	
	Whole year	Ⅲ	

Table 2 Every month water quality status at Yellow River estuary in 2005

Month	Water quality class	Primary over proof items	Month	Water quality class	Primary over proof items
Jan	Ⅲ		Jul	Ⅳ	COD、Petroleum
Feb	Ⅲ		Aug	Ⅳ	COD
Mar	Ⅳ	ammonia nitrogen	Sept	Ⅲ	
Apr	Ⅳ	Petroleum	Oct	Ⅲ	
May	Ⅲ		Nov	Ⅲ	
Jun	Ⅲ		Dec	Ⅲ	

2 Analysis of water quality fluctuation trend at Yellow River estuary

2.1 Determination of the analytic method and selection of water quality parameters

There are two kinds of water quality fluctuation trend analysis in stream, one is to model the water quality according to the field data in the past, which is used to deduce the water quality trend of development in the future, and it is also called water quality prediction. Another is to analyses the water quality change during the past to now according to the water quality series. The second case was considered in this paper. The water quality series of 1998 to 2005 at Lijin station was used, and eight water quality parameters were chosen, which include total hardness, chloride, sulfate, ammonia nitrogen, permanganate index, COD_{Cr}, BOD_5, petroleum.

Because the natural water quality data are random, seasonal, and relative, the routine parametric test methods, such as linear regression test, T test, analysis of variance and multivariable normal method, cannot completely meet the feature of the water quality series. So the water quality trend analysis is drawback when these methods are used. Combining the characters of water quality data, statistician named G. Kendall has brought up a more suitable and rational nonparametric test – Seasonal Kendall test.

2.2 Theory of seasonal Kendall test

2.2.1 The Kendall test

The theory of the seasonal Kendall test is to let the water quality data in the same month or season of every year to compare with each other, and that if the later value (increasing values in time) is bigger than the former, we will record it as "+", else as "−". If the number of the "+"

is bigger than the " − ", it is likely upward trend, similarly if the number of the " − " is smaller than the " + ", the likely trend is downward and if the two are equal, the trend is null.

According to the seasonal Kendal test, the null hypothesis H_0 is that the random variables is independent of the time, presume that there are the same probability distribution in the water quality data of the whole twelve months.

Suppose the series x of the observed water quality data in the n years and p months as follow,

$$x = \begin{bmatrix} x_{11} & x_{12} & \cdots & x_{1p} \\ x_{21} & x_{22} & \cdots & x_{2p} \\ \vdots & \vdots & & \vdots \\ x_{n1} & x_{n2} & \cdots & x_{np} \end{bmatrix}$$

In the formulae the data $(x_{11}, \cdots, x_{np})$ are the observed value of the water quality concentrations in every month.

(1) To the case of the ith among the p months $(i \leqslant p)$

Let the sum of the signs of the " + " and " − " which is from the compared water quality series in the ith month of every year equal to the S_i, and the number of data group which can be compared D − value in the ith month equal to m_i. Under the null hypothesis the random series, S_i, approximately submits to the normal distribution, then the expectation and variance of S_i are as follows,

Expectation: $E(S_i) = 0$

Variance: $\sigma_1^2 = \mathrm{Var}(s_i) = n_i(n_i - 1)(2n_i + 5)/18$

When there are t same numbers in the ni no − missing − value, the formulae σ_i^2 is as follow,

$$\sigma_i^2 = \mathrm{Var}(s_i) = \frac{n_i(n_i - 1)(2n_i + 5)}{18} - \frac{\sum_t t(t-1)(2t+5)}{18}$$

(2) The total case of the p months

Let $S = \sum_{i=1}^{p} S_i, m = \sum_{i=1}^{p} m_i$

Under the null hypotheses the mean and variance of S in the p months are as follow,

Mean: $E(s) = \sum_{i=1}^{p} E(s_i) = 0$

Variance: $\sigma^2 = \mathrm{Var}(s) = \sum_{i=1}^{p} \frac{n_i(n_i - 1)(2n_i + 5)}{18}$

When there are t same numbers in the water quality series of the n years, namely

$$\mathrm{Var}(s) = \sum_{i=1}^{p} \frac{n_i(n_i - 1)(2n_i + 5)}{18} - \frac{\sum_t t(t-1)(2t+5)}{18}$$

Kendall found that when $n \geqslant 10$, S also takes on the normal distribution, and the standard variance, z, is as follow,

$$z = \begin{cases} \dfrac{s-1}{[\mathrm{Var}(s)]^{1/2}}, \text{当 } s > 0 \\ 0, \text{当 } s = 0 \\ \dfrac{s+1}{[\mathrm{Var}(s)]^{1/2}}, \text{当 } s < 0 \end{cases}$$

(3) The trend test

The Kendall test's tau be defined as $t = s/m$, therefore in the two − side trend test, if $|Z| \leqslant Z_{\alpha/2}$, we accept the null hypothesis. Where $FN\ (Z_{\alpha/2}) = \alpha/2$, FN being the standard normal cumulative distribution function, namely:

$$FN = \frac{1}{\sqrt{2\pi}} \int_{|z|}^{\infty} \mathrm{e}^{-\frac{1}{2}t^2} \mathrm{d}t$$

α being the size of the significance level for the trend test, it's value is as follow

$$\alpha = \frac{2}{\sqrt{2\pi}}\int_{|z|}^{\infty} e^{-\frac{1}{2}t^2}dt$$

We take the significance level α as 0. 1 and 0. 01, that is, when $\alpha \leqslant 0.01$, the test has the highly significant level, and when $0.01 < \alpha \leqslant 0.1$, the test is significant, when the results of α meet the upper two conditions, t value is positive, it indicates that there is a prominent or highly significant upward trend, when the t value is negative, it indicates that there is a prominent or highly significant downward trend, and when the t value is null, it indicates no trend.

2.2.2 Seasonal Kendall slope estimate

The Seasonal Kendall slope is expressed with the slope of the linear regression, which reflects the size of trend. It is defined as the median of the whole quotients between the D – value of compared two numbers and the discrepant year number of them in the test. The estimated value of the slope only illustrates the mean annual situation of concentration change of water quality in the test year.

The estimated value of the trend slope was defined as follow:

To all X_{ij}, X_{ik} ($i = 1, 2, \ldots, p, j = 1, 2, \ldots, n$), the slope of two random numbers in the water quality series in month ith is defined as dijk . Because $d_{ijk} = (X_{ij} - X_{ik})/(j-k)$ $(1 \leqslant k \leqslant j \leqslant n_i)$, the estimated value of trend slope, B, is equal to the median of all the dijk. when $S > 0, B \geqslant 0$; when $S < 0, B \leqslant 0$. So B is not affected by the extreme value or singularity in the water quality series. Also it is not affected by season.

2.2.3 Flow adjustment concentration test

The flow adjustment concentration test is to judge whether the pollutant concentration change in the stream is caused by discharge variation or not by using the residual analysis.

(1) In order to seek the best relation with the linear regression analysis, the formula of flow adjustment is as follow:

$$\hat{c} = a + b \cdot c(Q)$$

where is $\hat{c}$ the estimated concentration; Q the flow in step with concentration, $c(Q)$ the function based on flow variation, and a, b the coefficient.

When the pollutants in the stream come from the point source load, it is diluting effect, and described as the following equations:

$$c(Q) = \lambda_1 + \lambda_2 \frac{1}{Q} + \varepsilon$$

$$c(Q) = \lambda_1 + \lambda_2 \frac{1}{1 + \lambda_3 Q} + \varepsilon$$

where ε is the error taken on zero mean, $\lambda_1, \lambda_2, \lambda_3$ are coefficient$(\lambda_1, \lambda_2 \geqslant 0, \lambda_3 > 0)$.

When the pollutants in the stream come from non – point pollution, the relation between concentration and flow can be expressed as follow:

$$C(Q) = \lambda_1 + \lambda_2 Q + \lambda_3 Q^2 + \varepsilon$$

$$C(Q) = \lambda_1 + \lambda_2 \ln Q + \varepsilon$$

In the formula the meaning of the signs is same as the above.

According to the series of concentration and flow, the a, b in the equation of linear regression, $\hat{c} = a + b \cdot c(Q)$, are estimated respectively, and R^2 is calculated, which reflects the parameter of correlativity.

Among the four calculated regression equation, the one which has the maximal R^2 was chosen. At the same time the regression test was carried out to the chosen curve.

(2) The residual series of W_{ij} of the flow adjustment concentration, which is the difference of measured value and the expected value of the estimated value, W_{ij} was calculated by using the accepted equation.

(3) The confidence of α and slope of B of the series of W_{ij} were got by using the seasonal Kendall test, which can be used to judge the trend of flow adjustment concentration.

2.3 Interpretation of results

The mainly eight water quality parameters of actual water quality monitoring data from 1996 to 2005 at Lijin station have been calculated by the professional water quality trend (PWQTrend) software which is based on the method of the flow adjustment Seasonal Kendall test. The results are shown in Table 3.

As shown in Table 3, the water quality parameters of sulfate, ammonia nitrogen, permanganate index, chemical oxygen demand (COD_{Cr}), five day biologic oxygen demand (BOD_5) show highly significant downtrend or prominent downtrend; Petroleum shows prominent uptrend; total hardness and chloride show no any distinct trend, which illustrate that except petroleum, the water quality pollution in the Yellow River estuary has lessened in recent decade, and the controlling of pollution has got some good results.

Table 3 The outcome of water quality trend analysis of the Lijin station at the Yellow River estuary

Analytic items	Trend of concentration	Trend of flux	Flow adjustment		
			Type of formula	B(mg/(L·a))	Trend
Total hardness	—	↑	$\ln(C)=a+b\times(\ln(Q)+B\times\ln(Q)\times\ln(Q))$	3.56	↑
Chloride	—	↑↑	$C=a+b\times(1/(1+B\times Q))$	1.23	—
Sulfate	↓↓	↑↑	$C=a+b\times(1/(1+B\times Q))$	−3.72	↓
Ammonia nitrogen	↓↓	↑	$C=a+b\times(1/(1+B\times Q))$	−0.014,3	—
COD_{Mn}	↓	↑↑	No Suitable Formula for Adjustment	−0.067	↓
COD_{Cr}	↓↓	↑	$C=a+b\times(1/(1+B\times Q))$	−1.91	↓↓
BOD_5	↓	↑↑	No Suitable Formula for Adjustment	0	↓
Petroleum	↑	↑↑	No Suitable Formula for Adjustment	0	↑

Note: (1) The sign of "↑" stands for prominent uptrend, "↑↑" highly significant uptrend, "↓" prominent downtrend, "↓↓" highly significant downtrend, and "—" no trend.
(2) COD_{Mn} stands for permanganate index.

It can be seen from the flux trend that eight water quality parameters indicate uptrend or highly significant uptrend. Combining the outcome of the water quality concentration trend analysis, it is illustrated that the total quantity of all pollutants in the estuary has been increased because of the increase of discharge.

From the trend analysis of flow adjustment, it has shown uptrend for total hardness and petroleum, while downtrend or highly significant downtrend for sulfate, permanganate index, chemical oxygen demand, Five day BOD, and no trend for chloride and ammonia nitrogen. Combining the different formula style of every water quality parameter, it is indicated that total hardness give priority to non-point pollution, while others give priority to point source pollution. Based on the feature of downstream channel, which is belong to over ground river, it is shown that the water quality pollution in the estuary mainly come from the drain in the upper or middle course. So the harness of point source is still an emphasis. In addition, it is need to explain that there are no flow adjustment formula styles for minor water quality parameter because the negative correlation between concentration and flow is intricate, and it is difficult to find the well-formed formula style, it should be thought as point source pollution.

3 Conclusions

(1) In recent years the water quality in the Yellow River estuary has become better than before, and the average water quality in 2005 has reached the requirement of drinking water of surface water, although there are still some months whose water quality is overproof.

(2)The water quality concentration trend analysis in recent decade has shown that except the petroleum which has still showed uptrend, the others have shown prominent downtrend or highly significant downtrend.

(3)The flux trend analysis shows that because the water inflow has increased in recent years, the overall pollutants which mainly come from the upper and middle river have increased.

(4)The trend analysis of flow adjustment shows the pollution in the estuary give priority to point source pollution, whose pollutant source mainly come from the drain in the upper and middle course, therefore the strengthen harness in the drain is still an emphases in the future.

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Discussion on Substituting Constructional System Reform on the Projects Invested by the Government

Fan Qingde*, *Zhang Zengwei*, *Song Jinglin* and *Ji Handa

Yellow River Henan Bureau, Zhengzhou, 450003, China

Abstract: It is suggested that the implementation of substituting constructional system in the flood control engineering construction and administration of the Lower Yellow River through analysis on the features and advantages of substituting constructional system starting from the characteristics of the flood control engineering of the Lower Yellow River and the present system of construction and administration.

Key words: governmental investment, project, substituting constructional system

1 "Substituting constructional system" is the highlight of recent engineering construction and administration system reform

On July 27, 2004, it was reported by Economic Channel of CCTV: to quicken pushing "substituting constructional system of project construction and administration" is one of the six highlights of investment system reform of the State Council in 2004, which is analyzed by interviewed related person. On April 19, 2005, it was reported by China Highway. com that "Experiment on Substituting Constructional System gradually Enters the Most Pleasant Stage": Since 2004, newly sanctified government – invested projects in Beijing would be managed under "substituting constructional system" according to the regulation in Administrative Measures of Substituting Constructional System on Municipal Government – invested Projects in Beijing (proposed). Recently, it was reported by Economic Channel of CCTV again: it only needs one quarter for electromagnetic train from inner city to airport in 2008. It will be invested 5000 million Yuan RMB under the substituting construction system, etc.

"Substituting constructional system" occurring frequently in all kinds of media is undoubtedly an attracting spot in construction field in the near future. And what is "substituting constructional system"?

2 What is the substituting constructional system

"Rules for Investment System Reform by the State Council" points out: to quicken the implementation of substituting constructional system on non – profitable government – invested projects. That is, through inviting public bidding, specialized projects administration unit is chosen to be responsible for construction to strictly control project investment, quality, time limit for the project and relegate to using unit after finishing and checked and accepted. Through referring to related material, writer thinks that substituting constructional system is projects administrative model: investor of the project consigns to the substituting constructor with corresponding qualification to manage the whole process such as feasibility, reconnaissance and design, supervising, constructing, etc. and finish the construction according to the design of time limit of the project until relegating to the using unit after finishing and checked and accepted. "Substituting constructional system" can also be thought as key relegating project management model from project construction to operation management, that is, design – construction contracting manner (EPC manner).

Substituting constructional system has a history of almost one hundred years in the United States. The manner of substitute construction has evolved constantly with the need of the market. It was reported by Yearly Report 2000 of Design – Construction of the United States that the ratio of design – construction contracting manner had reached 30%. It would rise to 45% in 2005.

Substituting constructional system is still in starting stage in China. Experiment on substituting constructional system has been finished in some provinces, municipals such as Shanghai, Chongqing, etc. in recent years. Substituting constructional system is spreading now. In April, 1999, it is successful that finance – invested project was constructed under substituting constructional system in Shanghai. It began to be spread in Shanghai from 2000. Successively Ningbo and Chongqing studied out Interim Measures of Substituting Constructional System and began to experiment. The experiments gained good effect. Based on the experiment experience of substituting constructional system in constructing Huilongguan Hospital, Handicapped Professional Training and PE Training Center, Beijing Ailment Preventing Center, Beijing constituted Substituting Constructional Measures in 2004. Substituting constructional system was carried out in government – invested commonweal construction projects. Since 2004, the Ministry of Communications has quickened pushing substituting constructional system according to the requirement of "Decision on Investment System Reform" issued by the State Council. Expressway investment field was formally opened to investors abroad and at home. Up to the present, 11 projects has been finished with the total investment of 30,000 million Yuan RMB. It is known that project juridical person inviting public bidding information has been released for Olympic Gym in 2008. Substituting constructional system has been a new span in engineering construction and administration reform.

3 Features and advantages of substituting constructional system

Substituting constructional system of government – investment construction projects is that governments separate construction unit from using unit and consign qualified substituting constructor to manage the construction. This system further parts the functions of investor, substituting constructor and user. Substituting constructor (juridical person or organization) takes on the management of government – invested construction projects according to substituting construction contract. Substituting constructors are mainly enterprises, which have full authority for management and assume sole responsibility for its profits or losses. Therefore, substituting constructor should be normative engineering management enterprises, which is better than the management of existing government – invested projects.

Firstly, it quickens the conversion of government's function. Government takes charge of industrial policy and macro policy making after substituting constructional system is carried out. The implementation of the project relies on marketing mechanism, which helps to standardize the management behavior of government – invested projects.

Secondly, it helps to keep corruption within limits. After substituting constructional system is carried out, the direct contacting among constructor, contractor and provider becomes the lowest. The ratio of crime by duty lowers correspondingly. In the scope of its power, substituting constructor finishes independently the work of engineering management by his own management system and experience according to the requirement of the law, regulation and criterion. Although substituting constructor implement concrete management confronting lots of contractors and providers, he is supervised by construction side and restricted by the limit of attorney power. Besides, some important power such as disbursement of funds, final accounts, audit, etc. is strictly supervised by construction side.

Thirdly, investment benefit can be raised. After substituting constructional system is carried out, saved would be praised. Constructor would pinch pennies on funds. For example, the drainage culvert project in the dump on Taiyuan Road of Qingdao had been finished and checked and accepted in 2004. Ratified investment is 19,000 thousand Yuan RMB. Final accounts supplied by substituting constructor is 16,890 thousand Yuan RMB, which saved 2,110 thousand Yuan RMB than budgetary estimate and the saving pay ratio is 11.1%. According to related regulation, financial department put a premium of 30% of the saving pay quantum, which is total of 630 thousand Yuan RMB.

Fourthly, excessive investment, excessive scale and excessive standard can be restrained.

Some projects were managed by government itself. Investor, user, constructor and manager are the one. Some unnecessary function is increased, which makes the budget superadded. After substituting constructional system is carried out, it is impossible to superadd budget. So construction side should guarantee construction quality within the budget.

Fifthly, the phenomenon of defaulting engineering fund would be controlled effectively. The defaulting of engineering fund of government – invested project is largely due to excessive budget. After substituting constructional system is carried out, it would be avoided to prevent engineering fund from defaulting.

4 Characteristics of the flood control engineering of the Lower Yellow River and suggestions on the implementation of substituting constructional system

4.1 Characteristics of the flood control engineering of the Lower Yellow River

Flood control engineering in the Lower Yellow River includes heightening and strengthening the embankment, heightening and strengthening the vulnerable spots and protecting dam, projects to control flood, communication engineering, equipment of engineering management, etc. These projects have the common features: ① All the projects are flood control engineering invested by the Central Government. ② Engineering can be built successively. The construction of the engineering is simple and mainly carried out in non – flood season with mud and stone. ③ There are many sub – items but they are quite familiar in region environment, engineering content, construction method, etc.

4.2 Status quo of constructional and administrational system

Since 1998, a construction administration system has been carried out using responsibility of project juridical person as precondition and centering on contract in the flood control engineering of the Lower Yellow River. The principal part and its rights, duty and obligation of construction were definitude. Management level of constructional projects was heightened. Better investment benefit was gained. Under the system, Yellow River Conservancy Committee and Yellow River Henan Bureau, Yellow River Shangdong Bureau are respectively as superintending unit of construction and secondary superintending units of reaches. Subordinated bureaus at the level of cities and counties (borough) are respectively as construction management units and operation management units after construction. They exert their respective rights, duty and obligation. Construction unit selects the units of design, construction and supervision by the way of bidding and guarantees and restrains constructional behavior with signed contract. It is ok but not so fit with the requirement of substituting constructional system proposed by Decision of Investment Reform issued by the State Council.

Writers try to give the following suggestion based on starting from the characteristics of the flood control engineering of the lower Yellow River and the present system of construction and administration:

(1) Both of opportunity and challenge exist. The promising one wins. It is suggested that to study the policy of substituting constructional system by organizing personnel and propose concrete implementing opinion. It was pointed out in "Outline of Construction and Administration of Water Conservancy" set by the Ministry of Water Resource in 2005: Special research should be carried out on substituting constructional system. Administration of water conservancy engineering construction should be strengthened. Construction behavior should be standardized to ensure the quality of engineering and raising benefit. Flood control engineering of the lower Yellow River belongs to government – invested non – profitable project, which should be under the substituting constructional system.

Therefore, firstly, experiment leading group of substituting constructional system is organized as soon as possible in Yellow River Conservancy Committee and Yellow River Henan Bureau, Yellow River Shangdong Bureau. Programming department, construction and administration department, financial department and economic department are organized to carry out research on policy. Feasible implementing opinion fitting the engineering construction on the Yellow River should be proposed. Organizing principle of investor, substituting constructor and user should be studied out and their respective duty, rights and obligation should be definite. Secondly, Economic Development and Management Bureau takes charge to organize specialized enterprises such as engineering design, construction, supervising, etc. within Yellow River Conservancy Commission to study on the special topic. Substituting constructor enterprise is proposed to organize to raise market competing capacity to contracting constructional projects. At present, there are Yellow River Engineering Consulting Co. Ltd., Yellow River (Henan) Reconnaissance Design and Research Institute, Yellow River (Shangdong) Reconnaissance Design and Research Institute in the scale of 甲, several construction supervision companies and many construction enterprises of first and second classes. But due to the narrow specialty, no one is registered enterprise fitting the qualification of juridical person of substituting constructor. Enterprise of substituting construction system is urgent to be organized. Thirdly, training class of substituting construction system should be hold to raise the knowledge and adapting ability of the employees to substituting construction reform.

(2) Stones from other hills may serve to polish the jade of this one. We can use administrational model of substituting construction system for reference of experiment to gather experience.

①Model of substituting construction system of the whole process—for those projects of small in scale or strong in specialty, such as to heighten or rebuild vulnerable spot, river course training, wood suitable for growing along the Yellow River, etc. Yellow River Conservancy Commission or Yellow River Henan Bureau, Yellow River Shangdong Bureau as investor consigns bidding agent to select substituting constructor through bidding. Investor, substituting constructor and user sign contracts to nail down duty, right and benefit. Substituting constructor takes on the design of projects, time limit for the construction, risk of quality and investment and would be praised if saving and punished if exceeding according to the combo document of primary design.

②Model of substituting construction system in two stages—for those large - invested projects such as to strengthen the embankment, engineering for prevent rolling river, to strengthen the embankment through digging riverbed. The first stage is prophase substituting management. The second stage is substituting construction of projects. The first stage is that Yellow River Conservancy Commission or Yellow River Henan Bureau, Yellow River Shangdong Bureau as investor selects prophase management substituting constructor through consigning bidding or bidding(equal to CM). The relative one of them would select design unit through bidding and finish the scheme design after user (bureau at the stage of city or county) finishes the work of project establishing. After the primary design goes through auditing, the design of shop drawing would be carried out. The relative one would get programming license and assist user to finish prophase work such as land requisition, pull down old building and move out the people. The second phase is Yellow River Conservancy Commission or Yellow River Henan Bureau, Yellow River Shangdong Bureau consigns agent to select substituting constructor through public bidding according to construction standard and content, investment budgetary estimate set by the primary design. Investor, substituting constructor and user sign contract. The relative one of the three authorizes substituting construction projects and gets construction license; substituting constructor takes on the risk of time limits, quality and investment of construction and would be praised if saving and punished if exceeding. Substituting constructor selects construction unit through bidding (including sub - contractor unit), organizes, manages and coordinates the construction or directly takes part in construction; he should carry out the responsibility of finishing and delivering to user as scheduled and ensure the formal using in the period of guaranteeing to keep in good repair of the project.

③Model of combining substituting construction system—for those government - invested synthesized projects which have some benefit such as the development of water supply works, the Yellow River scenic zone, etc. basic establishment for living and production. Yellow River Conservancy Commission or Yellow River Henan Bureau, Yellow River Shandong Bureau selects substituting constructor through public bidding after the feasibility of the project is expounded and proved and the construction scale, investment level and programming are confirmed. The investment of the substituting constructor should provide and reach the depth of the drawing in primary design stage. The substituting constructor which won the bidding signs contract with investment and user. The substituting constructor should know the risk of the time limit, quality and investment for the project which he is assuming, and would be praised if saving and punished if exceeding. At the same time, investor selects management agent of construction technology through public bidding (equal to appointed sub – contractor). Management agent of construction technology signs contract with substituting constructor and takes the charge of technology consultation and supervising and control of the whole construction process.

The implementation of substituting construction system on government – invested projects is an important reform of construction management system in China. In order to push substituting construction system smoothly and avoid unnecessary repeat in the process of implementation, the establishment of substituting construction system should be systematically studied from the background, feasibility, model, steps and means of government's controlling. Yellow River Conservancy Commission can make a trying measure and choose units which own specialty qualification such as engineering management consultation or engineering contracting to experiment on in order to sum up experience and standardize and popularize it gradually.

Study on Flood Characteristics of Scouring and Deposition and High Efficient Sediment – transport in the Lower Yellow River

Li Xiaoping, ***Qu Shaojun*** and ***Shen Guanqing***

Yellow River Institute of Hydraulic Research, Zhengzhou, 450003, China

Abstract: Based on the field data, this paper analyses the relationship between the effect of sediment transporting floods, the flow, the sediment concentration and their combination in flood period, and develops an estimation formula for sediment release ratio of floods by regression approach. Twenty floods have been picked out as high – efficient sediment transport flood after being comprehensively analyzed water volume for sediment transport and sediment – releasing ratio. In view of the mean case of high efficient sediment transport floods, it is recommended to utilize the Xiaolangdi Reservoir that is capable to regulate floods with mean flow of about 3, 200 m^3/s and mean sediment concentration of about 65 kg/m^3 to decrease channel sedimentation on the lower Yellow River and save the scarce water resources.

Key words: the Lower Yellow River, sediment release ratio, high efficient sediment transport flood, sedimentation reduction

1 Preface

The Yellow River is a sediment – laden river well known both in China and foreign countries, to which the famous expert Zhang Rong of Donghai Dynasty once pointed out, "The river water is overloaded, 60% sediment concentration contained", which means the sediment concentration in it is more than water. The feature of excessive sediment and few water of the Yellow River lead to an imbalance between sediment and water. The sediment delivered to the downstream mainly occurs in several floods during flood season, in addition to the sediment transport and channel aggradation. In recent years, the construction of numerous large and medium sized reservoirs on the main stream and tributaries of the Yellow River as well as impounding flood and regulation of runoff give rise to the distinct change to water and sediment rushing into the lower Yellow River, the flood level and frequency of occurrences have reduced, especially the evident reduction of major floods. Therefore, siltation by flooding always occurs in the channel of main stream, lowering the flood carrying capacity of the channel, but the probability of a major flood remains in future, which will be extremely unfavorable to the flood control of the Lower Yellow River. With the expanding economy, the water consumption by industry and agriculture grows continuously and the contradiction concerning the shortage of water resources of the Yellow River is increasingly urgent.

The research of scouring and siltation characteristics of floods of the downstream may help explore an ideal water – sediment combination by which more sediment of the lower channels can be drained into the sea and siltation of them reduced. That means, a water – sediment combination dedicating to drain more sediment and reduce siltation should be found out, namely a flood capable to transport sediment in a high efficient way. With the regulation by Xiaoliangdi Reservoir, such flood of high efficient sediment transport may be generated to drain more sediment by combined "Regulation" and "Drainage" in a sound manner to improve the sediment – transport capacity of a flood, which may not only reduce the siltation on the lower channels, but be in favor of saving the scarce water sources. Therefore, to find out the sediment transport flood of high efficiency in the lower Yellow River is currently a critical goal for its treatment.

2 Analysis of scour and siltation characteristic of floods

As the sediment sources to the downstream of the Yellow River feature uneven distribution and the floods there rise and fall in a rushing manner, the sediment transport capacity for the lower channels of the Yellow River during flood period differs from normal rivers. Similar conditions of inflow may produce different conditions of incoming sediment, for example, a flood from coarse sediment sources may give rise to a high sediment concentration of suspended bed sediment load at all hydrologic stations along the downstream, while a flood from the region with less sediment may give rise to a low sediment concentration, in this way, such a case survives after running through a river channel of a few hundreds of kilometers. Under conditions of identical flow intensity and bed composition, the sediment – carrying capacity for bed material load of coarse granule in a stream expresses in a multiform function with the change of fine particle concentration. Scouring or siltation caused by a flood depends mainly on flood flow, sediment concentration and their combination.

2.1 Relationship between sediment release ratio and incoming sediment coefficient

In order to analyze the relationship between sediment release ratio and incoming sediment coefficient(S/Q), 243 floods with mean discharge greater than 2,000 m^3/s occurring in flood seasons from 1950 to 2000 are selected to make the statistics on the flood characteristic elements, for example, the mean flow and mean sediment concentration at which all floods run into downstream channels, the water – sediment quantity, siltation reduction capacity of river channel and siltation ratio of all hydrologic stations.

By dot plotting of the relationship between sediment release ratio and incoming sediment coefficient at different flow levels and different sediment concentration levels in Fig. 1 and Fig. 2, it is obvious that sediment release ratio is greater than 100% when the flood incoming sediment coefficient is less than 0.01, the less the latter is, the more the former will be, and the downstream channel undergoes a distinct scouring, the sediment release ratio is fundamentally less than 100% when incoming sediment coefficient is greater than 0.01.

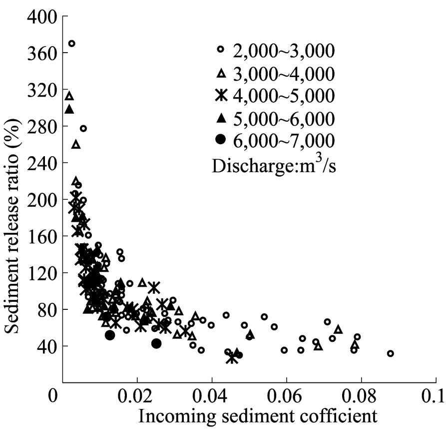

Fig. 1 Relationship between sediment release ratio and incoming sediment coefficient at different flow levels

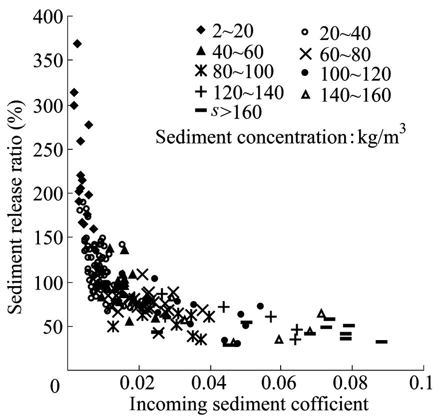

Fig. 2 Relationship between sediment release ratio and incoming sediment coefficient at different sediment concentration

Fig. 1 shows that the variation amplitude of sediment release ratio of floods with an identical flow is large, the less the flow is, the more the sediment release is. At a large flow level, the sediment release ratio is not high, because the flood of such grade may overflow a floodplain at downstream. Although scouring channel by beach nourishment works, the siltation still occurs on the whole cross section. Fig. 2 shows that the incoming sediment coefficient relates closely to sediment concentration, the less the sediment content is, the less the incoming sediment coefficient will be and wise versa. A large incoming sediment coefficient always corresponds to a flood with mean sediment concentration more than 80 kg/m^3.

2.2 Relationship among sediment release ratio and flow and sediment concentration

Fig. 3 and Fig. 4 both present a further analysis of the relationship among sediment release ratio and flow and sediment concentration, which shows that the sediment release ratio takes on a belt - like distribution corresponding to the change of sediment concentration which increases gradually from upstream to downstream, and the sediment release ratios at an identical flow reduce gradually. As to the floods of identical flow, the more the sediment concentration is, the less the sediment release ratio will be; as to floods of identical sediment concentration, the sediment release ratio increases with the increment of mean flow when it is greater than 4,000 m^3/s, the floodplain always occurs with the lower channels and siltation occurs with bottomland, which gives rise to the drop of sediment release ratio of a large - flow flood. In addition, as to floods of identical sediment concentration, when mean flow is less than 2,000 m^3/s, the sediment release ratio is small and the amplitude of variation is large, when more than 2,000 m^3/s, the sediment release ratio is large and concentrated relatively.

If the mean flow of a flood always ranges from 1,000 to 6,000 m^3/s, the amplitude of variation is only 6 times of that at peacetime, but if the mean sediment concentration of a flood always ranges from 1 to 300 kg/m^3, the amplitude of variation may amount to tens of or hundreds of times. Therefore, the variation which sediment release ratio varies with mean sediment content is more sensitive than that with mean flow.

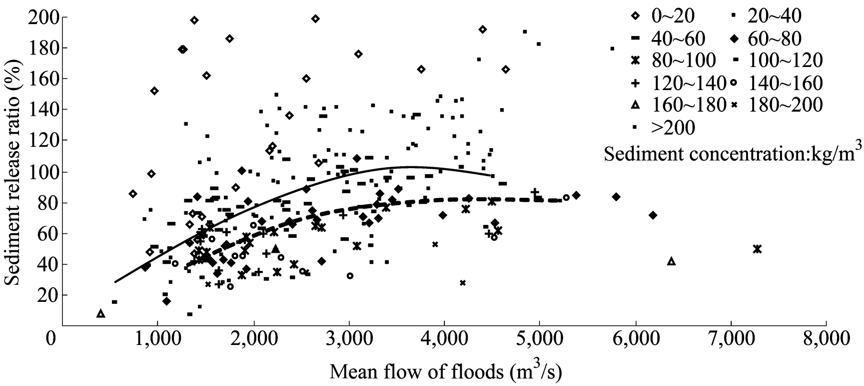

Fig. 3 Relationships between sediment release ratio and mean flow of floods at different sediment concentration levels

Fig. 4 illustrates the relationship between sediment release ratios of floods of different flows and their mean sediment concentrations. So, the sediment release ratio reduces with the increment of sediment concentration, with reduction amplitude from high to low, and distinct reduction with the increment of sediment concentration when the mean sediment concentration is less than 40 kg/m^3, but slows the reduction when greater than 40 kg/m^3. In an average view, the sediment release ratio of a flood with mean sediment concentration less than 40 kg/m^3 is greater than 100%, while that of more than 40 kg/m^3 is less than 100%, that is to say, when the mean sediment concentration is averagely greater than 40 kg/m^3, the siltation at the downstream channel occurs.

In sum, sediment release ratio relates closely to mean incoming sediment coefficient. Further analysis of the relationship between mean flow (Q) and mean sediment concentration (S) may conclude that when mean content is greater than 2,000 m^3/s, the sediment release ratio depends mainly on the mean sediment concentration.

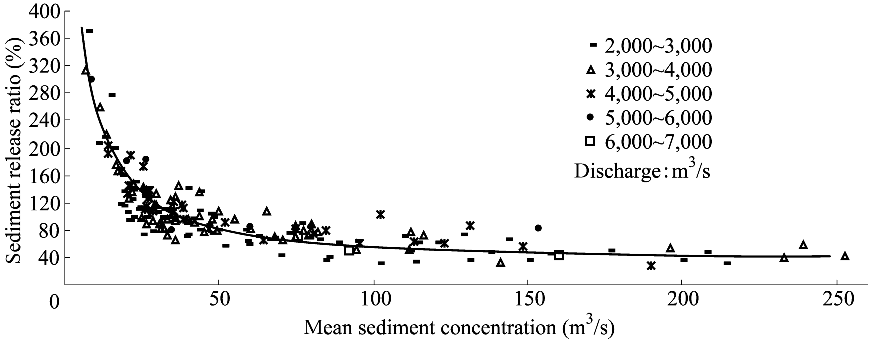

Fig. 4 Relationship between sediment release ratio and mean sediment concentration of floods at different flow levels

2.3 Estimation of sediment release ratio

According to the analyses above, mean sediment concentration may be used for the estimation of sediment release ratio of floods with mean flow more than 2,000 m^3/s. As viewed from Fig. 4, the sediment release ratio is inversely proportional to mean sediment concentration, the formula below, by regression method by the aid of Fig. 4, may be developed to estimate the sediment concentration:

$$P_s = \left(\frac{25}{S} + 0.32\right) \times 100\% \tag{1}$$

where: P_s is the sediment release ratio, S is mean sediment concentration.

Fig. 5 presents the comparison between the sediment release ratios calculated by the above formula and the sediment release ratios of floods with mean flow more than 2,000 m^3/s by field measurement in the Lower Yellow River. It shows that the sediment release ratio calculated is close to the field measurements, so the estimation formula is of good representative. When the sediment release ratio calculated is 100%, the corresponding sediment concentration is 36.8 kg/m^3, close to the 40 kg/m^3 obtained from the above analysis.

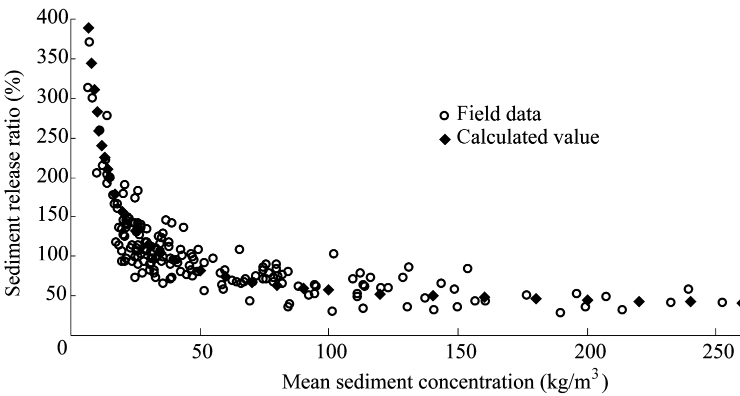

Fig. 5 Relationship comparison between observed and calculated data of sediment release ratio and sediment concentration

3 Sediment transport floods of high efficiency

A high efficiency sediment transport flood refers to a flood whose sediment transport capacity is higher in efficiency, mainly reflected at two aspects as high sediment release ratio and small sediment – transport flow. In this paper, a flood whose sediment release ratio is greater than 80% and sediment transport flow is less than 25 m^3/t is defined as the sediment transport flood of high efficiency.

3.1 Analysis of sediment transport flow and sediment release ratio

As the sediment transport efficiency depends mainly on the mean sediment concentration when a flood gets to some level, this section focuses on the relationship between the sediment release ratio and sediment concentration.

According to analysis, the relationship between sediment transport flow and sediment release ratio takes on a belt – like distribution in light of different sediment contents (Fig. 6), namely, sediment release flows with an identical sediment concentration have a sound relationship with their sediment release ratios. The sediment transport flows of floods with an identical sediment content drop with the increment of sediment release ratios when those get to some level the sediment transport flows no longer drop. If the sediment release ratios are identical, the more the sediment concentration is, the less the sediment transport flow will be.

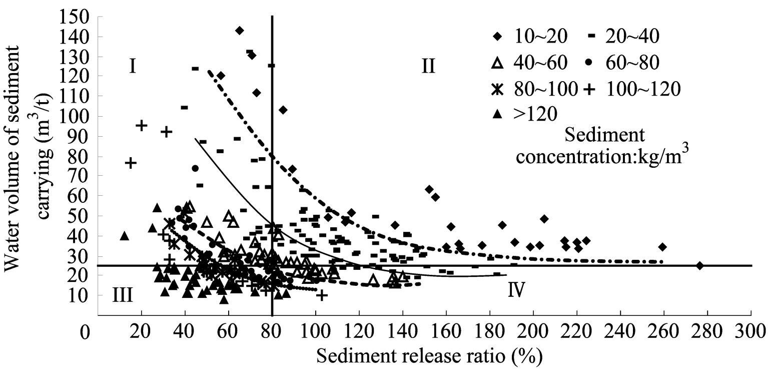

Fig. 6 Relationship between water volume of sediment carrying and sediment release ratio of different sediment concentration in flood period

Fig. 6 may be divided into 4 plots by two lines as sediment transport ratios at 80% and sediment transport flows at 25 m^3/s. Plot I is a low efficient area, in which not only the sediment release ratio is low but the sediment transport flow is large; Plot II is a high sediment release area, in which both the sediment release ratio and sediment transport flow are high; Plot III is a low water – consumed area, in which both the sediment transport flow and the sediment release ratio are small; Plot IV is a high efficiency sediment transport area, in which the sediment transport ratio is high, but the sediment transport flow is small, satisfying the characteristics of high efficiency sediment transport. Therefore, the floods in Plot IV are just the high efficiency sediment transport floods we search after.

3.2 Characteristic of high efficiency sediment transport flood

A further analysis on the characteristics of floods at the sediment transport zone of high efficiency as shown in Fig. 6 disclosed that the floods of the zone mainly refer to those with sediment concentration ranging from 40 ~ 60 kg/m^3 to 60 ~ 80 kg/m^3. Table 1 lists the characteristics of 20 high efficiency sediment transport floods satisfying the conditions to produce a high efficiency sediment transport flood. As water diversion and adding along the reach affect greatly the siltation reduction by flood, those floods whose flows along the reach change greatly are eliminated when selecting high efficiency sediment transport floods.

Table 1 Characteristic of high efficiency sediment transport floods at Lower Yellow River

Flood period	Sanheixiao			Lijin		Sediment release ratio(%)	Sediment transport flows (m^3/t)
	$\overline{Q}$ (m^3/s)	$\overline{S}$ (kg/m^3)	S/Q	$\overline{Q}$ (m^3/s)	$\overline{S}$ (kg/m^3)		
1952.7.30 ~ 8.7	3,054	43.5	0.014	3,333	39.9	100	23
1954.7.13 ~ 7.23	3,513	79.7	0.023	3,485	71.4	89	14
1954.7.31 ~ 8.24	5,379	60.4	0.011	5,758	47.6	84	20
1955.8.26 ~ 9.2	3,458	60.0	0.017	3,430	49.4	82	20
1956.8.26 ~ 9.6	3,405	47.9	0.014	3,473	44.9	96	22
1958.8.10 ~ 8.17	5,804	79.9	0.014	6,114	59.9	84	16
1966.7.27 ~ 8.8	4,155	102.1	0.025	4,523	93.4	103	10
1967.8.2 ~ 8.17	4,265	74.7	0.018	4,208	60.8	83	17
1967.8.27 ~ 9.6	4,495	84.6	0.019	4,393	68.6	80	15
1969.8.16 ~ 8.30	1,407	62.5	0.044	1,596	41.2	83	21
1970.8.20 ~ 8.24	1,404	44.6	0.032	1,294	54.8	140	20
1970.9.9 ~ 9.15	2,343	43.0	0.018	2,357	43.0	108	23
1973.9.6 ~ 9.22	2,734	43.8	0.016	2,599	59.2	135	18
1975.9.1 ~ 9.9	2,949	47.5	0.016	2,711	45.7	99	24
1978.8.28 ~ 9.12	2,559	76.1	0.030	2,275	66.1	89	17
1978.8.28 ~ 10.3	3,208	49.7	0.015	2,783	55.1	109	21
1981.8.16 ~ 8.29	3,323	74.6	0.022	2,994	62.7	86	18
1992.8.28 ~ 9.5	1,951	75.5	0.039	1,800	57.1	81	19
1995.8.15 ~ 8.27	1,508	42.5	0.028	1,454	54.1	136	19
1995.8.28 ~ 9.22	1,879	65.6	0.035	1,769	61.1	101	17

The minimal value and maximal value of incoming flow (Sanheixiao) of those floods are respectively 1,404 m^3/s and 5,291 m^3/s, and those of mean sediment concentration are respectively 42.5 kg/m^3 and 102.1 kg/m^3. The gross incoming sediment of all high efficiency sediment transport flood is 5.011,4 billion tons, and output of sediment 4.413,4 billion tons, sediment of diversion 0.274,3 billion tons, gross siltation of full downstream 0.323,7 tons; mean sediment release ratio is 93.5% and mean sediment transport flow is 17.6 m^3/t. Averagely, the mean flow of all floods is 3,192 m^3/s, mean sediment concentration is 64.7 kg/m^3 and mean incoming sediment coefficient is 0.020.

Of 20 sediment transport floods of high efficiency, the mean sediment concentration is greater than 40 kg/m^3, including 8 floods with sediment concentration ranging from 40 to 60 kg/m^3, accounting for 40%, 10 floods with sediment concentration ranging from 60 to 80 kg/m^3, accounting for 50%, 2 floods with sediment concentrations greater than 80 kg/m^3. It is obvious that sediment concentration for 90% high efficiency sediment transport floods ranges from 40 to 80 kg/m^3 which deem to be the range for water regulation in future. In addition, of the 20 high efficiency sediment transport floods, the mean flow ranging from 1,400 to 6,000 m^3/s are evenly distributed, of which 5 are less than 2,000 m^3/s, the number of floods with mean flow ranging from 2,000 to 3,000 m^3/s, 3,000 to 4,000 m^3/s, 4,000 to 5,000 m^3/s, and 5,000 to 6,000 m^3/s are 4, 6, 3 and 2 respectively. The 2 with flow greater than 5,000 m^3/s are over bank flood.

In sum, the flow of high efficiency sediment transport flood disperses relatively, while sediment concentration centralizes, which further demonstrates sediment concentration acts as a main factor to affect sediment transport floods.

4 Cognition and suggestion

4.1 Main cognition

(1) When a flood gets to some level, the sediment release ratio, if the mean flow is greater than 2,000 m^3/s, depends mainly on the mean sediment concentration. The sediment release ratio reduces with the increment of sediment concentration, with reduction amplitude from high to low, and distinctly reduce with the increment of sediment concentration when the mean sediment concentration is less than 40 kg/m^3, but slows the reduction when greater than 40 kg/m^3.

(2) The formula below may be developed by regression approach based on the recorded data: $P_s = \left(\frac{25}{S} + 0.32 \right) \times 100\%$, by which the sediment release ratio calculated is close to the field measurements, so the estimation formula is of preferable representative.

(3) Relationship between sediment transport flow and sediment release ratio takes on a belt – like distribution with the variation of sediment concentration. The sediment transport flow with an identical sediment concentration reduces with the increment of sediment release ratio when it gets to some level the reduction calms down.

(4) The flow of high efficiency sediment transport flood disperses relatively, while sediment concentration centralizes, which further demonstrates sediment concentration acts as a main factor to affect sediment transporting flood. It is obvious that sediment concentration for 90% high efficiency sediment transport floods ranges from 40 to 80 kg/m^3. In this sense, the mean values for high efficiency sediment transport floods may represent the course of it, namely, the water – sediment combination with mean flow of 3,200 m^3/s and mean sediment concentration of 64.7 kg/m^3.

4.2 Suggestion

As high – efficient sediment – transport floods feature high sediment release ratio and low sediment transport flow, it is recommended to optimize the flooding course of the downstream by the regulation of the Xiaoliangdi Reservoir in such a manner that the mean flow of floods is to be about 3,200 m^3/s and mean sediment concentration about 65 kg/m^3 so that the Xiaolangdi Reservoir can play a critical role in the siltation reduction of the lower channels and saving limited water resources.

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Analyses on Similarities and Differences between ADB Social Security Policies and Chinese Resettlement Policies

Liu Xinfang, ***Xie Xinfang***, ***Huang Peng***, ***Du Qiuping*** and ***Zhao Xin***

Yellow River Engineering Consulting Co., Ltd. Zhengzhou, 450003, China

Abstract: The basic resettlement policies of China have been briefly introduced in the paper. Having analyzed the land requisition for the Yellow River Flood Management Sector Project, the comparisons on both the Chinese resettlement policies and the ADB's social security policies have been made in aspect of such four elements as the basic resettlement policies of China, the trading cost brought about in the preparation of social impact evaluation to the borrower and owner, active role of the ADB in discovering and resolving of the security issue and the assessment on the resettlement plan implementation in the project completion report so that their differences could be located to closely link to the international practice.

Key words: resettlement, China, Asian Development Bank (ADB), policy, analysis

1 Similarities and differences, advantageous and disadvantageous of policies among the ADB, international development agency and China

1.1 Chinese basic resettlement policies

The fundamental elements of the Chinese resettlement policies are (i) economization on land use for a project and earnest protection of farmland; (ii) complying with laws in land use; (iii) giving attention to the interests of the State, collective and resettlers; (iv) integration the compensation by the State with self – dependence of the displaced people; (v) giving priority to agricultural settlement; (vi) the State's calling for and supporting development resettlement and adopting a method of prophase compensation and subsidy and anaphase production support; and (vii) properly arranging for the displaced people in livelihood and production so that their actual income level shall be kept and more – or – less improved gradually.

1.2 ADB's resettlement policies

The policies set up by the ADB aim to ensure the displaced people arising from a project receive benefits from it and mainly include to (i) avoid involuntary resettlement wherever feasible or minimize the resettlement; (ii) work out resettlement plan where population displacement is unavoidable, with a target of assistance for improvement or rehabilitation to achieve at least the same level of well – being with the project as without it; (iii) compensate for lost assets, provide exploration of all viable project options and assistance in the course of relocation and interim in the host communities; (iv) assist them in raising or at least rehabilitating to living standard, income and livelihood level with the project as without it; (v) pay a special attention to vulnerable people's requirements; (vi) encourage public participation in the process of planning and execution of resettlement; (vii) Resettlers should be integrated economically and socially into host communities; and (viii) provide affected people with appropriate land, housing, infrastructure, and other compensation.

Comparatively speaking, the Chinese policies coincide with those of the ADB in minimizing displaced people, appropriately arranging for their production and livelihood so that their livelihood level should not be lower than that without the project and should be somewhat improved. The Chinese policies call for development resettlement and emphasize the combination of the compensation by the State and the self – dependence of displaced people, whereas, the ADB particularly stresses on public participation and special tendance to venerable groups.

1.3 ADB's requirement on some kinds of losses

Some kinds of losses shall not be simply evaluated in money or compensated for according to the ADB's requirements, for instance, acquirement of public service means and production patterns close to customers and borrowers shall explore a new way so that the displaced people can be provided with varieties of chances for employment that is equivalent to those losses and acceptable in culture, besides, its compensation policies are in favor of particularly vulnerable groups and ethnic minorities.

1.4 ADB laying stress on public participation

The ADB particularly emphasizes the public participation, which should be carried out throughout the whole course of a project in its preparation, implementation and rehabilitation of livelihood and production after relocation so that the cooperation, participation and feedback opinions from the host communities and displaced people could be attained, in addition, during constituting of a resettlement plan the rights entitled by the displaced people and selective options should be informed. The ADB deems that timely transfer of resettlement responsibilities from the government agencies to the displaced people is a successful relocation.

The resettlement in China also pays a close attention to public participation. During the investigation on inundated object indices because of a project occupation, several working groups, made up of designers, local land administrative departments and grass – roots cadres, have visited and verified every household and village, and the results have been approved and signed by every head of the households. As for the preparation of a resettlement plan, the relocation sites, compensation standard and employment are usually decided among the designers, local departments concerned, affected village cadres and resettler representatives. An important procedure that should be gong through, after the decision made for resettlement compensation policies, is to endorse an agreement for resettlement compensation between the owner and the relative departments. A rule of registration book for compensation of relocatees has been formed in the resettlement for many projects, recording amount of losses, compensation standard and amount, payment time and number in detail. In the resettlement implementation, the displaced people have directly taken part in buildup of the host communities, rehabilitation of production means and infrastructure, which has offered them the chance for employment and direct benefits. The local governments and the project owner, after the completion of removing and relocating of the displaced people, have given them support so that their living and production level could be well – being with the project as without it.

The resettlement of the projects in China has proven that the public participation implemented there is of good practice, creating successful experiences, however, that subject is generally not incorporated in those planning reports. Nevertheless, the ADB requires to record the activities, time and form of the emigrants' participation in a table format that should be included in the planning report, meanwhile, the arrangement and pattern for their appeal should be specified in detail.

All in all, the analyses aforesaid indicates that (i) the Chinese resettlement policies are identical to those of the ADB in many aspects and are of good maneuverability; and (ii) as for the preparation of a resettlement plan, the requirements of the ADB is higher than those for the feasibility design phase by the Chinese. Prior to compiling of a resettlement plan for the ADB – financed project, the meaning of its policies should be fully comprehended, and then, the contents, complying with such requirements as public participation, resettlement compensation information to be published, administrative department, legal contents and financial management, should be written in the report. Those elements are essential for the project resettlement during planning in China, nothing but, they are not required in a planning report according to the Chinese convention for a feasibility study. Currently, the feasibility study plan for resettlement in China has expanded in terms of relocation and production means for the displaced people, rehabilitation of their livelihood system, etc. which can satisfy the requirements of the ADB.

2 The trading cost to the borrower and owner arising from preparation of social impact evaluation, and the resettlement plan so as to meet the other relative requirements of the ADB as shown in the chart (see Table 1)

3 Necessity of making assessment on the resettlement plan implementation in the project completion report

It is indispensable to include an assessment on the implementation of the resettlement plan and ethnic minority development plan in the project completion report, specifying comments and suggestions.

As for the evaluation on the compensation for land requisition and relocation of displaced people, first of all, the examination shall be executed on whether the land requisition has satisfied construction schedule, there are violation of the policies, differences between the approved and actual land geometry, a complete land requisition procedure concerned, and utilization and management of the fund for removal. And other components such as production and living situation of the affected people, the auditing conclusion for land requisition and removal, and the design and real major object indices accomplished also shall be dealt with herein.

The local governments take responsibilities of allocating compensation for land requisition and resettlement, and the special check and acceptance shall be performed in accordance with the approved budget for the compensation. In the case of a small proportion in the total project investment or in the total estimate for land compensation and resettlement, that special check and acceptance can be omitted, but subject to the approval of the acceptance units, and the local government shall submit a special report for it to the project acceptance commission. The special check and acceptance shall be carried out by the municipal government of the project seat or its authorized agent who shall submit a working report to the project acceptance commission.

4 The active role played by the ADB in discovering and resolving social security issues

4.1 Economic level providing a basic condition for establishment of a rural social security system

To set up a social security system for rural communities and put it into practice, economy is a basis, an essential for carrying out all work, headspring and power for social and economic development. The establishment of the rural social security system depends on the economic development level of the rural communities and income of the farmers, their consuming level and bank savings tendency, amount of surplus products and reproduction scale. The surplus products are precondition for production development and implementation of the social security system, and their magnitude or amount of balance income is a decisive factor for the rural economic development scale and social security level.

In analyzing the economic conditions that would influence the setting – up of the social security system, there involves two major indices.

(1) Per capita income of farmers. The farmers' income as a key index, can measure the rural economic development level and the farmers' living level, and is an important indicator for setting up the social security system. Analysis of this index can make an acquaintance of the minimum consuming demand of the farmers and be aware of the groups qualified for social security. The calculation on the income sample data taken from the project area indicates that the income level there is not high in general since the income per capita in 2003 only amounted to RMB 1,160 yuan. The income per capita in agriculture takes 430 yuan, or 37.07% of the total earning, that in industry and sideline gets 645 yuan, or 55.59% of the total, of which, the income from the provision of service by farmers occupies extremely important position, taking 66.87% of that in the

Table 1 Yellow River flood management sector project(loan No. :1835)resettlement plan, supervision and monotoring cost

Item	Total	1. Embankment									2. River training		
		Subtotal	Kaifeng subproject	Lankao (152)	Yuan yang	Puyang	Lankao (135)	Dong ming	Mudan	Juan cheng	Subtotal	Laozai zhuang	River training
Total	2,320.7	969.0	70.0	40.0	252.0	97.0	28.0	358.0	88.0	36.0	201.4	13.6	35.5
Planning, design and scientific research	1,528.1	690.0	47.0	29.0	180.0	69.0	20.0	256.0	63.0	26.0	29.4	9.7	19.7
Supervision and monitoring	640.4	279.0	23.0	11.0	72.0	28.0	8.0	102.0	25.0	10.0	19.7	3.9	15.8

Item	3. Floodplain safety construction							4. Dongpinghu			
	Subtotal	Changyuan subproject	Pingtan	Changuan floodplain	Lankao floodplain	Fanxian floodplain	Dongming floodplain	Subtotal	Dongpinghu subproject	Dongpinghu 1	Dongpinghu 2
Total	1,036.0	10.0	245.0	140.0	101.0	259.0	281.0	38.6	3.4	5.2	30.0
Planning, design and scientific research	728.0	7.0	163.0	100.0	72.0	185.0	201.0	27.6	2.5	3.7	21.4
Supervision and monitoring	308.0	3.0	82.0	40.0	29.0	74.0	80.0	11.0	1.0	1.5	8.6

Item	5. Vulnerable spot								
	Subtotal	Liuzhuang	Mangjinju	Dongbatou	Heigangkou	Zhongmoju	Liaocheng	Dongming	Luokou
Total	75.8	9.2	7.0	1.3	1.3	8.0	7.0	39.0	3.0
Planning, design and scientific research	53.1	5.1	5.0	1.0	1.0	6.0	5.0	28.0	2.0
Supervision and monitoring	22.7	4.1	2.0	0.3	0.3	2.0	2.0	11.0	1.0

industry and sideline and 37.18% of the total. However, aquaculture and poultry raising, and forestry and orchard only account for a little among the income in the project area, and they are 5.51% and 1.83% respectively.

(2) Collective economic status. The economic development in villages and towns, grandness of rural collective economy and increase of financial power of the governments at county and township levels are all significant factors for solving the rural social security problem and enhancement of the security level. At present, the State has actualized the policy of tax – free for the farmers, assisted them increase income and allocated adequate allowance to the rural social security. Generally speaking, the both above lay an economic basis for establishment of the social security system and decide its development scale and guaranteed level.

4.2 The government providing reliable pledge for the establishment of the rural social security system

The social security, as an important tache in setting up the socialist market economy, a major work of political and economic institutional reforms and a social policy action of the government, shall be carried out by the government who shall be the main body, and the leader, organizer, coordinator and supervisor. Therefore, the government shall play a full role in it and take the responsibility of its main body of action.

(1) Political responsibility. The Article 45 of the Constitution of the People's Republic of China specifies that Citizens of the People's Republic of China have the right to material assistance from the state and society when they are old, ill or disabled. The state develops social insurance, social relief and medical and health services that are required for citizens to enjoy this right. The government with social administration function, the organizer of the social security work, shall constitute the laws and regulations of the Chinese characteristics, and work out a long term development plan, relative with the social security system, in conformity with the situation of China, and organize the implementation. The government shall fulfill its social administration function, strengthen the management and supervision on the social security, and from political point of view, make the work that would benefit the future generations well done.

(2) Economic responsibility. The Chinese farmers are the most simple and laborious people, so the government has accountability to build the social security system to provide them endowment and hospitalization insurance. The government shall practice its regulating economic function, adjust financial payout structure, and increase the transfer payment to the rural social security, with attention to social efficiency and equity, thus the farmers would enjoy the socialist building fruit as the people living in urban areas, embodying the people – owned assets to be used by the whole people. Naturalness, the China is still being at the initial socialist stage, the national economy is not developed enough, the people – owned property is limited, and the state is unable to take over all endowment and hospitalization insurance for the farmers, so a method of proper subsidy by every level of governments and inflation proof and increment fund to be ensured by the state has to be executed. That is the rural social security system, i. e. compensating a part by the government, allocating a part by collectives, paying a part by individuals and endowing a part from society. In the system structuring, the income per capita is taken as the payment base and the payment proportion is the responsibility of each level of governments. The conditional provinces and cities can provide appropriate allowance to vulnerable people and well – being groups. For the villages, townships and counties that conditions are available, they can allocate 5% ~ 8% to all insurants accordingly, and the farmers pay 5% ~ 8%. Thus, based on the average payment years of 20, the farmers who reaches the age of drawing pension can get about 100 yuan per month, that would offer a basic living security to the insured farmers.

4.3 Legal system construction being fundamental basis for the rural social security system establishment

As a social system project, covering about 0.9 billion farmers, with varieties of fields and complicated operation, the rural social security system shall be established by way of strengthening legal system building, being implemented according to law and management in a scientific way. The legal system construction lays a fundamental basis for the rural social security system establishment

(1) Define security object. The central government has brought forward that the rural social security system should be set up where conditions are available. In terms of the security objects, "conditional" refers to the location and groups, of which the second is of more important. In terms of social reality, there are groups without conditions where conditions are available, while there are groups with conditions where conditions are not available. In terms of the requirements for the social security, the system should cover all conditional groups of the whole society, and with economic development, should be expanded in coverage, finally reach the whole rural area and proceed to a well – to – do society.

(2) Stipulate payment standard. Insured premium should be formed based on farmers' income, adjusted with economic development level and basic living requirements, and sustained by collective assistance, government subsidy and financial support. The principles of entrance permission of low standard, low security, multi – level and wide coverage should be followed. For weak people, the minimum security line for the rural shall be implemented with the support from the government and donation from society. For the people with adequate food and clothing, low standard, low security and low pension shall be adopted, and premium and security level shall be set up according to the aim of "payable" and "affordable". For well – being people, including the staff members of village and town enterprises, industrial and commercial individuals, and the farmers working in a city, the premium shall be collected in conformity with the amount and proportion specified by the provincial government. For affluent people, high standard and high security shall be employed, the upper limit stated by the government shall be collected from them and pre – tax payment shall be permitted, with encouragement of their contribution to society.

(3) Found institution. Work execution needs institution and project development rests with people. The development of the rural social security requires a powerful chain of command, intelligent and capable operation organization, well qualified working groups, restrict mechanism in scientific management and high efficient operation mechanism. Institution is guarantee, a leader is a key element, staff members are power and mechanism is energy.

(4) Amplify rules and regulations. A good system for the rural social security shall be founded and the previous successful experiences and practices gained shall be kept by legislation. The laws, regulations, rules and working procedures for the social security shall be continuously improved so that the work can be well developed in a systemizing, normalizing, scientific and legal way.

Discussion on Ecological Restoration

Sun Juan, ***Yang Yisong***, ***Cheng Xianguo*** and ***Jing Ming***

Yellow River Institute of Hydraulic Research, YRCC, Zhengzhou, 450003, China

Abstract: The conception of ecological restoration was given birth to in the development of eco – environmental protection. The ecological restoration, as a relatively important measure to improve ecological environment, includes biological species protection, vegetation restoration and soil melioration, etc. Compared with the ecological restoration between the delta and the Loess Plateau, their characteristics and interrelation have been analyzed, and the care that shall be taken in the course of ecological restoration has been pointed out.

Key words: Loess Plateau, delta, ecological restoration

Ecological restoration is neither natural secondary succession of ecosystem nor simple recovery of species, but is purposefully rebuilding of ecosystem by people and the comprehensive recovery for biological diversity, function and the structure succession of ecosystem. Ecological restoration is divided into two parts mainly: restoration method and restoration goal. There are many ways for ecological restoration in our country, the ecological restoration projects being implemented on the Loess Plateau, northwest desertification region and some bigger river basins etc. are of typical, and the Yellow River delta ecological restoration project is one of them. The ecological restoration of the Yellow River delta is a complex problem, involving many factors. The worsening ecological environment of the Yellow River delta has a close relation with its water quantity and quality. The ecological restoration carried out on the Loess Plateau has huge influence to the change of water and sand in the lower reaches of the Yellow River. The ecological restoration of the Yellow River delta has a stated contact with that on the Loess Plateau.

1 The difference natural condition of between Loess Plateau and Yellow River delta

The Loess Plateau lies in the region of the upper and middle reaches of the Yellow River, from the Taihang mountain in east to the Riyue mountain in west, from Qinling mountain in south to E – Er – Duo – Si plateau in north, with a total area of 62.38×10^4 km^2, including west Hebei, greater part of Shanxi, middle and north of Shaanxi, middle and east of Gansu, south Ningxia and east Qinghai, etc. The population there occupies 8% of the whole population in China. According to the process of physiognomy forming and the discrepancy of natural feature, the Loess Plateau is divided into 4 parts: Longzhong basin, Longdong and Shanbei plateau, Weihe river plain and Shanxi plateau. The Loess Plateau belongs to the semi – humid and semiarid continental climate of temperate zone, annual rainfall of region normally ranges between 300 ~ 600 mm, and 800 ~ 1,000 mm in some regions. Rainfall concentrates in July and August, with comparatively less amount and shorter duration. In winter and spring, strong wind and strong evaporation are familiar, the phenomena of dry winter and arid spring are also obviously witnessed correspondingly.

The regional climate resource of the Yellow River delta is superior, belonging to the semi – humid continental monsoon climate temperate zone. Annual average temperature is 11.7 ~ 12.6 ℃, and annual rainfall between 530 ~ 630 mm. The Yellow River delta is a newly – born land and looks like an impact fan, its geography structure obviously differs from that of the Loess Plateau. The Yellow River delta area is keeping change because of plenty of silt entering the sea every year from both the upper and middle reaches of the Yellow River. According to the Yellow River position of entering sea and scope of rushing or silting of mud and sedimentation in different historical periods, the delta can be divided into the ancient delta, the modern delta and the contemporary delta. This region owns rich land resource for a person averages in 0.43 hm^2 of farmland that is 2.5 times of the average land per capita in Shandong Province, in addition, another 0.2×10^4 hm^2 of the area is generated by siltation in the Yellow River every year recently. The rivers crisscross the region, the annual flow discharge by the Yellow River accounts for 366×10^8 m^3. The marsh resource is rich, with an area of 75×10^4 hm^2. Because of the existence of marsh, biological diversity is very obvious and presents different features and kinds of biological varieties from the Loess Plateau. Restorable method and goal adopted there differ from those on the Loess Plateau.

2 The difference of ecological restoration between the Loess Plateau and the Yellow River delta

The Loess Plateau is a unique physiognomy unit, and is suffered most serious soil and water losses in our country. Since hundreds of years' man – made cultivation and damage, the survivable condition turned worsening for forest plant, vegetation coverage reduced seriously, the loess is loose and soft, and the rainfall of the Loess Plateau is centralized, all of which easily caused soil erosion. According to statistics, the whole area of soil and water losses reaches 3.4×10^5 km^2, in which, the area with soil erosion intensity larger than 1,000 t/(km^2 · a) is approximately 2.9×10^5 km^2, the area of soil erosion intensity larger than 5,000 t/(km^2 · a) is approximately 1.66×10^5 km^2, some places even exceed 20,000 t/(km^2 · a). Serious soil and water losses has caused the serious degeneration of this district's ecological function, such as land turning barren, fertility attenuation, ecosystem product reducing. Because of the continuously increasing population and long history of cultivation in the Loess Plateau, original vegetation has been already destroyed almost, the secondary and artificial vegetation is less than 20% of whole coverage rate, population density has already far surpassed the upper limit that internationally recognized bearing capacity of population in semi – arid region. Forced by population increasing in the grain vigorous demand, for a long period, people keeping unitary operation and broad cultivation but thin receipt, that forms a vicious circle "more cultivation leads to more poor, and more poor requires more cultivation", so formerly unstable ecosystem becomes more and more fragile.

The regional area of the Loess Plateau is wide, where there is obvious regional discrepancy, hydrological and climate conditions are very complex. The Yellow River delta differs from the Loess Plateau, such as essential different geography structure, completely different physiognomy, and different vegetation correspondingly. Because of the deterioration of natural climate condition in the natural evolution process of the earth, the Loess Plateau original vegetation disappeared and replaced by the natural secondary vegetation and artificial vegetation. Present vegetation can not reflect vegetation zone substance objectively. According to the research of the investigation team of the Chinese Academy of Sciences, the Loess Plateau is divided into the following vegetation zones: forest vegetation zone, forest grassland vegetation zone, typical grassland vegetation zone and desert grassland vegetation zone. The ecological restoration of the Loess Plateau is a complex systematic project, not only considering historical changes, extant situation and development tendency of the natural factors of soil, water and vegetation, but also considering support disturb degree as a multiplex unit nature and society.

The geography situation of the Yellow River delta has decided that marsh vegetation is major natural vegetation type mainly, there is artificial vegetation simultaneously. Meadow growing in saline and shrub are the major marsh vegetation types of the Yellow River delta. The seaside bottomland is soaked frequently by tide, or is influenced by high salinity underground water, so saline alkali bedstraw, quitch, Chinese tamarisk community that could endure the high salt first invaded, from settling to competition. It is little to preliminary density and coverage degree, afterwards, running to closing community with development. The community of endurable medium salt and light salt will replace the already existent community along with the development of community, the decreasing of soil organic quality and the increase of soil salt. When soil containing salt falls 0.1% to 0.3%, the community that growing up respectively with white quitch may be formed, and the horsetail quitch, and wild soja mainly, become meadow growing in saline and shrub are the major marsh vegetation types relatively steady succession, finally to develop top community to defoliate broadleaved forest. From this, it may find out that the vegetation community succession in the Yellow River delta has great relation with the change of soil salt quantity. In addition, natural or artificial disturbance, such as storm tide, change of the Yellow River route, flooding, unreasonable reclamation, overgrazing, etc., can also cause ecosystem skip or the succession of worse turning. Therefore, the vegetation community of the Yellow River delta has instability and easy change by outside world around very much.

3 The Difference of vegetation restoration measures

The obvious regional discrepancy of the Loess Plateau and the Yellow River delta exist in the ecological environment, the focal point and measure of ecological restoration are also distinguished.

3.1 The focal point and measure of ecological restoration in the Loess Plateau

The ecological restoration of the Loess Plateau shall focus on the reconstruction and recovery of vegetation. The vegetation recovery of the Loess Plateau is greatly restricted by water resources. The loess is the soil reservoir with huge storage capacity, however, soil reservoir is not inexhaustible, if precipitation supply is not ample, ground water evaporation is strong, or artificial vegetation using improperly causes excessive steam, the storage capacity of soil reservoir would be insufficient, resulting in a dry layer of soil.

Now, according to the effect of water and soil conservation in the Loess Plateau for dozens of decades, all the people know that completely adopting arbor, shrub and grass plantation with manpower, disregarding discrepancy of water condition and plant biological feature can not reach the purpose of restoration. It is the perfect pattern of natural restoration, artificial and natural combination that in the Loess Plateau now. According to the regional discrepancy, selects different regions to protect, resume, rebuild and reform, protects and resumes natural resource and zonal ecosystem; carries out the combination of artificial intervention and natural recovery in the area of better water condition; some extremely degraded landscapes have lost economic meaning and ecological condition of artificial reconstruction, such as arid desert steppe, it is the best choice to maintain present situation. Vegetation restoration and reconstruction should according as vegetation zonal distributing rule and resource carrying capacity, research arbor, shrub and grass reasonable layout, suitable scale and the suitable type of vegetation construction, accomplish suitable arbor to arbor, suitable shrub to shrub, suitable grass to grass, arbor, shrub and grass combines, carries out after returning forest to seal a mountain pass, enclosure gives birth after plant grass, with the combination of farming, agricultural and herds. Determining arbor, shrub and grass proportion scientifically, insisting to construct ecological forest mainly, making scientific stipulation with the proportion of economical forest and ecological forest.

According to local conditions with specific restorable measure, basically follow the procedures of selecting restorable type – researching the water resource development – choosing and configuring species. The uniqueness of climate condition and geological condition of the Loess Plateau has made the water resources in this region rare. Therefore, the choice of the species which could resist drought becomes the foundation and the prerequisite of vegetation restoration and ecosystem stability. The disposition of arbor, shrub and grass is a constructing disposition form that is based on the principles of natural environment condition and biology property in a little valley, its species disposition should be the regular coexistence between species, should have the relation of interaction, mutual restriction and mutual dependence each other, should avoid competition for water resource and other ecological conditions. Testing result shows that the combination of various plants yields more benefit on water and soil conservation than unitary species apparently. Water resources is the leading factor of vegetation restoration and growth in the Loess Plateau. If the water resources problem could be solved, will may raise plant livability rate, promote biological output and economic output form; at the same time, may still enlarge the distribution scope of plant. The vegetation restoration and reconstruction process of wind, water and soil erosion in the Loess Plateau exist or go through the change course of "natural type", "irrigation type", "gather flow type". "Gather flow type" should be the main part of vegetation restoration and reconstruction work now in the three types. How to well merge the gather water measure into specific landforms condition is important aspect in the ecological restoration.

The ecosystem of the Loess Plateau after carrying out ecological recovery should be an open type system, which can become the system of sustainable development, only after being incorporated with the material flows, energy flows, information flow and value flow with population. The ecological recovery of the Loess Plateau is a complex systematic project so that natural law shall be accorded with, more attention shall be paid to the impact and restriction from fragile eco – environment conditions, ecological and economic recovery process shall suit reality, gradually recovery goal shall be set up, and the socio – economic sustainable development and ecological environment improvement shall be realized.

3.2 The ecological restoration of the Yellow River delta

The products resource of the Yellow River delta is rich, the exploitations such as oil field caused a certain damage to the local environment, especially since 1970s, the Yellow River dried up frequently, the water quantity of the Yellow River delta could not be supplemented promptly, entire marsh area of the Yellow River delta turned withered in large quantities, vegetation from degrading to disappearing, ecological balance had been destroyed, causing the extreme deterioration of ecological environment. The change of marsh area, marsh water quality and the reduction of marsh biological diversity have already become the major process of marsh degeneration. The Yellow River delta is a newly – born land, and vegetation development is in unceasing change. The marsh vegetation is main vegetation community. The focal point of the ecological restoration of the Yellow River delta is to insistently protect original marsh environment from destroying, protect the newly – born marsh. Thinking the frailty of the ecosystem of the Yellow River delta, to simply depend on natural restoration can not maintain the lasting stability of the ecosystem, therefore, the ecological restoration of the Yellow River delta with the combination of natural and manpower, promotes well restoration of ecosystem on the foundation of ecological safe development.

First, must keep the enough fresh water resource supply. Through the water quantity allocation of the Yellow River, as well as water and sediment regulation, the phenomenon of the Yellow River dried – up got control, a certain amount of water flowing into the sea was assured, the ecological environment of the Yellow River delta was improved, and the harmonious relation between the nature and people was restored step by step.

Secondly, resuming vegetation structure and protecting biological diversity. The major function of the marsh in the Yellow River delta is to purify water and degrades inland river contaminant, raises environmental quality, stores up flood detention etc.. Existent environmental problems are spread disproportion, insufficient water supply, soil saline and vegetation exiguity, and converse succession. Ecological restoration should ensure the supply of water source according to local conditions, protect original vegetation, and carry out breed with man – power, introduce into kinds and breed endurable salt plant, increase vegetation kinds, raise vegetation coverage. At the same time, uniform water quantity management has offered water condition for delta marsh restoration, reduced delta marsh area sharp withered, improved vegetation quality, biomass and species diversity obvious increasing, ecosystem stabilizes more, the ecological environment of the bayou improves apparently, marsh ecological environment of bayou gets effective protection.

Thirdly, strengthen protection of the fresh water marsh. Recently, besides 153,000 hectares of the Yellow River delta, another 200,000 mu have revived. The unceasing increase of marsh area and the improvement of the ecosystem of the Yellow River bayou have sufficiently promoted the raising of the overall ecological environment of the Yellow River delta. The fresh marsh landscape growth is in primary stage, its structure and change show obvious original state, landscape and ecosystem are younger in time and space, the succession of ecosystem begins from original succession, succession process is obvious and complete. These factors make the fresh marsh of the

Yellow River delta the same as the original marsh, showing obvious shortcoming of the ecosystem instability and weak acceptant capacity by ecology. So, strengthening protection of the fresh water marsh is very important.

4 Notice of ecological restoration

Now, ecological restoration concentrates on the restoration of vegetation, dealing with chosing of plant species, vegetation structural disposition and planting technology, etc.. No matter whether the Loess Plateau belongs to the semi – humid and semiarid continental climate of temperate zone region or the Yellow River delta belongs to the temperate zone of semi – humid continental monsoon climate region, how to deploy the species in ecological restoration reasonably is a very important problem.

Firstly, need to consider local water condition and the problem of water environment, select plant species carefully. The Loess Plateau and the Yellow River delta have a lot of native plants, these plants can adapt the ecological environment of local degeneration, and have formed the plant type of suitable different biological climate district, should be used. Importing foreign plants in large quantities blindly will more or less influence the original system if not considering that the zonal vegetation is the result of the plant and climate interaction for a long time. Vegetation reconstruction should be on the foundation of finding out water carrying capacity and capacity background value, choose suitable kinds of arbor, shrub and grass, determine reasonable disposition structure, suitable density, method of plantation and measure of management, control water quantity balance, basis water carrying capacity and rainwater resource to adjustment vegetation structure.

Secondly, should notice the interaction between species, pay attention to the heterogeneity of ecosystem. The interaction between species is very complex, between environment and species, between species and species have formed complex relation in ecosystem. Must concern the correlation between species, adopt proper method to promote and to establish a good ecological relation when restoring. A healthy ecosystem must have the heterogeneity of species composition, space structure, age structure and resource disposition. The heterogeneity has offered various subsisting opportunity and condition for different plants and animals. If considering these relations when carrying out the ecological restoration, deploying the forest zone that the different age structure, different species, the collocation of difference degree, will avoid appearring artificial pure forest kind and structural unitary, will avoid appearing that the forest vegetation coverage is short, the ability to protect water is inferior, the level of biological diversity is low, nutrition circulating process is not smooth, soil nutrition is gradually deficient, the ecological stabilities such as resistant insect are low etc.

Thirdly, should adopt various restoration patterns. Ecological restoration is now still perfecting constantly, former control measure collocation was unitary, the progress unbalanced of biological and engineering measures, optimization collocate proportion in different conditions was ambiguity. Considering the interaction in different landscapes structure and between different species when restores, establishes and connects various ecosystems, forming the good cycle of nutrition and water in ecosystem, improving landscape ecological function.

5 Concluding remarks

The Loess Plateau lies in the middle reaches of the Yellow River, serious soil and water losses have maximum influence on the lower reaches of the Yellow River and even the estuary of the Yellow River. Carrying out ecological restoration construction, reducing the silt that enters the lower reaches of the Yellow River, reducing the water consumption of rushing sand in the lower reaches of the Yellow River, increasing the main stream frequent water consumption of the Yellow River, the water resources for the lower reaches of the Yellow River will increase favorably. The Yellow River gave birth to the Yellow River delta, the rise and disappearance of the Yellow River delta cannot do without the Yellow River. Along with the raising of people for ecological environment and reasonably using the water resource knowledge of the Yellow River, the ecological restoration of the Yellow River delta gets attention increasingly. Along with the increase of the approval of importance and the intensity of ecological restoration, the ecological environment of the Loess Plateau and the Yellow River delta will have maximum improvement.

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Study on Selection Method for Construction Agent Enterprises Based on AHP

Yin Honglian[1,2], *Cao Guangzhan*[2] and *Liang Qiusheng*[2]

1. College of Water Conservancy and Hydropower Engineering, Hohai University, Nanjing, 210098, China
2. Shandong Water Polytechnic, Rizhao, 276826, China

Abstract: The paper puts forward selection index and AHP model for construction agent enterprises (CAE) combining to characteristics of construction agent system inviting bids. It can preferably avoid subjective liberty in selection — evaluation course and have determinate scientific character to choose the best CAE by using quantitative analysis and measurable method.

Key words: Analytic Hierarchy Process (AHP), construction agent system, selection index

Construction agent system (CAS) is a widely used international project management pattern. It is the beginning of CAS in China that municipal projects were operated experimentally in Shanghai 1999. On July 16, 2004 the State Council promulgated the "Decision of the State Council about reform of the investment system," (States, "2004" text on the 20th, here in after refers to as the "Decision") it is pointed out clearly about government investment projects that "Non - operating government investment projects should speed up the implementation of CAS…" on the second part of "Decision". In the "Decision" promotion, Shanghai, Beijing, Chongqing, Xiamen, Shenzhen and other cities have implemented on an experimental basis and gradually expand the application areas, in water conservancy project also has been applied and will be gradually extended throughout.

The third part of the "Decision" explicitly pointed out: "The government (investor) chooses project - management units with the necessary skills and social specialization as Construction agent enterprise (CAE) …." However, at present in China, there is no scientific applicable selection method of CAE, and Evalwated - lowest - quotation - as - bid - winner method or the project Quantities were not used like survey design and construction. The comprehensive assessment method were often used in the selection and location assessment, and this method is subjective and arbitrary distorted results very easily. Using Analytic Hierarchy Process, and according to the characteristics of CAS tender, the comprehensive evaluation system and a AHP model for selection of CAE are established, and the model is the foundation of using AHP principle to choose the best CAE qualitative and quantitative analysis.

1 Analytic Hierarchy Process (AHP)

AHP (Analytic Hierarchy Process. AHP) is a qualitative and quantitative systematic analysis methods which was the first put by professor T. L. Saaty, a well - known tacticians at the University of Pittsburgh in U. S. in the mid - 1970s to the 20th century. It decomposes the complex issues into a number of orderly level, the relative importance of each level is quantified according to the judge things objectively, and the numerical of all the elements of the relative importance of each layer sequence is determined by the expression of mathematical methods, then the analysis of the whole issue is derived according to the analysis of the various levels. Currently the method has been used quite a wide range of areas, such as the plan formulating, resource allocation, program scheduling, personnel selection and decision - making prediction. When the method is to be used in the selection of CAE, not only the reason is simple and operation is convenient, but also through improving hierarchical structure, we can achieve scientific reasonable tender and unification of the selection criteria and methodology.

2 Establishing the AHP selection model for CAE

Based on the characteristics of CAS tender, the AHP selection model can be divided into three basic levels : total target layer A, rule layer B and scheme layer C. Its model is shown in Fig. 1.

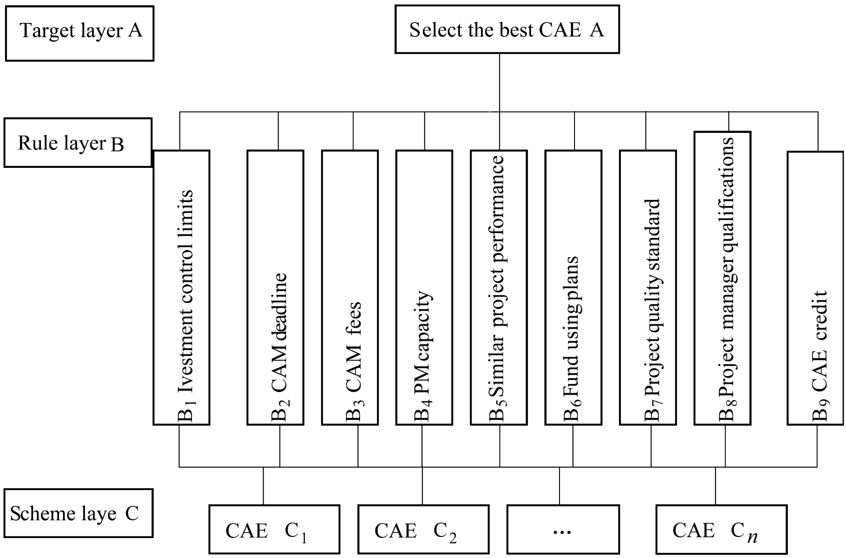

Fig. 1 Hierarchy structure model of selection CAE

2.1 Target layer A

The selection purpose is to determine which CAE is the optimization. So the target layer is to select the best CAE (A share).

2.2 Rule layer B

Rule layer is the criterion for measuring whether the objectives can be achieved, specific to selection CAE, the selection criterion is used to investigate the CAE. Selection CAE differs from other projects tender such as survey and design or construction. Selection CAE should focus primarily on management capacity, not just pay attention to the level established in fee quotations. The selected CAE should have a rich project management experience and strong project management capabilities, specialy will be able to reasonable control and management funds for the project. The indexes meaning in model is shown in Table 1.

2.3 Scheme layer C

Scheme layer is the project construction agent programs (or construction outline) of each CAE. (indicated to CAE).

Table 1 Selection index of CAE

Selection index	Meaning
B_1 Investment control limits	It is the project investment control objectives that is made by CAE based on their own management level as well as internal and external conditions of project implementation marked in construction contracts. The index is special important as a quotations in construction agent contracts
B_2 CAM dadline	It is the the number of days for the project implementation and management of CAS which is commissioned in construction agent contracts. The period is from the early planning, the implementation management of the project, trial operation, completed successfully, delivery of use units to complete the construction contract
B_3 CAM fees	It is the reward of CAE owning to their services as like the general contractor on biding price. It is not the most important factor in the selection, There is still not a unified admission standards in China, in experiment, construction management fees are usually≤Construction management fees of construction unit in the original infrastructure of the financial management system, does not normally exceed 70%, and is different strategies based on the actual capabilities of CAE
B_4 PM capacity	It is the comprehensive abilities of CAE about cost, construction period, quality, risk control and safety of project. Speaking on the implementation phase of construction agent project, it is the management capabilities that CAE is demanded to possess strong abilities of planning, design, construction, equipment and materials supply of project
B_5 Similar project performance	It mainly refers to the performance of CAE of participational similar projects or general contracting management projects in the recent two years. It can be choosed general understanding quality qualified rate, choiceness rate, relevant awards, quality accidents and other factors combining with owner's satisfaction degree
B_6 Fund using plans	It is the reasonable arrangement of government investment funds made by CAE according to the actual job schedule and fund needs and is as the basis of government competent departments in charge of investment funds after it is approbated by the user and supervision units
B_7 Project quality standard	It is the user's quality requirement of the construction agent project, and as the CAE control objectives of overall quality, it is more important that the index can be reflected CAE quality management capabilities, and is an important measure to ensure high quality from point of view of value engineering
B_8 Project manager qualifications	It mainly refers to the abilities of the stationed person in charge of the project, specific embodiment is the administrative organization setting, human resources equiping, staff division of labor as well as the project manager´s own professional quality, coordination and higher authority impower degree
B_9 CAE credit	It mainly refers to the CAE capital and credit, reflecting the CAE′s economic strength and ability to guard against financial risks. Enterprise credit is divided into 6 grades: AAA, AA, A, B, C, D in banks and the best CAE can be selected according to above credit grades

3 Application of the model

3.1 Constructing judgement matrix

In practical tender, bidding evaluation experts give all levels of 1 ~ 9 ratio scaling judgment matrix, that is the relative importance of this level element and related to various element against the above level. The relative importance is shown in Table 2.

Table 2 Relative importance of i element and j element

1	The i element and j element are of equal importance
3	The i element is slightly more important than j element
5	The i element is clearly more important than the j element
7	The i element is much more important than the j element
9	The i element is much much more important than the j element
2,4,6,8	The middl evalue of above – mentioned judgment

All given degrees of importance are weighted average, then judgment matrix [a] is set up as following:

$$[a]=\begin{pmatrix} a_{11} & a_{12} & \cdots & a_{1n} \\ a_{21} & a_{22} & \cdots & a_{2n} \\ \vdots & \vdots & & \vdots \\ a_{n1} & a_{n2} & \cdots & a_{nn} \end{pmatrix}=\begin{pmatrix} a_1/a_1 & a_1/a_2 & \cdots & a_1/a_n \\ a_2/a_1 & a_2/a_2 & \cdots & a_2/a_n \\ \vdots & \vdots & & \vdots \\ a_n/a_1 & a_n/a_2 & \cdots & a_n/a_n \end{pmatrix}$$

3.2 Single hierarchy sequencing and judgment matrix consistency test

Judgment matrix of each level is multiplied by eigenvector $[W]^{\mathrm{T}}$ on both sides the same time, $[W]=\{\omega_1,\omega_2,\cdots,\omega_n\}$, then : $[a][W]^{\mathrm{T}}=\lambda_{\max}[W]$, then will be the relationship: $[a]\lambda_{\max}[I]=0$. Using power method, product of sum method, root method Artificial or AHP software, we can calculate eigenvectors and the largest eigenvalue $\lambda_{\max}$ of judgment matrix and obtain the single weights of the same layer.

Calculating random consistency ratio CR in order to judge the consistency of matrix.

$$CR=CI/RI \tag{1}$$

where, CI is consistency index, $CI=(\lambda_{\max}-n)/(n-1)$, RI is the same order average random index, its value as shown in Table 3. When $CR \leqslant 0.10$, the result of sequencing has satisfied consistency, or the values of the matrix variables need to be adjusted until a satisfactory consistency.

Table 3 The RI value of 1 ~ 9 orders

Orders	1	2	3	4	5	6	7	8	9
RI	0.00	0.00	0.58	0.90	1.12	1.24	1.32	1.41	1.45

3.3 Total hierarchy sequencing and its consistency test

Using the results of all single hierarchy sequencing in the same level, we can calculate the importance weight of all factors against the above level. Total hierarchy sequencing is made along a top – down order from the top to the bottom level, as to the second below top level, Single hierarchy sequencing is the total one. The weights value are $a_1, a_2, \cdots, a_m$ after total sequencing of all factors $A_1, A_2, \cdots, A_m$ of above level have been completed, and the weights value of single sequence are b_1^i,

$b_2^i, \cdots, b_n^1$ corresponding the level factors B_1, B_2, $\cdots$, where, when B_j has nothing to do with A_i, $b_g^i = 0$, then total hierarchy sequencing is shown in Table 4.

Table 4 Total hierarchy sequencing

Level A	A_1	A_2	$\cdots$	A_m	Total sequencing of level B
	a_1	a_2	$\cdots$	a_m	
B_1	b_1^i	b_1^2	$\cdots$	b_1^m	$\sum_i^m a_i b_1^i$
B_2	b_2^i	b_2^2	$\cdots$	b_2^m	$\sum_i^m a_i b_2^i$
$\vdots$	$\vdots$	$\vdots$		$\vdots$	
B_n	b_n^i	b_n^2	$\cdots$	b_n^m	$\sum_i^m a_i b_n^i$

Consistency test of total hierarchy sequencing is similar to sigle one, here,

$$CR = \sum_i^m a_i CI_i / \sum_i^m a_i RI_i \tag{2}$$

where, CR is total hierarchy sequencing consistency ratio, CI_i is judgment matrix consistency index and RI_i is average random index of B level corresponding with a_i. Similarly, when $CR \leqslant 0.10$, the result of total hierarchy sequencing has satisfied consistency. Total hierarchy sequencing consistency text is also processed from highness to lowness, the lowest total sequencing order from big weight value to small one is the best CAE candidate order by bidding evaluation.

4 Conclusions

CAS has broad prospects as a management model of government investment public projects. How to determine application the selection CAE indexs and methods and select excellent CAE is one of the issues which are to be solved emergency by the competent government department. It can preferably avoid subjective liberty in selection—evaluation course and have determinate scientific character to choose the best CAE by using AHP principle, calculating weight values according to the relative importance of indexs and by using quantitative analysis and qualitative method.

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Analysis on the Influencing Factors of Discharge Hydrograph in River Channel

Zhai Yuan

Department of Water Conservancy, Tsinghua University Beijing 100084

Abstract: Based on theoretical analysis and case studies, the paper points out that the influencing factors of flood routing and the attenuation of flood peak discharge include external factors like both river channel boundary etc. and internal factors. It emphasizes on the internal factors of one flood in addition to external factors. Regarding floods which could be regulated, the operation of reservoirs should be enhanced to form suitable floods based on different goals of experiments.

Key words: attenuation of flood peak discharge, flood routing, flood – forming, optimum operation

1 Brief introduction

In general, flood forecasting is to forecast flood of next downstream station based on the data of upstream station. The flood peak time and peak discharge of the forecasted station is two main indices. Their precision is significant for the flood control and disaster relief of the lower river channel. If without pre – analysis and classification, it is not reasonable that flood routing time and the attenuation rate of various kinds of floods are compared as a whole, because the flood peak discharge of the downstream station and the flood routing time is mainly related to the flood process of the upstream station, in addition to river channel boundary conditions, flood peak discharge of upstream station, sediment load etc. In order to deepen the understanding of flood process, and to put it into practice, the paper made the relevant analysis.

2 Theoretical analysis

Below is the function of Muskingum flood routing.

$$O_2 = C_0 I_2 + C_1 I_1 + C_2 O_1 \tag{1}$$

In which,

$$C_0 = (0.5\Delta t - kx)/(k - kx + 0.5\Delta t)$$
$$C_1 = (0.5\Delta t + kx)/(k - kx + 0.5\Delta t)$$
$$C_2 = (k - kx - 0.5\Delta t)/(k - kx + 0.5\Delta t)$$

and

$$C_0 + C_1 + C_2 = 1$$

It can be deduced out that,

$$\begin{aligned} O_3 &= C_0 I_3 + C_1 I_2 + C_2 O_2 \\ &= C_0 I_3 + C_1 I_2 + C_2 (C_0 I_2 + C_1 I_1 + C_2 O_1) \\ &= C_0 I_3 + (C_1 + C_0 C_2) I_2 + C_1 C_2 I_1 + C_2 C_2 O_1 \\ O_4 &= C_0 I_4 + C_1 I_3 + C_2 O_3 \\ &= C_0 I_4 + C_1 I_3 + C_2 [C_0 I_3 + (C_1 + C_0 C_2) I_2 + C_1 C_2 I_1 + C_2 C_2 O_1] \\ &= C_0 I_4 + (C_1 + C_0 C_2) I_3 + (C_1 C_2 + C_0 C_2 C_2) I_2 + C_1 C_2 C_2 I_1 + C_2 C_2 C_2 O_1 \\ &\quad \vdots \end{aligned}$$

It can be seen from the above equations that the discharge of downstream cross section is related to the upstream discharge series. The influence of upstream discharge process is up to the river channel boundary conditions, which can be expressed with coefficients.

There are two kinds of calculation methods for flood routing time. One is to deduce out the wave speed of one flood based on the continuity function of unsteady flow and then to calculate the routing time with the length of river channel, the other is supposing the routing speed of flood wave is nearly equal to average velocity of flood, and then the flood routing time can be calculated with average velocity of flood at upper cross section and next downstream cross section and the length between the two sections. Based on the continuity function of unsteady flow, the below can be deduced out:

$$\omega = V + A\mathrm{d}V/\mathrm{d}A \tag{2}$$

in which, ω is wave speed, A is wetted cross section area, V is average flood velocity of cross section.

In general, flood wave speed is larger than flood velocity. In compound river channel, when floodplain is inundated, the cross section area increases, flood speed reduces and then the flood wave speed is smaller than flood velocity. If river width won't increases further after the floodplain is inundated, with the discharge increasing, wetted cross section area and flood velocity increases at the same time, then the flood wave velocity becomes larger than the flood velocity.

Below is the Chezy function,

$$V = C(RJ)^{1/2} \tag{3}$$

in which, C is Chezy coefficient, R is hydraulic radius, J is longitudinal gradient. To replace the equation (3) with Manning function $C = n^{-1}R^{1/6}$ and replace R with average water depth h, the below can be deduced out:

$$V = n^{-1}h^{2/3}J^{1/2} \tag{4}$$

It can be seen the flood routing time is related to roughness of river bed, wetted cross section area, average water depth, gradient of water surface etc. Although the influencing factors of flood routing time are complex, they can be classified into external factors and internal factors. The external factors mainly include the change of river channel boundary condition, and the internal condition includes inflow flood process, sediment content etc.

3 Case studies

3.1 Impacts of external factors

With the rapid social and economy development and population increasing, for most rivers, there are more human activities, and the competition between human being and river for space gets severe. Especially for northern rivers, due to frequent small runoff or even drying up, river channel was occupied, wetted cross section reduced, and the roughness of riverbed increased. These resulted in the abnormal flood wave of river channel flood and that the attenuation ratio of flood peak discharge increased. The flood velocity in river channel reduced and flood routing time increased.

The lower reach of Huayuankou to Gaocun with the length of 189 km, is a suspended river, hardly with water rejoining it. The floodplain of the reach is wide and large population lives here. The river channel is wide and shallow and human activities increase year by year, which make the attenuation rate of flood peak discharge and flood routing time increase gradually. Based on the maximum flood peak discharge of each year, it is analyzed out that in the 1960s, the attenuation rate of flood peak discharge is 4% and the average flood routing time is 28 h, in the 1970s and 1980s, the values are 16% and 38 h respectively, in the 1990s, the values are 26% and 42 h respectively, and the maximum routing time reaches 103.5 h. Although the influencing factors for the increased attenuation rate of flood peak discharge and lengthened flood routing time include both external factors and internal factors, the change of river channel boundary condition plays a significant role among them.

3.2 Impacts of internal factors

The internal factors include mainly the flood peak, flood process and sediment content. The flood peak mainly influences the area and water depth of wetted cross section and therefore changes the external factors which affect the flow. The sediment content and different grain size of one flood mainly influence the density of flow, which is not analyzed in the paper. The paper analyzes the impact of different upstream flood processes on the downstream flood process, including the attenuation and routing time of flood peak, under the condition of the same external boundary conditions. For the same reach, the longitudinal gradient of river bed is relatively stable. However, different flow results in different flood – caused additional gradient, which make the water surface gradient different, and then the flood is flattened and deformed differently when the flood flows downstream.

The river channel flood routing was deduced for different flow patterns. In order to simplify the analysis, the paper only analyzed floods with the same flood peak discharge, same runoff and adopt the same set of flood rooting parameters (which means assumption of the same river channel boundary conditions). The schemes are that the runoff is 0.7 billion m^3 and the peak discharge is 4,000 m^3/s. Scheme 1 is a 2 – day rectangular flood wave, scheme 2 is that both the rising and dropping of the flood change gradually, scheme 3 is the rising is gradual and the dropping is sharp, scheme 4 is the rising is sharp and the dropping is gradual. For all schemes, the base flow is assumed as 0, the time step is 6 h, the Muskingum parameter $k = \Delta t$ and the number is $n = 4$. For each period, $x = 0.2$. The flood routing results for the 4 schemes is listed in Table 1 and the characteristics is given in Table 2. The corresponding flooding routing is shown in Fig. 1 ~ Fig. 4.

Table 1 Flood routing calculation of the 4 schemes

Period of time	Scheme 1		Scheme 2		Scheme 3		Scheme 4	
	Inflow	Outflow	Inflow	Outflow	Inflow	Outflow	Inflow	Outflow
1	0	0	0	0	0	0	0	0
2	4,000	11	500	1	500	1	4,000	11
3	4,000	128	1,000	17	1,000	17	4,000	128
4	4,000	602	1,500	93	1,500	93	4,000	602
5	4,000	1,580	2,000	290	2,000	290	4,000	1,580
6	4,000	2,673	2,500	624	2,000	623	3,500	2,671
7	4,000	3,392	3,000	1,048	2,500	1,032	3,000	3,375
8	4,000	3,754	3,500	1,517	3,000	1,442	2,500	3,661
9	4,000	3,908	4,000	2,006	3,500	1,808	2,000	3,618
10	0	3,957	3,500	2,499	4,000	2,168	2,000	3,345
11		3,862	3,000	2,966	4,000	2,575	1,500	2,957
12		3,395	2,500	3,315	4,000	3,014	1,000	2,554
13		2,419	2,000	3,420	4,000	3,419	500	2,190
14		1,327	1,500	3,252	0	3,703	0	1,832
15		608	1,000	2,904		3,749		1,425
16		246	500	2,465		3,350		986
17		92	0	1,988		2,403		581
18		32		1,497		1,322		286
19		11		1,016		606		123
20		3		592		246		48
21		0		290		91		17
22				124		32		6
23				48		11		3
24				17		3		1
25				6		2		0
26				3		0		
27				2				
28				0				

Table 2　Characteristic data of outflow hydrograph of the 4 schemes

Item	Scheme 1	Scheme 2	Scheme 3	Scheme 4
Flood routing time(h)	48	24	30	36
Flood peak discharge(m^3/s)	3,957	3,420	3,749	3,661
Attenuation of flood peak(%)	1.1	14.5	6.3	8.5

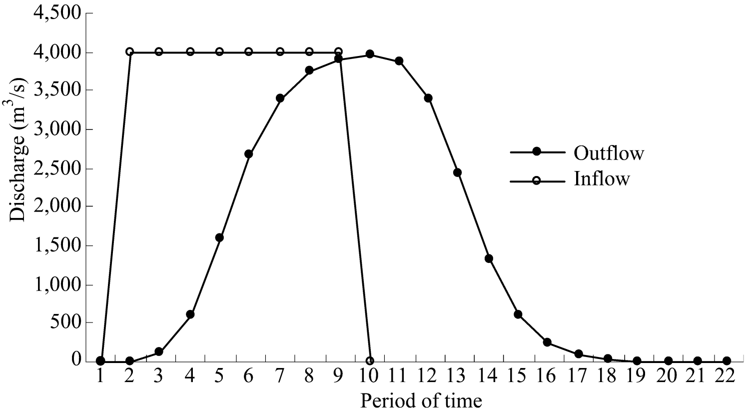

Fig. 1　Scheme 1 – discharge hydrograph of the outflow

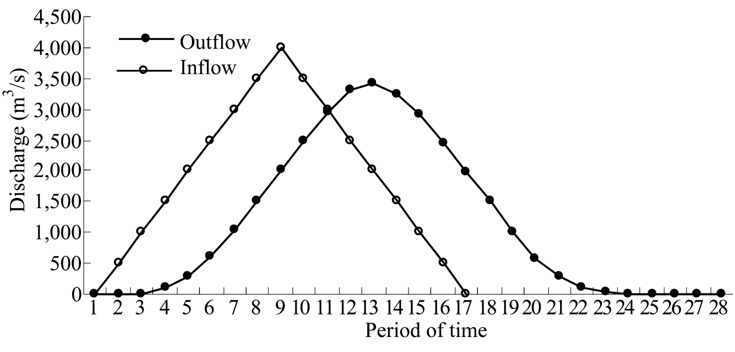

Fig. 2　Scheme 2 – discharge hydrograph of the outflow

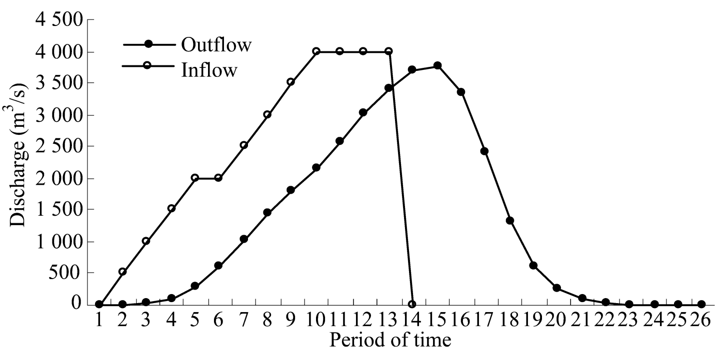

Fig. 3　Scheme 3 – discharge hydrograph of the outflow

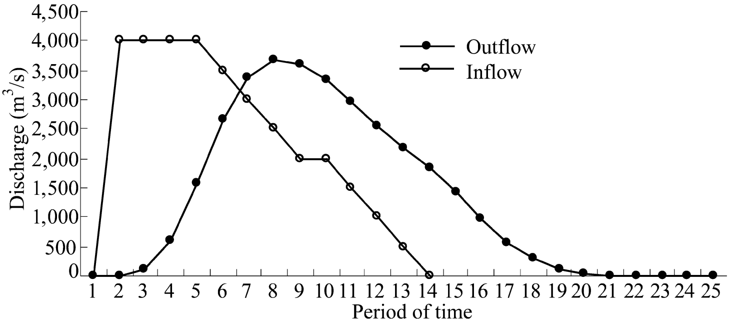

Fig. 4 Scheme 4 – Discharge hydrograph of the outflow

Regarding the 4 outflows of the 4 different upstream flood patterns, it can be seen from the above tables, under the same condition of flood peak discharge, runoff, flood routing parameters, the longest flood routing time is 48h and the shortest is 24 h, the maximum attenuation rate is 14.5% and the smallest is 1.1%. The variation of flood routing time and the attenuation rate among the 4 schemes is quite large.

4 Conclusions and suggestions

4.1 Conclusions

The influencing factors of flood routing time and its attenuation are very complex, induding not only external conditions like river channel boundary conditions etc., but also inflow process. Firstly, specific analysis should be made based on the practical situation to find the main influencing factors and reasons, instead of taking all factors into consideration equally when the flood routing time and attenuation is analyzed, secondly, the inflow process is suggested to be optimized. For the different inflow process, the routing of flood also change much including water level, water surface gradient, the scouring of river bed, the change of flow regime etc. Therefore, for the floods which could be regulated, the inflow process is suggested to be regulated and optimized based on the different demands of experiments.

4.2 Suggestions

4.2.1 Clearing river channel and maintaining smooth flood transportation

If river channels get narrow due to the land reclamation, planting high – stalk crops etc, the roughness of the river bed increases; the average flow velocity of cross section decreases, and the water level with the same discharge gets higher. The longer the water level keeps high, the larger the pressure of the flood control is. In order to discharge flood to the sea soon, reduce the pressure of the flood control and flood disaster, it must follow the instructions of Flood Control Law of China, Regulations on River Channels Management of China, that it is forbidden to construct anything which hinder the flood discharging in river channels and lakes, it is forbidden to plant trees and high – stalk crops in river channels. River channel protection and management should be enhanced and checked regularly, and barriers should be cleared to ensure the smooth flood discharging.

4.2.2 Regulating and optimizing flood process into the lower reach

At present, large reservoirs have been built in the river channels, which could play a significant role in regulating floods. For floods with the same flood peak discharge, if they have different inflow process, they will have different routing when they enter into the lower reach. Therefore, for floods which could be regulated by reservoirs, the regulating should not only adjust the flood peak discharge, but also the whole process so that to make a good use of floods.

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Evaluation and Analysis on Current Water Environment Quality and Water Pollution Trend for Shandong Section of the Yellow River

Wang Zhenzhen, ***Chen Dongling***, ***Li Lantao*** and ***Sun Shilei***

Hydrology Bureau, YRCC, Zhengzhou, Henan, 450004

Abstract: This article evaluates and analyzes current water environment status and water pollution trend of Shandong section of the Yellow River with single – factor evaluation method, basing on the study on water environment status of some representative water quality monitoring cross – sections in the recent years, thus it gives the conclusion that the main factors influencing the water environmental quality of Shandong section are pollutants from upper reaches as well as organic pollutants from Shandong section itself, and finally it provides some measures for pollution prevention and control.

Key words: Shandong section of the Yellow River, water environment quality status, sing – factor evaluation method, water pollution trend, measures for pollution prevention and control

The Yellow River flows into Shangdong Province from Dongming County, flowing through 25 Counties which belong to 9 Cities, Heze, Jining, Taian, Liaocheng, Dezhou, Jinan, Zibo and Dongying, and finally enters the Bohai sea from Kenli County, with the length of 628 km and discharge area of 18, 300 km^2. The Yellow River is the only water resource passing through Shangdong Province. For Shangdong Province, on average it transfers 8,000,000,000 m^3 of water from the Yellow River every year, so the Yellow River is the main resource of social and economic development for Shangdong. In recent years, with economic development of regions along the Yellow River and population increasing in rural and urban of Shangdong Province, more and more industrial waste water and domestic sewage water discharge into the Yellow River, making water polluted severely in Shangdong section. Since the "Tenth Five Year Plan", the situation of water quality in Shandong section improves increasingly, owing to the conjunctive application of reservoirs in upper and middle streams of the Yellow River as well as the strengthening of water pollution control and management along the Yellow River.

In this paper, it selects 4 representative water quality monitoring cross – sections to develop evaluation and analysis, i. e. Gaocun – the water quality controlling cross – section of the Yellow River flowing into Shandong Province, Aishan – the water quality controlling cross – section of Dongpinghu Lake flowing into the Yellow River, Luokou – the water quality controlling cross – section for Jinan suburbs, and Lijin – the water quality controlling cross – section of the Yellow River entering into the Bohai sea, using the continuous water quality monitoring data series of 2000 ~ 2005.

1 Comprehensive evaluation and analysis on water quality

1.1 Evaluation items, standard and method

According to the available monitoring water quality data, we select pH, DO, permanganate indicator, COD_{Cr}, BOD_5, NH_3 – N, volatilizes phenol, cyanide, general arsenics, six – valence chromium, mercury, copper, zincs, lead, cadmiums and fluoride, 16 items in total as the water quality evaluation indicators. Generally, in the flood season, both water and sediment are abundant in the Yellow River and water temperature is relatively higher, so pollutant in water is easy to be degraded and assimilated; while in the non – flood season, it is prone to be polluted by sewage water producing from rural and urban with less water and sediment. Further more, the low – flow season of the Yellow River just meets the irrigation time, so plenty water is diverted to the irrigation area along with a lot of water returning from irrigation area. In this regard, we divide the whole year into three periods to develop the evaluation on water quality in Shandong section of the Yellow River, i. e. high – flow season, normal – flow season and low – flow season, which is better to present the water quality variation in a year.

Here, the single – factor water quality evaluation method is utilized to identify the water quality class of all water quality monitoring cross – sections, according to "Environment Quality Standard for Surface Water" (GB 3838—2002).

1.2 Evaluation results

The water quality evaluation results for Shandong section are displayed in Table 1. From Table 1, it is found that almost all the cross – sections water quality belong to class III to V during the period of 2000 to 2001, for Gaocun cross – section, the maximum times of ultra standard of NH_3 – N and COD_{Cr} are 0.5 and 0.9 respectively; for Aishan cross – section, the maximum times of ultra standard of NH_3 – N and COD_{Cr} are 0.45 and 0.97 respectively; for Luokou cross – section, the maximum times of ultra standard of NH_3 – N and COD_{Cr} reach to 1.05 and 1.09 respectively; and for Lijin cross – section, the maximum times of ultra standard of NH_3 – N and COD_{Cr} are 0.53 and 0.77 respectively. In 2002, the water quality in Shandong section deteriorates further for severe pollution, all the 4 cross – sections water quality degrades to class V or poor V. For Gaocun cross – section, the maximum times of ultra standard of NH_3 – N and COD_{Cr} increase to 0.56 and 1.66 respectively; for Aishan cross – section, the maximum times of ultra standard of NH_3 – N and COD_{Cr} increase to 0.5 and 2.08 respectively; for Luokou cross – section, the maximum times of ultra standard of NH_3 – N and COD_{Cr} are both 0.88; and for Lijin cross – section, the maximum times of ultra standard of NH_3 – N and COD_{Cr} increase to 1.37 and 0.88 respectively. This because in 2002, the precipitation is less than the normal year in the Yellow River basin, and it has appeared the most serious less runoff of the recent 20 years both in the main stream of the Yellow River and its branches, the total runoff during the period of July to October is above 50% less than the normal. However, since floods in the autumn of 2003, the water in the Yellow River becomes abundant and the water quality in Shandong section has improved to class III to IV with the water quality meeting to class III in high – flow and normal – flow seasons.

Table 1 The water quality evaluation results for Shandong section of the Yellow River in the period of 2000 ~ 2005

Years	Gaocun				Aishan				Luokou				Lijin			
	Annual average	High – flow season	Normal season	Low flow season	Annual average	High – flow season	Normal season	Low flow season	Annual average	High – flow season	Normal season	Low flow season	Annual average	High – flow season	Normal season	Low flow season
2000	Ⅳ	Ⅳ	Ⅳ	Ⅴ	Ⅳ	Ⅴ	Ⅳ	Ⅳ	Ⅳ	Ⅲ	Ⅳ	Ⅳ	Ⅳ	Ⅳ	Ⅳ	Ⅳ
2001	Ⅳ	Ⅴ	Ⅳ	Ⅳ	Ⅲ	Ⅲ	Ⅱ	Ⅳ	Ⅲ	Ⅲ	Ⅱ	Ⅱ	Ⅴ	Ⅴ	Ⅳ	Ⅴ
2002	Poor Ⅴ	Poor Ⅴ	Ⅴ	Ⅴ	Poor Ⅴ	Poor Ⅴ	Ⅴ	Poor Ⅴ	Ⅴ	Ⅳ	Ⅳ	Ⅳ	Ⅴ	Ⅳ	Ⅴ	Ⅴ
2003	Ⅳ	Ⅳ	Ⅲ	Ⅴ	Ⅳ	Ⅳ	Ⅲ	Ⅴ	Ⅳ	Ⅲ	Ⅱ	Ⅳ	Ⅳ	Ⅱ	Ⅱ	Ⅴ
2004	Ⅲ	Ⅲ	Ⅲ	Ⅲ	Ⅲ	Ⅲ	Ⅲ	Ⅲ	Ⅱ	Ⅱ	Ⅱ	Ⅲ	Ⅲ	Ⅲ	Ⅲ	Ⅲ
2005	Ⅲ	Ⅲ	Ⅱ	Ⅳ	Ⅲ	Ⅲ	Ⅱ	Ⅲ	Ⅲ	Ⅲ	Ⅱ	Ⅲ	Ⅲ	Ⅲ	Ⅲ	Ⅲ

According to the evaluation results, it indicates that NH_3 – N, COD_{Cr}, COD_{Mn} and BOD_5 are the main pollutants that influence the water quality in Shandong section of the Yellow River.

2 Analysis on water pollution trend

2.1 Analysis on the variation trend of ultra standard rates of 5 factors

Two water quality monitoring cross – sections, Gaocun and Aishan are chosen to analyze the variation trend of ultra standard factors in Shandong section. From Table 2 and 3, it is found that the ultra standard rates of COD_{Cr} and NH_3-N are larger than that of the other three factors during the past 6 years, which proves that COD_{Cr} and NH_3-N are the significant ultra standard factors owing to the large scale and amount of non-point pollution sources, such as the organic fertilizer, chemical fertilizer and pesticide from farms along the Yellow River, as well as the industrial waste water and domestic sewage from cities.

Further more, it could be seen from Tables 2 and 3 that the ultra standard rates of COD_{Cr} and NH_3-N fluctuate grater than that of the other three factors. For Gaocun cross-section, the minimum ultra standard rates of COD_{Cr} and NH_3-N in 2004 are reduced by 91.7% and 83.4% respectively, compared with that of the maximum in 2000. While for Lijin cross-section, the minimum ultra standard rates of COD_{Cr} in 2004 is reduced by 100% compared with the maximum in 2000; and the minimum ultra standard rates of NH_3-N in 2004 is also reduced by 100% compared with the maximum in 2001.

Table 2 The ultra standard rates of five indicators excess to class III for Gaocun cross-section

Years	DO		COD_{Cr}		BOD_5		NH_3-N		COD_{Mn}	
	Appear times	Ultra standard rate (%)	Appear times	Ultra standard rate (%)	Appear times	Ultra standard rate (%)	Appear times	Ultra standard rate (%)	Appear times	Ultra standard rate (%)
2000			12	100.0	5	41.7	6	50.0		
2001			6	50.0	5	41.7	4	33.3		
2002	2	16.7	11	91.7	5	41.7	3	25.0	2	16.7
2003	2	16.7	6	50.0	5	41.7	4	33.3	3	25.0
2004	1	8.3	1	8.3	2	16.7	1	8.3		
2005	1	8.3	3	25.0			4	33.3		

Table 3 The ultra standard rates of five indicators excess to class III for Lijin cross-section

Years	DO		COD_{Cr}		BOD_5		NH_3-N		COD_{Mn}	
	Appear times	Ultra standard rate (%)	Appear times	Ultra standard rate (%)	Appear times	Ultra standard rate (%)	Appear times	Ultra standard rate (%)	Appear times	Ultra standard rate (%)
2000			11	91.7	3	25.0	2	16.7		
2001			6	50.0	3	25.0	3	25.0		
2002	1	8.3	3	25.0	5	41.7	3	25.0	1	8.3
2003	1	8.3	4	33.3	2	16.7	3	25.0	1	8.3
2004										
2005	1	8.3	3	25.0			1	8.3		

2.2 Analysis on the variation trend of the main pollution factors

Fig. 1 presents the monthly mean variation trend of COD_{Cr} and NH_3-N in Shandong section of the Yellow River during the period of 2000 to 2005. According to Fig. 1, the variation trends of the 2 factors are approximately consistent. It indicates that various pollutants discharge into the river channel nearly in the same time, resulting in the enhancement of oxygen consuming material, which is the main cause of pollution of water quality. From Fig. 1, the monthly mean COD_{Cr} and NH_3-N are reducing since the beginning of 2004 after appearing the extreme in 2002 and 2003, and the variation becomes very small after 2003.

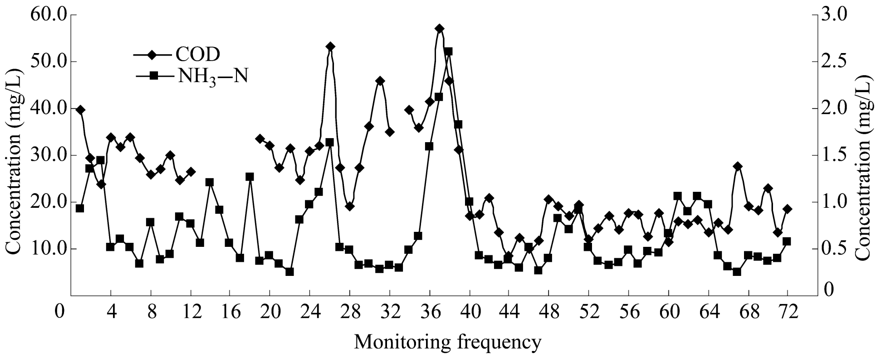

Fig. 1 Variation trend of COD_{Cr} and NH_3-N

3 Analysis on the waste load allocation /reducing amount

The water quality monitoring cross - sections in Shandong section of the Yellow River are beginning from Gaocun and ending in Lijin, take COD_{Cr} and NH_3-N as the evaluation indicators to compute the waste load allocation /reducing amount of Gaocun and Lijing two representative cross - sections utilizing the combined method of water quantity and quality. The computation results are displayed in Table 4.

Table 4 The waste load allocation /reducing amount of COD and NH_3-N

Years	Gaocun				Lijin			
	COD (10,000 t)		NH_3-N (10,000 t)		COD (10,000 t)		NH_3-N (10,000 t)	
	waste load allocation	reducing amount	waste load allocation	reducing amount	waste load allocation	reducing amount	waste load allocation	reducing amount
2000		11.98	0.09			3.1	0.17	
2001		8.53	0.27			5.22	0.17	
2002		25.54	0.48			4.37	0.14	
2003		5.88	0.14			1.17	0.59	
2004	7.39		0.79		7.65		1.14	
2005	8.08		0.87		5.79		1.04	

According to Table 4, it indicates that the water environment quality of Shandong section is mainly determined by the water quality of upper reaches, the waste load allocation reducing amount of Lijin cross - section changes according to the water quality of Gaocun cross - section. Because of poor self – purification capacity, it remains to exceed the standard at the lower cross – section for the item that highly exceeding the standard at the upper cross – section; while for the slightly exceeding the standard item, it will meet the standard at the lower cross – section through a length of self – purification.

4 Influences of annual runoff on water quality of Shandong section

Lijin cross – section is the last water quality controlling cross – section of the Yellow River discharging into the Bohai sea, and there are no large pollution sources around it, so its water quality is bound to mainly influenced by the water quality of upper reaches. The relationships of annual runoff and annual mean COD_{Cr}, and annual runoff and annual mean NH_3 – N for Lijin cross – section are displayed in Fig. 2 and Fig. 3 respectively.

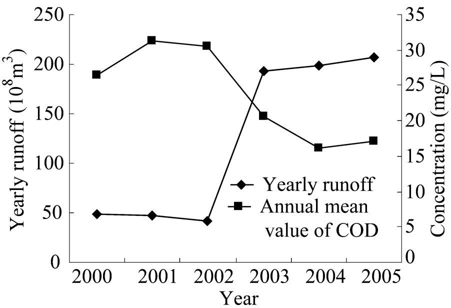

Fig. 2 The relationship of annual runoff and annual mean COD for Lijin cross – section

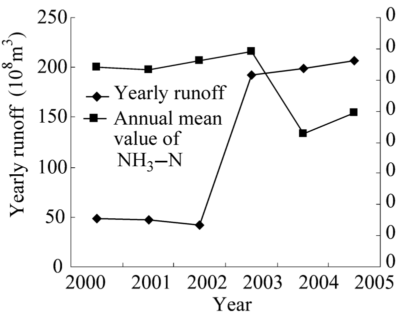

Fig. 3 The relationship of annual runoff and annual mean NH_3 – N for Lijin cross – section

It shows that the content of pollutants in the water reduces with the increasing of the annual runoff. During the period of 2000 ~ 2003, the content of pollutants is keeping a higher level, and it reduces in 2004 and 2005 with a stable level.

5 Conclusions

The situation of water quality in Shandong section of the Yellow River turns to better to some extent, however, the organic pollution is still very severe. In the period of 2000 ~ 2003, the water quality in Shandong section of the Yellow River is terribly polluted. Owing to the increase of water amount and the application of optimal dispatching of reservoirs, the water quality turns to better to some extent since the floods in autumn 2003, and basically the water quality in Shandong section could meet the water quality demand of class III. Water pollution in Shandong section is mainly caused by organic pollution, it is very prominent for NH_3 – N and COD_{Cr} pollution. And the organic pollution is mainly aroused by industry waste water, agriculture sewage and the municipal sewage.

This arcticle proposes to enhance the control and management to the industrial pollution sources along the lower Yellow River, such as printworks, chemical plants and paper mills etc. along the Yellow River, chastise the phenomenon of stopping waste water treatment without any reason, exceeding standard discharging of waste water or discharging waste water, etc., and control seriously the discharging of industrial waste water without any disposal; enhance the investigation and estimation on the agriculture pollution, study on the mechanism of pollution and forecast the trend of pollution. Intensify the control on the rural domestic sewage, return water from irrigation areas and dejections of beasts and birds. Further more, it suggests build the agricultural bases to produce the innocuous and green products, so as to decrease the usage of chemical fertilizer and pesticide; in the same time speed up of the construction of sewage treatment projects corresponding to the cities sewage discharge events.

Locating in the lowest reach of the Yellow River, the water quality of Shandong section is mainly influenced by two factors. On one hand, it is influenced by the water quality of upper reaches; on the other hand it is influenced by the pollutant from Shandong section itself. Basing on the analysis, it indicates that pollutant from upper reaches is the focal factor causing water quality degradation in Shandong section. So it proposes to enhance the control and management of water pollution of upper reaches, so as to improve the situation of water quality of Shandong section.

Further more, the water quality in Shandong section is highly influenced by water amount. It could be an effective way to improve the water quality situation in Shandong section by reasonable management on reservoirs in upper and middle streams with optimal water dispatching, to enhance the regulation and storage capacity of river channel.

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Research on Forecasting Operational Status of Flood Control Works by Safety Monitoring Facilities in the Yellow River

Lv Junqi, ***Meng Bing***, ***Su Qiupeng*** and ***Zhang Wei***

Henan Yellow River Bureau, Zhengzhou, 450003, China

Abstract: Currently, application of manpower in most of safety monitoring on the engineering works of the Yellow River can not satisfy the needs in their operation and management under the new situation. According to the requirement of the comprehensive plan for the "Digital Yellow River", the Yellow River engineering management units should establish a safety monitoring system for flood control works so as to timely and accurately know the real – time operational status of the flood control works, to forecast dangerous situation and safety parameters of the works, to make real – time online analysis and to provide decision – making support to flood control and integrated regulation of water resources. Flood prevention engineering management in future should be executed in automation, informatization and high efficiency.

Key words: safety examination, the Yellow River dike safety, monitoring and forecast, solutions

1 The main problems

1.1 Low level of scientific management

Currently, the management means and techniques adopted by the engineering management offices of the Yellow River, especially those below the regional or municipal levels, are at quite low level. Such information as engineering statistical data, engineering census, and river regime inspection and construction management are mostly collected and transmitted by man, which not only yields low efficiency and poor time effectiveness, but also is easy to make mistakes and lose data. The historical data available can not be made reference to fast and accurately check. Collections of important decision – making support information, for example, dike hidden defects, deformation due to displacement, root stone loss of river training works, engineering and dangerous situations, settlement of culverts and gates and seepage, are acquired by primitive engineering survey, people's observation or detection. The maintenance for works is judged by the past experiences and carried out by manpower, all of which restrict the improvement of engineering management.

1.2 Mostly damaged safety monitoring facilities

Safety monitoring like a telescope or loud speaker is of very importance in engineering management. Since the people has participated in managing the Yellow River, at the time of constructing the flood control works, some safety monitoring apparatus were installed. However, with the passage of time, most of them were damaged due to extended service, aging, inadequate maintenance. Besides, inconsistent standard for the monitoring facilities installed made it difficult to realize connection with the Engineering Management Center of YRCC. At the same time, along with scientific and technical development, the existing monitoring facilities seem to fall behind so that the demand of modernizing the engineering management can not be met.

1.3 Poor embankment foundation

The embankment of Yellow River was built on the basis of earth dam. There are many hidden trouble, such as complex embankment foundation, excessive entrance, and because the soil below 7 ~ 8 m over the toe surface is sandy soil, the hidden trouble such as seepage deformation, liquefaction and uneven settlement is easy to happen, and heightening and thickening and reinforcement for the dam still unsolved the problem. In recent years, most of the new built vulnerable spot and control project have not been tested by the flood, and it's at risk when water flow collides with the dam because of shallow foundation and inadequate foundation stones. All of these are the disadvantage factors that threaten the hydrological safety of dam. In this case, it should enhance the input of reinforcement project and strengthen the maintenance. But simultaneously, these measures will impose a heavy burden on the management.

2 Status of the research on safety monitoring

There are more than 80 thousand existing dams in China, and the length of embankments (higher than 5 m) is more than 250 thousand km. In order to monitor the operation of the dams and embankments and collect magnanimity data, many monitoring instruments have been installed in the projects. With the development of modern electronic technology, computer and communication technique, and with the development and perfection of monitoring technology, sound monitoring system have been installed in the earth – rock dam engineering, slope engineering and embankment at home and abroad. In Europe, embankments that exceed 500 km have installed sound monitoring system. In the reinforced embankments of Yangtze River, Ministry of Water Resources and Yangtze River committee request that there must be design of monitoring and list the special expenses based on the Technical Specification for Dam Safety Monitoring, which should not be less than one to three percent of the whole project budget, otherwise should not be approved. Now the planning and design of Yangtze River embankments' safety monitoring is being underway. At the same time, system study was done in the special experimental base which is established on zhanjiaji embankment by Yangtze River committee.

(1) Improvement of the long – term stability and reliability. The monitoring instruments and equipment should be long – term steady, because the instruments and equipment that are often embedded in bad condition are disposable. The practice shows that the monitoring instruments produced by some leading radar manufacturers are characterized with long – term stability. For instance, osmometer produced by Maihak Company in Germany can work for more than 60 years. The instruments and equipment produced by Hugeng Fortress in Switzerland were installed in Sanmenxia dam since 1958 and up to now most of them can also be used. At home the long – term stability is poor because there is a big gap in the materials and techniques between home and abroad.

(2) Development towards wide range and high precision. The displacement accuracy of SiFu acceleration – inclinometer produced by Sinco Company of America achieves 0.01 mm/500 mm of the precision. The minimum resolution of osmometer produced by Geokon Company of America achieve 0.02 mmH_2O, and it's accuracy exceed 1.5 ~ 2.0 m.

(3) Development towards continuous distributed instrument. Most of the traditional monitoring instruments are point – type which is one – point and one – wire. So it needs many cables. At abroad, distributed optical fiber sensors are used which integrated with induction and transmission. Dozens or hundreds of continuous distributed parameters such as stress, strain, deformation, temperature and seepage can be obtained form a piece of optical fiber as long as several kilometers to a few 10 – kilometer.

(4) Video technology is being used to safety monitoring of dams. With the development of computer and wide band communication technology, multimedia video technique was used to the safety monitoring of dams in Canada in the Middle of 1990s. This measure complements the

deficiency of monitoring instruments and partially replaces artificial perambulation inspection, which is beneficial for the realization of remote observation to the safety operation of the dams.

3 Selection of monitoring type

Now the safety monitoring information of Yellow River flood control project is mostly collected by manpower. Due to the impact of complex environment, the sensor installed in project worksite and automatically collecting information is still difficult to apply. Because of the rigorous request of precision and long – term stability to monitoring instruments and equipment, there also have been many key technologies to be developed. Furthermore, the current monitoring sensor is basically point – type and can only get the tested parameters at some spot. While the continuous distributed instruments need to be studied further. All of the above will bring difficulties to the autoimmunization of the safety monitoring system of Yellow River flood control.

3.1 The safety monitoring information of embankment project

The information which should be collected is as following:

(1) Seepage Information, including influent in the body and foundation of embankment and seepage discharge. Continuous distributed monitoring instrument is priority to be considered.

(2) Information of adjacent river water level.

(3) Deformation information in the body and foundation of embankment, including: vertical deformation (cave in and sink ground subsidence), horizontal deformation (dike sliding, including sliding along soft interlayer). If cracking, there should be crack monitoring information.

(4) Information of the hidden danger (caves, cracks and loose interlayer).

(5) Information of the impact of buildings in dam to the embankment body.

(6) Visual information of the surface of key embankments.

3.2 Safety monitoring information of river realignment project

River Channel Realignments are dominated by Yellow River Conservancy Commission, including the vulnerable spot and Control Projects. The information requested is as following:

(1) Information of the looseness and deformation of root rock.

(2) Information of the dam deformation (including wrapped protection section and non – wrapped protection section).

(3) Information of the water level, velocity and flow direction in the front of dam.

(4) Visual information of the surface of dam (including the dynamic of reserved bricks and stones).

3.3 Safety monitoring information of water sluice project

The water sluices in the lower Yellow River consist of water intake sluice gates and flood distribution sluice gates, and the safety monitoring information are as following:

(1) Seepage information of the joint of sluice and embankment.

(2) Deformation information of the joint of sluice and embankment.

(3) Water level information of the upstream and the downstream.

(4) Information of the uplift pressure at the sluice foundation.

(5) Deformation information of sluice body (vertical and horizontal deformation).

(6) Crack information of sluice body.

(7) Visual information of the key parts.

(8) Other general safety information during the flood period, such as the impact of large floating debris.

3.4 Safety monitoring information of key hydraulic project system

The information of key hydraulic project system is as following:

(1)Deformation information in the body and foundation of dam, including: vertical deformation and horizontal deformation.

(2)Seepage information of the body and foundation, including the monitoring to: flow through a dam body, uplift pressure, seepage around dam and seepage discharge.

(3)Stress and strain information of the body and foundation.

(4)Water level information of the reservoir and downstream.

(5)Information of the environment parameters.

(6)Scouring and sedimentation information in the reservoir and downstream.

(7)Reflection information of vibration.

(8)Information of the hydraulics.

(9)Information of the unit operation.

3.5 Other information of the project management

Other information of the management includes: the safety installation of beach area and flood detention basin, river regime, flood control roads and so on.

4 The selection of monitoring scheme

The key of monitoring is to give a correct assessment and analysis to the overall operation condition in time and to display and export safety monitoring data, model calculation results. According to the actual situation of the project distribution, the overall framework structure of safety monitoring system should be divided into five levels: the project management center of Yellow River Conservancy Commission, province – level Yellow River Project Management Center, city – level Project Management Sub – Center and County – level management station.

The key of monitoring is to give a correct assessment and analysis in time according to the overall operation condition of the project, and to display and output safety monitoring data, model calculation results of the project. According to the actual situation of the Yellow River projects' distrbution, the overall framework structure of safety monitoring system should be divided into five levels by management – level: the project management center of Yellow River Conservancy Commission, province – level Yellow River Project Management Center, city – level Project Management Center and County – level management station.

4.1 System functions

4.1.1 The functions of County – level project management department in Yellow River

County – level project management department in Yellow River mainly is responsible for operation and management of the regulated River flood control project monitoring system.

Its main function is the collection of data, that is using data acquisition software to acquire the data information of the region sensor, including timing, real – time and random sampling, to input the semi – automatic or manual data information, including artificial field inspection information, geophysical exploration, measurement information, to check and verify the collected data information, to save and process data preliminarily, to act as an early warning and alarm effect, that is when the real – time data monitoring and control beyond the rate of change indicator or other abnormality, it will issue different levels of the early warning alarm signal, to inquiries and display the project management information, to transfer the project management information, to give a simple assessment of the project safety, to generate a simple program of the engineering and maintenance.

4.1.2 The functions of Province – level Project Management Center

Province – level and city – level project management of the Yellow River Project Center are mainly responsible for the summarizing, proofreading and inputting of data information of county bureau of associated engineering centers in the Yellow River. Its main function is as following: data processing and storage which is to establish historical, real – time database, storing data associated section of the information to provide a basis for flood control projects evaluation of the security situation, distributed database management and maintenance to ensure the safe operation of the database, Inquiries and displays the project management information. Advanced technology, such as 3S, should be used to Project management information which is respectively displayed by audio, text, chart and three dimensional cartoon and Virtual – reality Technology, and could get the command information which is from the county area and the higher area . Simultaneously, it could achieve the function that communicates with the provincial center for voice, data, real – time two – way information exchange, Early warning and alarm function. When the real – time data monitoring and control beyond the rate of change indicator or other abnormality, it will issue different levels of the early warning alarm signal. Give a general assessment of the project safety. According to the forecasting model and the security evaluation standards that is provided by the Superior project management center , it could give an assessment and make a prediction to the project safety conditions and offer an decision – making for flood control, engineering flaws and maintenance; Formulate an assessment report of the project safety condition for flood control in a certain period.

4.1.3 The functions of the Yellow River project management center of Yellow River Conservancy Commission

Project Management center in the Yellow River Basin as a central project management department, is responsible for basin – wide project management. It is connected closely with data collection, management, and analysis, safety assessment, forecasting, reinforcement and decision – making. It is a center of the Yellow River's information collection, security assessment, reinforcement, maintenance and conservation policy objective. Its main function is as following : Collect various data and information of flood control projects in order to provide a basis for its evaluation of the security situation and forecasting, Establish a large data bank of information, including databases, graphics library, image database, to conduct a comprehensive data management and analysis, establish all sorts of project management models, as well as to give the lower level a model calibration and verification, Inquiries and displays the project management information. Advanced technology, such as 3S, should be used to Project management information which is respectively displayed by audio, text, chart and three dimensional cartoon and Virtual – reality Technology, and could get the command information which is from the county area and the higher area. Meanwhile, it could achieve the function that communicates with the lower level center for voice, data, real – time two – way information exchange functions, take flood control project safety risk analysis, give alarm raised security levels indicators, carry out project – level security assessments, or release security assessment report for flood control project based on demand.

4.2 Information transmission

The management system of Yellow River flood project consists of four levels, Yellow River committee level, province – level, city – level and county – level. The transmission of data mainly operates within the four levels or between the levels and the worksite. The construction place of Yellow River flood project is uncertain before the programming, and the construction phase of project is relatively short. The wireless network transmission is needed to meet data transmission of worksite request. The transmission data includes digits, static pictures, dynamic images and video.

Microwave communication is introduced considering of the existing technical situation.

The safety monitoring information and management information collected by manpower is directly inputted and transmitted, because the input points is in the management station of county – level. The video information of worksite can be transformed into texts and inputted into database by wireless way. The safety monitoring information collected by sensor is inputted into digital – analog converters by wired way, and then the data is transmitted to merged points nearly and finally joined in the main network.

5 Effect analysis and prospect

5.1 Effect analysis

The application of the safety monitoring system brings revolutionary changes to the conception and management measures, and modernizes the management of Yellow River's project. The modern collection, transmission and disposal of the information not only enhance the timely effectiveness but also improve treatment capacity, that save time to project construction and management and offer a lot of information for project management, safety evaluation, operation and maintenance.

(1) Development and utilization of information technology is a rapid progress in management. The traditional management pattern is broken. The acceptation, processing, decision – making and feedback of information is the only daily work needed. And the work efficiency will be greatly improved.

(2) The social benefit brought by the modern project management is huge. The safety of Yellow River will be improved.

(3) The development of social economy in Yellow River basin will be promoted greatly under the construction of the safety monitoring system. The people who worked in management department in the past will have enough time to develop related enterprise, for instance the development of the field silted in the back bank, the plantation of the trees.

5.2 Prospect

The society in the future will be the society of informationization. The project construction and management of Yellow River will be digital management with the development of society. By 2010, the application systems of projects management in the "digital Yellow River" will have been built up gradually based on the modern information technology, which includes construction management, operation management, safety monitoring, safety evaluation and maintenance, realized the transformation of traditional pattern to modern pattern . With the development of the system, the science and technology contents of project construction and management will be improved. Quality management of project construction adopted advanced monitoring system assures quality of the construction during the project implementation period. The construction of mobile laboratory and monitoring station makes monitoring more convenient and quick under the unpredictable conditions, and offers effective information service for project construction. The automatic monitoring, detection and measurement will be realized in water sluice project. The automation of key projects, modern management and the work efficiency will be improved greatly. The work intensity of the managers will be lowered. Manager will master the situation of project operation any time by network information.

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Effect of Water and Sediment Regulation with Xiaolangdi Reservoir on Yellow River Delta

Ren Ruxin[1], ***Yang Jun***[1], ***Zhang Zhichao***[1] and ***Du Juan***[2]

1. YRCC, Shandong Bureau Jinan, 250011
2. Information Center YRCC Shandong Bureau, Jinan, 250011

Abstract: After 5 times of water and sediment regulations, the Yellow River reaches in Shandong povince generally was scoured, but every section has different erosion intensity, and the erode result at the Lijin is the weakest. This article compares the eroding situation of the section below Lijin with other sections, analyzes how to enlarge the flood carrying capacity in the reach below Lijin, and gives proposal on how to steady the reaches near the river mouth.
Key words: the original source of water and sand, flushing of sand and silt in the river channel, Analysis, the Yellow River estuary

1 The basic information of the Yellow River estuary

The Yellow River is difficult to control, the most is in the estuary. The Yellow River in the delta swung naturally in history, paving the sand proportionally, governed by doing nothing that goes against nature. Since 1855, the Yellow River changed river course into the Daqing river in Tongwaxiang burst until Chinese liberation, the Yellow River regard Ninghai as the summit pinnacle, starting from the river outlet of Taoer river, reaching Zimaigou in the south, with a fan – shaped region of 6,000 km^2, the end reach swung more than 10 times, and average 10 years there was a course change. In the early days of the P. R. C was formed, the aim of administration in estuary is flood prevention and protecting safe, as it extend to deposit with estuary, the administration measure relies mainly on building the dyke and constructing a dam, complement it by changing its course artificially, has changed the situation that the end reach of river estuary is swung naturally. In July of 1953, the rever rectification of channel in Shenxiangou; in January of 1964, the rever rectification of channel in Diaokouhe; in May of 1976, the rever rectification of channel in Qingshuigou. Before the flood in 1996, located in Qing8 section and the above 950 meters of channel way of Qingshuigou, the project that diversioned the river artificially to utilize the Yellow River silt and make the land to explore oil, have adjusted the estuary, the flows shorten 9km. At present, the length of river is about 58 km under Xihekou, 2 km protracted than the end of the flood 1996.

The reach between Yuwa and mouth to sea is estuary, the length between the top of embankment is 5.4 ~ 11.5 km, the wide of main channel is 0.7 ~ 5.3 km. It lies in modern fan – shaped delta, depositting, extending, swinging constantly, so the way to the ocean current is unstably. In recent years, the reach above Shibalihu project bulided a lot of projects, so the river tendency controls better; the other reach has a polarity result, because there are less projects, the river tendency changes greater, especially one branch appears on the left bank under 3 sections of branch, divide and flow into the sea.

2 The inflow discharge and sediment to Yellow River Estary after water and sediment regulation with Xiaolangdi Reservoir

The reservoir of Xiao Langdi adjusted water and sediment for the first time in July of 2002, Xiao Langdi began to leave and let out since 8 o'clock of July 4, finish in 8 o'clock of July 18, it last 14 days. The water level droped form 236.54 m to 222.01 m, the storage constant reduces 1,810 million m^3. The peak rate of flood discharge of the Lijin station was 2,500 m^3/s, the total storage volume is 2,320 million m^3, the total amount of sand is 50,400,000 t, the average sediment concentration is 21.7 kg/m^3, the biggest sediment concentration is 30.2 kg/m^3. The water amount was 4,190 million m^3 in the whole year of Lijin station in 2002, the sand amount was 54,300,000 t, among them the water amount was 2,950 million m^3 in flood season and the sand amount is 52,400,000 t.

The Yellow River Basin had more rainfall in 2003, JingWei river, YiLuo river, Qin river had big flood. From August to November, the reservoir of Xiao Langdi work together with the reservoir of Luhun, Guxian, Sanmenxia to control flood for a long time. These measure lowered the flood peak, lightened the stress of prevention flood of the lower Yellow River, avoided large – scale floodplain, reduced losses of the people of beach district to the maximum extent. In the time of controling flood, the supreme water level of Xiao Langdi is 265.58 m (14 o'clock of October 15), corresponding storage volume was 9,520 million m^3, the most downtip flux was 2,540m^3/s, 10,600 million m^3 of amount of water to be discharged altogether, sand amount was 120 million t. The downstream flood course of the Yellow River is as long as 83 days, the peak rate of flood discharge of the Lijin station is 2,890 m^3/s, the total amount of the flood is 14,970 million m^3, the total amount of sand is 333 million t, the average silt content was 22.24 kg/m^3, the biggest silt content was 85.4 kg/m^3. The water yield was 19,300 million m^3 in the whole year of Lijin station in 2003, the sand amount was 370 million t, among them the water yield was 12,300 million m^3 in flood, the sand amount was 293 million t.

The reservoir of Xiao Langdi adjusted water and sand on 9 o'clock of June 19 in 2004, ended on July 18, it last 29 days. The water level of Xiao Langdi droped from 249.06 m to 225.00 m, droped 24.06 m, the storage constant reduced 3,300 million m^3, the most downtip flux was 2,940 m^3/s. The peak rate of flood discharge of the Lijin station was 2,950 m^3/s, the total amount of the flood was 4,725 million m^3, the total amount of sand is 70,700,000 t, the average silt content was 15.0 kg/m^3, the biggest silt content was 23.8 kg/m^3. The water amount was 19,900 million m^3 in the whole year of Lijin station in 2004, the sand amount was 258 million t, among them the water amount was 10,800 million m^3 in flood season, the sand amount was 198 million t.

The reservoir of Xiao Langdi adjusted water and sand on June 9 in 2005, ended on July 6, it last 28 days altogether. The water level of Xiao Langdi droped from 252.17 m to 224.81 m, the storage constant reduced 3,940 million m^3, the most downtip flux was 3,996 m^3/s. The peak rate of flood discharge of the Lijin station was 2,950m^3/s, the total amount of the flood was 4,183 million m^3, the total amount of sand is 59,900,000 t, the average silt content was 14.3 kg/m^3, the biggest silt content was 24.6 kg/m^3. The water amount was 20,700 million m^3 in the whole year of Lijin station, the sand amount was 191 million t, among them the water amount was 11,300 million m^3 in flood season, the sand amount was 125 million t.

The reservoir of Xiao Langdi adjusted water and sand on 10 o'clock of June 10 in 2006, ended on 8 o'clock of July 3, it last 23 days altogether. The water level droped from 254.05 m to 224.51 m, the storage constant reduced 4,271 million m^3, the most downtip flux was 4,200 m^3/s. The peak rate of flood discharge of the Lijin station was 3,750 m^3/s, the total amount of the flood was 4,880 million m^3 the total amount of sand is 68,000,000 t, the average silt content was 13.9 kg/m^3, the biggest silt content was 22.5 kg/m^3.

3 The scour and silting on reaches of the estuary

3.1 The scour and silting in main channel

According to the data of pre – freshet period of 2002 ~ 2006, the scour and silting happened in the main channel this period, the reach between Gaocun and Cha2 brushed deepen 0.51 m equally, brushed volume 254,430,000 m^3. Among them, the reach between Gaocun and Sunkou brushed deep 0.51 m, brushed volume 72,360,000 m^3; the reach between Sunkou and Aishan brushed deep 0.48 m, brushed volume 25,640,000 m^3; the reach between Aishan and Luokou brushed deep 0.76 m, brushed volume 50,210,000 m^3; the reach between Luokou and Lijin brushed deep 0.68 m, brushed volume 74,260,000 m^3; the reach between Lijin, and Cha2 brushed deep 0.28 m, brushed volume 31,580,000 m^3. (as shown in form 1 , form 2). In these reachs, only the reach between Qing7 and Cha2 filled up, silted volume was 8,200,000 m^3. The idiographic section as follows see Table 1, Table 2.

Tabel 1　The statistical form for the thickness of silt about the main trough of each reach in preflood 2002 ~ 2006　　Unit: m

Name of reach	Area of main channel (km^2)	2002.5 ~ 2002.10	2002.10 ~ 2003.5	2003.5 ~ 2003.11	2003.11 ~ 2004.5	2004.5 ~ 2004.10	2004.10 ~ 2005.5	2005.5 ~ 2005.10	2005.10 ~ 2006.4	2002.5 ~ 2006.4
Gaocum (four)—Sunkou	160.09	−0.11	−0.04	−0.11	0.01	−0.06	−0.07	−0.11	−0.02	−0.51
Sunkou—Aishan(2)	53.43	−0.05	0.00	−0.19	−0.03	−0.07	0.00	−0.23	0.08	−0.48
ISHAN—Luokou(3)	62.25	−0.12	0.03	−0.36	0.02	−0.2	−0.01	−0.28	0.16	−0.76
Luokou(3)—Lijin(3)	106.76	−0.13	0.06	−0.35	0.06	−0.2	0.04	−0.17	0.01	−0.68
Lijin(3)—Yihaoba	21.64	0.00	0.01	−0.38	0.02	−0.15	0.02	−0.14	0.04	−0.58
Yihaobq—CS_7	24.03	0.00	0.05	−0.25	−0.04	−0.01	0.01	0.00	0.01	−0.23
CS_7 ~ Qing7	65.82	−0.16	0.01	−0.10	0.08	−0.13	0.12	−0.35	0.22	−0.31
Qing7 ~ Cha2	18.61	−0.13	−0.01	0.01	−0.01	0.19	−0.02	−0.12	0.09	0.00
Lijin—Cha2	130.1	−0.09	0.02	−0.16	0.03	−0.05	0.05	−0.18	0.11	−0.28
Gaocun—Cha2	512.63	−0.105	0.01	−0.21	0.02	−0.10	0.00	−0.18	0.05	−0.51

Tabel 2　The statistical form for the volume of silt about the main trough of each reach in preflood 2002 ~ 2006　　Unit: 10,000 m^3

Name of reach	Space between (km)	2002.5 ~ 2003.5	2003.5 ~ 2004.5	2004.5 ~ 2005.5	2005.5 ~ 2006.4	2002.5 ~ 2006.4
Gaocun(4)—Sunkou	160.09	−2,400	−1,545	−1,571	−1,720	−7,236
Sunkou—Aishan(2)	53.43	−268	−1,160	−373	−763	−2,564
Aishon—Luokou(3)	62.25	−611	−2,157	−1,442	−811	−5,021
Luokou(3)—Lijin(3)	106.76	−815	−3,060	−1,690	−1,861	−7 426
Lijin(3)—Yihaoba	21.64	−65	−772	−221	−168	−1,226
Yihaobq—CS_7	24.03	129	−686	0	21	−536
CS_7—Qing7	65.82	−978	−185	53	−366	−1,476
Qing7—Cha2	18.61	−61	−13	187	−31	82
Gaoam(4)—Linjin(3)	382.53	−4,094	−7,922	−5,076	−5 155	−22,247
Linjin—Cha2	130.1	−975	−1,656	19	−544	−3,156
Sunkou—Aishan(2)	512.63	−5,069	−9,578	−5,057	−5,699	−25,403

May of 2002 ~ May of 2003, the main channel between Gaocun and Cha2 brushed volume 50,690,000 m^3. Among them, the main channel between Gaocun and Lijin brushed volume

40,940,000 m^3, accounting for 80.8%, it is about 107,000 m^3/km to erode the intensity, the main channel between Lijin and Cha2 brushed volume 9,750,000 m^3, it is about 75,000 m^3/km to erode the intensity. Only the reach between Yihaoba and CS_7 depositioned for 1,290,000 m^3.

May of 2003 ~ May of 2004, the main channel between Gaocun and Cha2 brushed volume 95,780,000 m^3. Among them, the main channel between Gaocun and Lijin brushed volume 79,220,000 m^3, accounting for 82.7%, it is about 207,000 m^3/km to erode the intensity; the main channel between Lijin and Cha2 brushed volume 16,560,000 m^3, it is about 127,000 m^3/km to erode the intensity. The reach between Yihaoba and CS7 brushed volume for 130,000 m^3.

May of 2004 ~ May of 2005, the main channel between Gaocun and Cha2 brushed volume 50,570,000 m^3. Among them, the main channel between Gaocun and Lijin brushed volume 50,760,000 m^3, it is about 133,000 m^3/km to erode the intensity, the main channel between Lijin and Cha2 depositioned 5,440,000 m^3. The reach between Lijin and Yihaoba brushed volume 2,210,000 m^3. The reach between Yihaoba and CS_7 depositioned volume 2,400,000 m^3.

May of 2005 ~ April of 2006, the main channel between Gaocun and Cha2 brushed volume 6,990,000 m^3. Among them, the main channel between Gaocun and Lijin brushed volume 51,550,000 m^3, accounting for 90.5%, it is about 135,000 m^3/km to erode the intensity; the main channel between Lijin and Cha2 brushed volume 5,440,000 m^3, it is about 41,800 m^3/km to erode the intensity. the main channel between Yihaoba and CS_7 depositioned volume 210,000 m^3.

We can know from the above analysis, since the reservoir of Xiao Langdi adjusted water and sand in 2002, the section of estuary presents the trend eroded overallly, but it is obvious weaker than the upper reaches. The section about the reach between Yuwa and Cha1 during 2002 to 2006 as follows Fig. 1 and Fig. 2:

3.2 The Compansion of the water level in same flux

According to the 3,000 m^3/s flow – rating curve of five hydrometric station in lower reaches of the Yellow River. The water level reduced 0.88 m compare with the end of 2002, the Gaocun hydrometric station among them reduced biggest this year, had reduce 1.26 m, the hydrometric station of Lijin reduced least, had reduce 0.64 m. Yihaoba and Xihekou station, lie backward position of Lijin station, water level of 3,000 m^3/s in falling tide had reduced 0.69 m and 0.48 m compare with the water level after flood period of 2002, and under the average among the five station. As shown in Table 3.

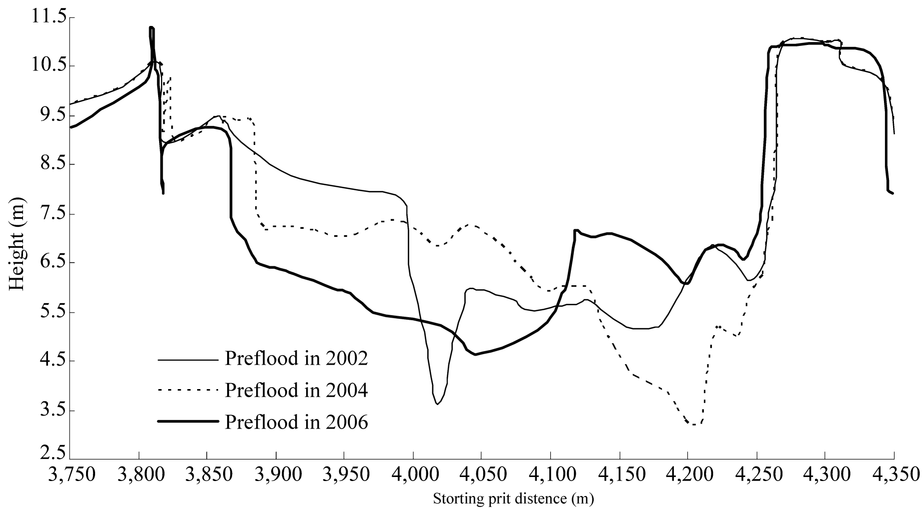

Fig. 1 Scour and silting of the main chaneel of Yuwa station in flood period between 2002 ~ 2006

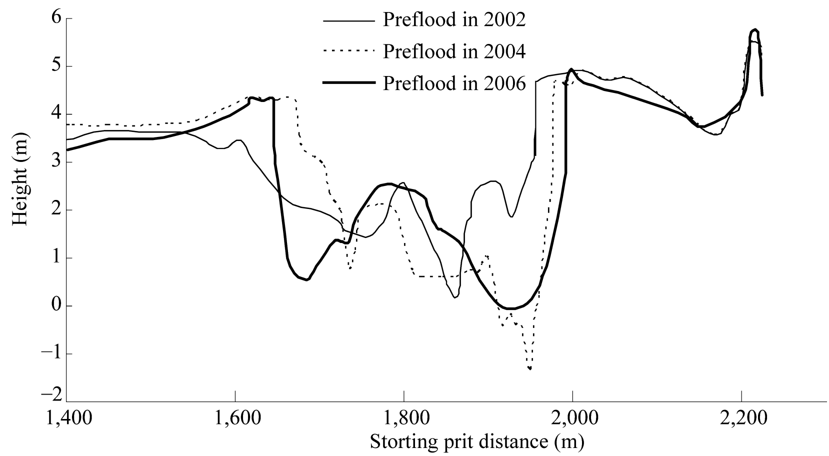

Fig. 2 Scour and silting of the main chaneel of Cha1 station in flood period between 2002 ~ 2006

Table 3 The statistical form for the comparative of the water level in 3,000 m^3/s of the main stations

Name of station	Post – freshet period of 2002	Post – freshet period of 2003	Post – freshet period of 2005	Post – freshet period of 2006	Dispersion		
	①	②	③	④	④ – ①	④ – ②	④ – ③
Gaocun	63.7	63.11	62.50	62.44	−1.26	−0.67	−0.06
Sunkou	49.08	48.78	48.58	48.35	−0.73	−0.43	−0.23
Aishan	42.06	41.46	41.04	41.14	−0.92	−0.32	0.10
Luokou	31.34	30.93	30.42	30.50	−0.84	−0.43	0.08
Lijin	14.12	13.62	13.26	13.48	−0.64	−0.14	0.22
Yihaoba	11.52	10.93	10.56	10.83	−0.69	−0.10	0.27
Xihekou	9.20	8.68	8.56	8.72	−0.48	0.04	0.16

Note: The form adopt the base level of Dagu, the unit is m.

4 The question and suggestion

According to the analysis of the above, we can find that because of the adjust water and sand for 5 times, scour is ubiquitous in Shandong province. But the intensity is different, the effect of eroding of the section which under the hydrometric station of Lijin is weaker, the Yihaoba section is a critical point near. For this reason , propose the following suggestion:

4.1 Since the Xiao Langdi reservoir regulated water and sand, the section of estuary erodes weaker, we should take measure to perturbation sand

According to the effect of adjusting water and sand in recent years, sections which lie backward position of Yihaoba had weaker effect than others just because these sections lie in estuary. The solution is ,we should adopt artificial perturbation , dredge estuary, increase the result of eroding of the river , reduce the corrode level of estuary. The estuary have thin foot – path of silt as to the upper reaches and river of it, it is easy to start suspending, the distance of sand is short to fail to the sea, furthermore help to transport the sand to the sea. Carry on the silt perturbation in estuary when the reservoir of Xiao Langdi adjusts water and sand , feeding sand to sea , these measures will improve the condition of flood channel and the ability of feeding sand to sea. Because the most silt depositted in estuary section which lie backward position of Yihaoba, so we should take the perturbation in sections under Yihaoba. In these sections , when the flux reaches above 2,500 m^3/s, the general velocity of flow is in above 2 m/s. we should make the boat disturb one by one, it will strengthen the result moved the silt to the sea greatly .

4.2 Devote more effort to digging channel, securing the bank and reducing silt project

It is an effective way to hold the downstream riverbed of the Yellow River not run – up by dig the sand in estuary , holding unobstructed of channel , reduce the erosive level , keep backscour in a long way. We have dug dyke for three times since 1998, dredge and complete 53 km altogether, excavate silt 10,570,000m^3. According to the situation of main channel of estuary in recent years, the main channel is singleness and discharge water smooth at present. At present, the Yellow River incoming flow is obviously reduce, no matter the reservoir of Xiao Langdi is used in initial stage or use normally , the main channel of estuary is still in shrink, we must keep digging the river to maintain the discharge capacity of the main channel , to fill the need of the flood. We propose give more attention to the estuary , in order to reach the aim of dredgeing up, firm bank, to improve the situation of preventing flood of the area of estuary.

4.3 Dredge up the barrier bar as soon as possible

Barrier bar exist in the estuary of all kinds of river in the world, the habitual resolve way is all to dredge. The Mississippi began to dredge since 1836, now still keep the deep by dredging in estuary and important section. The Yellow River estuary is a sediment – carrying estuary, the flood tide jacking the sand , the velocity of flow is reduced, the silt sinks and falls, silt flocculating and reunion after the salty fresh water is mixed, strength sink speed, as the barrier bar develop progressively , riverbed longitudinal gradient become slow , fill up become graveness. According to the analysis, the average solid discharge was 153 million t in Lijin between 2000 ~ 2005, though sand inflow was less, the speed of flow path extends still very fast, the sand spit of Qing8 have entered 6 km of inviting to the sea, it has already influenced the flood to enter sea badly, it is also the inportant reason of the estuary changing. We propose taking the measure of dredging in barrier bar as soon as possible, improve the riverbed border condition in the estuary, slow down the forming process of barrier bar, reduce the erode level, guarantee that water and sand enter the sea unobstructedly.

4.4 Accelerates the construction of flood – prevention project of the Yellow River estuary, level off the flow path to the sea

According to the situation of inspect in preflood period of 2006, such as bottomland collapse, river hypsography changed had appeared . ①The bottomland which lie upper reaches of Shibahu collapse badly, it formed a big riverhead for the first time on the project, the project is in danger. At present, the water level is fewer than 200 m from sideline to embankment, if it continuing to develop, it will be a threat to project security. ②The Qing8 sections of estuary is the artificial project, take shape here in the river one die curved, because it has not built control project , the direction of eduction is foul – up , it is very disadvantageous to fixing the flow path to sea. ③The left bank of Cha3 section has a new distributary , now there are two distributary , the speed of deposit expedite . If the great flood appear , there have chance to diversion, it is disadvantageous to the development of the oil field. We suggest : To prevent the projects during big flood, we shoule prolong the Shibahu section; we should build one control project in Qing8 section to fixing the flow path ; To the distributary of Cha3 , we should cut – off to fixing and stabilize the flow path.

Study on Application of Reliability Theory to Safety Evaluation of the Yellow River Dike

Zhao Shougang[1], ***Chang Xiangqian***[1], ***Yang Xiaoping***[1] and ***Yuan Hua***[2]

1. Yellow River Institute of Hydraulic Research, Zhengzhou,450003,China
2. Hydrology Bureau of Yellow River Conservancy Commission, Zhengzhou, 450003, China

Abstract: For evaluating the safety of a dike, it is essential to carry out the seepage and slope stability analysis. The results of seepage and slope stability analysis are much related to the geotechnical parameters. Due to the complex geological conditions and the great variability of soil parameters of the Yellow River dike, it is very hard to come up with actual results by deterministic methods. If reliability theory is applied for safety evaluation of the Yellow River dike, the variability of the parameters of soil properties can be fully considered. The results will well accord with the engineering practice. By analyzing the basic methods of reliability theory and studying the specific implementation methods for the safety evaluation of the Yellow River dike, it has proven that application of the method is much valuable and innovative.

Key words: reliability theory, seepage, slope, safety evaluation, Monte Carlo Method

1 Introduction

The Yellow River is a world – famous river for its suspended channel in the lower reaches. And especially in recent years, continuing water volume is becoming dry, and there are less water and more sand in the river. Relationship between water and sediment are uncoordinated. As the wandering reach of the lower Yellow River has not been well controlled, flood embankment, even some horizontal and slanting streams happened in the flood season, seriously threatening the safety of the Yellow River dike. As conditions of the lower Yellow River dike are complex, what's more, the geological conditions of each section and river regime have different characteristics. Therefore, how is the safety of each dike and how to realize objective evaluation of the problem have always been the concern of the people. For evaluating the safety of the dike, it is necessary to apply the seepage and slope stability analysis. Whether the results of the seepage and slope stability analysis are reasonable greatly relate to the soil parameters. On account of complex geological conditions of the Yellow River dike and heightening of the levee several times, homogeneous nature of the soil is poor. Even if the same type of soil, its physical and mechanical indicators are also much different. In view of safety evaluation of the seepage and slope stability of a certain section from the small number of geological exploring data analysis alone, it will be difficult to be fit to the actual situation. In many cases, even no any problem can be rooted out. Reliability theory can solve the above problems. Based on statistical probability, it can fully consider the variation of soil parameters. The analytical result will well accord with the reality. The basic points of reliability theory are to make the factors affecting safety as random variables, forming the function and solving reliability or failure probability and evaluating the safety of the project. It goes without saying that if using the theory, firstly, a large amount of test data need to be accumulated. According to the data, the probability distribution of the various factors affecting project safety is studied, and followed by the need for a lot of computation. Now it has accumulated a large quantity of data by several explorations on the Yellow River dike and large – capacity and high – speed computers have been widely used. Therefore, the conditions for application of reliability theory to safety evaluation of the Yellow River dike have been provided with.

2 Introduction of reliability analysis methods

2.1 Reliability analysis methods

At present, commonly used reliability analysis methods include Linear second order moment method, stochastic finite element method, probability moment point estimation method (also known as Rosenblueth), and Monte – Carlo simulation method.

2.1.1 Linear second order moment method

Linear second order moment method uses only mathematical model of the mean and standard deviation to solve the structural reliability. Specifically structure function is to work according to Taylor with neglecting high – level item and only retaining linear element. The mean and standard deviation are obtained by using first order moment and second order moment of basic random variables $x_i (i = 1, 2, \cdots, n)$, then determining the reliable index of the project structure. Because this approach is to deal with the nonlinear function for linear function, it is an approximate calculation method of reliable index. But because of its concision and strong applicability, it has been widely used in engineering practice. The four methods are based on the linear second order moment.

2.1.2 Stochastic finite element method

Because a large number of practical project problems are influenced by random factors. The relationship between the soil and statistical parameters has great nonlinear variation. Many scholars were committed to the research on the finite element theory in engineering application. It says simply that stochastic finite element is a method of applying the finite element method to analyze the problem of random structure. According to the different methods of deriving the equations, stochastic finite element method can be divided into Taylor stochastic finite element, finite element random perturbation method, the random finite element of Neuman Series Monte – Carlo method. The several methods are expended around this stochastic operator and random matrix in the delivery issue.

2.1.3 Probability moment point estimation method

Mexicans Rosenblueth brought forward a point estimation method to calculate the geotechnical engineering reliability index in 1975, and improved this method in 1981. Therefore, the probability moment point estimation method is usually called Rosenblueth method. It is primarily based on front three moment of the random variable (mean, variance, skewness coefficient) to describe the probability moment of limit state function. It does not need to know the precise distribution of the random variable in advance. Rosenblueth method requires some certain number of points to estimate value of the function. These points are generated from the mean and standard deviation of random variables by some certain principles. According to the function value of point estimate, reliable index can be determined by calculating formula.

2.1.4 Monte Carlo method

The basic principle of Monte Carlo method is firstly to take out a large – number samples, then taking into the model – function, the calculating failure times are the percentage of the total samples, consequently the reliable index can be obtained.

2.2 Conparsion analysis of reliability method

Based on study of some basic reliability theory analysis methods, the characteristics of each method were discussed briefly. ① Linear second order moment method is a simple method for approximate calculation of reliable index. But using Taylor series expanding without the high – power, and there are some restriction conditions. For example, central point method only adapts to the condition of normal or log - normal distribution and the structural reliability index = 1 ~ 2. But many scholars have improved the method. Because the calculation is simple, the method has been widely used in some projects required low precision. ②Stochastic finite element method combines the finite element method with the probability and statistics. Due to the whole discrete characteristic of finite element method itself, unknown factors of solving the problem are greatly increased, thus not only the stochastic finite element based on the perturbation solution or linear second order moment, but also the stochastic finite element based on statistic method have all the problems of control accuracy and much calculation inevitably. Although in recent years some scholars such as Wu Shiwei, Liu Ning and Gong Xiaonan et al. all have extensively studied the stochastic finite element method. However, it's still very complicated for the actual application. ③Rosenblueth method has the features that can not know in advance the random variable and the exact distribution of convenient, but, its accuracy and practicality still need further study. ④Now the Monte Carlo method has been used widely and deeply in reliability analysis. The advantage is that it avoids the mathematical problems of structural reliability analysis without considering the nonlinear function and the complexity of limit state surface. For solving many difficult problems that can't be dealt with by using traditional mathematical methods, it provides an effective and feasible way. Compared with other methods, reliability analysis is relatively precise. It can obtain more accurate and reliable index of the failure probability by only sufficient number of simulations. Meanwhile, by applying Monte Carlo to analyze the reliability problems, the influence restricted by it is much smaller, its convergence and ultimate state of nonlinear equations do not relate to the variables of the non - normal distribution. It has the advantages of high adaptability and simple ideas and easy preparation program. The drawback is higher workload and lower efficient. But with the improvement of sampling technique and computer hardwares, this shortcoming is greatly weakened. The method will be used widely.

Based on the above analysis, applying Monte Carlo method to analyze seepage and slope stability of the Yellow River dike has some advantageous. Therefore, Monte Carlo method was selected for the safety evaluation analysis of the Yellow River dike.

3 Implementation of reliability theory to safety evaluation of the Yellow River dike

3.1 Reliability analysis of slope stability

3.1.1 Principle of reliability analysis of slope stability

In the reliability analysis of the engineering structure, the structure limiting condition equation can usually be described by function, when n random variables ($x_1, x_2, x_3, \cdots, x_n$) influence structure reliability, the function equation can be indicated as follows:

$$Z = g(x_1, x_2, x_3, \cdots, x_n) \tag{1}$$

When $Z > 0$, the structure is at the reliable condition; when $Z = 0$, the structure is at the limiting condition; when $Z < 0$, the structure is at the failure mode.

Structural failure probability is expressed as:

$$P_f = P(Z < 0) = \int_{-\infty}^{0} \frac{1}{\sqrt{2\pi}\sigma_Z} \exp\left[-\frac{1}{2}\left(\frac{Z - \mu_Z}{\sigma_Z}\right)^2 \right] \mathrm{d}Z = \phi\left(-\frac{\mu_Z}{\sigma_Z}\right) = \phi(-\beta) \tag{2}$$

where: P_f is the failure probability; μ_Z is the average value; σ_Z is the standard deviation; β is the reliable index; ϕ is the standard normal mode function.

In slope stability analysis, its function can be indicated as follows:

$$Z(x) = \frac{R(x)}{S(x)} - 1.0 = f(x) - 1.0 \tag{3}$$

where: $R(x)$ is the glide - resistance moment; $S(x)$ is the glide moment; $F(x)$ is the safety coefficient.

Slope reliable indicator can be indicated as follows:

$$\beta = \frac{\mu_Z}{\sigma_Z} = \frac{\mu_F - 1.0}{\sigma_F} \tag{4}$$

where: μ_F and σ_F expresses average value and the standard deviation of the safety coefficient separately.

3.1.2 Monte Carlo calculation program of slope stability

It can be seen from the above analyses that the Monte Carlo method is superior to the other methods in simple programming, higher precision of results. Although it has the shortcomings of heavy workload, with improving the performance of today's computer, the problem has basically been solved. Therefore, we have chosen the Monte Carlo method for reliability analysis of the slope. Meanwhile, it applies classical limit equilibrium theory (the Bishop and Sweden) for slope stability analysis model. The following steps of programming are described:

(1) Inputting the distribution type and statistic characteristic of each random variable.

(2) Related variables will be converted to non – space – related variables by covariance matrix method.

(3) Generating a uniform random number, from which a group of variable parameters of obeying distribution will be created.

(4) Obtaining a group of parameters of independent initial variables by inverse transform.

(5) Incorporating into the Bishop and Sweden function, repeating n times, calculating statistical failure rate and the failure probability.

(6) Checking failure probability stability, if necessary, increasing the sample number and calculating repeatedly.

(7) Calculating reliability index as the failure probability.

3.2 Reliability analysis of seepage stability

3.2.1 Principle of seepage control design and random variables defined

According to limit state design principle of hydraulic structures, the hydraulic structures should be designed as the limit state and normal limit carrying capacity. The relative standards specify that the case of unstable soil – rock structure or foundation due to seepage can be regarded as exceeding the limit carrying capacity. Therefore, analyzing seepage of the Yellow River dike, the limit carrying capacity state should be considered and can be conform to the relevant standards.

When using the reliability theory to study the seepage stability, the loading effect, material properties and structure geometry are all regarded as random variables. As the complexity and uncertainty of the Yellow River levee are mainly caused by the soil material properties of dikes and foundation. For making the problem easier to be solved and grasping the essence of the problem, the soil density and permeability are only regarded as random variables. But the downstream water level and the cross – sectional dimensions are determined as certain value in order to study the seepage stability of the Yellow River dike.

3.2.2 Seepage stability function and seepage failure probability

When using the limited unit method for analyzing seepage stability, the research object may be each soil unit of destroyed area. Because the main soil of the Yellow River dike basically belongs to the non – piping earth, the seepage stability of the unit soil body at the bank foot of dry dike slope are judged by the following equation:

$$Z = R - S \tag{5}$$

where: R is the effective soil weight loaded on the unit bottom surface; S is the osmotic pressure on the unit bottom surface.

Due to the randomness of soil density, R is a random variable; when upstream and downstream water levels and cross – sectional dimensions of the dike were determined, the S value is only obtained by the permeability of the foundation and reaches of levee. When the soil permeability parameters are random variables, the S value is random variable too, although functional relation between S and soil permeability parameters can not be written as explicit formula.

In fact, the above formula is the function for studying seepage stability of levee.

When $Z = R \cdot S > 0$, the soil units are in steady state of seepage; when $Z = R \cdot S = 0$, the soil units are in limit state, the formula is the equation of limit state of soil seepage; when $Z = R \cdot S < 0$, the soil units are in state of failure. As results of instability in soil infiltration, it can be called the state of infiltration damage. If the probability distribution function (probability density function) R and S are calculated, the soil infiltration damage probability can be obtained as follows:

$$P_f = 1 - P_r = 1 - \int_{-\infty}^{\infty} f_S(S)\left[\int_S^{\infty} f_R(r)\,dr\right]dS \tag{6}$$

where: $f_S(S)$ is the probability distribution function of S; $f_R(r)$ is the probability distribution function of R; P_f is the probability of soil infiltration damage; and P_r is the reliability of soil infiltration stability.

Obviously, $P_f + P_r = 1$.

3.2.3 Relation ship between failure probability and safety factor

When R and S are two random variables, its average values are indicated as m_R and m_s separately, the standard deviations are indicated as σ_R and σ_S, then average value and the standard deviation of the function Z are given respectively:

$$m_Z = m_R - m_S \tag{7}$$

$$\sigma_Z = \sqrt{\sigma_R^2 + \sigma_S^2} \tag{8}$$

When the R and S are random variables of normal distribution, Z - function is also random variable of normal distribution. The probability of $Z < 0$ is namely the damage probability:

$$P_f = P(Z < 0) = \int_{-\infty}^{0} \frac{1}{\sqrt{2\pi}\sigma_Z} \exp\left[-\frac{1}{2}\left(\frac{Z - m_Z}{\sigma_Z}\right)^2\right]dZ \tag{9}$$

The above equation can be changed into:

$$P_f = \int_{-\infty}^{-m_Z/\sigma_Z} \frac{1}{\sqrt{2\pi}} e^{-t^2/2}\,dt \quad \left(T = \frac{Z - m_Z}{\sigma_Z}\right) \tag{10}$$

From the above formula, the value of t is a standard random variable; and P_f is a ceiling integral function. Therefore, it can be written as $P_f = \phi\left(\frac{m_Z}{\sigma_Z}\right)$.

Introducing reliable indicator $\beta = \frac{m_Z}{\sigma_Z}$, Then $P_f = \phi(-\beta)$. (11)

The relation between reliable index and reliability (P_r) can be deduced:

$$P_r = 1 - P_f = 1 - \phi(-\beta) = \phi(\beta) \tag{12}$$

Putting formula (7) and formula (8) into the formula (11) can obtain:

$$\beta = \frac{m_Z}{\sigma_Z} = \frac{m_r - m_S}{\sqrt{\sigma_R^2 + \sigma_S^2}} \tag{13}$$

Discussing the relation between reliable index and safety factor, and defining safety factor:

$$K = \frac{m_R}{m_S} \tag{14}$$

Transforming the type of formula (12):

$$\beta = \frac{m_R - m_S}{\sqrt{\sigma_R^2 + \sigma_S^2}} = \frac{\frac{m_R}{m_S} - 1}{\sqrt{\left(\frac{\sigma_R}{m_S}\right)^2 + \left(\frac{\sigma_S}{m_S}\right)^2}} \tag{15}$$

As

$$\frac{\sigma_S}{m_S} = V_S, \frac{\sigma_R}{m_R} = \frac{\sigma_R}{m_R} \cdot \frac{m_R}{m_S} = V_R \cdot K \tag{16}$$

V_R and V_S are variation coefficient of random variable R and S.

Therefore, the formula (13) is given:

$$\beta = \frac{K-1}{\sqrt{K^2 V_R^2 + V_S^2}} \tag{17}$$

It shows that the reliability index not only relates to the safety factor, but also variation coefficient of the random variable. After the safety factor is determined, the reliability of engineering structure or damage probability will relate to the distribution of random variables and it isn't a constant. So from statistical view, there are two problems in the traditional safety factor. Firstly, it doesn't consider random properties affecting the safety factors of engineering structure, and only depending on experience or engineering judgment. It has subjective factors. Secondly, the safety factor only relates to the average values R and S. This method can't reflect the actual structural damage.

It should be noted that the above conclusions are obtained when R and S are the random variables of normal distribution. If R or S is random variable of non - normal distribution, the conclusions are still approximate. For seepage stability analysis, the unit osmotic pressure depends on the soil permeability coefficient. It is a complex function. But the permeability coefficient is log - normal distribution. So function of total osmotic pressure is not necessarily normal distribution. Therefore, failure probability directly expresses seepage stability of the Yellow River dike in the following research.

3.2.4 Monte Carlo finite element method of seepage calculation

Known from the definition of probability, the probability of an incident can be calculated by the frequency of the incident through a large number of tests. Thus, a large number of random samples may firstly be chosen from random variables affecting the seepage stability reliability, then analyze seepage calculation of finite element method for each group of random value, the total osmotic pressure (S) of unit can be obtained by the research. Then comparing with the bottom effective soil weight (R), determining whether seepage failure will occur. And calculating the damage frequency, finally, the failure probability can be obtained.

Supposing the sampling number(N), function value of each group of sampling Z_i, if time of $Z_i \leqslant 0$ is L, then the seepage failure probability is:

$$P_f = L/N \tag{18}$$

Therefore, the failure probability of the Monte Carlo method is equivalent to failure frequency. For making above formula accurate to a certain degree, and according to reference[2], N must be large enough.

$$N \geqslant 100/P_f \tag{19}$$

Given $P_f = 10^{-3}$, so $N = 10^5$, when finishing complete reliability analysis of each section, the seepage stability must be calculated for 100,000 times.

To calculate the random number of known distribution is the key to Monte Carlo method for calculating reliability. Generally, it is divided into two steps. Firstly generating random number of uniformly distributed in the interval (0,1), based on which, transforming into the random number of given distribution. The random number of normal distribution can be obtained by the following transformation.

Supposing random number un and un + 1 are two even random numbers in (0,1), then

$$\left.\begin{aligned} x_n^* &= (-2\ln u_n)^{1/2}\cos(2\pi u_{n+1}) \\ x_{n+1}^* &= (-2\ln u_n)^{1/2}\sin(2\pi u_{n+1}) \end{aligned}\right\} \tag{20}$$

where: x_n^* and x_{n+1}^* are two random numbers of standard normal distribution $N(0,1)$. If the random variable x belongs to generally normal distribution $N(m_x, \sigma_x)$, then

$$\left.\begin{aligned} x_n &= x_n^* \sigma_x + m_x \\ x_{n+1} &= x_{n+1}^* \sigma_x + m_x \end{aligned}\right\} \tag{21}$$

where: x_n and x_{n+1} belong to random number of $N(m_x, \sigma_x)$ distribution.

For random variables of log - normal distribution, using the mean and standard deviation of the random variables after changing by nature logarithm, then obtaining the logarithm values by the formula. Then taking objection logarithm, a random number of log - normal distribution can be obtained.

For realizing the seepage calculation by Monte Carlo finite element method, the calculating program was developed on the basis of the existing program.

4 Conclusions

(1) Reliability theory is established on the basis of probability statistical analysis, fully considering the random variability and correlation of parameters in function. It reflects the engineering practice rather than the safety factor method. It has extremely important value on the safety assessment of the dike project.

(2) Safety of the Yellow River dike is always the great concern of the people. However, the classical deterministic analysis methods are often difficult in simulation. By adopting reliability theory, the problems in the seepage and slope stability of the dike are revealed successfully. And it coincides with the actual danger situation. It can provide the theoretical basis for design of dike reinforcement.

(3) The study is applying the safety evaluation of reliability theory to stability analysis of the seepage and slope. The concrete implementation is given. And the method is feasible and innovative.

(4) As the reliability theory is complex and dike safety evaluation system has not been yet completed, reliability theory for the safety evaluation of the dike is still at the preliminary stage. With the introduction of the random field theory in the future, more reasonable results can be expected. Therefore, it is necessary to further study the reliability theory application for safety evaluation of the dike systematically and deeply.

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Analysis on the Yellow River Engineering Management and Maintenance after Reforming the Water Management System

Bai Ye, ***li Xiao'e*** and ***Huo Junhai***

Yellow River Shaan bureau, Weinan, 714000, Shaanxi

Abstract: After the water management system reform was fully implemented in Shaanxi Yellow River Conservancy Bureau, the separated water management system operative frame was formed primarily. For many problems emerged in operating the new system, the author analyzed the existent practical problems and offered solvable strategy in this article.

Key words: reform, maintenance, problem, strategy

1 Introduction

According to "the Implement Guideline of Water Conservancy Engineering Management System Reform" (management system reform office of State Council), "The Guideline of Yellow River Water Conservancy Engineering Management System Reform" (Yellow River office [2006] No. 12) and correlative replying programs, in June 2005, Dali Yellow River Engineering Bureau in Shaanxi, as one of the 25 water system management reform experimental units, began to reform the water engineering management system firstly. Then in May 2006, the other three units, Hancheng, Heyang, Tongguan, also began the same reform one after another. On 15 June, all of the units finished their reform and completely achieved the separation of "organization, staff, property," that is, formed the new pattern of water engineering management and maintenance situation.

2 The situation of staff and organization after the reforming

2.1 The situation of organization

During the reforming process, "The Guideline of Yellow River Water Conservancy Engineering Management System Reform" (Yellow River office [2006] No. 12) was as a basis and carried out strictly.

(1) The Shaanxi Yellow River Conservancy Bureau set up five agencies due to the requirements, which are Office, Public Affairs Department, Water Conservancy Department, Financial Department, and Personnel Education Department. Besides, the Official Service Center is established as a branch.

(2) On 15th May 2005, according to "the Requirements of Carrying on Experimental Work of Water Conservancy Engineering System Management Reform" (Yellow River department [2005] No. 12), Dali Yellow River Bureau began to carry on experimental management reform. They set up Office, Management of Engineering Department, Water Conservancy Resource Department, Financial Department, Operation and Observation Department, and established Shaanxi Yellow River Water Engineering Maintenance Limited Company at the same time.

(3) According to "The Guideline of Yellow River Water Conservancy Engineering Management System Reform " (Yellow River office [2006] No. 12), under the guidance of the leader group, some professional department such as Personnel Department draw up the "The Plan of Shaanxi Yellow River Water Conservancy Engineering Management System Reform" which is based on careful investigation, research including seminars, discussions and so on , and is combined with practical condition of the bureau as well, Yellow River Conservancy Committee replied it as the file of [2006] No. 15. According to "The Guideline of Yellow River Water Conservancy Engineering

Management System Reform " (Yellow River office [2006] No. 12), Our bureau have set up Office, Management of Engineering Department, Water Conservancy Resource Department, Operation and Observation Department.

2.2 Situation of staff

According to Ministly of Water Resource and Ministry of Treasurys. "The Water Conservancy Engineering Management Units Position Confirmation Standard (experimental units) ", the staff positions and number were checked out strictly, the people who has public identification have been adjusted to public positions, the staff in vice – branches and others competed the employment in public. At the end, the number of employees was controlled within the permission scope.

3 The construction of maintenance companies

According to the arrangement of Yellow River water conservancy management system reform, the Shaanxi Yellow River Water Conservancy Maintenance Company was established in 2005, which is a limited company and passed the registration of National Industry and Commerce Department on 23 rd June 2005. The Shaanxi Yellow River Water Conservancy Bureau and its official service center together set up the company whose registration address is Weinan, the first registrar fund is 2,000,000 ¥, carries out independent accounting and self – managed pattern. The management field is mainly focused on maintenance. With the fully implement of water system management reform, more fund came from the other three no experimental units and until now the fund is amount to 4,500,000 ¥.

The maintain company has directorate which responsible for the operation decision. The general manager is responsible for daily work, the company has three departments as Financial Department, Comprehensive Department, Engineering Department, every water engineering management unit set up Maintenance Department respectively, and undertake the maintenance task.

4 Existing problems

(1) The delay of maintenance fund will directly influence the implementation of water conservancy engineering maintenance. The water conservancy engineering maintenance, which is not equal to the construction of water conservancy engineering, is a routine work and needs the fund come in time.

(2) The uncertainty amount of given fund influenced the arrangement of the plan, and restrained the special projects and others.

(3) There aren't supervision contents in the construction contract model. According to the 9 rules printed by Yellow River Water Conservancy Committee, the engineering maintenance must carry out supervision system, so many difficulties emerged when signing working contract in term of the construction contract model.

(4) It isn't clear that which parts should cover the expenditure of signing maintenance contract. The contract compiling and signing need certain amount of money used for prophase exploration, measurement, contract compiling, middle stage checking, completion checking etc, which are all the preconditions to guarantee the work implement properly in term of the contract. But the water engineering management reform documents didn't confirm whether this kind of expenditure should be paid by the maintenance or others.

(5) The expense of supervision is lower, which give some difficulties in introducing engineering maintenance supervision system into water engineering management. According to the guideline from Yellow River Water Conservancy Committee, the expense of supervision in the engineering maintenance only accounts for 1%. But in practice, the supervision task is much more complex, which included many projects and need more time. The engineering maintenance supervision is a new, which needs a large amount of prophase fund. The supervision units, which undertook the task

from our bureau in 2005, reflected that the expense of supervision is rather low and would affect the development of supervision in the future.

(6) The calculation of expense isn't corresponded with practice, which mainly includes ① the top of dam connection parts are hardening, but it is treated as normal road in the calculation, which will lead to mistakes; ② The department budget does not include the maintenance expense of roads which connect to dams; ③ some projects such as stones preparing, grass maintenance etc have lower quote, which leads to failure in completing the relative parts of the contact.

5 Strategies

(1) The relative agencies should give the expenses of water conservancy engineering maintenance as soon as possible, in order to guarantee the routine maintenance implementation.

(2) Because we will calculate the maintenance projects and their expenditures, and examine and design the special projects, routine projects respectively every year, the uncertainty of plan projects amount and correlative fund will influence the arrangement of plan and restrain the special projects and others. It is suggested that the plan projects amount and correlative fund should be identical, otherwise will influence the development of water conservancy engineering maintenance.

(3) The contract model of water engineering maintenance should be improved further, the supervision contents should be introduced into.

(4) The contract compiling and signing need certain amount of money used for prophase exploration, measurement, contract compiling, middle stage checking, completion checking etc. So it should be stated that which parts cover the expenses of contact signing and compiling.

(5)According to the documents from Yellow River Water Conservancy Committee, the expenses of supervision in the engineering maintenance account for 1%. But in practice, the supervision task is much more complex, which included many projects and need more time. The engineering maintenance supervision is a new, which needs a large amount of prophase fund. So the supervision expenditures should be adjusted in order to improve the quality and efficiency.

(6) In order to operate conveniently, the quote should allow to adding items and improving the standards due to the practice.

6 Conclusions

The management system reform is very important in the national water conservancy engineering management; which indicates there is a great step in the water conservancy reform and development. In 2006, Water conservancy reform of Yellow River Water Conservancy Committee has fully implemented, the management of water engineering has improved gradually. And there are more problems have emerged as well. As long as the problems are solved continuously, Yellow River Water Conservancy engineering management level will become better in the future.

The Problems and Countermeasures for Maintenance Works of Yellow River Engineering of Shanxi Province

Fan Yongqiang, ***Pan Dongcheng*** and ***Liu Xu***

Shanxi bureau of Yellow River affairs, Yuncheng, Shanxi, 044000

Abstract: After the reformation of mechanism of water conservancy, because of the lagged finance support and the problem of part maintenance project as well as low diathesis of staff, there exists many problems in maiantenance works. The writer put forward some useful suggestions according to their maintenance practice in order to resolve these problems, which just provides some references for those who work at this task.

Key words: maintenance, problems, countermeasures

1 Basic situation

1.1 Harness situation of secondary north – main reach of Yellow River

The harness works of secondary north – main reach started in 60s or 70s of last century. So far there has been built 23 projects of flood control, with total length of 80.706 km in which 19 items of projects are directly controlled by YRCC in length of 67.976 km, 4 items of projects are managed by local government in length of 12.73 km.

1.2 The project efficiency

Through thirty years harness the flood control system has become preliminary scale. It elementarily regulated river trend of this section and held bottomland back from its continuous collapse, thus basically guaranteed development outcome of river bank. The harness altered situations of river bank collapse and compulsory immigrants of countryside and this created advantage for eight hydrualic power stations. At the same time it protected important cultural relics and historic sites as well as traffic roads and living and producing facilities safety. All these works offered security for national economy development and society tranquilization. The social and flood controlling benefit is very remarkable.

1.3 The situation of project management

Secondary north – main reach project management has been through three stages, the first stage is from 1968 to 1985. Secondary north – main reach projects are chiefly controlled by Yellow River flood controlling headquarters along river. Because of the idea of setting importance on construction and ignoring management and lack of finance support, the engineering appearances are disparate and in low standard, the management lagged in other aspects.

The second stage is from the year of 1985 to 2004. All management projects are devolved on YRCC. The management items unit is integrated with maintenance, flood control, management and economy administration. So it ensured the management finance to some extent. As the main management unit of projects, Shanxi bureau includes five county sub – bureaus of Hejin, Wanrong, Linyi, Yongji and Ruicheng. The maintenance expenses held with 0.8 to 1.2 millions RMB or so. To raise the management level Shanxi bureau carried out responsible management and material method jointly, which activated the enthusiasm and creativity of those work in fieldworks, the appearances of engineering improved greatly. The third stage started from the year of 2004 to now. All units implemented mechanism reformation in terms of general layout of YRCC. The personal salary and maintenance expenses are ensured and it set up the new management system and operation mechanism through innovation of separation of management and maintenance.

2 background of mechanism reformation

Water projects are elemental facilities of national economy and social development.

However, for a long time our water projects management mechanism has been in disorder all along. The mechanism was not flexible. Due to lack of maintenance expenses it resulted in lack of normal maintenance of a large amount of water projects and badly decrease of efficiency, therefore, it brought much hidden troubles to people's lives and assets security. Under the long term of planning economy mechanism, the four units of maintenance, defense, management and economy are integrated as a whole. As far as project management is concerned, the managers are both administrators and maintainers, and management is entangled with maintenance. These managers are both custodians and executants. Therefore, there lack of competition outside and be difficult to form the intendance mechanism. The management is short of activities. This situation cannot meet the needs of economic market development as well as restrict the Yellow River harness.

3 Implemental situations of water mechanism reformation

In order to carry out the reformation steadily, Shanxi bureau picked out Yongji County bureau as experimental unit in 2004. They established the Ltd. of maintenance and adjusted some relative divisions and let the staff run for their fit post by competition. Thus they realized new mechanism and management mode. In 2006, within the whole scope the Shanxi bureau implemented reformation in terms of innovation policy of YRCC. To reinforce the leadership of reformation Shanxi bureau set up leading group of mechanism reformation and the bureau director was group leader, vice group leader undertaken by other remembers.

Before reformation, Shanxi bureau carefully stipulated plan of reformation implement of water mechanism according to their actual situations.

During the reformation it should resolve problems of thoughts of staff and grasp comprehend the essentials of reformation and properly carry out all tasks of reformation. Because of careful preparations the reformation was carried out successfully and realized the purpose of ceaseless work and non – disorder.

After reformation, no one staff is workless and every one found his fit post. The staff thoughts are stable. The reformation got its goal according to all preparations before implement. All water management units and maintenance companies associates with each other in staff, equipment, assets and business. Thus realizes the purpose of separation of management and maintenance. This means that integration of maintenance, flood controlling, management and economy is terminated.

4 Implemental situation of maintenance

4.1 To set up all kinds of regulations and rules

To establish all kinds of regulations and rules and ensure the all works be carried out orderly, Shanxi bureau earnestly stipulated a series of regulations and rules that include management methods of maintenance of Yellow River engineering of Shanxi bureau, capital management regulation of maintenance, management method of root stone reinforcement of maintenance, management method of project acceptance and implement details of maintenance, and so fourth.

4.2 To stipulate the special design and maintenance plan

All water management units finished the special maintenance plan on basis of investigations joined with their actual situation according to quotient standard of water project maintenance, and they sent the plan to their upper units for approvals. They did much preparation for well carrying out maintenances.

4.3 To sign the maintenance contract in time

After the making known to lower levels of maintenance plan, all water management units signed maintenance contract with maintaining company, and signed contract with supervising company. They transacted procedures of quality supervision at Sanmenxia quality stations and secondary north – main reach ones.

It set up all quality insurance system. During implement of maintenance we strictly manage all items according to contract. And relative units did their works seriously. The quality of maintenance was insured due to concrete responsibility and task as well as large amount of finance and manpower support.

4.4 To reinforce locale management and organize check and acceptance

Compared with construct project, maintenance works there are much difference. The project of maintenance is spread fragmentarily and locale is difficult to control and work load is hard figured out. To insure quality and capital safety, all water management units reinforced locale control. We contracted with company on little maintenance projects in total workload and thereafter acceptance according to approved maintenance items. As to large special one, we implement item management and management people operated with maintenance workers together. We organized relative staff of project division, finance division and observation division and supervision units to finish the project acceptance. If the project met the needs of us we would settle accounts with them. This insured high standard of project, top quality as well as enough workload.

5 The main problems in maintenance works

For the nonce, the reformation is in initial stage and there is still much work to do. During operation the follow problems should be settled down.

5.1 The maintenance capital lagged in

Presently, only after discussion by national people's congress can maintenance capital be to relative units, this renders the capital late while it arrives at the water management units.

The late investment resulted in fail signing contract between water management units and maintenance companies. And it cannot settle accounts in time. The maintenance company cannot afford for the payment and this situation always exists, at same time, it has influence on normal maintenance.

5.2 Part of projects of maintenance omit

To reasonably arrange the maintenance projects and guarantee the orderly implement of maintenance works, fiscal ministry and water resources ministry together made out the quotient standard of water project maintenance and it provided the policy dependence of capital for scientific weaving and auditing maintenance works. During practical operation we found that the maintenance items not includes all the quotients, that is to say it omitted some items, such as pavement of dam top, stone item along road and planting trees beside road. In our actual works, there are few maintenance items and thus resulted in real difficulties in our works.

5.3 Procedures of maintenance works needs further regulation

The maintenance works are implemented by contract and expenses is pain by actual workload. Every month the water management units make known to all levels the task bill of maintenance, while the maintenance company finishes their works according to task bill issued by water management units. The problems exist as follows.

Firstly, the maintenance works are passive and restricted by water management units per month they cannot actively fulfill the tasks they took.

Secondly, the observation staff is spread widely and each project occupies few people and observation task is heavy. After raining days it needs much time to check the rain – damaged maintenance, and the sending time is lagged in. hardly the old damaged projects are rebuilt when the new ones appears. The phenomena did great influences on restoration of rain – damaged projects.

5.4 Indoor data of maintenance need to be improved further

All kinds of works are gradually regulated now due to initial maintenance works. In our practical works, due to the restricted skill of staff and being not familiar with the new standards, the reformation policy was not carried through thoroughly. This results in non – regulated or non – improved recording data of maintenance, as well as simple record and non – round contents and non – regulated term, and so on. This cannot reflect real situations of maintenance course.

5.5 Staff on observation is fewer in numbers and lower in kill

All water management units carried out personnel optimization and adjusted the divisions after reformation. In order to insure front maintenance works carrying out smoothly, we set a observation section of second level. After mechanism innovation all staff went into observation section. The river bank line is long and dispersed. Every observation section of maintenance base possesses two or three people. The staff is relatively fewer, whereas, the observation task is heavy. Each person has two or three km of projects to maintain. At same time, they undertook flood control, water administration and river investigation. In addition, most of them were from workers and with lower culture level and poor skill. They could not accomplish the heavy workload of locale management and supervision.

6 Suggestions and countermeasures for maintenance works

6.1 To make the maintenance plan practically

Maintenance plan is the basis of maintaining works and is a very important dependence by which we sign contract with maintaining company. When weaving maintenance plan it should go into details in light of actual situations and make the problems clear that hidden in our works. It should strictly figure out the price of maintenance items according to maintenance quotient standard of water projects and the general investment of maintenance capital approved by upper levels. It should arrange the maintenance items according to principle of importance. Under premise of insure of normal maintenance task, we carry out the embankment and eliminations of hidden troubles. It should really get to the goal of integrated projects and gradual improvement of project appearance so that we may enhance the flood controlling competence and raise the managerial level.

6.2 To enhance personnel training and improve their skill

Maintenance work is a kind of new job. In order to regulate the maintenance conduct, the upper level department stipulated a great deal of regulations and rules. This provided much dependence for normal maintenance works. Aim at the new problems and situations appeared in maintenance works, all water management units should reinforce operation observation and skill training of staff in order to raise their levels and whole accomplishments. Next we will organize relative divisions, such as river affairs, treasures, and maintenance staff to study related laws and decrees. Combined with actual works we adopted the method of going out and coming in to resolve the problems existing in our works. Concretely speaking, we may do as follows.

Firstly, we organize relative staff to go to brother units to learn from them in advanced experiences and efficient operations in order to boost our works.

Secondly, we will invite some experts to give us lectures so that we can comprehend some relative regulations and rules and raise implemental competence of grasping policy.

Thirdly, we will determine the post responsibility of maintenance and realize the goal of specific duty and concrete task. In this way, it can constantly raise the standard of staff skill and work efficiency.

6.3 To reinforce maintenance project management

Because of maintenance projects are spread around, it is difficult to control effectively. To insure the quality of maintenance projects and finish the maintaining task timely all levels of water projects units should reinforce the front management. As to larger project or ones being done with supervision, we are intent to fulfill with them. To reinforce project management and acceptance and pay by actual workload, we carefully carried out our responsibility and strictly control the quality, by doing so, the projects appearances improved greatly and management level is raised higher.

6.4 To fully exert invest benefit of maintenance

With the maintenance capital investment, in order to carry out maintenance project and improve the appearances of projects, eliminate the hidden troubles, enhance the defense capacity, insure the healthy development of national economy, we devote much local society stability. In our actual works, to guarantee reasonable and safe use of capital all water management units should reinforce capital management and strictly control maintenance accounts. Before acceptance we organize relative divisions such as treasure, river affairs, to check the implement of maintenance projects, and earnestly carry out the capital audit works. Our goal is to realize safety of project, capital and carders, and to exert all invest effectively as whole.

7 Conclusions

At present, the reformation centered by departure of management and maintenance is only in its initial stage. The new mechanism and managerial mode is just established, it already emerged vigor and vim and it gets on healthy way. In our actual works we should constantly probe and improve new managerial mechanism and management mode and enhance locale supervision, and fully use maintenance effect, at same time we should improve the appearances of our engineering and raise the management level, and contribute much more to local economy development and society stability.

Natural Eecological Water Demand Calculating of Lower Reaches Area of the Heihe River at Present Year

Fu Xinfeng, ***He Hongmou***, ***Jiang Xiaohui***, ***Luo Yuli*** and ***Jiang Bingzhou***

Yellow River Institute of Hydraulic Research of Yellow River Conservancy Commission, MWR, Zhengzhou 450003, China

Abstract: The ecology and environment at the lower reaches area of the Heihe River is on the trend of deterioration because of less water entering the downstream channel which is caused by increasing water consumption in the upper and middle reaches. In order to restore and improve ecology at the lower reaches area of the Heihe River, the ecological water demand must be guaranteed by all means. The natural vegetation area at the lower reaches area of the Heihe River was interpreted by remote sensing image of 1998, and quota of natural ecological water demand at the lower reaches area of the Heihe River is analyzed, thus the natural ecological water demand at the lower reaches area of the Heihe River is calculated on base of the selected natural ecological water demand methods. Then, natural ecological water demand at the lower reaches area of the Heihe River at present year is calculated with groundwater storage volume change method, Аверьянов, Г. В method, and measured actual water volume method etc. In comparison, the natural ecological water demand at the lower reaches area of the Heihe River at present year is 0.391 ~ 0.405 billion m^3.

Key words: natural ecological water demand, the lower reaches area of the Heihe River, natural vegetation, remote sensing

1 Introduction

The Heihe River is the second largest endorheic river in Northwest China, originating from north of the Qilian Mountains in Qinghai Province and flows through three provinces which are Qinghai, Gansu and Inner Mongolia, with the whole length of 821 km. The lower reach area of the Heihe River is just below Zhengyi Gorge, including parts of Jinta County of Gansu Province and Ejina county of Inner Mongolia municipality, the areas is 80.4 thousand km^2 livestock areas of Mongolian that lives mainly descendants of Turehot Mongolian tribes and the Mongolian border with the length of 507 km exists in the area, Meanwhile, where a major scientific research base for national defense lies in and its strategic role is very important.

The lower reaches area of the Heihe River is located in Alxa high plains, which average rainfall is less than 50 mm, while surface evaporation is as high as 2,500 mm, the climate is extremely arid and eco – environment is flimsy. The majority of the region is desert and the oasis is distribute intermittently. In history, the lower reaches oasis survived relying on water from the Heihe River, and the area of the ancient Juyanze lake reaches 1,200 km^2 at end of the Heihe River once. The Heihe River dried gradually and eco – environment at the lower reaches oasis particularly the Ejina Oasis lower of Langxinshan Hill was worsening for example, area of lower reaches oasis is decreasing, vegetation is degraded, the tail lake of the Heihe River is disappeared, desertification is intensified with economic and social development and strengthening human activity. Since the 1960s, the tail lake of the Heihe River such as west and east Juyanze lakes had dried up. The Heihe River dried further, and the Ejina River evolves from perennial rivers into seasonal rivers especially since the mid – 1980s, which results in continuous fall of groundwater level in Ejina Oasis, and the ecological environment is deteriorating further. Then, the survival of the Oasis at lower reaches area of the Heihe River is affected, and the socio – economic development of lower reaches area is constrained and ecological and national security is threatened.

Through recent three – year harnessing and past six – year unified water regulation, the Heihe River water regulation task sending the Heihe River water into hinterland of the Ejina Oasis has been accomplished for six years since 2000. The harnessing and water regulation of the Heihe River mitigated further deterioration of the oasis at the lower reaches effectively, which realized the first step goal of water division brought by the State Council. the lower reaches area has the most flimsy ecosystem and the most serious degradation of vegetation and the key region for realization of ecological management objectives of the whole basin, reviewing of natural vegetation types objectively, and analyzing quota of different vegetation ecological water demand, and calculating their natural ecological water demand are of great significance for ensuring smooth achieving goals of the Heihe River harnessing.

2 Natural ecosystem water demand at the lower reaches area of the Heihe River

2.1 Natural ecological water demand estimation at the lower reaches area of the Heihe River based on remote sensing classification

The natural ecosystem water consumption at lower reaches area of the Heihe River is groundwater supplied by river water besides precipitation, which is mainly supplied by natural precipitation and groundwater. The natural ecological system at the lower reaches area of the Heihe River is mainly made up of natural vegetation of the natural oasis and vegetation of the transitional zone and water and desert zone. The depletion of groundwater of these ecosystems includes three parts, that is, water for vegetation cover growing of the natural oasis and the transitional zone, surface water and groundwater evaporation.

With increasing consumption of water on the upper and middle reaches of the Heihe River, the water entering lower reaches becomes less and less, the area of the lake at the lower reaches is shrinking gradually. The surface area of the West Juyanhai lake is 213 km^2 in year 1960, were all dried up in the fall in 1961. Then, continued to dry up for 43 years, has become crisscrossed salt crust and Hamada coverage till the Heihe River water entered the lake in 2003. The surface area of the East Juyanhai is 35.5 km^2 in 1958, then the surface area reduced to 23.6 km^2 in 1982, dried up in 1992, the Heihe River water had entered the lake till 2002 after regulation. Regard year 2000 as the present year, the water surface area of the study area is zero, and its ecological water demand is zero too. Thus, natural ecological water demand calculating at the lower reaches area of the Heihe River includes only two surface covers of vegetation and desert zone.

2.1.1 Methods for natural ecological water demand estimation

1) Natural forests and grasslands

The natural coverage at the lower reaches area of the Heihe River is mainly made up of natural forests land and grassland, which can be replaced by natural forests and grasslands. Its ecological water demand can be formulated as:

$$W_{ifg} = A_{ij} \times m_{ij} \tag{1}$$

$$m_{ij} = ET_{ij} - p_0 \tag{2}$$

where, W_{ifg} is Water demand of vegetation class i; A_{ij} is Area of vegetation of class i and coverage j; m_{ij} is Quota of vegetation water demand of class i and coverage j; ET_{ij} is Evapotranspiration of vegetation of class i and coverage j; p_0 is Effective precipitation.

2) The desert zone

The desert zone mainly refers to little or no vegetation region. That is the region with vegetation coverage of less than 5% and the region that is among oasis and be no plant growth. Where, water demand is mainly for groundwater evaporation, which is related with embedded depth of regional groundwater. Thus, the ecological water demand of the desert zone can be calculated with groundwater evaporation intensity under embedded depth multiply related desert. The formula is given by:

$$W_d = A_d \times E_g \tag{3}$$

where: W_d is Water demand of the desert zone; A_d is Area of the desert zone; E_g is Groundwater evaporation intensity.

2.1.2 Determination of ecological water demand

1) Natural forests and grasslands

Rainfall is scarce and the quantity is small in one time at the lower reaches area of the Heihe River, which can be neglected for plant use, therefore, groundwater consumption of natural forests and grasslands is ecological community water demand. Water consumption of natural forests and grasslands is composed of two parts as transpiration of plant growth and groundwater evaporation among plants. Therefore, water demand of natural forests and grasslands includes water for transpiration of plants and groundwater evaporation, moreover, groundwater evaporation includes that among plants and that of plant coverage zone in non – plant – growing phase.

Ecological water demand quota of natural forests and grasslands is the sum of transpiration for plant growth and groundwater evaporation among plants and that of vegetation cover area in non – plant – growing phase, as reported in Table 1. Ecological water demand quota is formulated as:

$$m = W + E \tag{4}$$

$$W = ET \times p \tag{5}$$

$$E = E_1 + E_2 \tag{6}$$

$$E_1 = \sum_{i=1}^{n} E_i \times (1 - p) \times k \tag{7}$$

$$E_2 = \sum_{i=1}^{n} E' \times p \times k \tag{8}$$

where: W is Evapotranspiration for plant growth; E is Groundwater evaporation of vegetation community; ET is Transpiration intensity of plant growth; E_1 is Groundwater evaporation among plants; E_2 is Groundwater evaporation of vegetation cover area in non – plant – growing phase; E_i is Groundwater evaporation intensity of certain embedded depth; E' is Groundwater evaporation of vegetation cover area in non – plant – growing phase of certain embedded depth; p is Coverage of vegetation community; k is Distribution of vegetation community of certain embedded depth.

Table 1 Water demand quota of natural forests and grasslands at the lower reaches area of the Heihe River

Class	Euphratica			Shrubs			Grasslands		
Coverage (%)	>75	75 ~ 25	25 ~ 5	>75	75 ~ 25	25 ~ 5	>75	75 ~ 25	25 ~ 5
Ecological water demand quota (10^4 m^3/km^2)	77.82	52.66	16.89	4.31	4.87	3.64	4.31	4.33	4.71

2) The desert zone

Ecological water demand quota of the desert zone is local groundwater evaporation intensity under certain embedded depth. The groundwater evaporation intensity of certain embedded depth at the lower reaches area of the Heihe River is shown in Table 2.

Table 2 Annual groundwater evaporation of certain embedded depth

Embedded depth (m)	0 ~ 1	1 ~ 2	2 ~ 3	3 ~ 4	4 ~ 5	5 ~ 6	6 ~ 7	7 ~ 8
Annual groundwater evaporation (mm)	621.5	209.5	70.7	23.8	8.0	2.7	0.9	0.3

2.1.3 Ecological water demand of study area at present year

The natural ecological water demand at the lower reaches area of the Heihe River is calculated with remote sensing image in 1998 in place of 2000. The ecological classification at the lower reaches of the Heihe River is obtained from the remote sensing data on August 25, 1998, which is shown in Table 3.

Table 3 The natural ecological classes at the lower reaches of the Heihe River

Classes of natural ecosystem	Area in 1998 (km^2)
Other forest	9.9
High – coverage grasslands	46.32
Middle – coverage grasslands	424.54
Low – coverage grasslands	893.83
Trench	137.82
Lake	2.58
Reservoir and pool	17.07
Shoals	272.57
Beach	10.96
Sandland	3,686.85
Gobi	16,331.33
Saline	1,078.96
Bare land	1.72
Uncovered rock to gravel	37,727.63
High – coverage euphratica forest	144.98
Middle – coverage euphratica forest	133.68
Low – coverage euphratica forest	98.02
High – coverage shrubs forest	249.27
Middle – coverage shrubs forest	490.94
Low – coverage shrubs forest	936.87
Total	62,695.84

Generally, three ecological classes from interpretation of remote sensing image is water, natural forests and grasslands, and desert zone. If the uncovered rock to gravel needs no water to maintain, and the water surface area at the lower reaches area of the Heihe River is zero, natural ecological water demand at the lower reaches area of the Heihe River can be calculated with two parts as natural forests and grasslands (High – coverage euphratica forest, Middle – coverage euphratica forest, Low – coverage euphratica forest, High – coverage shrubs forest, Middle – coverage shrubs forest, Low – coverage shrubs forest, High – coverage grasslands, Middle – coverage grasslands, Low – coverage grasslands and other forests) and desert zone (Shoals, Beach, Sandland, Gobi, Saline, bare land).

1) Natural forests and grasslands

The area of natural forest and grassland at the lower reaches area of the Heihe River is 3,428.35 km^2 based on remote sensing data at present year. In which, area of euphratica forest is 376.68 km^2 (Area of high – coverage euphratica forest is 144.98 km^2, area of middle – coverage euphratica forest is 133.68 km^2, and area of low – coverage euphratica forest is 98.02 km^2), area of shrubs forest is 1,677.08 km^2 (Area of high – coverage shrubs forest is 249.27 km^2, area of middle – coverage shrubs forest is 490.94 km^2, and area of high – coverage shrubs forest is 936.87

km^2), area of grassland is 1,364.69 km^2 (Area of high – coverage grassland is 46.32 km^2, area of middle – coverage grassland is 424.54 km^2, and area of low – coverage grassland is 893.83 km^2). According to natural ecological water demand quota and calculation method, the ecological water demand of natural forests and grasslands at the lower reaches area of the Heihe River is 0.339 billion m^3, as shown in Table 4.

Table 4 The ecological water demand of natural forests and grasslands at the lower reaches area of the Heihe River

Classes of vegetation ecosystem	Area (km^2)	Ecological water demand quota (10^4 m^3/km^2)	Ecological water demand (10^4 m^3)
Other forests	9.9	77.82	770.418
High – coverage grasslands	46.32	4.31	199.64
Middle – coverage grasslands	424.54	4.33	1,838.26
Low – coverage grasslands	893.83	4.71	4,209.94
High – coverage euphratica forest	144.98	77.82	11,282.34
Middle – coverage euphratica forest	133.68	52.66	7,039.59
Low – coverage euphratica forest	98.02	16.89	1,655.56
High – coverage shrubs forest	249.27	4.31	1,074.35
Middle – coverage shrubs forest	490.94	4.87	2,390.88
Low – coverage shrubs forest	936.87	3.64	3,410.2
Total	3,428.35		33,871.18

2) the desert zone

The area of the desert zone at the lower reaches area of the Heihe River is 5051.06 km^2 based on remote Sensing data. According to groundwater data at the lower reaches area of the Heihe River, the embedded depth of the groundwater in the desert area is 3.5 ~ 5.5 m. Then, natural ecological water demand of the desert zone is 0.5635 billion m^3, as reported in Table 5.

Therefore, the natural ecological water demand at the lower reaches area of the Heihe River is about 0.395 billion m^3.

Table 5 Ecological water demand of the desert zone at the lower reaches of the Heihe River Water

Class	esArea (km^2)	Quota of ecological water demand (10^4 m^3/km^2)	Ecological water demand ($10^4 m^3$)
Shoals	272.57	12.3	1,520.9
Beach	10.96	23.8	260.8
Sandland	3,686.85	0.8	2,949.5
Saline	1,078.96	0.8	863.2
Bare land	1.72	23.8	40.9
Total	5,051.06		5,635.3

2.2 Groundwater storage quantity change method

According to Oasis's annual groundwater change rule, natural vegetation survives mainly on groundwater, consumption of groundwater is mainly through evapotranspiration of natural vegetation in natural oasis area. Therefore, it can be concluded that water changes volume in the range of groundwater level is natural vegetation water demand in growing period. The natural vegetation water demand can be expressed as follows:

$$W_i = \mu F \Delta H \tag{9}$$

where: W is Ecological water demand for maintaining certain vegetation area; F is Area of natural vegetation; ΔH is Range of annual groundwater level changes of natural vegetation; μ is Water supply extent of groundwater; i is Class of natural vegetation.

Dynamic change of annual groundwater level of the Ejina Oasis is closely related to the Heihe River water and vegetation's transpiration and evaporation. Generally, influenced by the Heihe River water, groundwater of the Ejina Oasis rises twice annually. One is in spring generally mid-April, groundwater reaches its peak subject to spring river water supply. The other is in summer from August to September, groundwater reaches its peak the second time for coming water from the upper reaches of the Heihe River in strong evapotranspiration period in summer. In other time especially the vegetation growing period, groundwater falls gradually for zero flow and increasing vegetation evapotranspiration. The range of annual groundwater changes from 1.2 m to 1.5 m in the region that is closely related to the Heihe River water near the riverway, And the range of annual groundwater is only 0.20 ~ 0.30 m in the region that is weak influenced by the Heihe River water far from both sides of the riverway. Natural vegetation water consumption in Oasis region has a direct impact on the range of the decreasing groundwater. Due to volume of water required for different types of vegetation is different, the groundwater level that in different types of vegetation region are quite different, the vegetation should be distinguished for calculating ecological water demand. According to annual groundwater dynamic changes in the different vegetation region in Ejina Oasis, the range of groundwater changes is 1.4 m in the region of vegetation that is representative for the euphratica; and the range of groundwater changes is 1.1 ~ 1.2 m in the region of vegetation that is representative for the elaeagnus angustifolia and grassland; the range of groundwater changes is 0.8 ~ 0.9 m in the region of vegetation that is representative for the Chinese tamarisk; the range of groundwater change is about 0.5 m in grassland region of central Gobi; the range of groundwater change is 0.2 ~ 0.3 m in grassland region of Gobi and desert region. Base on the Report of Regional Hydrological-Geological Survey Study at the lower reaches area of the Heihe River, groundwater supply extent is 0.15 ~ 0.2 in the Ejina Oasis. Therefore, Natural ecological water demand for maintaining the size of Oasis of the Heihe River is calculated as 0.4 billion m^3, as shown in Table 6.

Table 6 Natural ecological water demand with groundwater storage quantity change method

		Euphratica	elaeagnus angustifolia and Grassland	Chinese tamarisk	Grassland of central Gobi	Grassland of desert	Total
Range of groundwater change		1.4	1.1 ~ 1.2	0.8 ~ 0.9	0.5	0.2 ~ 0.3	
Area (km^2)	Dingxin		62.31	1.62		3.31	67.24
	Dongfengchan	10.53	8.74	26.51		17.47	63.25
	Ejina Oasis	381.26	269.81	1,648.95	141.86	886.19	3,328.07
	Total	391.79	340.86	1,677.08	141.86	906.97	3,458.56
Ecological water demand ($10^4 m^3$)	Dingxin	0	1,433	21	0	12	1,466
	Dongfengchang	221	201	338	0	66	826
	Ejina Oasis	8,006	6,206	19,787	1,064	2,659	37,722
	Total	8,228	7,840	20,146	1,064	2,736	40,014

2.3 Аверьянов, Г. В method

The growth of natural vegetation along both sides of the Heihe River relies mainly on groundwater for vegetation's transpiration and evaporation. The soil moisture that affects plant growth depends on groundwater evaporation. When soil evaporation is stable, not only the strength of surface evaporation keeps stable, but also the soil moisture content is not changed with time, that is, groundwater evaporation intensity and soil moisture flux and soil evapotranspiration intensity are equal. Therefore, the actual evapotranspiration of natural vegetation is approximately equivalent to groundwater evaporation in arid region, thus, natural vegetation water demand can be calculated with groundwater evaporation.

The groundwater evaporation is closely related to meteorological factors and soil texture and moisture reserves and embedded depth of groundwater. Groundwater evaporation can be calculated with Аверьянов, Г. В formula.

$$E = 1.174(1 - H/H_{max})^{3.63} \times E_0 \tag{10}$$

where: E is Groundwater evaporation intensity; E_0 is Conventional meteorological evaporation; H is Embedded depth of groundwater; H_{max} is Maximum embedded depth of groundwater evaporation.

The natural vegetation water demand can be expressed with multiply of natural vegetation area and plant evapotranspiration per unit area (be equivalent to groundwater evaporation approximately).

$$E_{WT} = S_v \cdot E \tag{11}$$

where: E_{WT} is Natural vegetation water demand to maintain a certain area of vegetation; S_v is natural vegetation area; E is Groundwater evaporation intensity in natural vegetation region.

Natural vegetation area at the lower reaches area of the Heihe River is 5,738 km^2 according to remote sensing data, in which, the area of higher coverage vegetation is 1,490 km^2, and the area of sparse vegetation is 4,249 km^2. Investigation of the typical vegetation shows that vegetation is growing better with about 2.5 m embedded depth of groundwater and that vegetation is sparse with about 4m embedded depth of groundwater annually. Thus, 2.5 m embedded depth of annual groundwater can be regarded as evapotranspiration of good growing vegetation, and 4m embedded depth of annual groundwater can be regarded as evapotranspiration of sparse vegetation.

Factors of groundwater that is influenced by vegetation transpiration with certain embedded depth is shown in Table 7. Groundwater evaporation with different embedded depth can be calculated with formulas (10) and (11) and Table 7, as shown in Table 8.

Table 7 Factors of groundwater influenced by vegetation transpiration with different embedded depth

embedded depth(m)	1.0	1.5	2.0	2.5	3.0	3.5	4.0
Factors	1.98	1.63	1.56	1.45	1.38	1.29	1.00

Table 8 Groundwater evaporation of different embedded depth

embedded depth(m)			1.0	1.5	2.0	2.5	3.0	3.5	4.0
Groundwater evporation (mm)	Dingxin	Bareland	1,342	767	396	176	62	14	1
		Vegetation	2,658	1,250	617	255	86	18	1
	Dongfengchng	Bareland	1,342	767	396	176	62	14	1
		Vegetation	2,658	1,250	617	255	86	18	1
	Ejina Oasis	Bareland	1,607	919	474	211	74	17	1
		Vegetation	3,182	1,497	739	306	102	22	1

Natural vegetation evapotranspiration at the lower reaches area of the Heihe River is 0.405

billion m^3 with Аверьянов, Г. В formula, as shown in Table 9.

Table 9 Ecological water demand with Аверьянов, Г. В formula

Item	Subarea	Good growing	Sparse	Total
Area(km^2)	Dingxin	62.91	4.33	67.24
	Dongefngchang	29.48	33.77	63.25
	Ejina Oasis	1,237.46	2,090.62	3,328.08
	Total	1,329.85	2,128.72	3,458.57
Ecological water demand ($10^4 m^3$)	Dingxin	1,606	0	1,606
	Dongfengchang	753	4	756
	Ejian Oasis	37,824	288	38,112
	Total	40,183	292	40,475

2.4 Measured actual water volume method

Measured actual water volume method is that the water that enters the lower reaches area of the Heihe River in stages be regard as natural ecological water demand maintaining the size of Oasis in different period. Due to scarce precipitation at the lower reaches area of the Heihe River, water of the Heihe River is the only supply at the lower reaches area. Then, the ecological water demand at the lower reaches oasis of the Heihe River can be calculated with that the discharged water quantity from Zhengyixia Gap section rids water consumption besides of the ecological water demand. Some water is consumed for industry and agriculture and life in the area of the Dingxin irrigation region, and some groundwater is consumed for supplying Gurinai lake east of the Heihe River. According to statistics from year 1995 to year 1999, an average discharged water from Zhengyixia Gap is 0.814 billion m^3, Comparing with water for keeping ecological degradation trend at the lower reaches area of the Heihe River within limits, the average discharged water from Zhengyixia Gap is required to attain just 0.831 billion m^3 that is measured actual water discharged from Zhengyixia Gap from year 2000 to year 2005. According to water consumption of Dingxin basin from Dadunmen to Langxinshan, and that of Dongfengchang field, and that of Ejinaqi, the total water consumption for industry and agriculture and life is 0.371 billion m^3. Then, discharged water from Zhengyixia Gap is 0.46 billion m^3 based water balance. Removal water loss of 15% of the discharged water, and the remained water for ecosystem is 0.391 billion m^3. Therefore, the ecological water demand at the lower reaches area of the Heihe River is about 0.391 billion m^3 with measured actual water volume method.

3 Conclusions

Remote sensing classification based ecological water demand is 0.395 billion m^3. While the ecological water demand at the lower reaches area of the Heihe River with conventional methods are that 0.4 billion m^3 with groundwater storage volume change method, and 0.405 billion m^3 withАверьянов, Г. В method, and 0.391 billion m^3 with measured actual water volume method. The results are in agreement with these methods. Meanwhile, the trend of ecological deterioration can be curbed with ecological water quantity of 0.4 billion m^3 according to the results of three – year recent harnessing and past six – year unified water regulation. These shows that the water required to maintain natural ecological status at the lower reaches area of the Heihe River of 0.391 ~ 0.405 billion m^3 has some practical significance.

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Research on Large Machinery Application in the Yellow River Flood Emergency Tackling

Gao Xingli[1], ***Zhao Yusen***[1] and ***Liu Yun***[2]

1. Yellow River Henan Bureau, Zhengzhou, 450003, China
2. Reconnaissance, Design and Research Institute of Yellow River Henan Bureau, Zhengzhou, 450003, China

Abstract: Dangerous situations occur frequently due to the great fluctuations in the channel of the downstream Yellow River. Vast manpower, intensive labor and much time were needed in the ways of traditional flood fighting. To change this passive situation, a series of research have been conducted including the development of emergency tackling assistant machines, mechanized emergency tackling techniques and mechanized encroaching techniques, in which we have achieved significant progress. A set of effective successful experiences have been gained. Practice has proved that this research makes the important breakthrough from traditional emergency - tackling to modern emergency - tackling and is of significant importance to the Yellow River flood emergency tackling in the future.

Key words: large machinery, flood emergency tackling, the Yellow River

1 Introduction

In the Lower Yellow River, the channel is wide in the upper reaches and narrow in the lower reaches and changes gradually from the wandering channel to the meandering channel. The wandering channel has the characteristics of easy to silt, easy to break and easy to move from one place to another, thus the dangerous situations occur easily. Vast manpower and material resources have been used in order to solve the dangerous situation in the previous emergency tackling experiences such as Heigangkou Works in 1982, Beiweidi bank in 1983, Wenmengdi bank in 1985, Gaozhuzhuang rivers training Works in 1993. From 2000, in order to deal with the emergency situation, the Yellow River Henan Bureau has organized to develop the new flood fighting appliances such as soft material forklift, hexagonal steel mesh braiding machine and lead wire gabion sealing machine etc. the Yellow River Henan Bureau has also creatively practiced the following techniques including the techniques of adopting the large machinery to load and cast the large volume lead wire gabion, the mechanized emergency tackling fascine techniques such as the blend of wicker - stone, per layer of wicker with per layer of stone, etc. and the mechanized encroaching technique of wicker - stone cage, and has developed a whole set of mechanized flood fighting and damming techniques, which made a significant breakthrough in saving labor productivity, and won "the third - class Dayu prize of the Ministry of Water Resources in 2006".

1.1 The characteristics of dangerous situation of the Yellow River flood control works

There is a great change of scouring and silting in the Lower Yellow River. The river regime wanders without regularity. Therefore dangerous situations occur easily in the normal spots. There is less water and more sand in the downstream Yellow River, so silt and erosion can happen in different reach or different position of same reach, especially in the reach between Huayuankou and Dongbatou, Some abnormal inclement river regime such as transversal river and diagonal river occur easily which often resulted in serious danger.

Most river regulation works have a very shallow foundation, and they can get stable only after being reinforced. The groins built on dry land according to plan for lower Yellow River regulation usually has a foundation of 2 ~ 3 m. Only after newly - built groins touch the stream and are stricken by water can scour pits form and can the foundation keep deepening in the process of rush – repair. Usually, only when the foundation gets to the depth of 12m can the groins get stable. Therefore, newly – built river regulation works without rush – repair are subject to severe danger once washed by flood.

The soil in the foundation of the groin is very complicated. Most of them originated from the middle reaches which can be divided into the coarse sand area and fine sand area and arrived in the lower reaches has due to flood. The river bed in the lower reaches is deposited as many layers by the different diameter sand. The river bed is easy to be eroded by layers and the groins can be suddenly scoured out, so it is most difficult to prevent the collapse of the groins like that. This hazardous condition was the main reason for the groins missing in the history.

The emergency due to "the Secondary Suspended River" may cause serious aftereffects. In recent three decades, it is more and more clear that there are a higher main channel, the lower floodplain and the lowest zone near the dike in the lower reaches of the Yellow River. More water will be discharged through the floodplain and contracted in the lowest zone near the dike during the flood which can increase the velocity in some local place. The current with the big velocity along the dike could scour out the dike directly and threaten the safety of the dike and the people living in the floodplain. Both emergencies at Wanzhai in Puyang in 2002 and at Caiji in Lankao in 2003 are the result due to "the Secondary Suspended River".

1.2 Research necessity of mechanized emergency tackling techniques

The traditional flood fighting techniques cannot meet the requirements of current social and economical development. Some traditional flood fighting techniques such as casting riprap, casting lead wire gabion, pushing wicker – stone pillow were usually used to deal with the slide and collapse of the dike, root missing, riprap sinking, groin falling and other dangerous situations. Those methods need more workers and more time. About several hundred professional workers are needed for the commonly emergency condition thousands upon thousands are needed for the very serious situations. The rush repair time often took 10 to 15 days, sometimes 1 to 2 months, even more time. Take the rush repair of Beiweidi bank in 1983, 6,000 army men and civilians were mobilized, the rush repair time lasted 53 days.

The equipment of large machinery provides the foundation of application study on mechanized flood fighting techniques. From 1997, flood proofing professional team equipped some large flood fighting machinery such as Loaders, excavators, dump trucks, bulldozers etc. In order to adapt the Yellow River flood fighting characteristics, taking the existing mechanized device as the foundation, inheriting the successful traditional emergency techniques, we have studied and developed the new set of mechanized working methods.

It is necessary to improve the mechanized emergency tackling techniques in order to adapt the development of the Yellow River emergency situations. Many river training works have been constructed in the lower reaches of the Yellow River. The more river training works we constructed, the more emergency we could meet. Especially during the period with the relatively clear water flowing into the lower reaches of the Yellow River due to the operation of the Xiaolangdi reservoir, the Probability of so – called "transversal channel" and "diagonal channel" occurred more and correspondingly the possibility of the emergency increased. At the same time, more adults went out for a work with the development of economy and the people who can participate in the flood fighting are less and less. So, we have to further study the mechanized techniques to deal with the flood emergency in the future.

2 Achievements and application effects of mechanized emergency tackling researches

2.1 Emergency tackling facilities development

2.1.1 Re – equipment of the soft material forklift

The soft material forklift development passed through three generations. The first generation forklift is to directly drill holes on the bucket of the loader, and install forks. The second generation forklift is to dismount the loader bucket and improve it into a fork tool which can suit the flood prevention emergency conditions. The third generation forklift is to increase the strength of each part of fork on the basis of the second generation forklift.

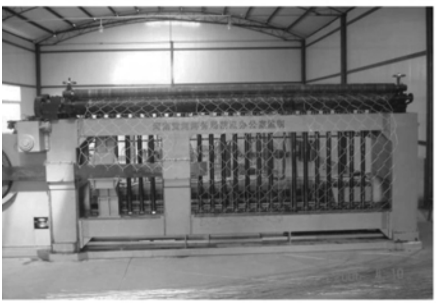
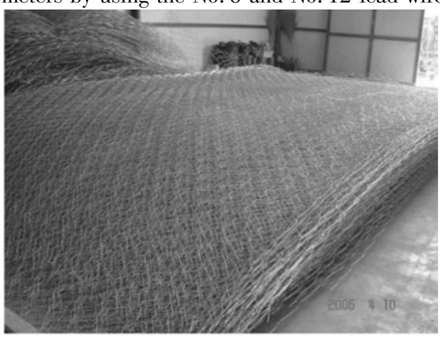


The first generation forklift　The second generation forklift　The third generation forklift

The re – equipment of the three generations soft materials forklifts have been improved through practice. This device enables the great improvement of construction efficiency of the traditional wicker – stone structure groin and plays very important role in the practical application. For example: the soft material forklift have been used in the No. 24, No. 27 ~ 28 groins which are the extension of Shendi river training works, and the No. 13 groin of Shunhejie river training works and so on. The use of the soft material forklift saves massive manpower and is very much of beneficial.

2.1.2 Hexagonal steel wire mesh braiding machine

According to the large machinery flood fighting requirement, in June, 2005, we improved the braiding machine which can weave narrow and the low strength mesh into the one which can weave mesh with high strength and any breadth under 4.3 meters by using the No. 8 and No. 12 lead wire.

Wide and high strength mesh braiding machine　　Mesh with high strength and wide breadth

Since the braiding machine was put into production, 1,500 m^2 mesh can be weaved per day, the total amount of three months' production can meet the needs of the whole year's flood fighting needs of Yellow River Henan reaches.

2.1.3 Lead wire gabion sealing machine

Three generations' lead wire gabion sealing machines have been developed in order to solve the problem of low efficiency of artificial gabion sealing. The first generation is "mutual twisted type machine". The second generation is called as "QLFK" type sealing machine, which has the advantages of light weight, small size, and reasonable design, portable and high efficiency. The third generation was developed on the basis of the second generation and is a kind of mutual twisted sealing machine with the merits of low rotate speed, big torque and better sealing effects.

Since the successful development of the first generation sealing machine in June, 2004, the technique and its application have been generalized in the Yellow River Henan reaches through the means of training and competition. This technique totally changes the way of artificial sealing, the sealing speed and sealing quality have been improved dramatically.

The first generation sealing machine

The second generation sealing machine

The third generation sealing machine

2.2 The mechanized lead wire gabion loading and casting technique

Flood fighting efficiency can be improved dramatically by casting the riprap using excavators, loaders, dump trucks and other large machinery before the research of mechanized lead wire gabion loading and casting technique. But because of the complicated emergency situation characteristics of the Yellow River training works, it is very much easy to cause the root stones missing if only depending on the casting riprap. And also the efficiency of pushing gabion by people is very much slow and can not satisfy the needs of flood fighting. Therefore, research of lead wire gabion loading and casting techniques under different conditions and with other different machinery have been conducted.

When rock resource material is relative far from the emergency spot (greater than 100m), The dump truck is spread with special mesh which is loaded with excavator and sealed with sealing machine, then the dump truck carries the gabions to the emergency spot and casts the gabions. Namely, the activities can be done by the cooperation of loader or excavator and dump truck.

If the stone material is insufficient in field and there are stones within the distance of 100m, Special mesh can be laid in the bucket of the loader, then the loader moves to the stone stack, the stone will be put into the mesh. Then the gabions are sealed by sealing machine and caste at the emergency field.

If the stone is sufficient in the emergency spot, excavator can be used to load the lead wire gabion. That is to put the mesh on the ground and to load the stone by excavator and to seal by sealing machine then to cast at the emergency site by excavator finally.

Lead wire gabion casting by dump truck

Lead wire gabion loading and casting by loader

Lead wire gabion loading and casting by excavator

2.3 Mechanized sunken fascine works techniques

Sunken fascine works have been the main method of river training works construction, emergency tackling, and blocking in the Lower Yellow River. We have proposed the new flood fighting sunken fascine techniques by combining the main arts of traditional sunken fascine works and modern large machinery considering the practice of construction and flood fighting of many engineering projects.

2.3.1 Blend of wicker and stone

Mechanized fascine damming using the blend of wicker and stone: laying on the wicker using forklift on the front of the encroaching body, then putting the riprap on the wicker, covering the riprap by wicker using forklift again, covering the wicker by stone again. Using the bulldozer to push the blend material and making the wicker and stone mix better.



Spreading the soft material by forklift loading stones by loader Blend with wicker and stone

The technique of mechanized fascine damming using the blend of wicker and stone saves a lot of pile ropes and can make the wicker – stone structure quickly. This technique was firstly used in the ground sills of Mazhuang river training works when emergency occurred. 5,000 m^3 blends of wicker and stone fascine was thrown in a short time and dangerous situation was changed in a short time.

2.3.2 Per layer of wicker with per layer of stone

Emergency tackling process by the mechanized encroaching of per layer of wicker with per layer of stones: Dig a pit behind the groin body of emergency position. Set up the timber dogs in the pit and fasten one side of ropes on them. Fasten another side of the ropes on a ship which is used to protect the fascine. Spreads a large amount of soft material on the ropes using forklift, unload the stones on the groin body behind the soft material. Then the excavator is used to push the stone and soft material into the river. As the soft material sunk into water, unfasten the ropes. Repeat the sequence and finish the whole work.


Put stones behind the fascine Fascine encroaching under the protection of ship

Emergency tackling process by the mechanized encroaching of per layer of wicker with per layer of stones is a kind of mechanized wicker – stone cage techniques which can save part pile ropes. This technique was firstly used in the emergency tackling of ground sill of Mazhuang river training works at Yuanyang County. 5,440 m^3 fascine was finished in a short time and the emergency situation was quickly turned.

2.4 New mechanized groin construction techniques

2.4.1 Mechanized encroaching techniques of wicker – stone cage

Groin construction by using mechanized encroaching techniques of wicker and stone cage is a kind of simplification of the traditional one. The main procedure is as the following. Firstly, wicker is transported to the construction spot by forklift. Secondly, the foundation of the fascine surface is cleaned by the excavator. Then the rocks are transported and pitched by the self – unloading vehicle, excavator and loading vehicle. After that, the wood pile is driven by the excavator and the ropes are tied manually on the pile. Finally, the groin body is filled with earth by the combination of self – unloading vehicle, bulldozer, excavator and loader.

Soft material transportation by forklift

Fascine surface handling by excavator

Stone unloading on the fascine

Piling by excavator

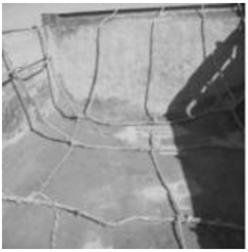
Fascine encroaching by bulldozer

Levels off by excavator

This method can be implemented quickly by large machinery instead of the manual work. In the past years, more people had to participate in the groin construction and at the same time, it took so much time to construct one groin. It is very useful to protect the bank and to control the main flow in an emergency if the groins can be constructed quickly. Before flood season in 2005, 5 buttresses were constructed at the beginning of the Wang'an works. The buttresses were finished in 10 days by the large machinery instead of 50 days by manual work in the past years. The construction is times shortened.

2.4.2 Mechanized encroaching techniques of wicker – rock rolls

The Mechanized encroaching techniques of wicker – stone rolls can be implemented in a wide field with enough stone and wicker. Firstly, the willow and stone are transported and placed in the self – unloading vehicle by forklift. Secondly, the wicker – stone rolls are made in the self – unloading vehicle with the help of manual work. Then willow – stone rolls are transported and pitched into the stack by the self – unloading vehicle. Due to the wide use of the large machinery, the bigger wicker – stone roll can be made, the shorter the time construction is needed, and the erosion of the groin body can be avoided. This way can be worked in a wider filed and more machinery can be used.



Set up the ropes in the dump truck

Loading soft material using excavator

Enlacing the wicker – stone roll

Wicker and stones pillow encroaching by dump truck

Wicker and stone pillow is in the water

This method was adopted to construct the No. 25, No. 26 and No. 27 groins at the beginning of the Wang'an works in June 2005. The mechanized construction of the wicker – stone rolls can shorten the construction period. At the same time, it greatly reduces the distance to transport the wicker by local people. It will be very useful to the groin construction and emergency tackling.

3 Economic efficiency targets

The successfully development of the large machinery emergency techniques enormously save the labor and reduce the people's labor intensity. The application of large machinery improves the efficiency of flood fighting activities and could control the emergency situation quickly and plays very important role to guarantee the safety of flood control works. According to the field measured data, the economic efficiency targets are estimated for the each item in this study.

3.1 Flood fighting assistant device

(1) Soft material forklift. For transport of soft materials over a distance of about 250 m, a forklift truck is over three times faster than 200 workers while the cost is only one – third that of labor.

(2) Hexagonal steel mesh braiding machine. Mesh with maximum breadth of 4.3 m can be produced by using the No. 8 lead wire; the weaving speed is 150 m^2/hour.

(3) Sealing machine of lead wire gabion. 3 ~ 5 seconds are needed to finish one knot by using the sealing machine. That is 10 times efficiency of the labor.

3.2 Mechanized loading and casting lead wire gabion

Loading and casting the lead wire gabion by large machinery is 50 times faster than labor while the cost is about five – sixths to one – third that of labor (the material cost is not counted).

3.3 Mechanized emergency tackling with blend of wicker and stone

The efficiency of mechanized blend of wicker and stone by the cooperation of 1 forklift, 1 loader, 3 dump trucks and 1 excavator is three times faster than that of 200 workers while the investment is only one – third to one – fourth that of labor (Material cost is not counted). At the same time, a lot of pile ropes can be saved.

3.4 Mechanized emergency tackling technique of per layer of wicker and per layer stones

Per layer wicker and per layer stones sunken fascine can be finished by the cooperation of 1 forklift, 1 loader, 3 dump trucks, 1 excavator, 1 ship and 10 workers. It takes one hour is to finish 210 m^3 sunken fascine, and that is 1.2 times faster than labor while the cost is one – second or one – third that of labor. At the same time, a lot of pile ropes are saved.

3.5 Mechanized encroaching technique of wicker – stone cage

Encroaching length is 7 ~ 8 m per time. The efficiency of cooperation of 15 workers, 3 dump trucks, 1 excavator, 1 bulldozer and one forklift is 2 ~ 3 times of that sunken fascine making by 300 works, while the investment is one – third or one – fourth that of labor (Material cost is not counted).

3.6 Mechanized encroaching technique of wicker – stone roll

The sunken fascine making efficiency by the cooperation of 15 workers, 3 dump trucks, 1 excavator, 1 bulldozer and 1 forklift is 2 ~ 3 times faster than that of 300 works, while the investment is one – fourth or one – fifth that of labor (Material cost is not counted).

4 Conclusions

Mechanized emergency tackling techniques inherits the traditional rush – repair techniques of the Yellow River. The mechanized operation mode helps deal with emergencies faster, and at the same time alleviates labor intension of emergency squad members and liberates productive forces. The techniques have been widely spread over Yellow River Henan reaches through training and competitions, and it has played an important role in a number of emergency tackling activities. The result of the study takes the lead in the country.

The study result has broken the operation mode of relying on heavy manual labor in the traditional emergency tackling, helped form the new pattern of dealing with severe emergencies and constructing dykes under water mainly with machinery, solved the problems of shortage of labor and low efficiency. At the same time, it combines large modern high – speed, high – effectiveness machinery with traditional technologies of emergency tackling and groin constructing under water, thus retains the marrow of the traditional technologies and advances the development of Yellow River sunken fascine works with the use of large machinery operation as well. This study provides a whole set of technologies and measures for the current emergency tackling in flood control and underwater construction of emergency projects, and opens up a broad prospect for the future development of technologies of emergency tackling in flood control, construction and crevasse repair.

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Visualization Methods Study on Bridge Influence Estimation towards Riverway Flow Field

***Huo Fenglin*[1], *Jia Aichen*[2], *Lan Hualin*[1] and *Xie Zhigang*[1]**

1. Yellow River Institute of Hydraulic Research, Zhengzhou, 450003, China
2. Institute of Civil and Hydraulic Engineering, Dalian University of Technology, Dalian, 116024, China

Abstract: In order to realize the visualization of the riverway flood flow field, this paper focus on the Triangle Net Model in the Digital Elevation Model (DEM), using OpenGL method of illumination, material, texture map and antialiasing to realize the multi – dimensional visualization of river way terrain. The modeling transformation of removing, rotate and scaling in VC + + and OpenGL are also used in order to realize the dynamic displaying effect. Searching functions related to visualization and riverbank flood forecast can be realized after adding flooding data under various conditions. These functions are for the reference of flood control decision – making.

Key words: DEM, OpenGL, river terrain, visualization

1 Introduction

In recent years, the technology of terrain multi – dimensional visualization has widely used in the area of GIS, digital basin simulation, flood control decision – making system and visual environment simulation. With the development of science and technology, visualization technology has become a leading way in flood forecast area and river channel evolution analysis. It is also an effective way in reappearing and analyzing the terrain multi – dimension information. In the process of developing river way flow visualization system, by using OpenGL three dimensions function, and forming triangle mesh through regular meshes this paper finally realize the riverway multi – dimension terrain. Searching functions related to visualization and riverbank flood forecast can be realized after adding flooding data under various conditions.

2 Model of Multi – dimensional river terrain

The realism display of channel terrain is the basis of riverway flows simulating and flood forecast. DEM model is the main form of multi – dimensional terrain visualization. DEM can be divided into three types: DCM (Digit Contour Model), TIN (Triangle Irregular Net Model) and RNM (Rectangular Net Model). As Digit Contour Model has the disadvantage of non realistic and small information content, it is comparatively little using in practice. The other two models, TIN and RNM, have become too widely used Digital Elevation Model.

2.1 Triangle net an grid model

Among all the possible triangle nets, delaunay triangle net model is the most excellent one in terrain construction interpolation, so it is always used the form of TIN. TIN has many obvious advantages and disadvantages, one of the main advantages is the changeable resolving power, when there is rough appearance and severe change, TIN can contain various data which can reflect the change of terrain. TIN also have the ability of considering main data site, which cause the complex stocking and operation of data.

Grid data structure is the typical raster data structure, the relation of every point and its neighbor point has already hide in the number of rank, the mixed point is the elevation number. The advantage of Grid is that it has simple data structure, small data storage and easy handling, suitable for large scale usage and management. However, it also has disadvantage of having difficulty of identifying the suitable net sizes and small rise and fall in the complex terrain area.

2.2 Riverway terrain data

The reorganized DEM data is needed in order to realize the river way terrain's three dimension visualization. Because the large amount of DEM data and larger net space are used in this paper, it uses interpolation calculating way to realize the Grid data of river terrain. The triangle has the characteristics of exact identity its normal, so it can solve the problem of different meaning of normal vector of planer element and improve its efficiency. By combining the characteristics of two data form, under the condition of small raise and fall of terrain and partly fall, it use the method of resolving the Grid data to triangle net to form the triangle net structure. This paper forms the river way terrain triangle net by the way of resolving the regular grid to triangle.

There are two ways of DEM data reading method: by forming data base and read by using relative functions. Because the data base is lack of moving ability, the analysis in this paper use relative functions. This paper use DEM data form, use function Import( ) to read useful data and filter the superfluous data information. Continue circulative reading and stock in the two dimension array, in order to save internal storage, the method of dynamic allocation of internal storage is used in this paper, which can save the expenses of system and improve the efficiency.

3 Three dimensions visualization of riverway terrain

OpenGL, as a software package for three dimension drawing tool, has open character and separation from window system and operative system. It has advantage in the three - dimension picture model forming ability and programming. It is formed by many picture functions and combining some complex method for computer graphics, With OpenGL as its basis, Program can be easily transformed among various operative platforms. Now OpenGL has become an open three dimension standard in International area.

Several parameters need to be set before using OpenGL. First, the RC and picture elements should be set, second, the characteristics and place of light source, the picture model and texture map should be correctly set, also the best watching place and direction should be set. OpenGL can provide relative parameter to assist these settings.

Viewpoint is a rectangular area in the computer screen which can be used to draw pictures. When it is not exist, it can be as big as window and measured by coordinate to reflect the position of picture elements. The main point of viewpoint is equal to the left - down side of the window. The change of viewpoint is to change the three dimensions coordinate to be the two dimensions coordinate in the screen. The height and width of viewpoint can be equal to its internal rate, otherwise the pictures appeared on the screen will be changed. The objective of OpenGL is set across the topmost, GlVertex * ( ) has provide coordinate information. This paper used triangle to construct the unit.

Because the different net for river terrain with bridge and without bridge, when drawing dyke, each side of dyke data should be change accordingly. The terrain area net with bridge was added secret key in this paper. Under the basis of relative terrain data, a general terrain data interface program was made in this paper, which can quickly realize and show the terrain data, it has greatly improved the system development efficiency. By using parameterized program to achieve terrain and flow data instead of imputing all the data in to the internal storage, it has save the expenses and improve the speed. Both availability of terrain display and realistic of terrain are considered in this paper, it has achieve a good effect by increase the height of river way elevation. Fig. 1 has showed the details.

After net terrain was displayed, normal vector should be correctly set. OpenGL itself does not provide the functions to calculate the normal vector; it should be calculated by us. Every side has two directions in three dimensions view, so when calculating triangle normal vector, it should follow

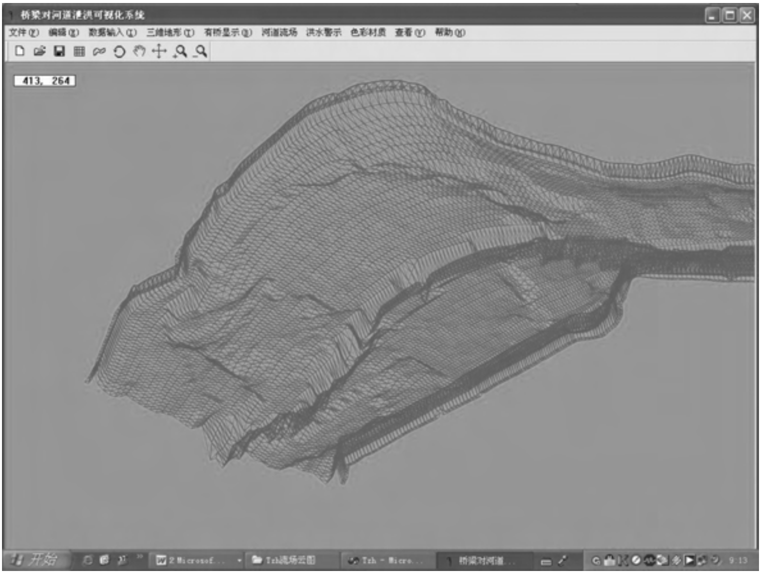

Fig. 1 River way terrain net display

the same order and take two direction lines; calculate cross products and its unit. In this way, the normal vector of triangle can be achieved. The vector of topmost can be evaluated by the average of its six triangle vectors. The visual surface drawn by anticlockwise is the default side of OpenGL. Different visual surface can be adjusted by the parameter of OpenGL (front side, back side, front and back side), By using GlEnable(GL_DEPTH_TEST), it can achieve that technology and greatly improve the speed and clearness of the pictures.

In order to make the pictures of riverway has stereoscopic effect, certain light illumination is important. When the light is sent out to the surface of object, part was absorbed and by the object and other parts was reflected by the object surface. For the transparent objects, some light will go through the objects and form transmission light. The intensity of light decides its lightness, and wavelength decides its face color. We can set light source through function, GlLightfv( ), and use GlEnable(GL_LIGHTING) start the light source. Suitable light setting and correct way of calculating triangle vector are the necessary elements to make the object more multi dimensional.

In order to realize mutual control of pictures, the functions of removing, rotate and scaling are set in this paper, and some control functions of mouse are also added in this paper, the left key of mouse can realize removing, the roller can control the scaling of terrain, the right key can realize the translation of river way terrain, we can choose function of OnMouseMove(UINT nFlags, CPoint point) to decide which key should be used, the code is as flowing:

```
void CTzhView::OnMouseMove(UINT nFlags, CPoint point)
{
    if(m_bLeftMouse)
    {
        Realize by rotating;
        Invalidate(TRUE);
        MouseDownPoint = point;
    };
    if(m_bRightMouse)
    {
        Realize by translation;
        Invalidate(TRUE);
```

```
        MouseDownPoint = point;
    };
    CView::OnMouseMove(nFlags, point);
}
```

The system can use the key and keyboard to realize the functions of removing, scaling and rotating, In order to achieve exact mutual control function, the functions of dialogue box was added in this paper.

4 Flood control prewarning of riverway flow field

4.1 Display of riverway flow field

One of most important effects of terrain three dimensions visualization is its application in flood forecast and riverway evaluation. After the river way terrain three dimensions visualization has been realized, the river terrain flow visualization can also be realized by using elevation data of river surface. There are four parts of flood data in this paper: 50 years flood, 100 years flood, 50 years flood with bridge, 100 years flood with bridge. Because the pier can affect the area of section, which cause the backwater of upper side of pier, the last two data has larger elevation value and has great effect for the dyke flood control. The river way terrain and flood overlying can be achieved by the examine method provided by OpenGL. It has formed a visualization system based on DEM three dimension flows. Certain elevation has corresponded with a color, which can easily analyze the flood effect. Below are the flood flow speed pictures under two different conditions(Fig. 2).

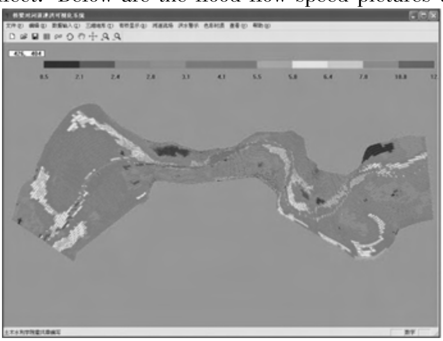

Fig. 2(a) 50 years flood speed display

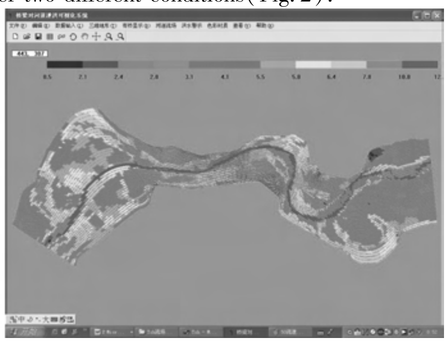

Fig. 2(b) 100 years flood speed display

The construction of bridge has reduced riverway section area, which cause the backwater of upper side. The column from OpenGL data bas was used to set functions GluCylinder (quadObj, base, top, height, slices, stacks). The relative data of bridge was selected from CAD terrain documents to make it exact.

The topmost of coordinate are used to draw the underside, that is the central point (0, 0, 0), When display the terrain, the elevation doubled , which also cause pier elevation double, it makes the pier looked much longer. The bridge section was made by four piers, each one has equal distance with another, through OpenGL translation function, and the column removing can be achieved, which can make the picture displayed more exact. By method of circulation, all the piers can be successfully displayed. By using some rectangular, the bridge top was simply set, the flow elevation is as Fig. 3.

4.2 Riverway flood forecast

This paper conducts research on the river bank warning water level forecast. Through reading relative functions, it compared the flow data with its dyke elevation by double circulating sentences. Red dynamic lines are used to sign the point where the flood data elevation above the dyke water warning level, in this way, the flood warning function can be achieved. Double buffering technology of OpenGL was used to realize red line warning effect. To get more fluent effect, the time value of function Set Timer( ) should be set, and draw the red warning line according to requirement. In this way, the over warning water level flood information can be read and we can fully understand the dyke position, speed and direction, which become a important reference for flood warning decision making.

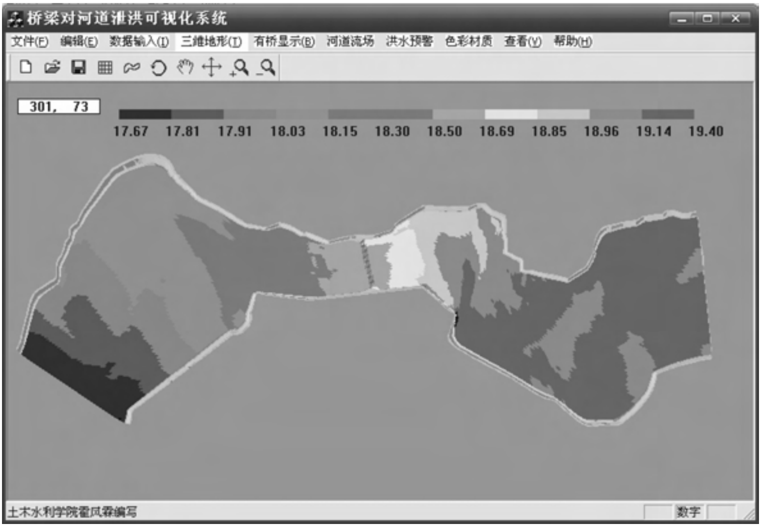

Fig. 3 Two dimension flow elevation display

5 Conclusions

With VC ++ as its development platform, and with Object Oriented Programming as its designing method, together with the function data base provided by OpenGL, this paper realize the two – dimension visualization of river way terrain under different conditions. The modeling transformation of removing, rotate and scaling in VC ++ and OpenGL are also used in order to realize the dynamic displaying effect. The visualization method discussed in this paper has its application value on the flood forecast and evaluation. It also provided a visual analysis for the warning water level forecast.

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Practice and Thinking on Mechanism Reform of Construction Management for Small Watershed Dam System on the Loess Plateau

Jiang Dejiang, ***Shi Yong*** and ***Yu Longhua***

Upper and Middle Yellow River Bureau, YRCC, Xi'an, 710021, China

Abstract: It is a new attempt for water resources management institution (WRMI) act as a constructor to build dams system in small watershed on the Loess Plateau. This is a matter involving with renewal of traditional concepts and reformation of existing institutional structures. Bureau of Yellow River Conservancy Engineering Construction just emerges at such a time and makes some research and exploration on the management of dam system construction in small watershed. In this case, the main explore refer the "Three Systems" for fundamental construction involving certain investigation and study on the realization mode of "Legal – Person – Responsibility – System", the establishment of win – win mechanism with locality, implementation of bid and tendering system, funds circulation procedure, and effective supervision mechanism. Some new processes have been summarized and some suggestions have been used in practice.

Key words: soil and water conservation, small watershed dam system, construction management; mechanism reform, Loess Plateau

With the establishment and perfection of market economy and normalized construction market, the concept of project management has been paid more attention in all trades and professions. Some aspects in construction of small watershed dam system on Loess Plateau for soil and water conservation, such as how to combine concept with practice, how to introduce new concepts for project management, how to accelerate the "Three Systems" for fundamental construction in a rigid way, so as to meet the requirements for institutional and financial system reform and smooth management routine thereby, thus actualizing standardized management, insuring construction quality, and giving full play of engineering effectiveness, have become imperative major tasks. Bureau of Yellow River Conservancy Engineering Construction (hereinafter to be called as Bureau of Construction) has been making useful research and exploration on this topic, especially on the issue of how to practice the "legal person responsibility system" and "bidding & tendering system", and has organized and implemented some dam system construction projects in small watersheds, with the aim to accommodate to the mechanism reform and practice for implementation management of small watershed dam system on Loess Plateau.

1 Deep reveleation from key sectors of construction management

Legal – Person – Responsibility – System, and bid and tendering system have been gradually carried out for small watershed dam system construction for water and soil conservation on Loess Plateau in recent years. Yet the degree of the system implementation is still somewhat distant from being proper as a whole, for it has been the first trial for WRMI, without any successful model to follow while being confronted with various drag forces. Besides those drag forces derived from old system and concept, some problems, such as local counterpart fund, moving from inundated land, construction environment, project handover, and implementation for routine management and protect, still need further coordination. And these problems get settlement mostly by local administrative intervention under current management system, and the administrative functions of WRMI are softening. Through research and investigation, base on reference from the construction management for the World Bank financed project – Loess Plateau Watershed Rehabilitation, and from the practice of Legal – Person – Responsibility – System in the South – to – North Water Diversion Project, consider the character of the construction of small watershed dam system, we have made attempts in aspect of implementation management, We follow four principles in the whole construction process, namely, principle of making innovations and practice, principle of procedure standardization and quality insurance, principle of improving ecological environment and maintaining a healthy Yellow River, and principle of coordinating with local government and masses, and a great phase has been initiated in the management reform for Loess Plateau small watershed dam system construction for soil and water conservation in such a way.

1.1 Making active practice, seeking to realize "Legal – Person – Responsibility – System"

We have established a set of management control procedure. First is to set up an "Interim Management Regulation on Soil – Retaining Dam System Construction Project", which prescribes the responsibility of the construction unit and specify its relationship with various participators. Second is to formulate Agent Construction System, since there are many dispersed small watershed dam system construction spots on Loess Plateau. And its purpose is to practice construction unit qualification system and agency system, which is fit for the local situation, and is helpful to harmonize all connections among the government, institutions and enterprises from perspective of organizing project entity and construction unit, thus making clear of each main body responsible for the project entity, for the project construction, and for the project management and protection. WRMI and the locality co – organize the project entity, and each takes charge of government investment and local supporting funds respectively. The project entity executes qualifications authentication and contract management on the construction unit, providing assistance for defining its artificial person, regulating its financial, technical and construction management, ascertaining sector liable for the project management and protection. In such a way, power and responsibility has been made clear, division of labor is reasonable, and affixation of responsibility is legal in the whole process of the project construction and management.

1.2 Making harmonious cooperation, and giving full play to each participator's activity and enthusiasm

The construction for small watershed dam system on Loess Plateau has its own feature of regionalism. In the stage of feasibility study before project proposal, the government of county should make written promises, for matters as land occupation, local counterpart fund, moving from inundated land, (traffic, power supply, communication) lines reconstruction, and management and protection after takeover, in the project implementation. After the project proposal & confirmation, WRMI shall supervise and urge the county government to set up a construction leading group consists of CEOs from each department as well as from township government, and the office of the leading group is to be set up at the county soil & water resources and conservation bureau, which is responsible for agreement and fulfillment of relevant system and method, and for settlement of certain scheme, thus providing good environment for construction. Bureau of Construction and the county soil & water resources and conservation bureau shall make an "Agreement on Management of Project Construction and Operation", and Party A may send its representative to the working site to establish an on – site construction office together with the county soil & water resources and conservation team (station). In order to regulate the responsibility and behavior of the representative, we have formulated "Office Procedure of On – site Representatives", and made good supervision, coordination and technical check on various participators on the construction site accordingly, to ensure the project construction quality and progress.

In stage of engineering design, we shall follow the basic principle of "the beneficiary acts as the manager and protector" to decide the form and responsible party for the project management and protection, while making reference to the project locality, scale and beneficial result. At the same time, we will supervise and urge the county soil & water resources and conservation bureau to sign the "Contract for Project Management and Protection" with the township government or village council where the project locates, abide by the county level's government promise. The party responsible for project management and protection should take participation on stage of construction.

1.3 Being strict with each procedures trying to find out suitable mechanism of bid & tendering

In terms of our bureau's prescriptions on management of bid and tendering, we strictly follow each procedure on report for filing, entrust the agency, FR, and sign of construction contract, and accept complete supervising from superior department in charge, that is, department of construction management and department of disciplinary inspection & monitoring. For entrust the agency, we will choose qualified intermediary organs in water conservancy industry. On division of tender sections, we use lateral ditch and backbone dam and dam system as the unit. Public bidding is adopted for backbone dam constructed by cushion method, with storage capacity over 1 million m^2; and selected bidding is adopted for backbone dam constructed with water saturation vibrating method, with storage capacity under 1 million m^2. Considering the qualifications of the construction unit, any participator for the public bidding should with be of general contracting of hydraulic and water power engineering, or of third grade professional contracting for large dam hydro – technical engineering. Qualifications for participation in the selected bidding are comparatively loose by actuality. And unit price contract is used, taking the project scale and necessity for management into account. As a result of sticking to the principles of being "impartial, Open, Equal and Alternative Optimum", we have achieved comparatively successful result in organizing the bidding for the 16 backbone dams of the three dam systems including Yuanping, and basically apprehended the features of bid and tendering for soil – retaining dam system construction project, got familiar with construction market environment for soil – retaining dam system project. And all these have laid a solid foundation for further regulating the construction market of small watershed dam system, and ensuring relevant project construction quality.

1.4 Reducing funds circulation, ensuring funds safety and efficient use

We have adopted two – level financial management system that is run both by WRMI and the county soil & water resources and conservation bureau. Special accounts for funds from the central government are to be set up on two levels by each item, and the local counterpart funds are under the special account of the county soil & water resources and conservation bureau. Two forms of spending, i. e. application for reimbursement and funds allocation are parallel, and has reduced funds circulation, the direct profit of which is to accomplish the construction task a year in advance.

Meanwhile, on basis of regulating accounting in construction unit, we have probed into account transaction of fixed assets application in construction, and solved some long – existing problems, such as negligence on final account of certain completed project, no distinction between unit undertaking projects and construction unit in accounting, all capital construction completion headings listed as non – profit, no handover of financial management to be as fixed assets, and etc.

1.5 Taking full advantage from the restraining mechanism of legal administrative supervision, and setting up a safe screen for project construction

We have introduced legal administrative efficiency supervision, and taken an active attitude to coordinate and accept complete following – up supervising from superior department in charge, that is, department of disciplinary inspection & monitoring, for administrative efficiency. Before start – up of project construction, we may ask permission from superior construction management department, and sign the letter of attorney on quality supervision, and accept legal administrative efficiency supervision from quality supervision station under local water conservancy in the whole construction process. After completion of final account for the project, we would make formal report to higher department in charge, making request for legal administrative audit supervision by corresponding auditing department. The behavior of construction management is standardized by fully applying effective administrative supervision mechanism. From it we have a deep understand about the effect of supervision and restriction mechanism which relies on administrative functions, and have a better understand about the action, division of work and correlations of the independent institutions and enterprises which participate into the management of project construction.

2 Existing Problems and Suggestions

2.1 Implementing the policy and regulation system of project legal – person – responsibility – system

The project entity of current small watershed dam system construction on Loess Plateau has been specified in the official reply of the project feasibility report: it seems that the main body responsible for organizing the entity is the approving institution; the responsibility of the entity may be realized through the county (banner) soil & water resources and conservation bureau, its subordinated soil & water resources and conservation team (station), as well as the construction units subordinated to WRMI, etc. Along with the deepening and perfecting of national structural and institutional reform, management units on various levels, including WRMI, have all set up institutions of independent legal entity (such as soil & water resources and conservation team). Though the current organized implementation is not flawless, for example, mode of organizing is not unified and form of realizing responsibility is interrelated, yet the structural establishment after reform has provided conditions for overall pushing the Legal – Person – Responsibility – System forward. Facing such a situation, we suggest that a proper project management method should be formulated or perfected as quick as possible, which is fit for the actual small watershed dam system construction, and practice the "Three Systems" for fundamental construction, and further define the main body responsible for organizing the entity, as well as form of realizing the project entity (construction unit) responsibility. While well linking up with the current managerial system, institutional regulations for management responsibilities on various levels should be made, especially for management responsibilities and behaviors in those construction units, thus realizing the transformations from administrative control to project control, from administrative relations of dependence to independent & equal main body, making the management procedure totally harmonious and standardized.

2.2 Standardizing administration procedure of bid and tendering by actuality

At present, in bid and tendering organizing, the provincial (autonomous region), municipal (Meng league), and county level (Banner) soil & water resources and conservation administrative authority and the units undertaking projects play the same role; in mode of bid and tendering, some entrust certain qualified social intermediary organs to make public bidding or selected bidding, and some may consult with several construction units to make decision, lacking the indispensable procedure of "negotiated bidding"; on division of tender sections, some may use single backbone dam as the unit, and some bind the small and medium scale dams together with backbone dam to form a complete set as the unit fir bidding; since some local counterpart funds do not reach the designated position, some work out the base number of the tender based on funds from the central government, and some only invite public bidding for ground works, while handing stone works over to certain town and village for construction. Due to restrictions on norm of rough estimates, project scale, construction environment and technical contents, large – scale construction unit cannot step in such kind of project construction, and only small – scale construction units with qualification on the trade undertake the project. All these problems may directly affect the standardization of bid and tendering, and we suggest that the administrative authority in construction put great emphasis on the problems, assign specific persons or set up specific organ to make complete and deep investigations, and formulate the office procedure and enforcement regulations, which if fit for the actuality of small watershed dam system construction. In such a way, problems such as admittance criteria of construction units, principle on division of tender sections may be clearly defined, and a supervising and managing mechanism for bid and tendering will be set up, which would be effective in regulating bidding procedure and administrating construction market.

2.3 Attaching importance on engineering cost management

Along with the implementation of "Three Systems" in dam construction on the Loess Plateau, and with the further unification of technical specifications and quality criteria, construction projects are facing with many new requirements while making the budget estimate, especially in aspects of "items of charge" and "charging standard". There are some new problems encountered in the implementation, for instance, in some projects the items of charge are incomplete, and in some projects the charging standard is on the low side, etc. These new requirements and new problems restrict the normal development of project construction and management. Hereby we make the following suggestions: for the key dams with dual roles of flood prevention and engineering effectiveness, the budget quota of flood – control works shall be applied; and the competent departments shall assign special persons or a consulting company to work out rational proposals and schemes based on systematic and all – around investigations, detailed and professional statistic process, and practicable analysis as well, by such means to help the current recommendatory – oriented budget quota change to application – oriented.

2.4 Strengthening and perfecting the quality supervision system

There exist two situations in quality supervising of the present small watershed dam system construction on Loess Plateau. One is the widely dispersed construction spots that cause difficulty for the quality supervision station to assign specific responsible person, and the legal administrative efficiency supervision is replaced by administrative routine quality inspection generally. The other is that the local department of water administration on various levels has not set up quality supervision station. Though most municipal level (Meng League) department of water administration or over has quality supervision station, yet no activities on quality supervision of soil conservation project (soil – retaining dam) has been carried out. The kind of negligence or mechanical use of those on hydraulic engineering may cause ineffective result of supervision on project construction, and all these need both the administrative authority in construction and the quality supervision station to make investigation and study, and to establish a small watershed dam construction quality supervision system, combined by the quality supervision station under WRMI and quality supervision station under local department of water administration. As a consequence, the legal administrative supervision mechanism for project construction will be perfected, and the small watershed dam system construction on Loess Plateau will be on a healthy and ordered way.

2.5 Ensuring the local counterpart funds to avoid the fund shortage in dam system construction

Presently, for soil – retaining dam construction projects, government investments only makes up 65% of the total investment on key dam construction, 50% on medium – size dam construction and 30% on small – size dam construction. The rest have to be raised by local governments and local people. Investigations showed that only 15% of the counterpart funds which should be raised by local government have been properly prepared because most of the counties (districts) where the dams would be built were in poverty and in financial difficulties. The shortage of local counterpart funds negatively influenced the engineering construction, and a series of problems arose consequently, first, engineering quality could not be guaranteed, second, safety in engineering construction could not be ensured, third, some of the dam construction projects were treated as government – invested projects while calling for tender, and sometimes money even might be unreasonably saved from the government investment after bid invitation, fourth, in the final account for the completed projects, the counterpart funds which should be raised by local government might be spuriously included in the total investment, resulting in the discrepancy between the final account made by the constructor and the final account made by the party called for tender. Such problems not only influenced the standardized operation of the soil – retaining dam construction market, but also brought about many potential and difficult problems in aspect of engineering construction, supervision, quality control and financial management. Therefore, taking the actual local finance conditions into consideration, the state shall further increase the government investment on soil – retaining dam construction in the Loess Plateau area; especially the construction of key dams shall be fully covered by government investment. Meanwhile, more efforts shall be made to strengthen the supervision and inspection on local counterpart funds, to set up incentive mechanisms and restriction mechanisms, and to promote the monetization of local counterpart funds as well. Some effective local experiences and measures shall be summarized and propagandized in time. For instance, in order to bring the benefits of soil – returning dams into full play, small watershed construction in Fenxi County of Shanxi Province is always accompanied by work – relief program (i. e. , providing work as a form of relief) focusing on building production dikes, dike fields, drainage facilities and roads for tractor plowing downstream the soil – retaining dams, by such means the auxiliary works of dam system construction in small watershed could be quickened. It is a method which integrates the funds and forms the project into a complete set. The government of Yan' an City has listed the soil – retaining dam construction into the schedule of key municipal works, treating the local counterpart funds for dam system construction as an essential work to be ensured. 40% of local counterpart funds are brought into the annual municipal financial budget and the rest are to be provided by means of county – level financial allocations. It is a method with features of "the local counterpart funds to be shared by the functional department in each level under the leadership of local government". Being effective and suitable measures for solving the local counterpart funds, all these methods should be applied and popularized widely.

2.6 Giving full play to the coordination function of local governments, properly solving the problems of submerged land and immigrant, and creating a fine environment for construction

In the "Method for Administrative Management of Soil – Retaining Dams" issued by the Ministry of Water Resources, it is stipulated clearly that "the county – level government shall be responsible for making compensation for the loss arising form land use, submerged land, and moving of immigrant due to soil – retaining dam construction within the county". However, it is very common at present that the constructors have to pay the money, that is, to make the above compensation through carrying on negotiations with the towns and villages involved in the construction under the arrangement of county water conservancy. In addition, the commitment system of mass labor contribution has not been put into practice enough, and the benefits of soil – retaining dams, such as land silting, water impoundment and dam – and – road combination, etc. , have not been completely utilized, and insufficient efforts have been made to arouse the enthusiasm of local cadres and people in the beneficiary villages to participant into the dam system construction by administrative means. For instance, in 2006, 4 key dams and 3 medium – size dams were to be built in a county, for which 0.99 million Yuan of compensation cost for forest land requisition and occupation was needed, however the total investment on these 7 dams was only 3.61 million Yuan. Because of the financial inability for going through the land – use formalities and the repeated obstructions coming from local villagers, the commencement of dam construction was delayed about half a year. Such things happened frequently and greatly affected the progress of soil – retaining dam construction. For the reasons given above, we hereby make the following suggestions. Firstly, along with the development and perfection of market economy and the practice of aiding – agriculture policy, it is more and more difficult to depend on the government's commitment to solve the compensation problems arising form land use, submerged land, and moving of immigrant due to soil – retaining dam construction. Such problems have to be solved by adjusting the budgetary estimate. Secondly, the governments below the county level have to make every effort to do well in coordination. In Shanxi Province, in order to supervising the county – level government making compensation for the loss arising form land use, submerged land, and moving of immigrant due to soil – retaining dam construction within the county, and to create a fine environment for dam construction, the county – level government is required to make clear compensation promise before the approval of project proposal through negotiating with township government and villagers' committee involved in dam construction in phase of feasibility study. Meanwhile, detailed executive plan for each engineering construction shall be worked out carefully, which would be an essential condition for the approval of project proposal. Actually this is a method which can perfect the preliminary works of dam system construction in small watershed, and can rationally solve the compensation problems as well. Therefore it should be properly summarized and widely popularized.

Establishment and Application of "Data Dictionary and Table Structure of the Yellow River Project Management Database"

Lan Hualin[1], ***Lu Dutian***[2], ***Zhao Le***[3], ***Xie Zhigang***[1], ***Deng Yu***[1] and ***Yue Yusu***[1]

1. Yellow River Institute of Hydraulic Research, Zhengzhou, 450003, China
2. Department of Construction and Management, YRCC, Zhengzhou, 450003, China
3. Information Center, YRCC, Zhengzhou, 450004, China

Abstract: "Data Dictionary and Table Structure of the Yellow River Project Management Database" is based on current national technical standards. It is produced by analyzing, sorting and compiling a great deal of basic information in the Yellow River project management, considering the characteristics of the flood control project management. It can realize the share and distributed storage of basin project management info by regulating development of the Yellow River project management database. According to info function, the flood control project management info is divided into three parts, i. e. basic info of project management, management info of project operation and safety monitoring info of flood control, as well as the analysis on data type and precision is carried out. At one time, the technical terms are defined detailedly. Its application indicates that the quick inquiry about basic info of the flood control projects can be realized, the project operation mode can be monitored at real time, and the decision support on laying down the management, operation and maintenance programs for the flood control projects can be provided quickly, accurately and scientifically.

Key words: project management, data dictionary, establishment technology, the Yellow River

1 Establishment purposes

High design standard and large scale features the flood control projects of the Yellow River including key hydro projects situated on the main stream and branch streams, dike projects, river training works and sluice projects. The "Digital Yellow River" project has the function of data collection, real - time transmission, storage management and on-line analysis and process, so it can realize effective management of the flood control projects. The establishment of "Data dictionary and table structure of the Yellow River project management database" (hereinafter abbr. as "Data dictionary") is an important means to realize the share and distributed storage of basin project management info and serves the function of regulating development of the Yellow River project management database.

2 Supporting references for establishment

The current national and professional technical standards that are referred to establish "Data Dictionary" are listed as follows:

(1) "Specification for the drafting of technical standards of water resources" (SL1—2002);
(2) "Standard for flood control" (GB50201—94);
(3) "Design specification for levee project management" (SL171—96);
(4) "Design criterion of reservoir management" (SL 106—96);
(5) "Design specification for sluice project management" (SL170—96);
(6) "Technical specification for concrete dam safety monitoring" (SDJ336—89);
(7) "Standard of Technical Terms on Hydro engineering" (S26—92).

At the same time, the standards referring "digital Yellow River" are:

(1) "Specification on Basic Information Coding of Water Conservancy Projects of the Yellow River" (SZHH07—2003);

(2) "Specification for the Information Coding Of the Yellow River Hydro Projects Construction and Management" (SZHH10—2003).

3 Establishment contents

The Yellow River Conservancy Commission is an agency of the Ministry of Water Resources in charge of the Yellow River basin and takes on the responsibilities of water administration in the basin. Undertaking, within the authorization, the management and protection of rivers, dikes and water projects is one of the responsibilities. It mainly includes guiding the harnessing and development of the rivers, lakes, beaches and coasts; checking and approving the construction of water projects; directing the safety management of water installations; being responsible for the construction, danger - removal and monitoring of the central - government - invested projects; checking and approving the construction in river management scope; supervising the market of water project construction.

According to the characteristics of the Yellow River flood control project management and practical situation, the large quantity basic info generated in the long - term management and operation of the Yellow River flood control projects is analyzed, sorted, compiled. Thus the management info is classified into three types, i. e. basic info of project management, management info of project operation and safety monitoring info of flood control.

3.1 Basic information of project management

The basic info of project management is the original data describing basic features about the Yellow River flood control projects, including declaration to project site, engineering structure and technology. It is categorized according to project type i. e. dike, river training project, water gate, through structure, stride river project, danger spot, reservoir, mechanical irrigation engineering and also contains their special info about biology protection engineering, pertain establishment and safety monitoring system. In addition, the basic info of project management units and engineering maintenance troops is included, too.

3.2 Management information of project operation

The management info of project operation is generated in operation and maintenance process of the Yellow River flood control projects and includes the management info about daily project maintenance, detection for hidden defect, project inspection etc. In addition, the management info of maintenance for biology protection engineering and pertain establishment is included, too.

3.3 Safety monitoring information of flood control

The safety monitoring info of flood control is collected by the inner - outer sensors and nondestructive examination technology from the flood control projects, such as dike, danger spot, river training project, water gate etc. The safety monitoring item of flood control is classified as seepage pressure and infiltration, distortion, stress, strain, vibration etc. It includes basic safety monitoring info, measuring network info, monitoring instrument parameter info, measuring value info and measuring alarm info, etc.

4 Technical analyses

To establish "data dictionary", it is needed to define data type, data range and data precision, provide encoding method for identifier, specify the database table structure, establish data dictionary and define technical terms.

4.1 Data type

There are four data types in the data table structure: character, numeric data, date data and text.

4.1.1 Character

It is used mainly to describe non – numerical data. The data belong to it couldn't be used in the mathematical calculation in general sense, but only possess a descriptive meaning, such as observation station code, designation and comment description.

The description format of character is expressed in Equation(1).

$$C\ (d)\ \text{or}\ VC\ (d) \tag{1}$$

in which Where C (abbr. of Character) is type designation describing character fixedly; VC (abbr. of Variable – length Character) is type designation describing variable – length character fixedly; "( )" is sign, as the permanent symbol describing data length; d is decimal digit, no less than 1, describe the maximum possible string length of field.

4.1.2 Numeric data

Numeric data contains two kinds of data, one is floating number with decimal fraction, and the other is integer. All data lengths are described with bit number in decimal digit.

The description format of numeric data is expressed in Equation(2).

$$N\ (D\ [\ ,\ d]) \tag{2}$$

in which N is type designation describing numeric data fixedly; "( )" is sign, as the permanent symbol describing data length; "[ ]" is sign, as the permanent symbol describing bit number of decimal fraction for floating number; D is total bit number of numeric data (regardless of decimal point); d is bit number of decimal fraction for floating number.

4.1.3 Date data

Date data type is to describe the data field relative to time. A. D. Beijing Time is adopted as the standard of all date data, for example, 1st Oct, 1999 14:20. For those time data that only year – month – day is described, A. D. Beijing Time a. m. 8:00 signifies this day. The date data is described with "DATE".

4.1.4 Text

Text is to describe non – numeric data info as same as character, but the text can carry more info. Text is described with "TEXT".

4.1.5 Value range

The value range of field in the table structure has two description modes. One is described with abstract continuous number and the value range is given in field description. The other is described with discrete number or enumeration set. What's more, each code should be explained concretely if the data belongs to code set.

4.1.6 Data precision

The flood control project management involves extensive contents, the daily observation and monitoring data is considerable, meanwhile, its precision requirement varies with the profession. So it's difficult to define the data precision of every term in filed description. So then, the data precision should be chosen according to practical situation in application of the table structure of this database.

4.2 Rule of compiling identifier

ID is an important part of the database identification system and is composed of table ID and field ID. It's remarked with English abbreviation or Bopomofo for special name.

The format of table ID is described as follows:

XX_YY……YY

Table ID is composed of a prefix of two characters (XX) and some suffixes (YY……YY).

The value of XX is chosen as the following table 1 according to the different info of project construction and project management. The suffixes of database table name and the field name ID both adopt English abbreviation.

Table 1 Prefix of database table name comparison table

Class name	XX value
Dyke project	DK
River training project	RP
Water gate project	WG
Through structure	TS
Stride river project	SP
Danger spot	DS
Reservoir	RE
Mechanical irrigation engineering	MI
Biology protection project	BP
Pertain establishment	PE
Safety monitor system	SM

4.3 Table structure

Table structure is composed of table name, table ID, table No. and table body. Chinese table name is the Chinese name of every table structure, which expresses the described contents in concise words. The table ID is the Eng abbr. of the table name, and used as database name in establishing database. Table No. is the only code to each table. All of the followings are listed with a form of table in table body: each field and its name, ID, data type and its length, null value or non - null, metering unit, master key or not and the order number in the master index. For example, the info table structure of dike is as the following table 2.

Table 2 Information table structure of dike

Field name	ID	Type and length	Measurement unit	Main key	Null value	Inhaul serial number
Dike project code	Dknmcd	C(11)		Yes	No	One
Administer unit code	Aduncd	C(6)		Yes	No	Two
Information update date	Inupdt	DATE		Yes	No	Three
Information update principal	Inudperson	C(8)			No	
River code	Rivercd	C(8)			No	

Continued to Table 2

Field name	ID	Type and length	Measurement unit	Main key	Null value	Inhaul serial number
Dike class	bncl	C(1)				
Earthquake basic intensity	erbsin	N(2)	Class			
Earthquake design intensity	erdsin	N(2)	Class			
Dike full extent	dkbnig	N(6,2)				
Coordinate zero position	coordzeropl	C(40)				
Leveling base plane	baselv	C(10)				
Instance intro	inin	TEXT				

4.4 Data dictionary

Data dictionary is used to describe the field meaning and the corresponding relationship of the field name with the ID in the Yellow River flood project management database. Hereinto, the description of each field's meaning only is indicated the chapter No. in the description of table structure. Moreover, data dictionary is in Bopomofo sequence of field name. For example, date dictionary part contents are as the following Table 3.

Table 3 Date dictionary

Field name	ID	Type and length	Measurement unit	Field chapter
Embankment crack type	Mntntype	N(5)	bar	B.5.9
Measurement point code	Mspicd	VC(18)		C.2.5
Dike length	Bnscln	N(7,3)	km	A.2.18
Flood capacity	Flcap	N(6,2)	a hundred million stere	A.25.22
Sluice type	Clgttp	C(10)		A.14.12
River training project Classify	classify	C(32)		A.12.12

4.5 Technical terms

"Data Dictionary" contains extensive contents, involves more specialties. The technical terms in the "Data Dictionary" would be adopted in principle, if which have existed in "Standard of Technical Terms on Hydro engineering" (S26—92) or else, would be explained according to professional faith. What's more, each term is added so detailed comments that the operability is enhanced when logging data.

5 Application of the system

The database structure construction of the Yellow River project management database had been finished in the end of 2003 and the test operation run in the Yellow River Transaction Agency Zhengzhou foremost. The database is late – model according to unified standards of "Digit Yellow River" (ORACLE 91, ARC/INFO). So far, the database has been logged in a lot of transaction agencies.

5.1 Info acquisition

There are two manners for database info acquisition of the Yellow River project management database. One is on – line real time acquisition, such as sensor collecting data on site, which can realize real – time monitoring, regular observation and entering warehouse automatically, and the other is non – on – line and non – real – time acquisition, including file info of project history and late data of artificial acquisition.

5.2 Info log – in

The info of the Yellow River project management is collected by county project management departments and checked to log in base by town project management departments. The staff of logging data is authenticated safely.

5.3 Authority of system management

The administrative organization for the Yellow River flood control projects is ranked to four grades, whose authority can be set according to application function and user demand.

(1) The county administrative departments are the basic net station. They are in charge of logging data and the logging data staff should pass the safety authentication. In addition, they have the access to call the relevant info of one's county, call – on the superior public platform.

(2) The city project departments manage the county project departments within their domain. They are in charge of the work of check and log – in data, authenticating log – in data and the staff entering warehouse. They have the access to call data info of all county project management stations within their domain, call – on the superior public platform.

(3) The provincial project management departments manage the city departments. They have the access to call the data info of all city and county project departments within their domain, call – on the superior public platform.

(4) The Yellow River Conservancy Commission project management department manages the provincial project departments and directly under project departments. And it has the access to call the data info of the departments within its domain.

6 Conclusions

So far, "Data Dictionary" has been warranted as a project standard of "Digit Yellow River" and put into effect from Dec 30, 2004. Its standard No. is "SZHH16—2004". It has guiding significance for normalizing the construction of the Yellow River project management database and realizing the share and distributed storage of the basin project management info. Popularized application of "Data Dictionary" has accelerated largely the speed of realizing "auto collecting info, transferring info by net, real – time safety monitoring and treating work intelligently" in the Yellow River flood control project management.

Exploration of Processing Leakage Method in Combined Parts of Flood Discharge Structures of Warping Dam

—Case Study on the Key Dam of Jiuyuangou

Li Yao, ***Shang Guomei***, ***Ma Jian*** and ***Wang Caiqin***

Yellow River Soil and Water Conservation Suide Bureau, Suide, 718000, China

Abstract: Based on correlative information, there are 90% sickness and danger phenomena about warping dam which induced by flood discharge structures. And there are important significations by resolving combined problem between flood discharge structures and ground base, dam body backfill soil for that of loess plateau dam system engineering construction, safe operation and sustaining benefits. So we bring forward many settled countermeasures to deal with combined place of earth and stone, such as manual compacted backfill method, water drop method, and both combination and so on.

Key words: combined place, leakage, processing method, warping dam

Warping dam has many particular functions which include holding up sand and silt land, storing up and resorting flood, increasing land and production. These functions are very popular to the farmers in the areas of water loss and soil erosion. But, thanks to variety matters many warping dams have leakage problems in combined place, which is a big difficult problems to builders of water and soil conservation project. Because repair and leakage problems are very general which increase sickness and danger situations when warping dam is production running in production, it restricts and impacts efficiency exertion of warping dam. So positive analysis of rooted problems and utilization of proper disposal methods are validity approaches to resolve problems.

1 Reasons and hazards caused by leakage

1.1 Conjunction untight between masonry and backfill soil

As for irregularity in the end part of masonry, causing earth volume backfill difficulty, and backfill soil compacted by labour generally, controlling degree of density in 1.3 ~ 1.4 g/cm^3, it is fall short of requirement and can not realize conjunction tight between masonry and backfill soil. The situation causes leakage, mud stream, piping which is likely to initiate the danger such as landslide and so on.

1.2 Low quality of masonry partial engineering

As for terrene condition limitation, the degree of hardness of partial stone materials of masonry is fall short of regulation which requires $400^{\#}$ upward, in the process of construction, so gaps are formed easily by exogenic force effect such as pressing stone materials. Moreover man – induced factors create gaps caused by imperfected mixing slurry, which are new leakage points. This is also main reason which generates leakage and mud stream.

1.3 Dealing with incipient fault of soil matrix of discharge structures properly

In the process of construction, ground base of earth and stone, collapsing ground base, mountain body cracks mousehole, graves and all appear on the ground base of flood discharge structures, which cause easily cracks of bricking – up and collapse form leakage.

1.4 Falling short of design requirement in the aspect of soil matrix excavation dimension and slope

Cutting base side slope of flood discharge structures, following standard requirement, degree of earth slope is greater than or equal to 1∶1.5, degree of stone slope is greater than 1∶0.75. If the other way round, it cause bad combination between backfill soil and old soil body. There are cracks between new and old soil, which likely forms leakage when falling rain.

1.5 Cheating in work and cutting down materials phenomenon in the period of construction

Due to benefits of construction units, there are some concealed work (cutoff ring, cutoff wall and so on), which's design size reducing or no building, using inferior materials preparing sand pulp according to no reasoned design standards, so leaving magnitude incipient fault to engineering.

As those reasons lead to leakage, if no dealing with in time, when falling across high intensity rainfall, water surface of the inner dam will rise, easily forms centralized infiltration flow in the leakage place, which causes piping, earth slide, even dam – break and all in the conjunction place between downstream dam slope flood discharge structures and dam body, which have catastrophic consequence for warping dam project security.

2 Disposal methods

There are important significations by resolving combined problem between flood discharge structures and ground base, dam body backfill soil for loess plateau dam system engineering construction, safe operation and sustaining benefits. So we bring forward many settled countermeasures to deal with combined place of earth and stone and leakage treatment of repair dam, mainly including manual compacted backfill method, water drop method, and both combination method and so on.

Manual compacted backfill method is a more comprehensive applied disposal method, but shortcoming is hard tightening combination and lower assurance coefficient because degree of density is non – homogeneous between compacted soil and original embankment.

Degree of density reach standard could be more easily treated by water drop method, but single water drop method treatment is likely to come into being multiple directional alligator crack, which is also likely to turn into incipient fault of second leakage.

Water drop and manual (mechanical) compacted backfill combination is an effective treatment method, which is generalized by long – term work experiences. Its feature is that degree of density reaches higher standard, and will not generate new cracks which form new danger to dam body.

3 Illustration of examples

This article studies on some warping dams of Jiuyuangou watershed in Suide County in Shaanxi province, which illustrate practical effectiveness about all kinds of treatment methods.

The key dams of Wujiapan Liushugou and Shejiajian Liangjiagou all appeared large acreage cracks and collapses caused by leakage from the upper of plunge pool. Then according to judgement from leakage trace, the reason is that combined place of earth and stone of the upper of plunge pool backfill quality is low – rise, accumulated water leak from lying pipe the upper of plunge pool. Combined place to lower river 10 m distance from lying pipe plunge pool, again flow from stone gap of the upper of arch ring to the sluice culvert. At disposal time, firstly, dam bodies appeared cracks and collapses are excavated entirely, will use cements and sand pulps to repair leakage places, build temporary cofferdam in the place of plunge pool, using bank slope soil body layer disposal of water drop and manual compacted backfill combination method. At first, demanding backfill parts cut the degree of slope no greater than 1∶1.5, proceeding water drop treatment, controlling 20 ~ 30 cm height altitude per layer, meantime observing dewatering degree of mud fluid, generally, dropping rate of water content of mud fluid to 25%, implementing manual squeeze puddle backfill (analogously filling soil in water), for little cracks formed by manual backfill, adopting stronger adhesiveness clay mud fluid repetition grouting treatment, till canceling cracks basically, then dealing with next layer. By one year more observation, no new cracks and leakages were found.

The dam flood discharge structures of Pujiawa build shifting from right bank to left bank, which is impacted by the express highway of Wubao – Zizhou, both slopes of ground base of the culvert as standard cut the upper of original dam 30 m long, except establishing intercepting rings every 10 m intervals, cutting three combination arks to strengthen impermeable ability in the axial cord and the upper, lower river, sluice culvert masonry later, when backfill, building margin bank in the upper, lower river, three combination arks be divided into two units, proceeding layer water drop treatment, water drop place under intercepting rings put up compacted treatment when basically dewatering consolidation later. Upward of the intercepting rings, water drop body dewatering later, it uses mechanical roller compaction instead of manual compacted backfill. Whether manual work or mechanical backfill, the place of water drops and backfill all generate small cracks, subsequently. Use moderate concentration clay suspension time and again till cancel cracks basically. When backfill ends later, vegetation is recovered for cutting ground base generating damage to the upper and lower of dam slope, displaying good protection. By post inspection examination to cutting part, it is found after mechanical loader rolled, including water drop part of both side walls culvert, irregular stone are tightly combined through the actions of mechanical vibration and squeezing, which explains that machine instead of manual work can quicken progress and also can increase backfill quality.

4 Epilogue

Leakage problems of warping dam in many watersheds are repaired unilaterally, no finding essential reasons and appropriate settled measures in the process of construction. Actually the key is no matter what occured, it should put up scientific reasonable analysis, according to practical situations, setting down processing method, which is able to display perfectly the benefits of warping dam.

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The Design and Application of the Vertical Displacement Monitoring System in the Dam

Li Jue*, *Wu Chuangfu*, *Gao Li* and *Li Yiming

Graduate Research Institute of Pearl Water Resources Commission
Ministry, Guangzhou, 510611, China

Abstract: A dam – reservoir vertical displacement monitoring system for strong motion observation is designed. The principle and structure of the system are described in detail. The operation in the Dashuiqiao Reservoir proves the rationality of the system. The operation is satisfactory.
Key words: dam – reservoir, vertical displacement, static force level, PLC, configuration soft

1 Prelude

The water resource is abundant in our country. In order to gain the energy sustainable development, we gradually sped up the reservoir and the hydroelectric power station construction in recent years. They are undertaking the duties such as electricity generation, the flood control and storage, irrigation and so on. They are directly relating to the national electric power facilities and people's life and properties. So their status is very important. A dam – reservoir safe monitoring includes many contents, such as seep, horizontal displacement, vertical displacement and so on. This paper just discussed the monitoring method about vertical displacement. It can provide basic data about the dam – reservoir's safe evaluation. These data are most valuable information to not only the new – building dam but also the repairing of old dam reservoirs.

2 The function of a Dam – Reservoir Vertical Displacement Monitoring System(DRVDMS)

The Dam – Reservoir Vertical Displacement Monitoring System is requested to be able to monitor continuously because the dam vertical displacement has the unpredictability. Moreover, the dam all constructs generally in the quite far area. They have special distance with the control center. So this system is requested to be stable and reliable. It can realize auto – operation. In emergency the emergency power can start automatically.

Considered the structure test and analysis angle, DRVDMS must have following functions:

(1) Displacement data record. DRVDMS can be able to form the effective displacement record and transmit the data record to the control centre automatically. It can provide the basic data for the dam safety control and the dam structure analysis.

(2) Collecting equipments must have suitable sensitivities and enough dynamic ranges.

(3) In order to adapt the design of the lamination distributional system, we integrate DRVDMS as the subsystem of the safety supervises and control system. Then we gather the data of the Static Force Level turning on the location control unit.

(4) The communication mode is the RS485 between the Static Force Level and the location control unit. They run the protocol of the free port. The location control unit connects with the control centre by the fiber optic cable, so we can share the data.

(5) The control centre real – time shows the data and may transmit the instruction to the location control unit. The data analysis software can take the information from the control centre and store them into the database. The software can carry on the computation analysis using these data and provide the data theory support safely for the dam.

3 The framework of DRVDMS

The system includes Static Force Level, location control unit, computer system and communication line(Fig. 1).

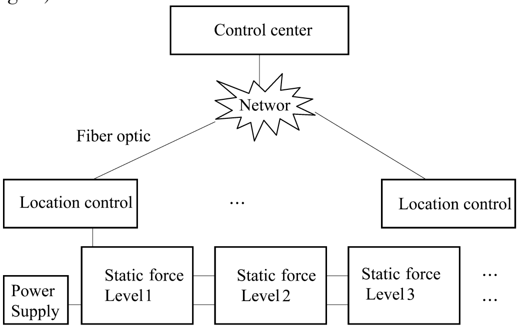

Fig. 1 The frame diagram of the DRVDMS

3.1 Static force level

We choose the Static Force Level as the main equipment of move survey. It adopts the communicating pipe technology when the basic plane is the gravity surface. It roots in the principle that the liquid surface keeps the level under the gravitation. It uses the symmetrical design and takes the difference value between the measuring point and the relative fixed point.

The Static Force Level chooses the flat spring with the axial symmetry double layer spiral line function as the float unit's track. The float tracks fluid position, then the link transforms the small elevation difference changes of the measured reference point into the sign post vertical displacement. Simultaneously according to the photoelectricity image sensing method, the Charge Coupled Device (CCD) is used to detect the tiny move. The CCD integrates several thousand precise arrangement photoelectricity sensing units. The optical image can transform the video frequency scanning signal and output the data with the quantification form under the function of the actuation and control pulse. So it has realized many fine technical specification of the width survey scope, the high accuracy, the non – electricity drifting and so on. The periphery electric circuit around the CCD equips Single Chip Micyoco (SCM). The data transmit to the location control unit by the RS485 communication mode. It realizes the data permanent recording and the data storage(Fig. 2).

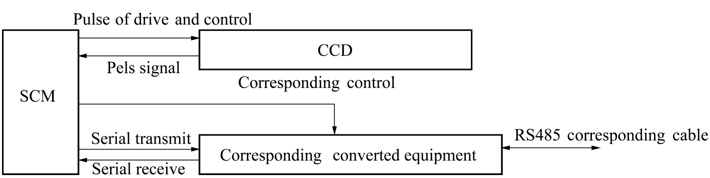

Fig. 2 The frame diagram of the Peripheral system around CCD

3.1.1 The mathematics model of the Static Force Level

As is shown in Fig. 3, suppose that n measuring points are given. No. 1 is the relative datum mark. The distances are $y_1, y_2, \cdots, y_i, \cdots, y_n$ $(i = 1, \cdots, n)$ from all measuring point's fixing high distance to referenced high distance ΔH_0. The distances are $h_1, h_2, \cdots, h_i, \cdots, h_n$ respectively between all measuring point's fixing high distance to liquid surface. So

$$y_1 + h_1 = y_2 + h_2 = \cdots = y_i + h_i = \cdots = y_n + h_n$$
$$y_i - y_1 = -(h_i - h_1) \tag{1}$$

After the asymmetric vertical move, the variety measures of ΔH_0 are $\Delta h_1, \Delta h_2, \cdots, \Delta h_i, \Delta h_n$, the distance between liquid surface and fixing high distance are h'_1、$h'_2 \cdots h'_i \cdots h'_n$. So we can get for the Fig. 3:

$$y_1 + \Delta h_1 + h'_1 = \cdots = y_i + \Delta h_i + h'_i = \cdots = y_n + \Delta h_n + h'_n \tag{2}$$

So the relatively variety measures ΔH_{i1} from the NO. i measuring point to the relative datum mark No. 1.

$$\Delta H_{i1} = \Delta_{h_1} - \Delta_{h_i} = (h'_i - h'_1) - (h_i - h_1) = (h'_i - h_i) - (h'_1 - h_1) \tag{3}$$

The dam – reservoir is going down when ΔH_{i1} is positive.

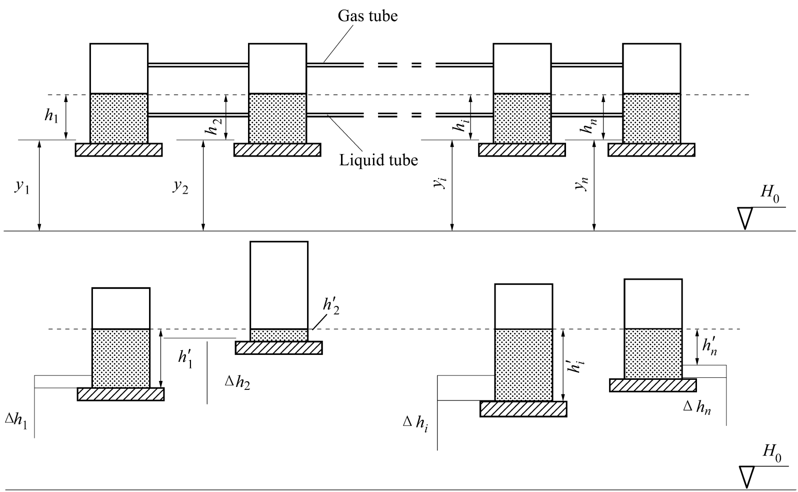

Fig. 3 The sketch map of the Static Force Level's working theory

3.1.2 Main technical specifications of the Static Force Level

(1) Metrical scope: 0 ~ 50 mm.
(2) Minimal resolution: 0.01 mm.
(3) Precision: 0.1 mm.
(4) Electrical drift: no.
(5) Working temperature scope: −10 ~ 40℃.
(6) Working humidity scope: 100% RH.
(7) Communication port: RS485.

3.1.3 Function characteristics of the Static Force Level

(1) The Intelligence digitization automatic metering equipment: It can judge the goal and diagnose the fault automatically.

(2) The measuring unit choose integrative, intelligent sensor basing on CCD. It has high reliability and non – electricity drifting.

(3) No – touch measuring mode.

(4) RS485 communication port.

(5) Digitalsignal and exoteric protocol can convenient join the lamination distributional system.

(6) Symmetrical design. The measuring method is to take the difference value between the measuring point and the relative fixed point. It can remove the influence of the common mold factor.

(7) The flat spring with the axial symmetry double layer spiral line function as the float unit's

track can provide enough lineal scope of the float in the vertical direction.

(8) The multiple moisture – proof measures can long – term continuous work under 100% relative humidity environments.

3.2 The local control unit

The local control unit is the data collector and data recorder in the DRVDMS. It has analytic and processing functions. We choose the PLC made by Siemens. The data exchange by the communication method.

Characteristic of PLC:

(1) High reliability. It chooses the micro – electronics technology and industrial electronic components. So PLC has very long no – fault time. We can say PLC has the highest reliability among all industrial control equipment from the moment. PLC has perfect self – diagnosing function. It can diagnose software and hardware fault timely. Moreover it can protect the fault scene.

(2) Strong environmental adaptability. It can work under the very extremely bad industry scene. It can continuous work as usual when the power supply breaks to open in a twinkling. It has very strong anti – electromagnetism interference, anti – flaps and anti – pounds ability. It can work as usual even if there are $-20 \sim 65$ ℃ temperature and 35% ~85% relative humidity.

(3) Agility and currency. PLC adopts module design. It is easy to build a construction according to different request. PLC takes control by applied program. We can complete different tasks by different software even if there is the same hardware construction. We can complete new control request expediently when the control object need change the control logic.

(4) Usage convenience and support in brief. It is provided the plug and pull function and standard ports. It is easy to build the net of PLC – PLC and computer – PLC.

3.3 Communication method

PLC provides manifold communication ports. It includes RS485 serial port and net port. We can choose one of them or use multi – mode at one time.

The inner protocol of the Static Force Level is SDI – 12. It is the standard of data recorder based on microprocessor. The baud rate of SDI – 12 is 1,200 bit. The power wastage and system cost are low. The transmitted distance is 200 feet between the sensor and the data recorder. SDI – 12 is the open protocol. PLC chooses free port communication mode to unscramble SDI – 12 protocol. So PLC can get the data from the Static Force Level.

3.4 The control center

The control center locates in the dam administrative office. It manages the static force level and the PLC. Computer is the main equipment. There is managing software on it. The managing software is compiled by configuration software. Characteristic of the configuration software:

(1) If one project adopts configuration software to be developed managing software, it is easy to update and upgrade with few modifications according to client demand.

(2) It can work on the Windows XP/NT/2000.

(3) It integrates animation manifestation, flow control, data collection, equipment control and output, data transmission, project report forms and curve function.

(4) It has strong compatibility. It can hold out many data collection and output equipments in domestic and international.

(5) It can build different data collecting system according to different demands.

(6) It can transmit data to the control center at any time and assure expedite exchange in the total system.

(7) It has net function and is able to keep the contact with the other department.

4 The application of the DRVDMS in the Dashuiqiao reservoir

The Dashuiqiao reservoir in Guangdong Province is located south of the Leizhou Peninsula and the middle and lower reach of Dashuiqiao River in the east of the Xuwen country. The Dashuiqiao reservoir was built in 1958 and rebuilt after several years. Now the total storage capacity is 14,680 thousands cubic meters. The irrigated area is 10,000 ha. It is one to regard irrigation primarily and has at the same time the flood prevention, the city water supply, the electricity generation and the cultivation and so on combined earnings big (2) reservoir. In order to monitor the inner transform condition, we installed four static force water levels in the section of 3 + 850, 3 + 900, 3 + 950, 3 + 992. The section 3 + 992 is the relative datum mark. The following is the man – machine interface and the graph of DRVDMS(Fig. 4 and Fig. 5).

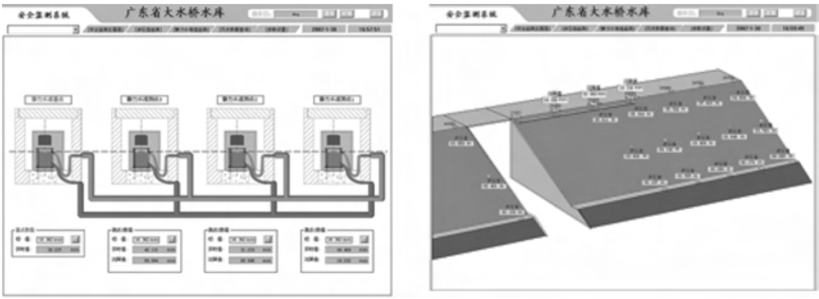

Fig. 4 The man – machine interface

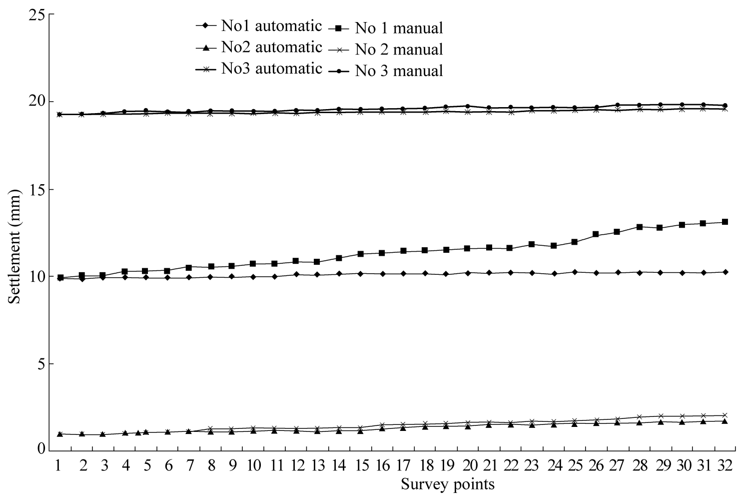

Fig. 5 The graph of DRRDMS

We can see from the above curve diagram (Fig. 5). The mutative trend basic consistent between manual observation and automatic measure, but the curve of the automatic measure is smoother, near more physically and higher than the manual observation.

5 Conclusions

DRVDMS of Dashuiqiao reservoir adopt the no – touch measuring mode static force water level, PLC and the configuration software. The automaticity is high. The operation is convenient. The gathering precision meets the actual needs well.

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Integrated Analysis of Seepage Stability on Old Gate at the Dike Foundation of Yellow River Downstream

Lv Junqi, *Meng Bing*, *Chen Peng* and *Su Qiupeng*

Yellow River Henan Bureau, YRCC

Abstract: The length of Yellow River downstream course is approximately 800 km with the dike length of 1 371 km. The hidden trouble concealed under the dike—seepage stability of dike foundation old gate is geological problem of dike foundation and major issue of embankment management, plan, reinforcement, and reconnaissance design of Yellow River downstream. Therefore, it is necessary to implement widespread analysis and research on historical breach old gate and data of dike seepage deformation of previous big floods.

Key words: Yellow River downstream, old gate, hidden danger, seepage distortion, control measure

1 Introduction

There are many historical breach old gates under the dike foundation of Yellow River downstream. Some old gates became the hidden danger of flood prevention because of the bad engineering geology characteristic of stuff. Most of the old gates with longer history have not detail records, even if some have records, position of gates are not clear, moreover the data of gates are mutually contradictory. When Yellow River breached, some villages were flushed away, afterwards the different name village was built, even if the village did not change name, the village position changed. Therefore, it is difficult to determine the accurate location of historical old gate, especially the few data for the dike peg number of old gates.

2 General situation of Yellow River dike old gates

The downstream of Yellow River breached frequently in history. There are 1,500 times breaches from the Western Han Dynasty (206 B. C.) to 1949, with overflow of 413 times. Some did not breach on current river course, some breached at the same location many times. For example, more than 5 times occurred on the section of Henan Fengqiu Jinglonggong dike in history, the width of gate is 1,250 m. Most of above mentioned breach occurred in the period of summer and autumn flood season (July, August, and September), some occurred in the period of ice flood season (January, February), peach flood season, and other seasons. The types of dike breach are generally overflow, flush, burst and dig breach.

The reasons for dike breach of Yellow River, except for dike build quality, dam foundation stratum structure and hydrology, meteorology, human factors, also concerned with the geologic structure. For example, Yellow River Dongbatou Dongming section located in the sedimentation area, sediment of this section silt up seriously, river course is very wide, shallow, scattered and disordered, river morphology changed fiercely, therefore, breach happened frequently. In addition, the section of west Shandong located in the ridged area, which is the result of the Taishan mountainous region rising all the time from the Quaternary Period, especially after Holocene Epoch, and effected on the north side of Yellow River. Therefore, the dike of Taochengpu to Qihe will endure the water pressure of Yellow River rolling north. In fact, there are many dangerous point and breach gates in this section.

3 Stability appraisal of foundation of dikes old gates

Levee was flushed broken by flood, while dike foundation was also flushed into groove with different width and different depth. For example, the width of Jiubao dike old gate is 1,438 m with the depth of 36 m. Jinglonggong dike old gate is 1,250 m with the depth of 23 m. Fine and normal sand deposited in the deep old gate frequently, sometimes argillaceous soil deposited. The stuff of filling gates are various: for smaller gates, which could be dry after flood, should be filled with soil, namely pure soil fill; Regarding big gates , the stuff filled is extremely complex including straw, reed, tree branch, wooden stake, wooden raft, gunny sack, lead wire cage, stone, earth and so on. Sunken ship had been used in Susizhuang. Straw material includes jowar pole, corn stalk, millet straw, wheat straw and so on. According to the data of Dongming Gaocun, straw material was in state of rotten above the groundwater and half rotten below the groundwater level. Straw material should be used in the big gates, more than 20,000 stacks of straw used in Wuzhi Mayingkou gates in 1820. From this, we may determine the stability of dike gates concerned with the stuff composition.

(1) For smaller gates, flood did not scour foundation deeply, the gates were filled with soil and became solidify after many years of dike weight compaction, the stability was better.

(2) For bigger gates, flood scoured dike foundation deeply, water permeability of the stuff of fine, normal sand, stone, straw was good, seepage distortion would occur in the back of the river easily. According to the statistical data, the gates with serious seepage occupied 40% of the total gates.

(3) Density of the soil filled is small. For example, the dry density of Jiubao is 1.21 g/cm^3. Un – uniform settlement would occur when inundating into the water, which caused the dike crack and subsidence, when meeting macroseism, liquefied phenomenon might happen.

(4) Cavity hole formed after straw rotted for the big gates. For example, Susizhuang, 30 m^3 soil was filled into the hole, 50 m^3 soil was filled into another hole. In 1987, when drilling into the layer of straw in the section of Fengqiu Jinglonggong, Zhongmou Jiubao, and Dongming Gaocun, slurry leak happened seriously.

4 Seepages stability problem of dike foundation

4.1 Types of seepage deformation

Soil seepage and deformation of Yellow River downstream occurred in the modern alluvium layer, belonged to the machinery seepage distortion. Seepage distortion might be divided into following several kinds:

(1) Pipe gushing: refers to the phenomenon of the soil body under the action of seepage, fine – grain flow away through coarse grain.

(2) Soil flowing: refers to the phenomenon of surface hunch or the soil granule fluctuation under the action of seepage.

(3) Contact brush: refers to the phenomenon of seepage water flow along the contact face of different penetration coefficients of different stratum and take away the fine – granule acted by seepage.

(4) Contact soil flow: refers to the phenomenon of seepage vertically acted the soil body of different penetration coefficient, seepage water take fine grain in the small penetration coefficient layer into pore space in the layer of bigger penetration coefficient.

To distinguish pipe gushing and soil flow is mainly according to the non-uniformity coefficient. When the non – uniformity coefficient is bigger than 5 ~ 10 for pipe gushing, otherwise for soil flowing. Alleviation sandy soil of Yellow River downstream was quite even, the non – uniformity coefficient is between 1.5 and 4. Moreover, the granule became more even with downstream of Yellow River. Yellow River downstream from Mengjin to river mouth, from the alluvial fan plain , silting alluvial plain to river mouth deltaic plain the average non – uniformity coefficient is from 3 , 1.7 to 2.3, smaller than 5. Therefore most of the seepage distortion type of Yellow River downstream of river dike back of river is soil flowing, few of them was contact brush. Because soil flowing does not have the coarse grain as skeleton like pipe gushing, when seepage distortion occurred, only fine – grain flow away. But when soil flowing occurred, all granule moves, with the characteristics of sudden burst. Therefore, soil flowing is more dangerous than pipe gushing.

4.2 Classification of seepages distortion form

The form of soil body is different when penetration distortion occurs because of different granulometric composition, soft hard degree condition and the stratal configuration of covering cohesive soil. At present, there are not the uniform standards for the form classification, naming as well as the description of seepage distortion. Yellow River downstream seepage distortion will be classified into the following several kinds according to its shape characteristic, seepage distortion situation, and related data.

(1) Wellspring: The popular name is pipe gushing, bubble spring or land spring, with the form of fountain, mouth of the pipe is like the funnel shape, water outlet diameter is 3 ~ 10 cm, the largest is 50 cm, gate of the hole spray water, sometimes with sand moving in the hole. Wellspring sand on the slope was washed away by the water, sand in the flatland sometimes deposit circling the gate, forms the sand ring, which diameter is 0.5 ~ 1 m. Wellspring often happens in the back of river or foot apart from the dam 10 ~ 20 m or 50 m. It often occurs in the drainage, pond, side of dike, or soil body weak points.

(2) Sand boiling: Also boiling spring. Water outlet diameter is smaller than 2 cm, often appears in groups, the little sand ring piled by small hole like honeycomb, formicary. It often occurs in the stratum of fine sand and soil, appears near the dike foot and pond.

(3) Bleb swell: The popular name is cowskin bleb, often occurs in the area with topsoil linking greensward together well, topsoil forms swell bleb due to the seepage holding against the topsoil, but the soil layer does not break.

(4) Water over and sand cast: When the seepage broke harder clay, water swell out of the land and cast sand.

(5) Mud cast: it is the phenomenon of sullage was hold and cast by the seepage.

Emergency manage should be carried out for wellspring and sand boiling, otherwise may cause dangerous situation of dike foundation scour and collapse, even dike break.

4.3 Distribution rule of seepage water and seepage distortion of dike foundation

(1) Most of the stratum of seepage water and seepage distortion is single – layer arenaceous sand soil stratum, or double – layer with the upper of thin layer cohesive soil, lower of arenaceous sand soil stratum or multi – layer arenaceous sand soil stratum. The next is that of multi layer sand soil linking together between the both sides of the bank, only this can transfer infiltration pressure, when the pressure increased beyond the permission gradient of soil, seepage distortion can happen.

(2) Seepage distortion often occurs in the area of old river course or old gates. According to incomplete statistics, about 37% of the dike with the problem of seepage has the old gate. Seepage of the dike foundation of Lankao Nanbeizhuang is serious due to the passing of Yellow River old course. The dam section with the problem of seepage and distortion of Dongping Lake reservoir during storing water has the thick sand layer, which was passed by old river course of Wenhe River.

(3) Seepage distortion happened in the protruding side of the river or the joints between the tributary and mainstream of Yellow River. Because the ground water in this place was recharged by surface water, the radiation flow will cause seepage in the back of river. Baima Spring of Wuzhi County and Changqitun of Jinan belongs to this kind. During flood season, serious seepage and distortion happened in the flood season.

(4) Location of seepage distortion is in the soil pit, puddle, pond, ditch apart from the dike

foot 10 ~ 20 m and the face to the water drainage.

5 Control measures of dike foundation seepage

In order to prevent the dike from the seepage, many control measures were adopted to control seepage. According to the principle of truncation infiltration for the face to the river, lead infiltration for the back of the river, some measures including trough, clay slanting wall, clay bedding etc are taken for the face to the river, and measures including pond solidbase, sand and stone filters, reducing pressure well and sedimentation and reinforcement of dike and so on for the back to the river.

(1) Dig trough to change soil is to dig a ditch with the bottom width of 2 ~ 2 . 5 m and the depth same with the back of river, and then fill with clay. Clay slant wall is the wall with the thick depth of 1 ~ 2 m located on the dike slope. This measure is very simple to operate, but only suit to the situation of thin sand layer seepage in the dike body. It is invalid for the dike foundation with thick sand layer.

(2) Three measures of clay bedding, front soil wall and back soil wall can extend infiltration radius, still can not solve the serious seepage of dike sand foundation.

(3) Truncation infiltration wall can penetrate into the dike foundation, cutoff the seepage in the sand layer, control seepage. It is the best measure to control seepage.

(4) Measure of controlling seepage on the back of river is to adopt sand reverse filter to reduce the soakage line to prevent the dike foot from destroy for the dike foundation of sand soil. Seepage of Shuiniuzhao work of Qihe is dangerous in 1954 flood season when wellspring happened. The dike collapse 90 m. In 1955, sand and stone reverse filter project with the length of 375 km was made to enable the seepage distortion under the control. Regarding the stratum with the upper of the cohesive soil, lower part of the thick sand layer, reducing pressure well can reduce the confined water head effectively to prevent from seepage destruction. This kind of measure, because of construction complex, high cost, is not easy to maintain and has its limit.

(5) At present, siltation and reinforcement dike is a simple measure used generally. Most of the width of siltation in the back of river is 30 ~ 50 m or 100 m. It can widen dike, fill up deep pool pit and the low – lying land, reduce elevation difference between face and back of river, strengthen stability of dike body, but according to the findings and the actual observation of Yellow River water conservation science academy, soakage line rised after siltation, so we should combine with the type of stratum to study the length and depth of siltation when using the method.

A Tentative Analysis on Monitoring Results of Eco – recovery Project in Yijinhuoluo Banner of Inner Mongolia

Wang Yu [1] , ***Wang Xiao*** [1] , ***Shi Yinglu*** [2] and ***Zhang Jianguo*** [3]

1. Yellow River Suide Soil and Water Conservation Improvement and Supervision, Bureau Suide, Shaanxi, 718000
2. Yijinhuoluo Banner Soil and Water Conservation Bureau Yijinhuoluo Inner Mongolia, 017200
3. Erdos City Soil and Water Conservation Bureau, Dongsheng, Inner Mongolia, 017000

Abstract: Eco – recovery is one of the main measures for vegetation recovery, soil loss reduction and ecological environment improvement. The observation results of eco – recovery project in Yijinhuoluo Banner show that ① eco – recovery plays more important role in improving small scale climate. The average strong wind days and dust storm days were reduced by 39.9% and 57.1% than the averaged data of the Whole Banner during the monitoring period. ② the growth of arbor tree, shrubs and natural grass was increased by 30.0% , 22.0% and 81.0% than that in the contrast zone. ③ the average runoff modulus and sediment modulus is respectively 17,260 m^3/km^2 and 1,135 t/km^2 that is reduced by 33% and 41% than the annual averaged in the monitoring station controlled area. ④ the eco – recovery promoted land – use structure and rural industrial structure readjustment, enlarged the vegetation area and increased the output value of forestry and animal husbandry.

Key words: monitoring, analysis, eco – recovery, Yijinhuoluo Banner

Yijinhuoluo Banner lays in the southwest of Inner Mongolia Autonomous Region. Considering the population density, precipitation, soil erosion degree, vegetation and plant community etc, it is suitable for self eco – recovery in the Banner. Therefore, Ministry of Water Resources implemented experimental project of eco – recovery in the Banner in 2001 by aiming at researching of the environment of eco – recovery, effect and potentials so as to provide basis on large scale eco – recovery project and setting up scientific monitoring and evaluation system.

1 General situation of the project area

The project area locates between northern latitude of 39°32′ ~ 39°45′ and east longitude of 109°33′ ~ 109°44′. It is 16 km from east to west, 21 km from south to north dealing with 11 political villages of Hetongmiao township, Habagexi township and Atengxire township etc with the total area of 116.86 km^2. The project area is in the Wulanmulun River watershed of the upper of Kuye River where is the typical sandy rolling and gullied loess plateau. The plant type is varied and the plant resource is rich. Herbaceos perennial is majority. Then the annual and biennial herbs, semi – shrubs and mid – shrubs spread wide. The type of shrub and arbor is less. The characteristics of natural grassland are that: the community of sand wormwood is the majority. Shrub grassland is large and grass community is short and fewer.

2 Layout of monitoring plot and monitoring content

2.1 Climate monitoring

A small scale climate station was set up in the project area. The contents of observation are rainfall, evaporation, air temperature, wind speed and wind direction. The observed data were compared with those provided by Yijinhuoluo Banner Meteorological Bureau.

2.2 Vegetation monitoring

According to related technical rules and regulations, monitoring plots and contrast plots were set up in the project area which are similar in slope degree, slope direction, slope length and soil type etc. The sample plots of arbor tree, shrub and natural grassland were set up. The size is 20 m × 20 m, 5 m × 5 m and 1 mm × 1 m respectively. The obvious mark was set up around the sample plots. The indices of growth etc were observed three times a year.

2.3 Runoff and sediment monitoring

By using the current 3 key dams, there were set up observing section for calculating runoff and sediment produced in the controlled area then the runoff and sediment situation in the whole project area will be reckoned.

2.4 Social and economic monitoring

The main contents are land use structure, vegetation situation of farmland replaced by planting and grass, output of agriculture, forestry, animal husbandry and sidelines before and after the project. 18 typical households were selected for monitoring.

3 Monitoring results and tentative analysis

3.1 Climate monitoring

According to the data observed in 2002 and 2003, there was no distinct change in once rainfall and yearly rainfall within and without the project area, monthly and yearly evaporation and air temperature is near to the annual average of the whole Banner. The strong wind days within the two years are 22 days and 11 days which is reduced by 14.7% and 57.4% than the average of 25.8 days from 1959 to 1999. Dust storm days is reduced by 42.8% and 71.4% correspondingly. Seeing in Table 1.

Table 1 The record of strong wind days and dust storm days in the project area

	Month	1	2	3	4	5	6	7	8	9	10	11	12	total
Strong wind days	2002	1	2	6	5	5		1				1	1	22
	2003	1	1	3	3				1			2		11
	Average of the whole Banner from 1959 to 1999	1.7	1.7	2.5	4.4	4.1	3.0	1.8	0.6	0.8	1.3	2.2	1.7	25.8
Dust storm days	2002		1	5	4									10
	2003		1	2	1							1		5
	Average of the whole Banner from 1959 to 1999	1.4	1.5	2.4	3.7	3	1.5	0.9	0.1	0.3	0.5	1	1.2	17.5

3.2 Vegetation monitoring

3.2.1 Arbor tree monitoring

To select standard sample plots in the project area and contrast area and to monitor poplar growth. The monitoring result shows in Table 2. From the table, you can see that the averaged growth was 0.63 m by taking 30% in the project area, but 0.42 m in the contrast area. The growth is obvious from spring to summer. The poplar diameter net growth is 0.30 cm in the project area within a year. But it is not obvious in the contrast area.

3.2.2 Shrubs monitoring

To select standard sample plots in the project area and contrast area and to monitor caragana growth, the main contents are maximum height and diameter during different season. According to the data in 2003, the average height of growth is 0.23 m by taking 22% in the project area. but the average height is 0.18 m in the contrast area. The growth is obvious from spring to summer. The net growth of yang caragana is 0.30 cm in the project area. But it is not obvious in the contrast area. The result shows in Table 3.

Table 2 The arbor tree monitoring result in standard sample plots in 2003

No.	Area	Sample plot (m^2)	In spring		In summer		In autumn		Net growth	
			Height (m)	Diameter (cm)	Height (m)	Diameter (cm)	Height (m)	Diameter (cm)	Height (m)	Diameter (cm)
1	Project area	20 × 20	4.05	4.00	4.45	4.00	4.70	4.40	0.65	0.4
2			5.13	5.20	5.45	5.30	5.90	6.00	0.77	0.8
3			3.15	3.80	3.48	3.90	4.10	4.40	0.95	0.6
4			1.27	0.50	1.51	0.50	1.79	0.80	0.52	0.3
5			1.25	0.70	1.59	0.70	1.85	1.00	0.6	0.3
	Average		3.04	2.80	3.31	2.90	3.67	3.30	0.63	0.5
1	CK	20 × 20	2.02	2.00	2.32	2.00	2.50	2.50	0.48	0.5
2			2.23	3.00	2.54	3.00	2.85	3.90	0.62	0.9
3			1.38	0.40	1.61	0.40	1.75	0.50	0.37	0.1
4			1.18	0.30	1.33	0.30	1.50	0.40	0.32	0.1
5			1.07	0.30	1.27	0.30	1.40	0.30	0.33	0
	Average		1.58	1.20	1.81	1.20	2.00	1.50	0.42	0.3

Table 3 The shrub monitoring result in standard sample plots in 2003

No.	Area	Sample plot (m^2)	In spring		In summer		In autumn		Net growth	
			Height (m)	Diameter (cm)	Height (m)	Diameter (cm)	Height (m)	Diameter (cm)	Height (m)	Diameter (cm)
1	Project area	5 × 5	1.32	1.90	1.48	1.90	1.58	2.00	0.26	0.1
2			0.62	1.20	0.74	1.20	0.85	1.30	0.23	0.1
3			0.61	1.10	0.73	1.10	0.82	1.20	0.21	0.1
4			1.27	1.40	1.41	1.40	1.52	1.50	0.25	0.1
5			0.68	1.20	0.84	1.20	0.90	1.30	0.22	0.1
	Average		0.9	1.36	1.04	1.36	1.13	1.46	0.23	0.1
1	CK	5 × 5	0.43	0.70	0.54	0.70	0.64	0.80	0.21	0.1
2			0.28	0.60	0.41	0.60	0.50	0.70	0.22	0.1
3			0.21	0.50	0.27	0.50	0.33	0.60	0.12	0.1
4			0.72	1.00	0.85	1.00	0.96	1.20	0.24	0.2
5			0.24	0.60	0.32	0.60	0.39	0.60	0.15	0
	Average		0.38	0.68	0.49	0.68	0.56	0.78	0.18	0.1

3.2.3 Grass monitoring

Selecting standard sample plots in the project area and contrast area and to monitor natural grass (sand wormwood) growth. By comparing, the average grass height is 61cm from No. 1 to No. 4 sample plot which the net average height was 46 cm in 2003. The average fresh grass yield is 0.225 kg per shrub amount to 0.135 kg dry grass in the project area. But it was 37.5 cm of grass height with net growth of 23.5 cm. The average fresh grass yield is 0.06 kg per shrub amount to 0.036 kg dry grass in the contrast area. The monitoring results show in Table 4.

Table 4 The natural grass monitoring result in standard sample plots in 2003

No.	Area	Sample plot (m^2)	In spring height (cm)	In summer height (cm)	In autumn height (cm)	Net growth height (cm)	Grass yield fresh (kg)	Grass yield dry (kg)
1	Closed area	1×1	17	61	76	59	0.225	0.135
2			12	39	50	38		
3			16	48	67	51		
4			13	42	49	36		
	Average		15	48	61	46		
1	CK	1×1	18	33	44	26	0.06	0.036
2			9	20	35	26		
3			14	34	54	40		
4			8	11	16	8		
	Average		12	25	37.3	25.3		

3.3 Runoff and sediment monitoring

To take Agetu, Shuitougou and Mawangmiao key dams in the project area as monitoring plots. To survey the base or current warping area, warping height, warping section and warping volume and set pu gage on discharge structure. The work procedure is that: ① to observe water gage after rain and read out the storage volume correspondingly then calculate the total flood volume. ② after the sediment silted, discharge the clear water then measure the warping depth and calculate the warping volume. The warping volume also can be measured from the observing section set up in the dam body. ③ to calculate the runoff and sediment from the controlled area and reckoned the change of runoff and sediment in the project area. Finally analyze the effect on runoff and sediment by eco – recovery project.

Table 5 shows the observed result of the three monitoring plots in 2003. You can see from the table there was once runoff i. e. "2003.07.29" flood and the runoff is more different among the three dams. This proved that the slope degree and vegetation etc were more different in their controlled area. The average runoff modulus is 17,260 m^3/km^2 and sediment modulus is 1,135 t/km^2 in the controlled area which is lower than the annual average of 33% and 41% in the project area.

3.4 Social and economic monitoring

Since the project implementation in 2001, the land use structure and rural industrial structure has been readjusted step by step. By the end of 2003, the planting trees and grass by replacing slope land area was 132 hm^2. The slope farmland reduced and basic farmland increased. But the grain yield was kept the same. This changed the situation of wide cropping and less harvest. Meanwhile, the vegetation area is increased and forestry and animal husbandry output value was increased.

Table 5 Runoff and sediment observation in the project area in 2003

Plot name	Controlled area (km^2)	Date		Rainfall (mm)	Rainfall duration (hr:min)	Runoff (m^3)	Runoff modulus (m^3/km^2)	Sediment yield (t)	Sediment modulus (t/km^2)
		month	day						
Mawangmiao	3.1	7	29	53.7	01:00	152,300	49,129	9,450	3,048
Agetu	3.27	7	29	40.0	02:30	3,013	806	405	109
Shuitougou	3.5	7	29	39	00:40	15,050	4,357	1,350	386
Average							17,260		1,135

Note: There was once runoff in the year, i. e. on July 29.

According to the monitoring result (in Table 6), the rural gross output value increased from 8.3 million Yuan before the project to 8.877 million Yuan in 2003 in the project area by taking 6.95%. The output value of animal husbandry increased the fastest by taking 30.1%. This shows the effect of pen breeding is more obvious after the implementation of planting trees, shrubs and grasses by replacing slope farmland and the closed tending. After the monitoring to 18 typical households, per capita grain yield, agriculture income, non – agriculture income, net economic income and budgetable consumption pay raises in some degree after the project implementation.

Table 6 Social and economic monitoring result in the project area in 2003

Content		Quantity	
		In 2001 (base)	In 2003
Land use structure (unit: hm^2)	Total land area	11,689	11,689
	Farmland	646	514
	Forest land	1,670	2,102
	Grassland	3,670	4,120
	Waste land	5,345	4,595
	Others	358	358
Industrial structure (unit: 10^4 yuan)	Gross rural output	830	887.8
	Agriculture	76	71
	Forestry	525	524.7
	Animal husbandry	196	255
	Sideline	33	37

4 Conclusions

4.1 Peroration

Based on the above monitoring results, you can see that ① the eco – recovery project plays important role in improvement of small scale climate. It reduces strong wind and dust storm days and decreases wind – force. ② the growth of arbor trees, shrubs and natural grass in the project area are better than those in the contrast area. It shows that the closed tending reduced human being's activity and created the condition for plant growing. ③ through closed tending, the vegetation cover rate is increased which retained runoff effectively so that the runoff modulus and sediment modulus are lower than the average in the whole project area. ④ the implementation of eco – recovery project further promoted land use structure readjustment. The ratio of agriculture, forestry and animal husbandry is 1∶4∶8. This result accords with the local condition. According to the output value, the value of forestry and animal husbandry takes more and will be raised in certain.

4.2 Present problems

Because there is no monitoring regulation for soil and water conservation eco – recovery now, the monitoring plot layout and observation content refer to "Soil and Water Conservation Experiment Rules and Regulations". But this can't meet the eco – recovery project monitoring. It needs improvement.

The paper only analyzed the stage observed data. Because the datum series is not enough, the systematic analysis can not be undertaken for recovery effect, recovery mechanism, recovery potential and environment impact.

Filling up the Mine Goaf with River Sands along the Yellow River for Flood Prevention

Wang Dianjie, ***Hou Tao*** and ***Zhang Xiaoqing***

Jinan Yellow River Bureau

Abstract: Some coal mines have been exploited along the downstream of the Yellow River recently. Mine goaf will lead to ground subsidence and affects the security of the watercourse and the embankments. This article focus on the analysis in the following five aspects: the gravity of geological disaster caused by mine goaf, the successful experience of dredger excavating sand in the Yellow River, the feasibility and the unit price analysis of filling sand in the mine goaf, and the benefit of filling sand. Filling up the coal goaf and replacing the coal column with the Yellow River sediment, and exploiting most of the supported coal. These methods will not only enhance the coal mining rate, and reduce the waste of coal resources, but also eliminate the ground subsidence of the mining area because of exploiting, eliminating the influence of the channel and embankment caused by the man – made geological disaster, and ensure the flood prevention and geological security of the mining area.

Key words: coal goaf, ground depression, filling with sands, security of flood control

Some coal mines have been exploited along the downstream of the Yellow River recently. For example, Qiuji, Zhaoguan and Xinyang Coal Mine, etc.. The pithead is no more than 6 km away from the dikes of the Yellow River, and some is only 3 km away. The workable exploit area extends to the area under the channel of the Yellow River. Although the administrative licenses request that excavation is not available in the protected area of the engineering, the depth of the coal bed is 300 ~ 600 m, even exploit according to the requests of mining, the subsidence area of the coal mine will also affects the security of the channel and the embankment. In order to guarantee the flood control security of the Yellow River, it needs us to deal with the new problems with modern technology. This paper the author believes it is necessary to use the channel sediment with the dredger, blow and fill the depletion region with pipelines under the mine, replace the coal column with the Yellow River silt, and even fill up the depletion area completely. It does not only increase the coal mining rate, but also eliminate the geological disaster caused by over exploitation, and insure the flood prevention security of the Yellow River.

1 Gravity of geological disaster caused by mine goaf

It is too numerous to mention one by one the examples of the geological disaster caused by over exploiting. In Shaanxi Province, the depletion region reaches to approximately 5,000 km^2, in which, 2,940 km^2 have caused serious geological disasters, with an increase of about 94 km^2 every year. A large quantities of villages have to move because of over exploitation. Certain places are trapped in the situation that there is no place to move. In the city of Jixi, the depletion region covers 114 km^2. The ground depression area is about 193 km^2. The ground depression is a man made geologic hazard. The phenomenon is visible everywhere in the mining area in China.

The ground subsidence in mine goaf is also destructive to the environment. It leads to desiccation crack and subsidence of the ground. Houses are pulled down. Road, railroad, and bridge are pulled apart. Grain fields turn into refused land, and rivers dried up. All these bring enormous inconvenience and massive loss to the people living in the mining area, and also affect the sustainable development of the national economy.

It should arouse more attention of the leaders that coal mines will be exploited in the downstream area along the Yellow River. Geologic hazards made by mankind, like ground depression caused by over exploiting, must be prevented around the channel and the dike. Otherwise, the security of flood control will be put in danger, and the consequence is inconceivable. Therefore, high regard should be paid and countermeasures should be made.

2 Feasibility of the Dredger Excavating Sand in the Yellow River

The Yellow River is well – known in the world for its high sediments concentration. Sediment concentration is the key problems of the Yellow River. The Sediments accumulate in the reservoir and the downstream, which reduce the storage capacity of the reservoir and lift the riverbed. Before the liberation, for a result of the backwardness of productive forces, the Yellow River forms into a tragic situation of "dike brench twice triennially, and channels change centennially". After the liberation, with the development of productive forces, people gradually realize to make use of the Sediment in the Yellow River. In the early 1950's, areas along the Yellow River start to use sluice gates and siphon off the Sediment for field refinement (which is also named "Yu Gai" at that time). The harnessing of the Yellow River comes into the period of dike strengthening by flowing automatically. In 1976, in Shandong Province, the dike strengthening was 459 km and sank sediments were 10,531 million m^3. In the 1960's, based on the characteristic of too much sediment in the Yellow River, the Yellow River staff create simple jetting suction dredgers. They destruct the soil body of the river bed with hydraulic monitor and make it into mud. And then transport the mud through pipes with scum pump of the dredger to places where need to reinforce. Widen and reinforce the Yellow River dihe to 50 ~ 100 m. In the 1990's, with mechanization, people dug the river and reinforce the dihe, built houses with silt, rebuilt the road, and made bricks using for construction. The Yellow River silts become more valuable and helpful to the humanity.

To reinforce the Yellow River dihe with the dredger, the process includes making mud, mud transportation, and sink – putting. The sediment concentration is low at the beginning, and the distance for mud – transportation is only 500 m. In the production process, through innovating technology, exploring high production and low consumption, and using safe practical way, people made remarkable enhancement of the dredgers. The sediment concentration reached 600 kg/ m^3, and the distance for mud transportation by single pump developed to 3,000 m. This technology won the national science and technology prize in 1978.

During the past 40 years, only the Yellow River in Shandong province, dikes strengthening reaches more than 800 km with the dredger and the width is about 50 ~ 100 m. It completes mechanical dike strengthening approximately 700 million m^3. In recent years, it also succeeded in developing the technology of transporting sand by using both pond excavator and conflux mud pump, and combinatorial outputting sand by silt pump. At present, one dredger (pump type 10PNK) produce mud more than 3,000 m^3 per day, and the distance for tramsporting sediment is more than 10 km. The practice proves that it is practical to dug sand in the Yellow River with dredger and the technology is reliable.

3 Feasibility of filling coal goaf with sediment

Filling coal goaf is no longer a new method of preventing ground subsidence. A hundred years ago, coal masters reused the unsellable slag and coal gangue to fill the coal goaf in order to enlarge the ground area and reduce expenses. On the one hand, it enlarged useful ground and reduces the danger of ground depression. The technology of filling coal goaf with slag and coal gangue is mature, and not a few mines filled with slag and coal gangue. In 1980s, in order not to affect the regional security of Yihe River, Shandong Linyi mining bureau fill river sand in depletion region in Wusi village coal mine, and Zhubeizhuang coal mine. They make use of sediment in Yihe channel and transport it to the mine nearby with belt machine. Let river sediment into mortar through mortar mill, and transport it to the filling place with stock pump and pipelines. Filling with river sediment aims to strengthen the goaf and eliminate geological disasters so as to guarantee the security of the

Yihe region.

4 Unit price analysis of filling sediment in mine goaf

4.1 Construction method

Based on the sediment – excavation experience of over 40 years at the down stream of the Yellow River, excavate sediment with 10 PNK simple suction dredger, the position is fixed at the both ends of critical levee section, or at the protruding bank of the new – formed river beach. Set relay pump when the sanding distance of suction dredger is over 2,500 m, and the optimum distance between relay pump stations is around 2,500 m. Sanding pipeline uses 300mm – diameter steel pipe, and the relay pump station uses 136 kW pump. Lay the sanding pipeline from the shaft mouth into the goaf, fill sand from the inner end of the goaf, set tail collecting gutter, and draw the water out of the well by water pump.

4.2 Unit price analysis

Unit price is calculated according to documents of the Ministry of Water Resource (Shuizong [2002] No. 116) and the Yellow River Connuewouly Committee (Huangjianguan [2005] No. 55). Unit price of diesel fuel is 5,500 Yuan/ton; analyze unit price separately at different sanding distances of 5,000 m and 8,000 m. See details in Table 1 and Table 2:

Table 1 Unit price analysis of filling project

Serial number of fixed amount: detailed estimate norm of the Yellow River【82344】

Distance of sediment transport 5,000 m Fixed amount unit: 10,000 m^3

Construction method	136 kW washing dredger	136 kW	Relay pump	Unit price (yuan)	Total (yuan)
Serial number	Name and specification	Unit	Amount		
Ⅰ	Direct construction cost				97,277.10
1	Direct cost				90,913.18
(1)	Labor cost		326.3		800.31
	Section chief	Working hour	8.0	4.91	39.28
	Medium worker	Working hour	50.8	3.87	196.6
	Primary worker	Working hour	267.5	2.11	564.43
(2)	Miscellaneous material cost		3%		2,647.96
(3)	Mechanical operating cost				87,464.91
	Washing dredger 136 kW	Machine hour	78.81	194.31	15,313.57
	Ponton300 × 5,000 mm	Machine hour	1,576.20	0.77	1,213.67
	Mud pipe 300 × 4,000 mm	Machine hour	96,542.25	0.49	47,305.70
	Silt pump 136 kW	Machine Hour	157.62	149.93	23,631.97
2	Other direct cost		2.00%		1,818.26
3	Scene cost		5.00%		4,545.66
Ⅱ	Indirect cost		5.00%		4,863.86
Ⅲ	Company profit		7.00%		7,149.87
Ⅳ	Hydraulic tax		3.22%		3,519.16
	Total				112,809.99
	Material price difference (Diesel fuel)	kg	7,053.50	2.06	14,530.21
Total					127,340.20

Budgetary price of diesel fuel is 5.5 Yuan/kg, calculate the cost at 3.5 Yuan/kg, and the other cost can use the price difference.

Table 2 Unit price analysis of filling project

Serial number of fixed amount: detailed estimate norm of the Yellow River【82374】

Distance of sand bypassing 8000 m Fixed amount unit: 10,000 m^3

Construction method	136 kW washing dredger	136 kW	Relay pump	Unit price (Yuan)	Total(Yuan)
Serial number	Name and specification	Unit	Amount		
Ⅰ	Direct construction cost				143,102.48
1	Direct cost				133,740.64
(1)	Labor cost		356.30		890.01
	Section chief	Working hour	8.0	4.91	39.28
	Medium worker	Working hour	65.8	3.87	254.65
	Primary worker	Working hour	282.5	2.11	596.08
(2)	Miscellaneous material cost		3%		3,895.36
(3)	Mechanical operating cost				128,955.27
	Washing dredger 136 kW	Machine hour	87.29	194.31	16,961.32
	Ponton300 × 5,000 mm	Machine hour	1,745.80	0.77	1,344.27
	Mud pipe 300 × 4,000 mm	Machine hour	172,397.75	0.49	84,474.90
	Silt pump 136 kW	Machine hour	174.58	149.93	26,174.78
2	Other direct cost		2.00%		2,674.81
3	Scene cost		5.00%		6,687.03
Ⅱ	Indirect cost		5.00%		7,155.12
Ⅲ	Company profit		7.00%		10,518.03
Ⅳ	Hydraulic tax		3.22%		5,176.98
	total				165,952.61
	Material price difference (Diesel fuel)	kg	7,812.46	2.06	16,093.67
Total					182,046.28

Budgetary price of diesel fuel is 5.5 Yuan/kg, calculate the cost at 3.5 Yuan/kg, and the other cost can use the price difference.

Dry density of sediment is calculated at 1.45 ton/ m^3, and it is measured and calculated that the cost to transport sand from the Yellow River course to 5,000 m down the well is 8.78 Yuan/ton, and the cost of transport it to 8,000 m down the well is 12.55 Yuan/ton. When the distance is over 8,000 m, the cost increases 1.26 Yuan/ton for every km over that distance. Since after the desanding down the well it needs to draw the tail out of the well, the bailing cost for each ton of sand is 5 Yuan, and if the sanding distance is between 5,000 ~ 8,000 m, it costs 14 ~ 18 Yuan to fill one ton of fluvial sand.

5 The Efficiency Analysis of Filling the Coal Goaf with Sediment in the Yellow River

There are several limiting factors for the exploitation along the Yellow River area. First of all, the security of the Yellow River must be taken into account. Some protection areas, where peripheries are prohibited to exploit, should be available outside the protection terra of the Yellow River Projects. What's more, because it is also prohibited to exploit in the underground area of villages, highways, railways, high – voltage circuitry, oil and gas pipelines, as well as the irrigating areas channeling off the Yellow River, some coal columns should be preserved to avoid the ground Subsidence. Due to a number of preserved coal columns which couldn't be exploited, it is a great waste of the limited coal resources hence the exploitation rate is greatly reduced. If the silo investment is unchangeable and there is a low exploitation rate, the cost of coal will be relatively high. If we let the villages move away and change the lines of the highways, railways and pipes, there will be a lot of problems such as a heavy workload, hard moving tasks and high compensation fee. We can just preserve a great deal of coal to support the ground while a large abundance of it will be abandoned in the mine. If we absorb the channel sediment of the Yellow River and replace the coal columns with it, then the sediment of 16 yuan could get the commodity coal of more than 200 yuan. Consequently, with using the Yellow River sediment to blow and fill the coal goaf, the economy benefit is considerable. Meanwhile, it also has a great social impact with eliminating the geological disaster caused by the coal goaf.

6 Conclusions

Every technology for filling the mine goaf with sediment in Yellow River by using dredgers is mature and available. It has many advantages to replace the coal column with the Yellow River sediment. In order to fill the coal goaf and exploit the supported coal. Firstly, the mining enterprise receives high price coal in exchange with the inexpensive river sand. It makes high economic efficiency. Secondly, the mining rate has been enhanced, and it reduces the waste of the coal mine resources. Thirdly, it eliminates the ground depression of the mining area and its influence to the Yellow River flood control security. Therefore, filling the mine goaf with sediment in the Yellow River will ensure the security of flood control, and benefit to both the country and the people.

Preliminary Idea about Using Interference of Dynamic Load to Reduce Height of Entrance Bar

Wei Maojie*, *Fan Peijun*, *Liao Zhanqiang* and *Jia Li

Shandong Yellow River Reconnaissance Design & Research Institute

Abstract: This paper, obtained from the analyses of the Entrance bar's grain composition based on the detailed analyses of the Dynamic performance, showed that the Entrance bar is easy to lose strength by the dynamic load, and then liquefies. According to this characteristic, proposed exerts using the manual interference of the Dynamic performance, causes preliminary idea which the Entrance bar's ridge goes against highly reduces.
Key words: entrance bar, dynamic performance, dynamic load, strength

1 Introduction

The Yellow River is a sediment rich river, the massive silt being carried to the estuary, and hence formed the entrance bar in the mouth, upraise the water level, the silt deposited, the river bed raises unceasingly, and the retrogressive erosion happened, all of those made section of aboveground river's degree to be aggravate, bad influence to the ability of flood discharge, silt drainage, ice drainage and so on. How to harness the Entrance bar, reducing its feedback influence as far as possible to the downriver, maintaining the flow of estuaries stable relatively, is the duty which estuaries govern item urgent and also must be persist for a long time. In the author's opinion that make effective processing in the Entrance bar, which first is clear about what type of the physical mechanics characteristic its, in order to choose the reasonable processing measure, obtain the good effect.

2 Static performance of the Entrance bar

According to the analysis of Zang Qiyun, the Entrance bar makes up of sand and silt loam. The sand accounts for 20% ~ 80.6%, above 97.6% is the very fine sand (particle size range is 0.125 ~ 0.063 mm); And the silt accounts for 20% ~ 70.4%, above 96% is the thick silt (particle size range is 0.063 ~ 0.016 mm). Thus thought the Entrance bar (sheet iron sand) mainly consists of the sandy silt and silty sand. But Zeng Qinghua, etc. consider that the granularity of the Entrance bar along the regulation distribution is well, basically that in the upstream is thick, in the downriver is thin, in the river course and the Entrance bar is thickly, below the steep slope is thinner. The crest of the Entrance bar granularity is thicker, the front part has the obvious seasonal variation, and the median particle size range of the deposit (d_{50}) in the low water season is 0.062 ~ 0.080 mm, belonging to the silty sand. The deposit in the flood season is thinner, and the median particle size range (d_{50}) is 0.031 ~ 0.062 mm, belonging to the silty sand too. Therefore we can though the Entrance bar mainly is made up of the silty sand. In the area of the Yellow River estuary, the velocity of flow is reduced due to the mutual functions both river power and the sea power. As a result of the difference of the particle size, silt particles have different settling rate, and hence enable the Entrance bar to have a quite well gradation. In addition the sand better water permeability enables the Yellow River's Entrance bar to have higher intensity under the static state, namely the characteristic of the performance for compares is "hard". Below qualitative carries on the analysis, the Entrance bar under the static state should have the characters: the weak permeable, normally consolidated sand, higher shear strength, at the state of saturation. Under the delivery head function, it is easy to have the seepage failure, the main form of the seepage failure is soil flow, and excavate is extremely easy to produce the quick sand.

3 Dynamic performance of the Entrance bar under the dynamic load

3.1 Basic characteristics of the dynamic load

The definition of the dynamic load in "the Standard for fundamental terms of geotechnical engineering" (GB/T50279—98) is the pressure whose size, position and direction change with the time variation. The dynamic load will be divided into four kinds in the soil dynamics: the first kind is single big pulse load, for example the action dynamic of explode which will be caused. The second kind is micro repetitious vibration, for example the vibration of machinery's foundation. The third kind is the higher oscillating amplitude repetitious vibrations, for example the vibration of a vibrator. The fourth kind is the limited number of times disorder vibrations, for example the vibration of the earthquake. Those four kinds of dynamic load have the same characters also along with the differences. The research computational methods are different, and they have different effect to the soil mass in a big way, but the common characteristics of each kinds of dynamic load are its size, direction and position all changing with time variation.

The research function effect of dynamic load on soil mass should focus on two kinds of effects, one is the speed effect, namely the load exerts the effect in the very short time by a higher speed which on the soil mass causes; the other is the cyclical effect, namely the soil mass effect on many times which the load repeatedly function produces. The first kind in all four kinds of dynamic loads is mainly the speed effect, the second and the third mainly are the cyclical effect, and the four kinds of loads both have the speed effect and the circulation effect, whose leading role is decided by the size and the frequency. The dynamic load of this paper refers to the third and the fourth kinds, also namely have characteristics of the cyclical reciprocation to fluctuate, also have dynamic load which destructs to the soil mass structure.

3.2 Mechanism analyses about the strength losing of sandy soil under the dynamic load

Saturated sandy silt would be lost its original strength under the dynamic load, even transforming into the liquid condition, namely having the thixotropic phenomenon. The thixotropic phenomenon is one kind special phenomenon of dynamic strength, and the characteristic of this is the strength losing with large scale suddenly. "The Standard for fundamental terms of geotechnical engineering" (GB/T50279—98) has made the following definition about the sandy soil liquefaction: the shear strength of the saturated incompact sand tends to zero, the process and the phenomenon which it transforms the solid to the liquid.

Through lots of experimental studies, when dynamic load affects to the saturated sandy soil, the soil skeleton would be extrude because of the influencing vibration, when this kind of extrusion surpasses between the binding force of particle, can destroy the original joint strength of particle and the structural condition, causes between the particle of sand each other to disengage, and then, the original pressure which undertakes by the particle of sand wants the pore water to undertake, causes suddenly the pore water pressure advances. On the one hand, the pore water attempts under the certain ultra pore water pressure upwardly to discharge, on the other hand, the sand particle attempt under its action of gravity to sink, the moment in the disarrangement of the structure or in a certain time, the sand particle sinking would be receive the hindrance of pore water pressure upwardly to discharge, this kind of situation developing, which may lead the sand particle partial or completely is under the aerosol condition, the shear strength partial or completely lose, namely has the liquefaction. This kind of phenomenon may qualitative interpretation with the soil principle of effective stress and the shear strength theory. The equation of the soil shear strength is:

$$\tau = (\sigma - u)\tan\varphi' + c' \tag{1}$$

where: τ is soil shear strength;

σ is the normal stress in soil mass shear surface;

u is soil pore water pressure;
φ' is effective angle of internal friction;
c' is soil effective cohesion, the soil effective cohesion of sand tend to zero, and then the equation (1) is

$$\tau = (\sigma - u)\tan\varphi' \tag{2}$$

From the formula (2), due to φ' in the vibrant process to be relatively stable, σ is invariable, the pore water pressure u raises would result in the shear strength depresses. When $u \approx \sigma, \tau \approx 0$, that means the soil mass turns into the liquid state, namely the liquefaction.

3.3 Characteristic property analyses on dynamic load of the Entrance bar

From the above, the entrance bar is composed primarily of sandy silts. A characteristic property of it probably should be losing its strength and then liquefied after suffering from the dynamic load. Engineering Practices, indoor experiments, earthquake disaster investigations discover that its strength lose rapidly at the action of dynamic load. That is, the silt, sensitive to dynamic load, may have these characteristics: saturation, loose, lower permeability, short time deposition sandy silts. In other words, this kind of silt is easiest liquefied under dynamic load.

Indoor experiments and earthquake disaster investigations have proved that sand average particle size d_{50} of silts have obviously affect liquefaction resistance. Haicheng earthquake's ejecta average particle size range from 0.015 to 1.08 mm in 1975, during Tangshan earthquake, the ejecta average particle size range from 0.035 to 0.09 mm in Tianjin city. Indoor experiments have proved that average particle size d_{50} in about 0.07 mm is too susceptible to liquefaction silts. From above, average particle size of the Entrance bar silts is 0.015 ~ 1.08 mm. So from side of particle size, the Entrance bar silts belong to easily – liquefied silts.

Those get more non – easily – liquefied due to more years of deposition. For instance, liquefacient layer of Tianjing city most is paleo – river flooded sediments, that is the recently deposited. But sandy soil layer of antiquity deposition chronology is less liquefy. Relative to the geochronology, the silts of the Entrance bar belong to the recent deposited soil, and most of them are underwater, in the state of saturation.

The silts of the Entrance bar are that suspended substance in water deposit by natural separation, obviously in normal consolidation state, shouldn't in compaction state, most are in slight consolidation state, and the silts of the Entrance bar are in upper layer, overburden pressure is less. What's more, since it belongs to sandy silts, its permeability is between $10^{-3} \sim 10^{-4}$ cm/s, and permeability is sluggish.

Therefore, a comprehensive analysis of the structure of the Entrance bar, average particle size, compacted density, deposition age, overburden pressure, permeability, the silts of the Entrance bar that sensitive to dynamic load are easily – liquefied silts.

4 Preliminary idea about using the interference of dynamic load to reduce the height of the Entrance bar

Since the silts of the Entrance bar have the characters of losing strength rapidly and then liquefied at the action of dynamic load, let us suppose if we can use its characters to harness the Entrance bar. By using artificial dynamic loads subject to the top of the Entrance bar, liquefied and diffuse on both sides, hence to reduce the height of the top of the Entrance bar, overflow into the sea fluently, and reduce the feedback of lower reaches of the Yellow River. If there is a good interference choice, for example, ebb tide, flood discharge period, during experiments for water and sediment regulation, it may be transport liquefied sediment to the deepwater area. To test the feasibility of this treatment measure, the following works should be carried out:

(1) A lot of research on indoor experiments about the Entrance bar should be done, and the basic parameters could be found out one by one, such as dynamic strength, dynamic deformation and the degree of liquefaction under dynamic load, rate of strength reduction, requirements of load

strength for liquefaction, frequency, waveforms, amplitude, preliminary establish dynamic constitutive relation of the Entrance bar.

(2) Under the guidance of indoor experiments, choose appropriate exciting – vibration equipments to do in – situ vibration liquefaction experiments, though experiments these parameters should be got at least: duration scope of vibration, the size of exciting – vibration force required for silts liquefaction, model selection of exciting – vibration equipments, the impact range of a single vibrator liquefaction, the best arrangement of a number of vibrators etc.. And select the equipments operation state, solve problems such as how to install vibrators, is shipborne or putting up, is placed at the top or buried inside the Entrance bar.

(3) Operating test may be done based on the ideal in – situ soil test results. To test results, using comprehensive technical and economic compare with other methods to test whether such plans is feasible. Of course, in order to gain the goal of reducing the height of entrance bar, other exciting – vibration equipments can be selected except vibrator. Such as the machinery reciprocation disturbs, the jet flow perturbation, the small equivalent multi – spots dynamite under the ridge and so on. Actually, which one is suitable for the Yellow River estuary depends on experiments and practices.

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Brief Analysis on the Government Management Pattern of Public Welfare Hydraulic Engineering Construction Project

Zhang Bin*, *Zhang Shuhong* and *Chen Huanying

Yellow River Yanggu Bureau

Abstract: With the start of western hydraulic project construction (rebuilding, expansion) and the fast development of our country economy, one batch of national large – scale water conservations engineering construction with the high of flood prevention standard , the environmental protection requirement and the modernized level, which requests for the project managers' specialized level and experience is becoming higher. By analyzing oversea matured project management pattern which is used for many years and their advantage and disadvantage, considering main management pattern of domestic public welfare hydraulic construction projects, for the adaptation to characteristic and request of modern hydraulic engineering project management, the author believes the hydraulic engineering project management pattern must be innovated.

Key words: public welfare, hydraulic engineering, management

1 Foreword

The project management is that the project superintendent uses the viewpoint, method and theory of the system to manage the entire work which involves the project effectively under the limited resources restraint, namely carrying on the plan, the organization, the direction, the coordination, the control and the assessment, to achieve the project goal. from the start of project investment decision – making to the project completion . The hydraulic engineering project management is suitable for one – shot assignment management of the huge investment, the complex relations, the limited time and the resources, is to manage the entire process according to the objective economic law to the engineering project to carry on effectively the plan, the organization, the control, coordination system administration. Namely from the written project, consideration of feasibility study report, the engineering design, the project constructs to completion goes into production the entire process management. The project management is not only the microscopic foundation of fixed asset investment management, but also belongs to the investment management category.

2 Present situation analyses on our country public welfare hydraulic engineering construction project management

Our country public welfare hydraulic engineering project management has obtained some achievements in the developing process, but it also produced some quality problems, the delayed completion and the expense exceeding expenditures due to the imperfect system and the irregular management, which has caused the certain losses to the country, created bad influences on the society.

The domestic traditional public welfare hydraulic engineering project management mostly is that the owner manages the engineering project design, the purchase, the construction and tries through the establishment of a temporary department (for example capital construction headquarters, office and so on). For the owner who has project management experience, or the project of simple technology, smaller resilience, this kind of pattern has played a good role.

In recent years, and west the hydraulic engineering was popular along with the our country economy fast development (changes expands) constructs, the national one batch of large – scale water conservations projects begins the construction, also the project flood prevention standard high, the environmental protection performance requirement high, the modernized level was high, organized superintendent's specialized level and the experience to the project requests more and more high, but the project management on improving the construction quality, speeding up the construction progress, enhancing investment benefit function is also obviously. Because the specialized degree is low, the experience is unable to accumulate, The traditional management pattern is very difficult to adapt the modern project management request again. We must establish and improve the national related policy, the laws and regulations system, improve the project administrative personnel ' s quality, strengthen the human resources reserve, adapt to the international convention connects rails, speed up the information and the network of the management project, which needs to study and introduce overseas advanced project management pattern, fuses in our country hydraulic engineering construction project and positively discusses the management pattern. of our country public welfare water conservation project.

In our country, since 1960s mathematician Hua Luogeng spread PERT – CPM , which is the start of project management research and the application, but the real application of project management should be the World Bank loan project – Lu Buge hydroelectric power station. In 1984 our country first used the international tender, implemented project management, reduced the construction time, and decreased the construction cost, which obtained the obvious economic profit. In recent years, some quite advanced architectural engineering company, in order to adapt to the large – scale project construction, integration, large – scale raising and the need of dispersing project risk, some mature project management patterns have been promoted. Studying these management patterns has certain practical significance in exploring management system of our country basic capital construction objective law, effectively implementing the control of construction process, the expense and the quality and obtaining the best investment benefit. It is sure that some engineering project management in many aspects has not suited practical need. The major problems in our country engineering project management are as follows:

2.1 Investments management system appears many malpractices, which restrict consultation industry development

Our country hydraulic engineering construction investment mainly root in country or certain international currency organization, but all levels of governments play the decisive role in the project construction. In order to manifest the importance and guarantee the project smooth implementation, the project legal person ' s management of the project mostly is composed of all levels of administrative leaders and the head of department responsible . In essence, the project legal person responsibility system is the "manager responsibility system" plus "the project headquarters system", the investment system still had the strong administrative color and the plan nature. This kind of system causes the project consultation industry to appear unnecessarily, also is easy to appear the phenomenon of "high investment, low benefit, high accumulation, low development".

2.2 Overstaffed organization, overlapping, administrative personnel imbalance, which affects the management potency and the working efficiency

Originally supervising unit is able to be responsible for the comprehensive surveillance and management, but under the project legal person the project management group is set up. This not only has caused the organization inflation, but also increased much constructions units management fee, and deviated from the request of reducing the cost. In addition, in "Temporary provisions about Implementation of Construction Legal Person Responsibility System" project construction manager appointed by the project legal person has the power from the preliminary design to the after—project appraisal, and is responsible to organize the engineering construction implementation and the control engineering investment, the construction time and the quality, which has the very tremendous repetition with the supervise jurisdiction. All of them have seriously affected the project management potency and the working efficiency.

2.3 Staff troops structure is unbalanced, the quality is not high, which is difficult to meet the need of developing architecture industry

At present existing design department is mostly comprehensive designing department in our country, including the specialized kind of work such as construction, structure mechanical and electrical, and so on. Most of them are huge organizations, smallest of which include hundreds of people and biggest of which contains over one thousand people, these designing departments cannot adapt to present internationally popular total contract system by far. which centers on the design. There are not many small but special, big but strong contract units and the project management companies. As a result of the distance of management pattern and level, the domestic engineering project management market is controlled by the foreign company like the Lu Buge hydroelectric power station, the Xiaolangdi hydroelectric power station, the Daya Bay hydroelectric power station and so on. The project management basically is in the charge of the European and American countries project management company or the project consultant firm.

2.4 Breaking the law, not having the law to obey

At present it is worried about the irregular phenomenon in hydraulic engineering construction market, some construction main bodies do not emphasize the construction quality under the urgency of economic interests, which has seriously harmed the national benefits. The related engineering project management laws and regulations are not perfect, which cause some projects have no laws to obey and can depend on, only can depend on the government especial authorization, which is easy to produce corruption.

3 Overseas public welfares hydraulic engineering construction management pattern

Since the Three Gorges hydro – junction, the northward rerouting of southern river the median line begin one after another, our country uses international bid pattern. The foreign corporations unceasingly participate in our country's hydraulic engineering construction, which needs to have a detailed understanding of oversea project management patterns, and perform to quote. In the advanced countries of European and American, generally they take the project management as a center. Its organizations and agencies establishment is based on the project management and the technical level enhancement, which has the project management, design, purchase, construction, tries to move the complete function, which can complete the engineering construction and can meet each kind of contract project management need.

3.1 Traditional project management patterns (DBB pattern)

It is namely Design – Bid – Build pattern. This management pattern is most popular all over the world, World Bank, Asian Development Bank loan project and projects supported by consulting engineer federation (FIDIC) the condition of contract all uses this kind of pattern. The most prominent characteristic is that the implementation of the engineering project must carry on the order of the design – bid – build. A new stage can not start until the previous stage ends.

It has the versatile merit, thus it is widely used in every place of the world. Its management method is mature, so all sides are all familiar with the related procedure; so we can be free to choose consultation, design, overseeing side; All sides are familiar with standard contract text, which is advantageous to the contract management, the risk management and the reduced investment. Its Shortcoming: The engineering project must go through the plan, the design, construct before turning over to the owner, the project cycle is long. The charge of the owner management is higher, the earlier period invest is larger; When changes, it is easy to cause more complaint for damages. The way has already been accepted by most people and used in practical application.

3.2 Designs – constructions way (DBM pattern)

The Design – Build Method is that the owner only designated the only entity to be responsible for the design and the construction of the project after the project principle is determined. The design – construction contractor not only is responsible for the design stage cost, moreover may use the competitive tender to choose Sublets Merchant or use their own specialized staffs to complete the project implementation, including design and construction and so on. Under this way, the owner first chooses a specialized consultation organization to replace the owner to study, and draw up plans to construct request of the plans to be constructed and authorized to have the enough specialized knowledge and the management ability person took the owner representative, to contact the design – build contractor.

3.3 Constructions – operations – turning over pattern (the BOT pattern)

The Build – Operate – Transfer pattern is briefly called the BOT pattern. The BOT pattern is the project management way which makes overseas government infrastructure construction depend on private capital or the construction project management way, or the state – owned infrastructure project privately – operated. The government opens its country's infrastructure construction and the operation market, authorized project company to be responsible for the raising fund and organizing construct, after completion responsible for the operation and repaying the loan. After the agreement expiration, it will be returned to the government free of charge. Its merit: Do not increase the host country foreign loan burden, also may solve the problem of the insufficient of infrastructure facilities and construction funds. Its shortcoming: The project initiator must have the very strong economic potentiality (big financial group), the qualifications preliminary hearing and the bid procedure is complex.

3.4 Projects contract pattern (Project Management Contractor)

It is briefly called the PMC pattern. Namely the owner invites the specialized project management company to implement on behalf of the owner the engineering project organization carries on the entire process or certain stages management and the service. Because the PMC contractor has difference in project design, purchase, construction, debugging participation degree and the responsibility scope , therefore the PMC pattern has a bigger flexibility.

The PMC pattern generally has some characteristics: First, giving the design management, the investment control, the construction organizes and manages, contract and so on equipment management to the PMC contractor, striping arduous and trivial concrete supervisory work off from the owner, which is advantageous to owner's macro – control, and achieve the engineering construction goal well; second its management strength is relatively fixed, and can accumulate an entire set of managerial experience, and improves and the develops increasingly, enable the experience, the procedure, the personnel and so on to have inherits and accumulations, and forms specialized management troop, simultaneously may greatly reduces the owner's the administrative personnel, which is advantageous to after – completion placement; third, reducing the project cost through the engineering design optimization. The PMC contract chamber of commerce, according to the actual condition, utilizes own technical superiority, carries on the comprehensive technology economic analysis of the entire project and compares, consummates, and carries on the optimization of the entire design in line with the improved function, the advanced technology, the economy feasibility principle.

3.5 Partnering pattern

The Partnering pattern refers to project participation all sides in order to obtain the biggest resources sharing, on the basis of mutual trusts, mutually reach one kind of short – term or the long – term mutual agreement. This kind of agreement breaks through the traditional organization boundary and considers the benefit of participation. Through determining the common project goal, establishes the work team, and promptly communications to avoid the occurrence of the justice and the lawsuit. We should cultivate the cooperation relationship, solve the project problem together and share the risk and cost together.

3.5.1 Partnering pattern characteristic

Establishing the project common goal, it caused project participation sides to take the project overall benefit as the goal, and weaken the benefit conflict of project participation. Because the goal has decided the organization, therefore the partnering pattern organization both needs to follow the principle of the organization theory, and also must have its characteristic.

The Partnering need establish a cooperative management group (TEAM) between participation sides, in mutual trusts directly supervise, management project work, realizes double wins and avoids the dispute or the problem occurrence through the effective communication. Work team's work content by no means directly intervene independent production management, but is to unceasingly appraise the project performance and to solve the emerging problems, and carry on the strict control of the risk, thus realizes the mutual benefit maximization. This kind of pattern usually appears after the owner and the contractor has once or many successful cooperative experience. It is one kind of long – term stable cooperation relations except considering specific project life cycle, also must consider the enterprise the future development. The pattern is generally applied to the large – scale or the super large – scale project. The owner can pay great attention to the social efficiency of the project and the enterprise's fame. The long – term cooperation not only can bring each participation side the economic profit, but also produce more prestige.

3.5.2 Partnering good and bad points

The international project uses experience proves that, The Partnering pattern is advantageous to the project participation side cooperation realization. This kind of pattern can reduce in the project implementation process the dispute and the conflict appearance probability, enhances the working efficiency, realizing project low cost and high – quality request. But, because Partnering is a new kind of project management pattern after all, it still has some insufficiencies in the implementation process:

The Partnering pattern must be established on the foundation of mutual trusts, but our country tradition pattern obtains the success experience on opposition foundation, therefore, in the short time it is very difficult to establish mutual trusts.

The Partnering pattern needs to break some traditional the work customs, requesting more exchange between the members. But breaking the worn – out enterprise culture is not done in short time.

In the Partnering pattern each participation side is easy to have the dependence psychology. If the power and responsibility are mixed together, it is very easy to cause the responsibility division chaotic, the working efficiency is instead low.

In the cooperation initial period work duty is heavy. It is one kind of initial period high investment pattern. Therefore, it can cause the cost increasing, and some people to halt.

4 Development direction of Public welfares hydraulic engineering construction management

According to the new management pattern request which is "Organization does not overlap, post does not have blank, work does not duplicates" and "condensing manager group, optimizing service group, reducing management span, decreasing the management cost", combining the character of the matrix type organizational structure, for a project, the construction side, the consultation organization select capable staff to compose a powerful management group which operate together, take the risk together, sharing the benefit together. They would thoroughly take the responsibility for the construction, the quality monitoring, the safety control, the relational coordination and the economic accounting. Under the precondition of safety, high quality and on time accomplish, realize maximum economic benefit advantage.

(1) Reduced management ranks, expanded management scope, strengthened unification management.

According to the project's different situation, choose the suitable management pattern. According to the overall plan and the goal, unifying thoughts, mutually coordinates each other, and fully displays the resources advantage.

(2) Exert the superiority of centralism material purchase, largely reduces the cost of material purchase.

In the project cost, approximately 30% ~ 50% of cost is the material cost. So effectively reducing the material cost is to become the key to the cost control. Under the precondition of guarantying material quality, invite public bidding for main material can reduce the cost of material purchase efficiently.

(3) Combining entire management resources effectively, develop the resources using efficiency to the maximum.

Optimizing resources disposition is an important method of management. The project management department is authorized to use the human, material and financial resources. They should enable each person to develop his talents, all material to be fully used, reasonably arranges the time and the space, effectively enhances the equipment use efficiency, enhances the turnover material turnover times, reduces the unessential repetition purchase and not using.

(4) Via carrying out the responsibility cost accounting system effectively, consummates the responsibility inspection system and award and penalty system, guarantee profit goal realization.

(5) Positively creating an atmosphere which is advantageous to the cultivate and develop comprehensive managerial talents. The project department superintendent directly faces the construct workers, they must be responsible for the work location. It needs the management must have not only the special skill, but also the ability of coordination, organization and direction. And they can makes the response and the adjustment according to the scene and the environment change, through the effective resources disposition any time, while maintaining quality and quantity of the construction production task, guarantees the realization of the project profit goal.

5 Concluding remark

At present, our country is in the initial stage of the socialist market economy and should study, summary and absorb the international advanced experiences frequently, combining the national condition. In aspect of the public welfare hydraulic engineering project management, we should gradually adapt to the international conditions to accelerating our country public welfare hydraulic engineering construction step.

We use the traditional design - tender - construction pattern. It is more suitable for the transformation period. But government should support the pattern of conditional design—construction—turning - over key and provides the policy support for this kind of pattern's promotion. Although B O T pattern is difficult to carry out in China, in order to face WTO's challenge, we must complete the related laws and regulations as soon as possible. It can provide the protection and support for the powerful engineering firm to improve the international competition strength.

The Partnering management pattern is widely used in Europe and America, Australian, Singapore and Chinese Hong Kong. But it is one kind of new management pattern in engineering. It would be applied in our country engineering construction. Therefore, while introducing this kind of pattern in our country, we cannot rigidly adhere to the above pattern, we must consider character of Chinese construction industry and the character of project. And then, make the essential improvement to let it serve the public welfare hydraulic engineering management in China.

Present Issues and Countermeasures Research on Construction Project Management in the River Channel of Shanxi Province

Zhang Dongfang[1], **Xiong Qiuxiao**[1] and **Li Yuehui**[2]

1. Department of Construct and Management, Yellow River Conservancy Commission, Zhengzhou, 450003, China
2. Department of International Cooperation, Science and Technology, Yellow River Conservancy Commission, Zhengzhou, 450003, China

Abstract: This paper gave a brief introduction about the project management general situation within the river channel of Shanxi Province. It pointed out many management problems, such as: un – harmony management system, faultiness operation mechanism, non – standard examine and approve process, weak administration function, non – powerful supervise, and shortage of training plan of part of river channel etc., analyzed reasons of issue, and put forward measures and suggestions of enhancing river channel management accordingly.

Key words: river channel, construct project, management, countermeasure

1 Present management situation of project in the range of river channel

1.1 Situation of rivers

Shannxi is situated in the center of mainland of China, which includes 10 municipalities, 107 counties with the area of 205,600 km^2 and population of 36.44 million. There are 4,296 rivers with the drainage area larger than 10 km^2, 560 rivers with the area larger than 100 km^2, 64 rivers larger than 1,000 km^2, 14 rivers larger than 5,000 km^2, 8 rivers larger than 10,000 km^2. These rivers are divided into south and north part as the boundary of Qinling, north of it belongs to Weihe, Jinghe, Luohe, Wudinghe, Kuyehe, it is main part of Yellow River basin with the area of 133,300 km^2, south of it belongs to Hanjiang and Jialingjiang, which is the main component of Yangtze river with the area of 72,300 km^2.

1.2 Management situation of project within the river course

Recent years, shanxi province implements involved laws and regulations of nation and Ministry of Water Resources (MWR), standardizes process of project construct examination and approval, strengthens supervision management of project, and guarantees normal management order of river course.

First is to enact matched policy and enhance propagation of regulation. After promulgation of "rules of project management within the river course" by MWR and sate planning commission, water conservancy department and local department in shanxi province established corresponding matched policies, make a detail complementary rules for detail problems. After establishment, water administration department in all levels propagated to peoples along the river, department of project, and construct department widely.

Second is to standardize process of project examination and approval. Project should be applied for jurisdictional water administration department. This department should implement technical censor. It is clearly prescribed that survey and technology argumentation should be made for large – scale project which can guarantee the quality of censor. License with the uniform censor writ can be handed to the project approved. In recent years, there are more than 300 projects passed the censor in shannxi province including large or normal scale reservoirs, bridges, and pipes for transporting gas, oil, and water supply.

Last is to establish expert institution, enhance staff management, and pay attention to construct supervision of project. It should be implemented to sign agreement of clearing obstacle and handing in deposit money in advance, which can ensure project build according to scheme. shannxi province water administration department organize to check up the project of main river course (such as Yellow River main stream, Weihe, Jinghe, etc. ,). Some obstacles of Xian – Yanliang high way Weihe bridge are cleared to maintain the safety of normal order and river course flood control.

2 Present issues and reasons involved

In recent years, river management department reinforced supervision of project in river channel by taking many kinds of measures and according to relevant laws and regulations, maintain normal river channel management order. But there are still some problems which should be paid more attention and dealt with by adopting relevant measures.

2.1 Un – harmony management system

There are main two aspects. One is multi – department management, management of part of rivers (section in city zone) disengage from the water trade unification management of water conservancy department. Projects management in river channel of Jintai and Weibin district in Baiji city still belongs to city construct department. Multi – department management led to construct randomly without examination and approval of water conservancy department, enhanced the difficulty of river course management. The other is inner management system of water conservancy department did not harmonize. River management lacks of corresponding function department from MWR, basin institution, province water conservancy department to local water administration department.

2.2 Operation mechanism of normal river course management did not set up completely

One is that responsibility of relevant function department of water administration major department is not clear about the process of examination and approval. Project examination and approval is not standard. Sometimes the phenomena of administration permission cover or instead of technology censor. Inner communication is not enough which plan department responsible for project censor without attendance of water conservancy department. Some procedure is ignored. For projects in the section of city zone, it is difficult to establish normal river management supervision system due to city construction department is both the construction department and river management department. Examination and approval process is ignored. The other is that policies of project management are not consummate. Locale survey and construction supervision during the censor of project spends some money, finance of river management is not enough, no clear policy for asking for money from construction department, impacts the project management work.

2.3 Procedure of examination and approval of project in river course is not standard or starting construct without approval

Many railroad bridges crossing Weihe River, Jinghe River of Baolan railroad, Baoshang bridge in the Baoji city sector, 310 highways Weihe River bridge, etc. , many large and middle scale river construction projects have not been examined and agreed by water conservancy department. Its reasons involve ① water laws and regulations consciousness of partial constructions department is indifferent, not earnestly fulfills the examination and approval procedure, and refuses to accept river department's management. For example, after many cross river bridges of Baolan railroad multiple track begins, the river department or repeatedly sends the letter for supervision, or scene supervisor, but the construction department does not pays attention due to Baolan multiple railroad is the national key project. ② The country plan department censors not strictly, permits construction projects without water administrative department agreement starting construction. ③ Local administration intervention influence river course project censor work. Because of the majority projects is priority project, the local administration intervention makes the water administrative department be unable to carry on the normal censor work.

2.4 Weak administrative function of water administrative department, un – powerful surveillance management, and bad results

In recent years, with the fast development of local economy, the phenomena of many places in Shaanxi occupied river course increases, some constructed market, build house on the river course, some encircles river for field ,recreation area and so on, specially some local authority key projects. Local government often acts authority as substitute of law, use words instead of law and construct randomly in the river course management scope. It has already become the significant difficult problems of river course management. The water administrative department lacks of the deterrent restriction means to projects without declare initiatively. It is very difficult to investigate violation works. If the Baolan railroad multiple track cross river bridge construction, Baoji river course major organization, under the situation of non – results after many times in the situation, send correction written notice to the construction department, ask construction department makes up the project examination and approval formalities, but the construction department did not fulfill.

2.5 Capital of work is not in place. Surveillance management power can not satisfy the request of standard river course management order

With the development of the economic society, construction projects in the river course increases day by day. Presently, majority of river course administrative department belongs to receives or pays on own way or the differential subsidy institution, funds can not be guaranteed. Annual mean funds vacancy is more than 200,000 Yuan in 5 rivers management departments of the county Huxian. Because management funds is not in place, work condition is bad, vehicles, communication equipment, etc. law enforcement equipments were short, which has influenced the work of river course management.

2.6 Parts of river courses lack of training plan

Because of no unification river training plan, river management scope can not be determined, which makes river course management lack basis. Whether project construction does conform to the river bed evolution characteristic or river flood routing are safe are unable to obtain the guarantee.

Because of above reasons, the phenomenon of regulation violation still exists. The main performance is that construct is not according to the scope of the examination and approval and the construction location did not clean up thoroughly. The main part is the city section of urban construction management.

3 Measures and suggests of strengthening river course management

3.1 To make the management system put in order

Strengthening trades coordination between the water conservancy department and the urban construction department, the geology and mining departments, making the river course management system put in order, and suggesting projects in the river course unified management by the water conservancy department guaranteed the river section in urban flood travel security and prevented encircling river to make fields and disorderly development construction.

3.2 To establish normal management operation mechanism

First is to strengthen water management organization; second is to clear unification management department, to standardize interior coordination and work coordination of management departments. It is suggested to consummate the essential procedure and clarify process of project censor, examination and approval.

3.3 To revise and consummate related management policy

It should be improved about the related policy of the river course management according to the investigation, the emerged questions of river course management, new Water Law and Flood Prevention Law.

3.4 To strengthen daily supervision and management of projects in the river course management scope, and enhance the investigation power to project of violation regulations

As soon as construction project in the river course completes, obstacle clear is very difficult. Therefore, it is suggested that management regards regularity management as the key point. For projects of regulation violation, it should be discovered and stopped early. For projects completed, for example, obstructing flood of Xianyang railroad bridge of Longhai railroad, Weihe River training plan confirms river width 600 m, but span of two highway bridges is only 311 m, seriously obstructs flood, once big flood happened, not only influence bridge security, also threaten Xianyang city security, suggests department concerned consulting to solve. For those who refuse to accept from the management, sticks to one's own way of doing things, must investigate firmly legally and set up authority of river management.

3.5 To research and make the capital of river course supervision in place

It should be clarified about the charge standard of examination and approval for projects in the river course management scope and surveillance management funds in construction time, which guarantee the river course management fund use normally.

3.6 To enhance harness of the small or normal scale rivers

It should be organized to develop training plan work of important rivers, complete the river course harness plan as soon as possible, and delimit the river course management scope. It should be determined as soon as possible especially for flood control plan controlling line of river section of frequent construction development and dispute, which can the provide the reliable basis for the river basic construction management. The rivers harness must have integration plan, all - round consideration, combination engineering construction, river course plan, and river course harness.

The Influence and Countermeasures Research of Sediment – water Regulation of Yellow River on Flood Prevention of Jiaozuo Section

Zhang Yuanlong[1], ***Li Shuancai***[2] and ***Huang Hongfen***[3]

1. Construction and Management Station of Engineering, YRHB, Zhengzhou, 450003, China
2. Yellow River Jiaozuo Bureau, YRHB, Jiaozuo, 454001, China
3. Water Supply Corporation of Puyang City, Puyang, 457000, China

Abstract: The Yellow River is famous for much sediment in the world. The practice of Sediment – Water Regulation in Xiaolangdi Reservoir increase the flood carrying capacity in the lower reach, meanwhile, it takes a series of new situations for flood prevention. Jiaozuo reach is transition section form the middle reach to the lower reach of the Yellow River. So the influenced is the earliest and the most serious. Through analysis the changes of Jiaozuo channel, the paper discusses the influence of Sediment – Water Regulation on flood control works and the countermeasures should be taken.
Key words: sediment – water regulation, jiaozuo reach, flood control

1 Introduction of Jiaozuo reaches

Jiaozuo reach is transition section from mountain area to flat area; it has only 32 km to the Xiaolangdi Reservoir, the channel is wide, shallow, disperseel, disorder, which is the typical wandering part. There is 4.7 ~ 11 km between two bank dikes of river, and 1 ~ 3 km widen of main channel; The stream gradient is 0.25‰. Flood control works are located in the left bank of the Yellow River, which include in 99.5 km dike of Yellow River (including 39.969 km Wenmeng dike). the numbers of dike are 0 + 000 ~ 90 + 432; 5 spots of projection works for dangerous section (Huangzhuang, Zhaozhuang, Liucun, Yuhui, Huapodi); 145spots of dike dams; 8 spots of training works (Lucun, Kaiyi, Huagong, Dayulan, Zhangwangzhuang, Jiabu, Dong'an, Laotian'an), 1 spots of beach safety project (Beiwendi) and 3spots of Gun river safety projects (Baimaquan, Yuba, Qinchang), in all 394 spots of dike dam projects. The area of Yellow River floodplain is vast. There are 61 villages, 92 thousands population, 40 thousands hectares floodplain, and 27 thousands hectares farmland.

2 The chief performances of channel after sediment – water regulation practice of Xiaolangdi Reservoir

2.1 The compose and characteristics of water – sediment during sediment – water regulation

2.1.1 Introduction

After utilization of Xiaolangdi Reservoir, it controls the most discharge of the lower reach. The first experiment of sediment – water regulation began at 9 AM of 4th, July, 2002, and finished at 9 AM of 15 th, July, 11 days later. The indexes of this experiment were: 2,740 m^3/s of the average flow (more than 2,600 m^3/s at Huayuankou station), 2.61 billion of the discharge in total, 12.2 kg/m^3 of the average sediment concentration. In 2003, the sediment – water regulation experiment lasted 12.4 days, from 9 AM of 6th, September to 6 PM of 18th, September; the control indexes at Huayuankou station were: 2,500 m^3/s of the average flow, 30 kg/m^3 of the average sediment concentration. However, because of the flood that appeared in the upper reach, Xiaolangdi Reservoir controlled the flood at about 2,500 m^3/s as Huayuankou station from 18th, September to 26 th, November. The sediment – water regulation of 2004 last 24 days from 9 AM of 19 th, June to 8 AM of 13 th, July; however, in fact, it lasted 19 days deducting 5 days of small flow rate from 0

AM of 29 th, June to 9 PM of 3 rd, July, the indexes were: 2,600 m^3/s of the control flow rate at Huayuankou station, 452.6 billion m^3 of the discharge at Xiaolangdi Reservoir, 4.37 million tons of the discharge sediment mass. The sediment – water regulation of 2005 lasted 20 days from 16 th, June to 4 th, July, and the flow rate at Xiaolangdi Reservoir was controlled at 3,000 m^3/s.

2.1.2 Sediment and water characteristics

The sediment and water characteristics during Xiaolangdi Reservoir sediment – water regulation showed as follow: ① The discharge of sediment and water are concentrated. Collect the upper reach water and discharge continuously in short time with high flow rate, carry much sedimentation of Xiaolangdi Reservoir through manpower density flow to the lower reach and pour into sea. ② Control the discharge under the floodplain. According to the analysis of the present year channel flood carrying capacity before flood season, control the flow rate under flood plain, which carry maximum sediment as well as prevent flood plain. ③ The amplitude of flood flow rate is small. The flow rate at Huayuankou station is controlled at about 2,600 m^3/s during sediment – water regulation period from 2002 to 2004 and 3,000 m^3/s in 2005. ④ The flood at the same dimensional last long time, such as in 2003, the sediment – water regulation practiced with flood prevention and hump modulation, the Huayuankou station kept 2,500 m^3/s of control flow rate 80 days, from 9 AM of 6 th, September to 26 th, November.

2.2 Situation of the channel scouring

During sediment – water regulation, because of long time discharge and small sediment concentration, the channels of Jiaozuo section show different degree scouring. The average depth of scouring is 1.38 m; and the largest scouring depth is 1.94 m on the east cross – section of Huangzhaiyu, the smallest is 0.72 m on the cross – section of Guanzhuangyu (see Table 1).

Table 1 The table of scouring situations of Jiaozuo Section during October, 2001 to October, 2005

Cross – section name	Scouring silt area (m^2)	Standard channel		Working channel	
		Width	Average depth of scouring (m)	Width	Average depth of scouring (m)
Xiagujie	1,197	4,040	−0.30	1,150	−1.04
Huayuanzhen	1,271	2,669	−0.48	800	−1.59
Huangzhaiyudong	3,882	5,800	−0.67	2,000	−1.94
Shilipudong	1,725	3,000	−0.60	1,000	−1.73
Guanzhuangyu	362	4,700	−0.08	500	−0.72
Laotian'an	1,669	3,300	−0.51	1,350	−1.24

2.3 The change of river regime

The basic river regime of Jiaozuo reach is: Tiexie→Lucun→Huayuanzhen→Kaiyi→Zhaogou→Huagong→Peiyu→Dayulan→Shendi→Jingou→Xigou, following as Mang mountain, passing Lubu stage and Licun electric irrigation station to Gubaizui→Jiabu→Zaoshugou→Dong'an→Taohuayu→Laotiao'an→Baohezhai (see Table 2).

Table 2 The parallel table of Yellow River Jiaozuo section channel projects changes around sediment – water regulation

Project name	Year	Near river dam number	Main stream dam number	Edge side dam number	Overtopped dam number
Lucun	2002	25 ~ 36	25 ~ 36		
	2005	22 ~ 36	34 ~ 36	22 ~ 33	
Kaiyi	2002	18 ~ 37	22 ~ 26	27 ~ 37	18 ~ 21
	2005	7 ~ 37	23 ~ 28	17 ~ 19,29 ~ 37	20 ~ 22
Huagong	2002	3 ~ 35	5 ~ 35	3 ~ 4	
	2005	3 ~ 35	16 ~ 20	21 ~ 35	3 ~ 15
Dayulan	2002	14 ~ 41	29 ~ 41	14 ~ 28	
	2005	5 ~ 9,14 ~ 41	20 ~ 41	5 ~ 9,14 ~ 19	10 ~ 13
Jiabu	2002	3 ~ 36	10 ~ 16	3 ~ 9,17 ~ 36	
	2005	3 ~ 36	24 ~ 36	3 ~ 23	
Laotian'an	2002	10 ~ 25	25	18 ~ 24	
	2005	18 ~ 25		21 ~ 25	

From the table above, the channel boundary condition has changed due to the changed sediment and water stream condition, result in the section elevation and subsidence, even some parts get worse especially the lower reach under Yiluo river mouth. In those parts, main flow swings frequently, the probability of appearing transverse and insequent stream increase. Take Laotian'an training works as example. No. 10, 15 ~ 25 dams were near stream and No. 25 dam was near master stream before sediment – water regulation, but the master stream moved south after sediment – water regulation, thus projects are near edge stream now. There ever was serous dangerous that the No. 25 dam back was scoured seriously. In 2004 ~ 2005 year, on Dong'an project 800 ~ 1,200 m part, the bank slumped 3,250 m bend opening, which the average width was 200 m and the largest width at bend top reached to 356 m. Even worse situation emerged in 2005 year, the changed river regime caused that the Zhangcaiyuan sluice couldn't divert water where had better water diversion condition before sediment – water regulation. That caused adverse influence for industry and agriculture of irrigation area.

2.4 Project emergency and reasons

2.4.1 Reinforced projects situations

There were 895 projects on Yellow River Jiaozuo reaches from 2001 to 2005. Reinforcements and emergency tackling completed stonework 159, 700 m^3, among those emergency tackling completer 101,200 m^3 and root – stone reinforcements completed 58,500 m^3 (see Table 3).

Table 3 The statistics table of reinforcements and disaster wrecking of channel prejects

Year	Dangerous dam number (No./dam)	Stonework for disaster(10,000 m^3)	Root – stone for reinforcement (10,000 m^3)	Total (10,000 m^3)	Remarks
2001	77/23	0.75	1.95	3.71	All year amount
2002	154/30	1.65	2.9	4.55	All year amount
2003	366/86	3.63		3.63	All year amount
2004	112/50	2.12		2.12	All year amount
2004	186/51	1.96		1.96	All year amount
Total	895/240	10.12	5.85	15.97	All year amount

From the above table: ① The disasters probability of channel projects raises sharper during sediment – water regulation, and volume of every disaster and total stonework for disaster of all year increase. ② The disaster probability of channel projects and stonework for disaster wrecking display linear relationship with the same dimension flood. For example, the sediment – water regulation of 2003 last 80 days, therefore, numbers of dangerous dams and stonework for disaster wrecking are obviously higher than other three years. However, they are more or less the same in 2002, 2004 and 2005. ③ The great projection disasters concentrate in sediment – water regulation period, approximately more than 80%. ④ The disasters in 2002, 2003 emerge more times, and relative less times in 2004, 2005. The first reason is the flood last short time, the second reason is the antecedent disaster wrecking and reinforcement rootstone work steady on flood prevention.

2.4.2 Analysis of emergency reasons

The reasons of projection disasters during sediment – water regulation chiefly show as follow: ① In sediment – water regulation period, for the steady flow rate and if the boundary condition don't change, the river regime contain steady for a long time, that from long time climax scouring on some part of projects, and there would be dangerous and bad disasters in bad river regime reach. Such as Laotian'an No. 25 dam in 2003 year and Kaiyi No. 18 dam in 2004 year. ② In sediment – water regulation period, for small sediment concentration in flood, the channel scoured is seriously, especially serious on upflow part of buttresses, that cause the projects root – stone lose, thus lead to disasters of the bank subsidence and slump. ③ In sediment – water regulation period, for the big flood, some buttresses that don't near stream in other time near stream to lead to disasters. ④ For the change of the river regimes, some buttresses that don't near stream originally near stream and cause disasters. ⑤Some new buttresses emerge dangerous easily, even big and bad disasters for shallow footing and big flood scouring.

3 The influence of Yellow River sediment – water regulation on flood prevention

3.1 Scour channel deep, increase flood carrying capacity, and decrease the probability of flood plain

During sediment – water regulation, Xiaolangdi control the flood under plain flow rate flood, and the flood pass along main channel, result in t the channel under cutting, the channel depth and capacity of carrying flood increase, change the block phenomenon of Yellow River channel, and the river regime develop better. Meanwhile, for regulation Xiaolangdi Reservoir, the probability of flood plain decreases, that promotes economic development of beach region.

3.2 Flood prevention capability of projects system increase relatively

During sediment – water regulation, Xiaolangdi Reservoir clear discharge increase scouring capability to channel, and the big discharge increase carrying sediment capacity of flood, so that the lower channel is scoured year by year and the carrying flood capability increase obviously. As Jiaozuo section, the plain flood flow rate is 3,000 ~ 4,000 m^3/s in 2002, and reach to 5,000 ~ 6,000 m^3/s in 2006, thus increase the flood prevention capability of projection system relatively.

3.3 Adverse development of river regime

Because a great difference between the discharge flood and the nature flood, the river regime develop to disadvantage. The master stream of some parts swing frequently, the probability of appearing transversal and insequent stream increase, even may scour dikes to influence dikes safety. For example, Lucun control and guide project of Mengzhou showed river regime subsidence, and the distance is only 65 ~ 90 km between the edge of stream to Wenmeng beach dike. The No. 10 ~ 25 dams of Laotian'an control and guide project of Wuzhi country near stream river before

2002 year. However, the river regime shows subsidence continuously after sediment – water regulation. The big flood scours the river back of No. 25 dam many times from 2003 year to now. only No. 18 ~ 25 dams near river currently and no buttress near channel.

3.4 The emergency intensity increase

The flow concentration in front of project buttresses, serious undercutting of channel, increase the depth of water in front of dam. The out water depth of buttresses raise 1.5 ~ 2.5m relatively because of channel scouring depth. In addition thee same dimension flood went on for a long time cause some parts of projects are scoured by the main flow during sediment – water regulation. There objective disadvantage increase the probability of appearing big and bad emergency and difficult of disaster wrecking. In bad river regime part, these would be caused the bank sloughing and bend opening, even occur bigger emergency such as transversal and insequent stream.

3.5 Condition of water diversion by culvert gate be worse

Some river regime have changed during sediment – water regulation, result in some culvert gate are away from master stream. Meanwhile, as river bed undercutting, water level in front of gates and at the head of channel decrease continuously, obviously cause decrease of water diversion guaranteed efficiency, such as Zhangcaiyuan gate, the flow rate of guaranteed efficiency was 200 m^3/s in 2002, but increased to 600 m^3/s in 2005.

3.6 Adverse effects on flood prevention preparation of people along Yellow River

The Yellow River comes into run dry and sediment – water regulation in 90s of 20th century. The people along Yellow River have a think is "One reservoir can protect everything" and " Rest easy". So the flood prevention preparation is not enough and hid a trouble for flood prevention. And lack flood fighting experiences.

4 Flood prevention countermeasures

4.1 Projection measures

4.1.1 Complete the planning and construction of channel projects

The river regime from Yiluo river mouth to Laotian'an control and guide project worse year by year. Because the sediment and water change of the upper flow, another reason is the not matching of channel projection construction. In additional Yiluo river and Qin River converge with Yellow River in this part, and some important country projects such as South – North Water Transfers. West – East Gas Transfers cross the Yellow River, which also influence the river regimes. Therefore, in order to keep river regime steady in this part, we should complete the planning and construction of channel projects quickly, improve projection constraint to flood.

4.1.2 Build control and guide projects with rootstone and reinforce rootstone without delay

The serious scouring of flood on river bed raise out water height of channel projects 1.5 ~ 2.5 m relatively. Thus the out water height of channel projects reach to 5 ~ 6.5 m, that cause volume increase of every disaster, difficult and intensity increase of disaster wrecking. Therefore, according to the corresponding water level of Yellow River sediment – water regulation control flow rate standard, build rootstone stage in upflow of channel projects, which the height should be higher 0.5m. And according to scouring situation replenish and reinforce rootstone without delay to guaraniee the whole projects steady.

4.2 Other measures

4.2.1 Strengthen leadership, recognize severe situation of flood prevention

The construction and practice of Xiaolangdi Reservoir can't take decision responsibility on Yellow River lower reach flood prevention. Jiaozuo section still faces severe flood prevention situations, which chiefly show as follow: ① Yellow River enters plain from mountain area, so that the flood would emerge suddenly and predictable time is short. ② Suspended River situation doesn't change. The channel is wide, shallow, scattered, disorder and master flow wandering and change. ③ All kinds of flood of Huayuankou are formed in Jiaozuo section, so that the convergences are complex, and the threat of Yiluo River and Qin River still keep. ④ The serious scouring of channel during sediment – water regulation, obviously increase probability of appearing big dangerous. In order to do flood prevention well must improve all society flood prevention realization based on totally fixed responsibility to government leader. In order to increase initiative and enthusiasm on flood prevention, make people to know the severe situation of flood prevention in Jiaozuo section.

4.2.2 Strengthen government leader training on flood prevention, improve capability of making decision

According to frequent change of all levels government leader, strengthen government leader training on flood prevention to totally fix responsibility to all levels leader. Through training, firstly, they improve realization on flood prevention responsibility based on their recognition of importance, necessity and severity on flood prevention, so that can guarantee all responsibilities to be fixed actually, Secondly, improve leaders capability of making decision through training, to guarantee correct measures on complex disaster spot. This point is critical to fight flood successfully.

4.2.3 Accelerate team construction of disaster wrecking, increase high speed reaction

According to heavy work and severe situation of flood prevention in Jiaozuo section, and to assure safety of flood prevention, must take advantage of market operating model based on keeping disaster wrecking special skills improve and very well equipped training. Accelerate public prevention team construction, improve capability of high speed reaction and prevention. Through disaster wrecking skills and discipline training. Therefore, from flood prevention and disaster wrecking nets with special team as main force, public team as base and Chinese People's Liberation Army as shock force.

4.2.4 Use new technologies, new materials, new crafts

Spread and take new technologies, new materials and new crafts in flood prevention and disaster wrecking, not only greatly accelerate disaster wrecking speed, improve effects of disaster wrecking, also greatly decrease the use of labor and materials, save the disaster wrecking cost. But for limited condition, new developed machines don't widely spread, and don't play their really effect in flood prevention based on "Three New" research rapidly to transform productive force better and quickly, and serve for flood prevention.

4.2.5 Complete flood prevention plan, improve operation

According to detail performance of river regimes, projection situation, dangerous situation in flood season last several years, and present year reality before flood period, predict river regimes during flood period based on serious research and analysis, to estimate all kinds dangerous and make every kind early prevention plans. Whether the early plan is practical, would play important role to whether can prevent disaster high efficiency. Therefore, when make disaster wrecking plans, pay more attention to collect and sort out basic data of buttresses with high probability to emerge dangerous, including projection construction and reinforcement situation, practice situation and problems, disasters in record and protection methods and so on. And compare all plans according to disaster prediction to improve operation of early plan.

4.2.6 Strengthen water administration enforcement, plan management of channel projects

Strengthen water law publicize, make great efforts to improve public law realization, and public consciousness to integrity of flood prevention projects. Meanwhile, strengthen water administration enforcement, carry out management and supervision to construction in channel, avoid to cause that the local decrease in flood prevention capability of projects or adverse influence on river regimes, and to form new dangerous spots.

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Discussion on Construction Quality and Safety Supervision Work Mode of Yellow River Hydraulic Engineering

Zhou Li[1], ***Li Jianjun***[1] and ***Ma Zhiyuan***[2]

1. Project Construction Administration Center of YRCC, Zhengzhou, 450003, China
2. Construction and Administration Bureau of YRCC, Zhengzhou, 450003, China

Abstract: According to the current situation of construction quality and safety supervision work of Yellow River hydraulic engineering, this paper combines the working practice of its own to investigate and discuss how to better exert the quality supervision work efficiency of the government and puts forward the work mode and conceive in the forthcoming days.

Key words: quality and safety supervision, work mode, conceive

1 State requirements on government quality supervision

In September 1984, State Council issued Provisional Regulations on Restructuring Building Industry and Infrastructure Administration, clearly prescribed that project quality supervision institutes of great authority shall be established to supervise and inspect the project quality in this area in light of relevant regulations and technical standards. It was the first time to state to carry on quality supervision work in China. In June 1997, Ministry of Water Resources issued Regulations on Quality Management of Hydraulic Engineering and Regulations on Quality Supervision Management of Hydraulic Engineering, which gave principle regulations on institutes, staff, responsibilities and content of quality supervision and further made clear the main methods and requirements to the hydraulic quality supervision institutes.

In January 2000, State Council promulgated Regulations on the quality management of engineering construction by decree No. 279, which for the first time stipulated the government to carry out supervision management system by the form of law rules and clarified the status and responsibility of the government quality supervision on engineering construction. In June 2001, Ministry of Water Resources published Suggestions on Further Rearranging & Regulating the Order of Hydraulic Construction Market, which stated to improve the market supervision and management institutes and strengthen the obligation of market supervision. Meanwhile, it required each place should combine the local project construction and the demand of rearranging and regulating the order of hydraulic construction market to improve the supervision institutes including staff, expenditures and equipments and definite the supervision duties, furthermore it emphasized the importance of strengthening the function of government supervision on engineering construction.

2 Current situation of quality supervision on engineering construction in China

The quality of engineering construction relates to the social public interests and safety. No matter in developed or developing countries, the government takes charge of the supervision and management on project quality. The construction administration departments of building, communications, railway and hydraulic in China should carry on the quality supervision work in light of state's relevant rules and always regard large scale projects and government - invested projects as the emphasis. Working situations in recent years have shown that construction system has walked ahead of other industries in terms of quality institute, staff, expenditure and regulations. They have set up professional institutes of quality supervision in provinces, cities and counties, arranged professional quality supervision staffs. As undertaking units, these institutes independently execute government function of quality supervision with their expenditures coming from the charge of project quality supervising fees. The quality supervision work has gained a standardizing progression and formed a sound operation mechanism.

Government quality supervision on hydraulic industries started from 1980s, it was in its developing stage in 1990s and fully implementation stage in the end of 1990s during which Ministry of Water Resources took charge of the nationwide quality supervision on hydraulic engineering. Presently, quality supervision institutes of hydraulic engineering adopts three – level, which means that Ministry of Water Resources sets key quality supervision station of hydraulic engineering (basin institutes sets quality supervision branch as the appointed institute of key station), Provincial Water Resources Administrative Department sets central quality supervision station and Municipal Water Resources Administrative Department sets quality supervision station. In terms of setting up modes, Affiliating Water Resources Administrative Departments are about 2/3 of the total number, and independent enterprises 1/3. Particular quality supervision institutes of enterprises also is attributed to properties of consulting the management of officeholders, allocating funds in full sum, subsidizing the balance and charging and spending on their own. Moreover, quality supervision staffs also have three forms of full – time, part – time and engage.

3 Developing situation of Quality Supervision Institutes of YRCC

3.1 General developing situation of quality supervision institutes before 2006

Yellow River Conservancy Commission established Yellow River Conservancy Commission Quality Supervision Central Station of Infrastructure Project in February 1991, whose name changed to be Ministry of Water Resources Key Station of Quality Supervision on Hydraulic Engineering Yellow River Basin Branch in 1998 (Yellow River Conservancy Commission Quality Supervision Branch for short below). Yellow River Conservancy Commission Quality Supervision Branch affiliates to the Yellow River Conservancy Commission Construction Administrative Department and quality supervision work is the duty of staffs in charge of construction management part – timely. Yellow River Conservancy Commission Quality Supervision Branch set affiliated Shandong and Henan quality supervision stations, of which management methods are similar to the Yellow River Conservancy Commission and all the institutes and staffs are part – time.

The quality supervision institute under this management mode is convenient to develop the work, but the staff cannot do well of the project quality supervision work because its part time and they are restricted by their own jobs. Especially in recent years, there are many engineering construction, much investment, heavy task, less staff taking on the construction management work. The depth and efficiency of the project quality supervision work cannot be ensured because the staffs must fulfilled his own duty at first, and in the work it's easier to attend to one thing and lose another. The staffs under each quality supervision station are transferee temporarily from each unit. All of the staffs are always outward who contact less with the former units, which is not good for them. It is difficult to solve some practical problems; as for the quality supervision station, there are also some existing problems such as inconvenient management, and that staff cannot fix long term etc. All of these affect the sound development of the quality supervision. Vice station masters of some engineering stations are charge by chief sectors of construction unit, supervised by them, which mismatched pertinent regulations of state and Ministry of Water Resources.

Confronted with all above problems, In order to increase the work force of quality supervision and upgrade the quality work level of the quality supervision. Yellow River Conservancy Commission puts forward to improve quality supervision system further, bring in and absorb advanced construction management experience from the projects invested by home and abroad government. Set up special quality supervision institutes; appoint full – time quality supervision personnel, and independent institute to exert quality supervision function of government in 2005.

3.2 Discussion on work mode of the quality and safety supervision institute since 2006

In July 2005, the Yellow River Conservancy Commission approved to establish Yellow River

Conservancy Commission project construction & management center, according to the conceive of gradually realizing construction independent, full – time workers of quality supervision work. The Yellow River Conservancy Commission project construction & management center takes charge of construction quality supervision of hydraulic engineering and assigns full – time staff to take on the quality supervision work entrusted by quality supervision station Yellow River branch. Referring to the work mode of Yellow River Conservancy Commission, Shandong and Henan respectively established construction management stations in May 2006, taking charge of quality supervision of governing areas.

In March 2006, Ministry of Water Resources published Notice on Name Change of Ministry Key Quality Supervision Station Of Hydraulic Engineering and Relevant Issues (S R J [2006] No. 75), and changed Ministry of Water Resources Key Quality Supervision Station of Hydraulic Engineering into Ministry of Water Resources Construction Quality and Safety Supervision Station of Hydraulic Engineering. Yellow River Conservancy Commission changed Ministry of Water Resources Key Quality Supervision Station of Hydraulic Engineering Yellow River Branch to Ministry of Water Resources Construction Quality and Safety Supervision Station of Hydraulic Engineering Yellow River Branch by H R L [2006] No. 15 document in May 2006, and stipulated to add safety supervision function.

At present, Yellow River hydraulic engineering construction quality and safety supervision carries out level – to – level management system, and Yellow River Conservancy Commission quality supervision branch sets up 4 quality supervision stations, namely, Shandong station of Yellow River Water Resource project quality & safety supervision, Henan station of Yellow River Water Resource project quality & safety supervision, Yellow River upper stream station of management bureau quality & safety supervision, and Heihe River control engineering quality & safety supervision station. Each quality & safety supervision institute monitors the quality and safety of governing hydraulic engineering according to project management authority, forming quality and safety network of level management, complete institute, clear obligation, and river coverage. Each quality & safety supervision station can establish quality & safety supervision station, and specifically take charge of the quality & safety supervision work of each engineering construction, according to the situation of region and project construction. Now, Henan station of quality & safety supervision has set up 4 project stations, and Shandong station of quality & safety supervision 3 project stations.

4 Conceive of quality & safety supervision work in Yellow River Hydraulic engineering

4.1 Strengthen team construction in each level quality and safety supervision institute

It requires grave responsibility, high specialty and high requirement of quality & safety supervision workers for hydraulic engineering construction quality & safety supervision. In order to develop and improve the sound development of quality & safety supervision on Yellow River hydraulic engineering, all level of quality & safety supervision institute shall pay attention to the team construction. They also shall appoint relative workers in light of requirements, intensify the work learning and training force to the staff at the same time, and gradually set up a quality and safety supervision team with dedication, profession, and high efficiency.

4.2 Perfect and improve quality supervision mode

At present, quality supervision takes random inspection as its primary mode, setting up engineering stations to carry out field or circuit supervision. With the deeply developed of construction management system reformed, mode of quality supervision should also be adjusted and transferred gradually from field supervision by setting up project stations to circuit checking – up supervision, from single institute supervision to multi – institutes supervision. In terms of work emphases of quality supervision, there also should give prominence to supervise on quality behavior of construction unit and execution condition of compulsory article and regulated standards.

Meanwhile, branch station of drainage area should also enforce its relation with quality supervision work in the drainage area, building collaboration mechanism of quality supervision on hydraulic engineering, learning from strong points to offset weakness, forming holistic dominance to play an important role in quality supervision reform.

4.3 Strengthen quality detection management

Quality detection is the important means of quality supervision for hydraulic engineering, whether there are problems in engineering quality or not finally determined by detection data. To make sure the quality security of engineering construction, supervision institute shall implement Entity Quality test from time to time and increase strength on detection work, meanwhile continually strengthen management and guidance on detection work of hydraulic engineering to guarantee data of detection true and reliable. It is required to gradually perfect quality detection market – admission system, further strengthen independent status of detection institute, actively explore and build detection system and evading system of the third party, and promote preciseness, correctness and justice of detection result.

4.4 Standardized project quality evaluation behavior

During the process of construction, according to relevant regulation, quality and safety supervision institute shall supervise and inspect the quality management system, quality management behavior of each party involved in the engineering, which asks for relevant units to develop construction quality evaluation work canonically and orderly in light of construction quality assessment standard, and fulfill their responsibility by levels, and strengthen control over construction quality. Before construction is completed, checked up and accepted, according to relevant regulation, legal representatives of the project asked to consign test institute with relevant qualification to test quality randomly toward engineering parts and project confirmed by quality and safety supervision institute, and take the result as important basis for appraising and deciding engineering quality grade.

4.5 Effectively prevent and decrease the engineering construction quality and the occurrence of accidents

In recent years, the construction task of flood control and standardized dike project in the downstream of Yellow River is heavy. All levels of quality and safety supervision institute should go on doing emphatic random test and special supervision. The emphasis is to check up and exclude insecure behavior of human, insecure situations of objects, insecure conditions of environment, etc. existed in measurement, working procedure, construction, further eliminating hidden security troubles in engineering construction, strengthening supervision management according to law, implementing system and supervision in the actual work. Meanwhile, they shall continually perfect the market – admission system, assessment system, contact contacting system and accident report system of safety production to prevent and decrease accidents from the headstream, and put an end to occurrence of the grand safety accidents.

5 Conclusions

Yellow River hydraulic engineering construction quality relates to its investment benefit, social benefit and environmental benefit. Attaching great importance and strictly controlling construction quality is duty – bound obligation of each party who takes part in engineering, as well as primary embodiment of government' functions in maintaining state and public's interest. As management system reform of hydraulic engineering construction deepens continually, we should go on exploring new work modes which are not only suitable for the new requirements of quality supervision management, but also for the practice of Yellow River hydraulic engineering construction, continually promote quality and safety supervision working level, and practically exert effectiveness of government quality supervision.

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The Study and Countermeasure to Abnormal Water Loss in the Luokou—Lijin Section of the Yellow River

Zhou Aiping*, *Wang Guanglin*, *Feng Li* and *Mu Yueyun

Yellow River Binzhou Bureau

Abstract: During the dispatching of the Yellow River water quantity, especially in the non – flood season, water dispatching is very tense. "Abnormal water loss" often occurs between the hydrological stations in the middle and lower reaches of the Yellow River. According to the hydrological data in the Loukou – Lijin section, water loss is calculated with the water quantity balance method. The sources of error and its influential degree are analyzed. And the countermeasures are presented to these sources of error.

Key words: water loss, water quantity regulation, measures

1 Introduction

Since 1990s, with the rapid economic growth along the Yellow River, the Yellow River water resource has been the key restricted factor to the Yellow River basin, especially to the middle and the lower reaches. Since 1999, in order to solve the problem of water resources shortage, the Yellow River Conservancy Commission has been regulating the water quantity to the middle and lower reaches of the Yellow River. This is the way to make use of the limited water resources and to make sure that the Yellow River can not stop flowing. But during the dispatching, especially in the non – flood season, it often occurs that there is disagreement in water quantity between the hydrological stations. That is to say, there exists a lot of water loss except the normal drawing. The reason and quantity are uncountable. We name this kind of water loss as the abnormal water loss.

1.1 The brief introduction to the Luokou—Lijin section

The total length of the Luokou—Lijin section is 175.8km. It is a man – controlled zigzagging section. The average width between two dykes is 2 ~ 3 km. The main bed width is 450 ~ 800 m. The main bed has a flow capacity of 3,500 m^3/s or so. The floodplain is 280.65 km^2, including agricultural area of 20,050 hm^2 and alluvial area of out of the dykes of 2,180 hm^2. There are 27 water – abstract gates (designed flow capacity is 881.3 m^3/s) and 65 fixed water – abstract projects in the floodplain (designed flow capacity is 39.55 m^3/s).

This area belongs to a temperate humid continental monsoon climate zone. The solar energy is rich. The average temperature is 12.1 ~ 13 ℃. The average rainfall is 575 ~ 600 mm. The rainfall in spring is 11% to 14% of the whole year. It is the rain – lacking area in Shandong Province. The average evaporation is about 2,000 mm. During the period between March and May, because of the hot southwest wind, the average month evaporation is 220 ~ 400 mm. That is the biggest evaporation time. The main plants in this area are wheat, corn, cotton. These plants need water for their growth in March, April and May. In this period, there is a great need of irrigation water from the Yellow River.

1.2 The present condition and effect of water loss

According to the water – sand data from January to May of 2005 and 2006, the Yellow River water amount flowing into Shandong Gaocun Hydrological Station is 6.366 billion m^3 and 8.104 billion m^3 respectively. The water – abstract amount in the Gaocun – Lijin section is 2.887 billion m^3 and 3.249 billion m^3 respectively. The water loss is 1.105 billion m^3 and 1.396 billion m^3 which is about 17.36% and 17.22% of the whole amount. And in Luokou—Lijin section, in

March , April and May of 2005 and 2006, the flow capacity in Luokou is 2.195 billion m^3 and 4.295 billion m^3 respectively. The water loss is 0.196 billion m^3 and 0.560 billion m^3. This is about 8.94% and 13.03% of the whole.

More than 8.94% of the total water flow disappeared because of the water loss. This caused the inconsistence between the hydrological stations and the real using water quantity. It's a block to make the water dispatching more scientific and specific. At the same time, the water loss also caused the waste of water resources and the loss of water fee. According to the data, in March, April and May during 2003 ~ 2006, the average annual abnormal water loss in Luokou – Lijin section is 0.318 billion m^3. After deducting the evaporation and leaking, the real abnormal water loss is 0.179 billion m^3. According to the agricultural using water fee 0.012 RMB Yuan/ m^3, the total water fee losing is 2,148,000 RMB Yuan.

2 The analyses of the reasons of water loss.

To analyze the reason and provide the countermeasures has great importance to the scientific water dispatching and efficient using of the water resources. We use main drawing section control method to balance the drawing section flow capacity in the upper and lower section. The formula is:

$$Q_{Li} = Q_{Ui} \times t + Q_{Ui-1} \times (T - t) + Q_{Ai} + Q_{Bi} - Q_{Di} - Q_{Loi} - Q_{Ri} \tag{1}$$

in the formula,

Q_{Li} is the water flow quantity of the lower drawing section; Q_{Ui} is the water flow quantity of the upper drawing section; T is the days in the present month; t is the time of the water flow between the upper and lower drawing section; Q_{Ui-1} is the water flow quantity of the upper drawing section of the last month in t days; Q_{Ai} is the adding water quantity between the upper and lower drawing section; Q_{Bi} is the back water quantity between the upper and lower drawing section; Q_{Di} is the drawing water quantity between the upper and lower drawing section; Q_{Loi} is the losing water quantity between the upper and lower drawing section; Q_{Ri} is the reserving water quantity between the upper and lower drawing section.

Because there is no adding and back water and the analyzing time is long in Luokou – Lijin section, the formula above can be adjusted as:

$$Q_{Loi} = Q_{Ui} - Q_{Li} - Q_{Di} - Q_{Ri} \tag{2}$$

After calculation: The total flow water quantity in Luokou drawing section in March, April and May of 2003 ~ 2006 is 1.127 billion m^3, 3.308 billion m^3, 2.195 billion m^3, 4.295 billion m^3 respectively. The water loss is 0.232 billion m^3, 0.282 billion m^3, 0.196 billion m^3, 0.560 billion m^3 respectively. This is about 20.60%, 8.53%, 8.94%, 13.03%. The average loss rate is 11.63%. The average day loss is 39.96 m^3/s. The biggest day loss is more than 102 m^3/s.

The reason for water loss are mainly the drawing water in floodplain, evaporation, leaking, measure error, water loss in watergate drawing, river bed reserving, etc.

2.1 The drawing water in floodplain and alluvial area of the dykes

According to the floodplain investigation data by the Yellow River Shandong Bureau in 2006, if the assurance rate is 50%, the main agriculture plants need: wheat 245 m^3/mu, corn 207 m^3/mu, cotton 127 m^3/mu. If the plants in the floodplain all need to use water drawn from the Yellow River, the total quantity would be 65 million m^3 in spring, plus 6.9 million m^3 water need in alluvial area of the dykes. The total agricultural water need would be 71.9 million m^3. Furthermore, there is a non – agricultural water need of 7.2 million m^3.

In the normal year, the effect of floodplain water need in non – flood season can be expressed in the next formula:

Daily biggest flow quantity = (the total quantity of drawing in floodplain in spring × the ratio of the present using water + the total drawing water quantity in alluvial area of the dykes in spring × the percent ratio of the present month + the non – agricultural water need)/irrigation (the period of drawing water)/8.64 (3)

Suppose the irrigation drawing water circulation is 10 days, after calculation, the most daily loss in March is 35.05 m^3/s, and 40.39 m^3/s in April and 11.95 m^3/s in May. If the circulation is month, then the daily loss would be 11.3 m^3/s, 13.46 m^3/s, 3.85 m^3/s in March, April and May respectively. If these 3 months is a circulation, the daily loss would be 9.49 m^3/s averagely.

2.2 Evaporation

In March to May, the area in Luokou—Lijin section has strong hot southwest wind. The temperature is high. The humidity is low. So the monthly evaporation is great. According to the data from Binzhou Weather Bureau, the water surface evaporation from March to June in 2003 ~ 2006 is 225.6 mm, 375.4 mm, 396.8 mm, 312.5 mm respectively. If the width of water surface is 395 m, the length is 175.8 km, then the evaporation area of the Luokou—Lijin section is 69.441 km^2.

Calculate according to Pu Peimin Formula from Nanjing Geography and Lake Institute, Chinese Academy of Science:

$$E = \Delta e \cdot F(\Delta T, \gamma, W) \tag{4}$$

Δe is air pressure saturation difference; ΔT is water - air temperature difference; γ is relative humidity; W is wind speed.

We can see from the Table 1 above that in the average year, the evaporation water loss is 5.63 m^3/s, 9.36 m^3/s, 9.95 m^3/s respectively in March, April and May. If we treat this period as a circulation, the daily volume of flow loss would be 8.30 m^3/s.

Table 1 Evaporation table

Month	March	April	May
Water surface area(m^2)	69,441,000	69,441,000	69,441,000
Air temperature (℃)	8.5	16.5	21.5
Relative humidity(%)	36.1	39.1	58.7
Surface relative wind speed(m/s)	3	4	4
Water temperature (℃)	6	12.5	19.5
Evaporation (m^3)	15,070,000	24,250,000	26,650,000
Convertion volume of flow(m^3/s)	5.63	9.36	9.95
Average(m^3/s)		8.30	

2.3 Leaking

The Yellow River bed is sandy soil and its water level is higher than the underground water level out of the dykes. According to Binzhou city underground water level data, the Yellow River water level is 2 ~ 5 m higher than the underground water level out of the dykes. This causes a lot of leaking. Furthermore, there is well drawing water loss in the floodplain.

According to the leaking formula:

$$Q = BKHq_r,\ q_r = H/\pi * \text{arcsh}[(s+b)/b] \tag{5}$$

where, s is half of the water surface width(395 m), b is (distance between dykes - 395)/2, k is 1.59 m/day.

There are 2,362 wells in the floodplain area in the Luokou—Lijin section. The total volume of flow is 8.5 m^3/s. The wells are drawing water once in March and April respectively. Each time lasts 10 days. If the volume of flow is 60%, that is 5.1 m^3/s.

After calculation, the daily volume of flow loss from March to May is 6.60 m^3/s, 7.22 m^3/s, 6.11 m^3/s. If we treat this period as a circulation, the daily volume of flow loss is 6.64 m^3/s.

2.4 Measure error

There are two main methods to measure the volume of flow in the Yellow River. They are current meter and curve estimation. Because the Yellow River is sandy, the boarder is changing with the water flow. This causes the curve estimation method has a big error. And the current meter is small in density, the quality of the hydrological station isn't qualified to the need.

Next is the table of the difference between the practical and estimated flow volume of Lijin Hydrological Station in May 2006. We can see the difference is big. On May 12, when the water level is the same, the estimation is 970 m^3/s. The current meter is 912 m^3/s. There is a difference of 58 m^3/s. This kind of measure error doesn't matter in great volume of flow. But in small volume, it has a great influence to the water dispatching (Fig. 1).

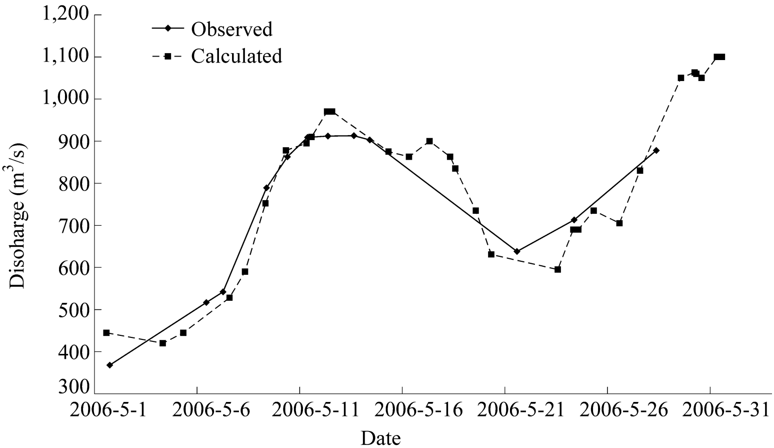

Fig. 1 The volume of flow in May, 2006 of Lijin Hydrometric Station

According to Lijin and Luokou Hydrological Stations' data of March to May in 2003 ~ 2006, the measure error can be analyzed with the average amount of relative error of volume of flow and standard deviation amount.

(1) The relative error of volume of flow formula:

$$\delta_{Qi} = \frac{Q_i - Q_{ci}}{Q_{ci}} \times 100\% \tag{6}$$

(2) The average amount of relative error of volume formula:

$$\bar{\delta}_Q = \frac{1}{N} \sum_{i=1}^{N} \delta_{Qi} \tag{7}$$

In which, δ_{Qi} is relative error of volume of flow formula of measure point to line or line to line; Q_i is the volume of flow of the ith time or the ith water level; Q_{ci} is the volume of flow relate to Q_i line; $\bar{\delta}_Q$ is the average amount of relative error; N is the number of samples.

In calculation, 368 practical and estimated samples of Lijin Hydrological Station and 9 of Luokou Hydrological Station in 92 days from March to May in 2003 ~ 2006 were used.

When the volume of flow is 300 ~ 500 m^3/s in Luokou, if the circulation is month, the error is −2.85% to 1.89%. If the circulation is March to May, the error is −0.33% to −0.30%. The measure data is diverting. In a short period, half a month, for example, the error is big. The biggest may be 12.75%. The most typical is in the end of March and the first half of April in 2006. Luokou Hydrological Station's estimated volume of flow is bigger. The average amount of relative error of volume is -4.21. But Lijin Hydrological Station's estimated volume of flow is smaller. The average amount of relative error of volume is 4.68. This caused the abnormal water loss in Luokou—Lijin section in some degree. During May 11 to May 12 and May 21 to May 31 in 2006, the water loss in Luokou—Lijin section is $-21 m^3/s$, $-13.7 m^3/s$ respectively.

According to the hydrological data in 2003 ~ 2006, in March to May, Lijin Hydrological Station's error is $1.79 m^3/s$, $0.18 m^3/s$, $-2.04 m^3/s$ respectively. If this period is a circulation, the error is $-0.03 m^3/s$.

2.5 Water loss in watergate drawing

At present, traditional measuring equipment is used to measure the volume of flow at all the watergates in the Yellow Rive. It is low frequency, big error and low precision. In the non-flood season, the change of volume of flow from Xiaolangdi Reservoir and the adjustment of drawing water cause the water level in the lower drawing section change frequently. Sometimes, the changing is big. The rising of water level and the watergates' untimely adjustment cause big error between the daily drawing volume of flow and measuring calculation.

2.5.1 Measuring error in drawing volume of flow

Casually choose 20 measuring samples in 6 time on April 6, April 23, May 30, August 21, September 27 and December 5, 2006. After analyzing, there are different errors because of different reasons. The biggest error is 25.4%. The smallest is 2.55%. The average amount of relative error of volume is 9.25%.

2.5.2 The drawing water error caused by the change of water level

Influenced by the Xiaolangdi Reservoir opening gate and watergates drawing water, the water of Yellow River advanced wave upon wave. Take the changing curve of water level in Zhangxiaotang Station (Fig. 2). We measure the volume of flow once a day at 8:00. If the water level rise, the water loss appears. After calculation, in March to May, 2003 ~ 2006, the average daily changing is 8.58 cm, 6.87 cm, 8.72 cm respectively.

According to 10th measure data when the water level is fixing in 2006, we analyze the data of rising and changing. We use EXCEL data changing into table tool and the volume changing relation curve of different watergate during the water level changing time. The revised water level volume of flow curve is produced.

Fig. 2 The changing curve of water level in Zhangxiaotang Station

After put many years of average changing data from March to May into experience formula, the volume of flow changing is 5.07%, 3.82%, 5.17%, 7.92% respectively.

2.5.3 Measure error analyse

Multiple the drawing water quantity from March to May of 2003 ~ 2006 and measure error and water level changing error, the water loss rate by watergate drawing water is 11.79%, 11.16%, 11.84%. Multiple the drawing water quantity from March to May of 2003 – 2006 and loss coefficient, Table 2 is the result.

2.6 River bed reserving

When the volume of flow gets bigger, the water level must rise between two hydrometric stations. This causes a water level difference and some river bed reserving. That is a water loss to the lower station. The Luokou—Lijin section is 175.8 km long. The river bed is 395 m wide. If the rising is 0.1m, the river bed reserving would be 175,800 × 395 × 0.1 = 6.944 million m^3. The temporary daily water loss would be 80.37 m^3/s. This causes difficulty to the scientific water dispatching. This kind of river bed reserve matters in a certain short period. In the long run, this can be neglected. But in the water dispatching tense time, this kind of water loss can't be neglected.

Table 2 mearure and water changing error table

Unit: volume of flow m^3/s

Year	March	April	May
2003	8.91	11.00	6.95
2004	17.85	16.37	4.25
2005	8.84	20.49	12.16
2006	26.66	16.29	6.43
Yearly average	15.57	16.04	7.45
Average		13.02	

2.7 Comprehensive analyse

According to water loss balance formula:

$$Q_{Li} = Q_E + Q_{Di} + Q_{Ri} + Q_{MEi} + Q_{Loi} + Q_{Dfi} + Q_{difi} \tag{8}$$

We put the former anajyzed results into the following tabe (Table 3).

Table 3 water loss balance table Unit: volume of flow m^3/s

Project	March	April	May	average	biggest
Water loss in 2003 ~ 2006	44.72	50.47	25	39.96	88
Drawing water in food area	11.3	13.46	3.85	9.49	40.39
Evaporation	5.6	9.36	9.95	8.30	12
Leaking	6.6	7.22	6.11	6.64	7.58
Drawing section measure error	1.79	0.18	−2.04	−0.03	62
Watergate measure error	15.57	16.04	7.45	12.98	
River bed reserving	0	0	0	0	
Other error	3.86	4.21	−0.32	2.57	

If we treat March to May as a circulation, the theoretical error is differ from practical error by 2.57 m^3/s. If we treat a month as a circulation, the water loss is bigger. The reason is drawing section measure, drawing water, water flow, bed deposit change. For example, in the 3 period of April, 2006, the water loss of the Luokou—Lijin section is 102 m^3/s, 80.5 m^3/s, 122.6 m^3/s. This is because of the drawing water and drawing section measure error.

In 2003 ~ 2006, the air temperature is similar to the yearly average amount. The evaporation and leaking is stable. The drawing section measure and river bed reserving are the main factors to influence the total water loss in a short period. But in the long run, they make little difference. The main factor to influence the total water loss is the error in water drawing in flood area and watergates. It is 56.23% of the total water loss.

We call this kind of water loss the normal water loss. There is another kind of water loss we call abnormal water loss. It is caused by subjective purpose, such as artificially interfering the measure to cause the disagreement between measure result and practical, purposely dispatching the water quantity, the management or person of watergate purposely more drawing less report or zero report. This kind of water loss can't be calculate and analyze accurately and is hard to illustrate. But it is bigger than the normal water loss.

3 The measures to reduce the water loss

The reasons of water loss are mainly caused by man's purpose besides the normal evaporation and leaking. They are hard to get rid of. But they can be reduced to the least degree by technical, policy and regulation measures.

3.1 Technical measures

(1) To use advanced measure equipment, improve the correctness and automatic degree, adjust the equipment regularly and correct the measure error caused by equipment in time can reduce the error to the least degree caused by equipment.

(2) According to the water dispatching and water changing, frequent the measure times of the hydrometric stations. It is suggested that the hydroelectric station measure at least 4 times a day during the water dispatching time. This can provide more accurate reference data.

(3) All the watergates strictly follow the requirement of measure. When the water level changes a lot or there is a great change in bed deposition, measure times must be added in time to accurate the measure result.

(4) Through technical improvement, to use new measure technique and automatic the measure process can realize the automatic measure.

(5) Based on the built surveillance and control system in a long distance, improve its function to realize automatic monitoring.

3.2 Management measures

(1) Enforce the management of water drawing in flood area and solve the disorder drawing water problem in flood area. A concentrate water supply system of irrigation in flood area was built. Government provides the fund to establish the water drawing project and irrigation system. The water bureau or the Yellow River Bureau manages them. This can solve the difficulty in water dispatching caused by disorder water drawing.

(2) Improve the supervision system to hydrometric station and watergate measure and carry out strictly. Clear the supervising organization, make supervising system and check regularly and casually to make sure of the accuracy of the measure.

(3) Enforce the inner regulation system. Standardize the management personnel's behaviors. Get rid of the subjective eater loss. Enforce the supervision to water supply party, harsh the punishment to the disobeying.

(4) The perfect hydrologic station and makes Huang Zha the movement to manage and to supervise the mechanism, and strict execution. Be clear about the supervise agency, the formulation surveillance system, implements regular and the non – periodical inspection, thus the reduced river damages.

3.3 Policy measures

(1) Make reasonable water price policy. Enforce the propaganda. Improve people's focus and attention to the Yellow River water resources. The present water price is too lower. The price of per 100 m^3 is less than that of a bottle of mine water. Less attention is put on the water measure error and loss. Make reasonable water price policy. Enforce the propaganda. Make people realize that the Yellow River water resources is an important and short goods and a strategic resources and it is a great loss even to waste 1 m^3 water. Focus the attention to water waste. These measures can reduce the abnormal water loss to the lowest degree.

(2) Establishment standard the Yellow River valley water rights, water market. Speeds up the water rights system and the water rights transfer to existing takes the water permission management the influence as well as the water rights transfer rule, the policing method research work. Gradually establishes the Yellow River water supply market which adjusts by the economical release lever, establishes adapts the market economy system science, reasonable also the effective water used compensation, the transfer, the drive mechanism.

Environment Impact Assessment of the River Training Projects in the Wandering Stretch of the Lower Reaches of Yellow River

Li Yongqiang[1,2], **Liu Yun**[2] and **Li Shu**[3]

1. Hohai University, Nanjing, 210035, China
2. Reconnaissance, Design and Research Institute of Yellow River Henan Bureau, Zhangzhou, 450003, China
3. North China University of Water Conservancy and Electric Power, Zhengzhou, 450011, China

Abstract: With the development of the economy and society, people have paid more attention to environment that they live in. The river training is the most important measure and plays an important role in the flood control in the lower reaches of Yellow River. However, it unavoidably brings some negative influences, too. Based on the analysis on all possible influences due to the river training, the evaluation is obtained by using the Battelle system methodology and the matrix system. At the same time, measures and suggestions are proposed to reduce or to mitigate some of the adverse consequences of the projects.

Key words: EIA, river training, wandering stretch, lower reaches of the Yellow River

In the past 57 years, a lot of river training works have been built in the wandering stretch of the lower reaches of Yellow River. They have been used for reducing the flood damage, controlling the main flow, limiting the change of the channel regime, improving the irrigation conditions and protecting the beach and villages in the flood plain.

However, with the development of the economy and society, people have paid more attentions to environmental and natural system aspects and have gradually realized that the projects brought and would bring some unavoidable negative influences to the environment. These influences directly impaired the benefits of the projects at the same time.

The river training system is built by stages based on real demand of the change of the main flow and there are still lots of groynes to be built in the future according to the plan of the flood control. Normally it is difficult to say that one or several groynes will make serious environmental impacts if we don't take into consideration the whole river training system. However, the combination of all the groynes brings some influences to the environment. Therefore it is necessary to carry out an integrated Environmental Impact Assessment (EIA) for the whole river training system and provide mitigation measures to reduce the negative impacts instead of doing the same for one or several groynes each time.

1 The objective of the EIA

Normally, the EIA process makes sure that environmental issues are raised when a project or plan is first discussed and that all relevant concerns are addressed as a project proceeds towards implementation. The river training in the lower reaches of the Yellow River is a long-term and an expensive project and the implementation of each groyne is determined by the local hydraulics and hydrology conditions of the River and investment of the country. Although a lot of the river training works are already built, there are still a number of groynes that need to be built in the future.

At the same time, due to the change of the water and sediment flowing into the lower reaches of the Yellow River, it is necessary to regulate the design parameters of some of projects. As a result it is necessary to conduct a full EIA in order to:

(1) Identify and forecast the possible positive and negative impacts to the environment resulting from projects;

(2) Provide the measures and suggestions that will reduce or offset the negative impacts of the projects, resulting in acceptable environmental changes.

2 EIA screening

The lower reaches of the Yellow River is famous for its wandering and sediment. People had suffered drastic flood disasters before the foundation of People's Republic of China. In order to reduce the threat from the flood, many reservoirs have been built on the trunk and the tributaries, for instance, Sanmenxia, Xiaolangdi, Luhun and Guxian reservoir. The dykes of 1,400 km long in the lower reaches have been strengthened and heightened for 4 times. Strengthening the dykes by clearing away the silt has begun and large – scale channel improvement has been carried out. The detention basins of the Beijin Dykes and the Dongping Lake have been built, and the estuary has been brought under control tentatively. A flood control system in the lower reaches of the Yellow River which is "interception in the upstream and discharge in the downstream, bypass and detention on both side of the channel" has been formed. The above measures have improved the lower reaches' ability to resist floods and ensured the security of the Huanghuaihai Plain and its steady development.

However, many projects were built only for flood control and beneficial promotion. In that time, people did not have enough knowledge to understand and predict the environment impacts due to the projects. As a result, now there are still some negative influences that have not been eliminated after many years of the construction. Like the other measures, people built the river training works for the flood control and did not make the detailed analysis for the impacts of the sediment transport, sediment distribution and wetland and so on.

Nowadays, the key node projects for controlling the main flow were almost set up and a lot of river training works were built. However, due to the continuity and duration, there still have many groynes that are being built or will be built according to the plan of the whole river. Whether a certain groyne should be built depends on the local hydraulic and hydrologic conditions of the River and the investment of the country. Normally, in order to avoid to the big change of the main flow and the limitation of the economy, fewer than 10 groynes were built in one project each time. Normally it is difficult to say that one or several groynes will make serious environmental impacts if we don't take into consideration the whole river training system. However, the combination of all the groynes brings some influences to the environment which greatly changed the nature situation of the river and beach. Therefore it is necessary to carry out an integrated Environmental Impact Assessment (EIA) for the whole river training system and provide mitigation measures to reduce the negative impacts instead of doing the same for one or several groynes each time.

3 EIA

3.1 Main changes due to the river training

The main channel was gradually well controlled within a small scope due to the river training. Table1 shows the change of the main channel in recent years. The total width of the main flow variation of all the cross – sections decreased from 82.3 km (1949 ~ 1960) to 57.1 km (1964 ~ 1973) then to 36.7 km (1989 ~ 1994). At the same time, the combination of the change of water and sediment flowing into the lower reaches of the Yellow River, the character of the wandering river was gradually decreased. In consequence, the main channel usually flowed between the river training works and the so – called "transversal channel" and "diagonal channel" occurred less. The river type will gradually change from the wandering river to the meandering river. Theoretically, the sediment transportation will decrease with the increase of the meandering length and meandering amplitude.

Table 1 The change of the main channel between Jingguang Bridge and Dongbatou

Unit: km

Cross Section	The change of the main channel		
	1949 ~ 1960	1964 ~ 1973	1989 ~ 1994
Jingguang Bridge	2.1	2.2	1.1
Baohezhai	7.2	5.5	3.2
Mazhuang	7.0	2.7	1.5
Huayuankou	3.5	4.6	1.8
Babao	5.5	3.8	1.2
Laitongzhai	4.2	1.5	0.3
Wuzhuang	5.8	2.3	2.2
Wantan	5.1	1.0	3.8
Xinzhai	4.0	4.0	1.4
Heishi	5.5	3.0	5.2
Weicheng	6.0	4.2	2.2
Heigangkou	2.5	1.5	1.6
Liuyuankou	4.0	2.0	1.3
Wang'an	4.5	5.0	2.1
Gucheng	6.5	4.9	4.0
Caogang	2.5	1.7	1.3
Changdi	3.0	2.4	0.5
Jiahetan	1.0	1.0	1.5
Dongbatou	2.4	3.7	0.5
Total change	82.3	57.0	36.7
Average change	4.33	3.00	1.93
Maximum	7.2	5.5	5.2

The distribution of sediment silting in the river was markedly changed. Due to less water flowing into the lower reaches of the Yellow River, fewer floods inundated the flood plain. At the same time, the main channel was limited by the river training works and the variation scope of the main channel was decreased. In consequence, more sediment silted in the limited scope and this aggregated the threatening of the "second hanging river".

The beach along both sides of the river is a space for flood discharging, flood storing and sediment silting. At the same time, this is a space for people to live and crop, too. Before the construction of the river training works in the wandering stretch, the main flow changed drastically and washed out a lot of villages and beach. For example, there were 180 thousands mu high beach washed out and 7 villages were dropped in the river in 1961, 1964, and 1967 in Yuanyang beach. Due to the river training, especially in last decade, the main flow is controlled well and there was no village dropped into the river. The erosion of the beach decreased greatly, too. This made a good condition for people to live and crop in the beach.

Encouragement for great development of the flood plain led to further demands for flood protection works. People are willing to live in the flood plain and there are more than 1 million people living in the flood plain in the wandering stretch now. At the same time, agriculture is developed with the improvement of the irrigation system and it enhanced the handicraft industry and led the improvement of the economy. In consequence, the standard of the flood control is required to improve and more and more summer dikes are built by the people living in the flood plain. It is difficult to break down all the summer dikes when the flood season is coming.

The flood propagation is changed with the construction of the river training. Even the minimum width for discharging the flood is preserved, this led to change of the propagation of the flood and the water level is increased with the same frequency of flood. This made bigger pressure for the flood control for the embankment both sides. At the same time, the propagation time is lengthened and this may lead to more inundation times of the flood plain during the big flood.

Vegetation along the stream banks is changed. With the development of the river training, more wild grass and shrub that can endure the longer inundation time and erosion were replaced by the crop, for instance, corn, earthnut and soybean and so on. These crops are usually high and are planted in denseness way. So bigger roughness is created and this leads to higher water level in the same discharge and reduces the capacity of discharging flood of the flood plain.

Wetland is decreased due to the river training. With the scope of the main channel decreasing and the branch reducing, the water surface of the river and the pit near the main channel were decreased gradually. Now though it is difficult to say this made a great influence to the number of the wild animal, especially the wild birds, their environment of living is changed.

The protected bank provides the good condition for intake of the diversion channel. This efficiently increased the opportunity of directly getting water from the river and reduced the cost of the irrigation.

3.2 Environment impacts during the construction phase

Most of the river training works in the lower reaches of the Yellow River were built with stone and earth and a part of projects adopted reinforced concrete filling pile structure to reduce the flood control pressure according to different places and the hydraulic conditions. The construction capacity of the dam built in the dry land mainly includes: clearance of the dam base, building of the dam body, laying of the geo – textile, riprap of the revetment, protection of the dam toe, etc. The construction of underwater dam mainly includes: riprap, earth filling, apron stone, leveling of the dam face, etc. The construction of the reinforced concrete piled dam includes mainly: borehole – drilling, clearance, making of the reinforcing cage, underwater filling of the concrete, etc. So some short – term impacts must be considered as the following during the construction phase of the river training.

A lot of earth materials are needed to fill the groynes and big quarries have to be excavated. It causes the vegetation – cover alteration and it is impossible to use for economic purposes without large additional expenses. At the same time, water and wind erosion can not be avoided.

Due to the excavation of the quarries, lots of areas are unusable for agriculture for a long time, at least in one year or longer. Without big flood inundating the flood plain in short term, it is difficult to recover the land for agriculture by nature.

Surface and ground water pollution usually occur at the construction site. There are usually the industrial and domestic effluents in the absence of sewer and treatment works. Untreated sewage is directly discharged into the channel or the Yellow River or seeped through the soil. In consequence, this polluted the water source around the project.

Air pollution is unavoidable, too. Firstly, all kinds of vehicle including truck, tractor, road roller are used to transport the construction material and fill and compact the dam body. Almost these mechanized operations are related to combust the liquid fuel. Secondly, formation of dust is easy to be produced by wind when earth material is transported over a long distance. In addition, smoke and combustion products formed in burning timber waster are another air pollution source.

Public health needs to be paid more attention during the construction phase. Lots of people crowded at the construction site with unwholesome sanitation condition and it is easy to spread all kinds of contagions.

3.3 Evaluation

Numerous techniques and methods have been developed for evaluating and presenting the effects of proposed and ongoing developmental activities on the environment. Based on the simplicity, systematication, relative accuracy, good predictive capability and including more information, two kinds of methods are chosen to evaluate the environment impacts.

3.3.1 Evaluation by the battelle system methodology

The Battelle system methodology was used for prediction and evaluation of the impacts. This methodology is an Environment Evaluation System (EES) for WRD projects developed by the Battelle Northwest laboratories for the United States Bureau of Reclamation and has been taken on the basis of the development of other several methods. The method takes the item - by - item evaluation approach and then determines a numerical value of each parameter. This methodology has the obvious shortcoming that is the difficulty in replication because different experts have trouble in agreeing values of the parameters. In EIA, ten different experts in different fields were consulted and they made the decision on the values of the parameters.

The EES was used to evaluate the expected future condition of the environmental quality both with and without the project. A difference in environment impact units (EIUs) between these two conditions constitute either an adverse impact, which corresponds to a loss of EIUs or a beneficial impact which corresponds to gain in EIUs. Mathematically this process is represented as follows:

$$E_I = \sum_{i=1}^{m} (V_i)_1 \times W_i - \sum_{i=1}^{m} (V_i)_2 \times W_i \tag{1}$$

where, E_I is Value in environmental impact; $(V_i)_1$ is Value in environmental quality of parameter i with the project; $(V_i)_2$ is Value in environmental quality of parameter i without the project; W_i is Relative weight (importance) of parameter i; m is Total number of parameters.

Based on the experts' decision and the Battelle system methodology, the evaluation of the environmental impacts are shown in the following Table 2.

3.3.2 Evaluation by the matrix system

The environmental impact matrix was prepared to identify impacts (the most important effects), to identify the causes (those with high environmental impact coefficients) and to compute the overall integrated environmental impact index of the project. The E. I index gives an indication of the expected environmental quality with project (0 means an unchanged environmental quality; 1 means a maximal change in environmental quality).

The cell contents of the matrix are I/A, where I index indicates the intensity of the effect (0 = no effect, 5 = maximal effect), and A indicates the propagation area of the effect (0 means 0%, 5 means 100%).

The E. I. Index is determined using the following formula:

$$E.I = \frac{1}{2 \times 5 \times n \times p} \times \sum (I_{ij} + A_{ij}) \tag{2}$$

where, n is the number of columns containing the causes of environmental impact, p is the number of rows containing the environmental - effects.

The results of the Matrix evaluation system are shown in the following Table 3.

Table 2 Evaluation of the impacts (Battelle system)

No.	Effect	Weight of effect (W_i)	Environmental quality With project (V_i,1)	Environmental quality Without project (V_i,2)	Impact units (EIU) With project	Impact units (EIU) Without project	Net change
	Physical environment						
1	Sediment distribution	90	0.4	0.6	36	54	−18
2	Sediment transport	80	0.5	0.6	40	48	−8
3	Flood discharging and propagating	80	0.4	0.6	32	48	−16
4	Air pollution	20	0.3	0.7	6	14	−8
5	Surface water quality	20	0.1	0.7	2	14	−12
	biological						
6	Vegetable in the flood plain	30	0.3	0.8	9	24	−15
7	Wildlife	20	0.4	0.7	8	14	−6
	social − economic						
8	Flood control	300	0.8	0.3	240	90	150
9	Land distribution (land loss and creation)	30	0.4	0.6	12	18	−6
10	Agriculture	60	0.7	0.3	42	18	24
11	Wetland	40	0.4	0.7	16	28	−12
12	Recreation	30	0.6	0.4	18	12	6
13	Resettlement	50	0.4	0.9	20	45	−25
14	Irrigation condition	40	0.8	0.2	32	8	24
15	Riverine fishery	20	0.4	0.6	8	12	−4
16	Local transport	30	0.7	0.4	21	12	9
17	Food supphy	40	0.8	0.5	32	20	12
18	Public health	20	0.4	0.9	8	18	−10
	Total	1,000			582	497	85

3.3.3 Evaluation result

Table 2 and Table 3 show that the environment impacts are not so obvious and serious due to the river training.

Table 2 shows that the net change of the environment is positive. It means the total environment quality will be improved gradually although some adverse factors will make some negative influences for the environment.

Table 3 shows the overall environmental impact index computed was 0.13, which indicates slight environmental impact with the project. According to the theory behind the matrix method this means that if the project is implemented there is only 13% chance of causing adverse environmental changes, and this may be considered acceptable.

4 Measures for environmental impact mitigation

Measures being proposed to reduce or to mitigate some of the adverse consequences of the project include the following:

(1) River width for discharging the flood. An enough width for discharging the flood must be

preserved. Now some river training works don't work well and the main flows are wandering in the front of these works or are bypassing these works to make adverse erosion after works. When some groynes controlling the main flow have to be built with less river width for discharging the flood, the groynes with the low crest level should be adopted instead of the groynes or sill with normal standard.

(2) Sediment transport and sediment distribution. The river training works were designed for flood control and limiting the change of the main flow, but the sediment transport was not taken into account. So with the combination of the river training and the regulation of water and sediment, the design river width and design discharge of the river training should be regulated according to the requirement of the flood control and sediment transport in the future design. This will increase the capacity of the sediment transport, and reduce the silting in the main channel.

(3) Wetland. Wetlands are important habitats for the wild animals. Wetlands are decreasing with less water flowing into the lower reaches of the Yellow River and the small variation of main flow. It is important for wild animals to maintain these wetlands especially Tiexie and Liuyuankou wetlands. Now maintaining base flow, making flood peak by reservoir and protecting the wetland by law are important to sustain these wetlands.

(4) Resettlement. It is important to reduce the excavation depth of the quarry, to preserve the soil of the cultivatable layer and to recover the quarry for agriculture timely. At the same time, appropriate compensation can help to improve the income for the people who lost the land in short time or longer time.

(5) Construction phase. During the construction phase, a treatment plant for sewage is good to deal with the waste water from the living and production. Sprinkling water on the road to avoid the dust and arranging appropriate construction time to reduce the noise are helpful to mitigate the dust pollution and noise pollution for the other people living near the construction site. At the same time, it is necessary to set up the sanitation system to avoid the infectious diseases.

5 Conclusions

With the development of the river training in the wandering stretch of the lower reaches of the Yellow River, the pressure due to the flood control is decreasing and it makes a good living condition for the people living in the flood plain and Huanghuaihai Plain. However, the adverse influences are occurring and some negative influences gradually emerge clearly. Although the flood control is the most important issue for the lower reaches of the Yellow River, more attentions need be paid to the environment with the development of the economy and society. In consequence, in order to reduce the negative influences as many as possible, we must take into account the requirement of the sediment transport in the design of the river training. At the same time, the non – engineering measures of flood control should be also intensified in future.

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Recent Development of Flood Risk Management in the Rhine Delta and Coastal Zone in the Netherlands

Huang Bo[1] and ***Ma Guangzhou***[2]

1. Shandong Yellow River Reconnaissance, Design and Research Institute, Jinan,250108,China
2. Yellow River Conservancy Press, Zhengzhou,450003,China

Abstract: After the flooding disaster of storm surge in 1953 and the flood of Rhine in 1995, large – scale dike construction and reinforcement were carried out along the coast and Rhine River in the Netherlands. The safety standard of flood protection has been raised from 1/1,250 in eastern Netherlands to 1/4,000 and eventually 1/10,000 along the coast. Whereas with the uncertainty of climate change in the future, the discussions on The Netherlands' flood control strategy were intensified and extended in long term consideration. Recent estimates of the change in the discharge regime of the Rhine River forecast an increase in the so – called design discharge from 15,000 m^3/s in the 1990s towards 16,800 (minimum scenario) to 18,000 m^3/s (maximum scenario) by 2100. Additionally, in the downstream deltaic area, sea level rise may hamper the discharge. For The Netherlands, sea level rise is currently estimated as between 0.2 and 1.1 m above present. Finally, in deltas and alluvial plains both shrinkage and oxidation of extensive peat layers cause the subsidence of large areas.

Traditional measures such as dike heightening and strengthening are efficient in flood protection, but with social developments in the future, more claims will probably be made on space for functions other than safety against inundation, such as the landscape, the environment, ecology, inhabitation, industry, etc. Because of this, traditional dike strengthening will come up against greater social objections. This calls for a change of strategy in flood risk management of both integrated river management and spatial planning in coastal zone.

Key words: recent development, flood risk management, Rhine Delta, coastal zone

1 Background

The storm surge of February 1953 caused one of the biggest natural disasters in the history of the Netherlands. The death toll of 1,853, an unprecedented high figure for Dutch standards, made a profound impression and roused emotions. The water levels that occurred during this storm surge at Hoek van Holland are the standard for the northern part of the delta area, and showed a highest water level of 3.85 m + NAP, which is 0.57 m higher than the highest recorded water level of 3.28 m + NAP in 1894.

After the flooding disaster, large – scale dike reinforcement started. The so – called Delta Project included the closure of coastal inlets and estuaries. Along whole coast and in the region of the downstream rivers the flood protection structures were strengthened in an unprecedented way. For the first time the level of protection in a certain region was normative. For Central – Netherlands the flood protection structures had to give a protection against a storm surge from the sea with a chance of occurrence of one in 10,000 per year.

In 1993 and 1995, The Netherlands experienced periods of uncertainty when the Rhine River reached very high levels. The discharge is up to 12,000 m^3/s at Lobith. In the Rhine River, only in 1926 had a higher discharge (12,600 m^3/s) been recorded. Over 240,000 people were evacuated from a number of polders when the stability of the dikes seemed no longer guaranteed. Fortunately the dikes did not fail.

Since 1995 structural measures have been taken. An emergency act was passed in parliament, which was called Delta Plan Great Rivers. In this act it was laid down that the entire dike reinforcement programme along the rivers had to be completed before 2000. Based on this at the dikes in the river region were indeed strengthened very quickly at the previously prescribed chance of occurrence of one in 1,250 per year. Now they protect the river region against high water levels belonging to a discharge of the Rhine of 15,000 m^3/s at Lobith.

After the flood of Rhine in 1995, the discussions on flood control strategies in the Netherlands were intensified and extended to include climatic change as an additional relevant factor for the long term. Recent estimates of the change in the discharge regime of the Rhine River forecast an increase in the so – called design discharge (a peak discharge with a probability of 1/1,250 years) from 15,000 m^3/s in the 1990s towards 16,800 (minimum scenario) to 18,000 m^3/s (maximum scenario) by 2100. Additionally, in the downstream deltaic area, sea level rise may hamper the discharge. For The Netherlands, sea level rise is currently estimated as between 0.2 ~ 1.1 m above present. Finally, in deltas and alluvial plains both shrinkage and oxidation of extensive peat layers cause the subsidence of large areas, a process which in The Netherlands is enhanced and maintained by a history of over 1,000 years of drainage.

Summarizing, the design water levels in the rivers will probably rise because of higher peak discharges and a higher sea level, whereas the vulnerability of the protected areas will increase through population growth and economic development, aggravated by land subsidence. This calls for a change of strategy in the policy fields of both integrated river management and physical planning. In this paper, we first briefly introduce the present situation along the Rhine River branches and coast, and then have an analysis for the problems existed, at last introduce some solutions in flood risk management.

2 Problems on flood risk management

2.1 Discharge increase of Rhine River

Due to global warming, changes will occur in the precipitation pattern in the Rhine basin area. It is expected that the Rhine, at present a combined rain and melt – water river, will increasingly become a rain river with high discharges in the winter and low discharges in the summer. The increasing winter precipitation will affect an increase in the discharge of the Rhine in winter. Summer discharge will decrease as a result of a reduced amount of melt – water and a strong increase in evaporation, the latter outweighing the effect of the smaller increase in the average rainfall in the summer.

The Fig. 1 and Fig. 2 shows that in all of the climate scenarios (low, medium, high and dry) the expected winter discharge of the Rhine will increase even further and the summer discharge will decrease even further relative to the present discharge.

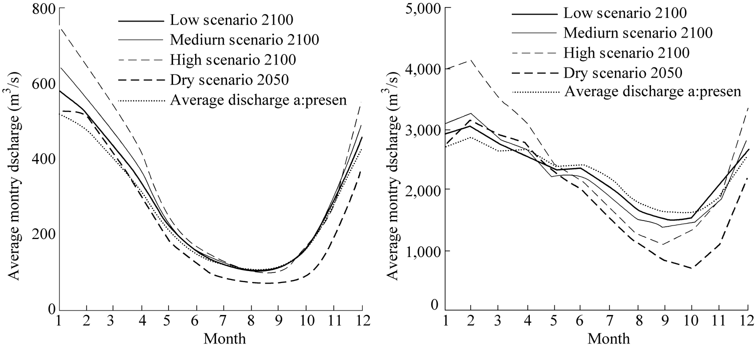


Fig. 1 Expected river discharge with four climate scenarios

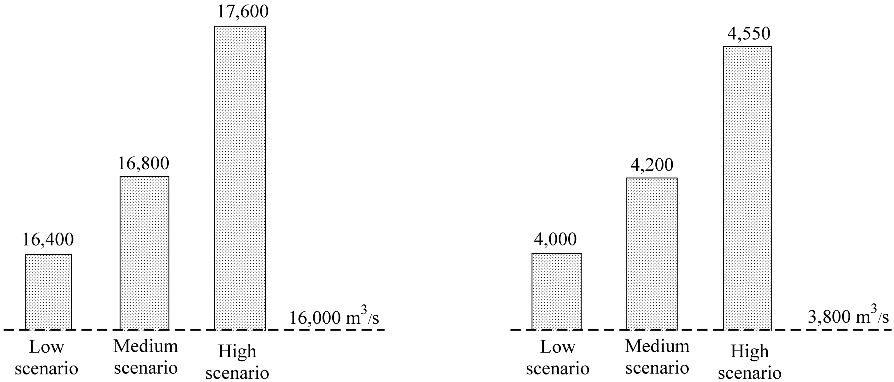


Fig. 2 Increase of design discharge in 2050

The design discharge, which is used as the basis for the legal safety standards in the Flood Defences Act, is indicative for extreme discharges. In the Rhine/Meuse area, the design discharge is based on a discharge quantity, which occurs on average once every 1,250 years. In legal terms, this is the maximum quantity of water the river must be able to discharge without the hinterland becoming flooded. The dykes, flood plains, main channel and other related factors are dimensioned on this discharge.

Following the high water levels in the Rhine/Meuse system in 1993 and 1995 the design discharge for the Rhine was adjusted from 15,000 m^3/s to 16,000 m^3/s. The direct consequence of this adjustment is that the current situation in the Rhine/Meuse area no longer satisfies the legal safety standards.

According to the climate scenarios, in 2050 the design discharges of both the Rhine and the Meuse will have increased: the Rhine by 3% ~ 10% and the Meuse by 5% ~ 20%. This means that additional measures in the Rhine/Meuse area will be necessary to ensure that the legal standard is still met.

2.2 Sea level rise

The expectation for 2100 is that climate change will lead to a further rise in sea level at the Dutch coast in the order of 20 ~ 110 cm relative to ground level. This prediction is based on an average land subsidence of 10 cm per century and takes into account both land subsidence as a consequence of time lag effects from the last ice age—to which the NAP is also subjected—and the average value for fall in the ground level due to the settling of clay and peat. However, considerable local differences in ground subsidence can occur. Note that there is a large time lag between the warming up of the oceans and the temperature rise in the atmosphere. This implies that if the average temperature of the atmosphere would be limited as a result of reduced emissions, an effect on sea level would only be realized after many centuries.

One consequence of the expected rise in sea level is the need for more and larger volumes of sand to be added as beach nourishment to the coastal system to compensate for the losses of sand that now occur and to maintain current safety levels. The addition of sand to the coastal system will also ensure that the coast, estuaries and the Wadden Sea keep pace with the rise in sea level. In the future, stronger and wider dykes will be needed to offset the greater pressures arising from the rise in sea level.

Over the next 50 years, the additional costs for coastal management are expected to be no more than 0.13% of the gross national product. In the case of a further rise in sea level after 2050, the costs for coastal management could increase to (much) more than the present spending level. Next to the influence of sea level rise, the occurrence of flood levels is strongly determined by the occurrence of storms on the North Sea. However, it is not yet clear how the frequency and intensity of storms will change in the future.

2.3 Increase of land subsidence

Independent of the changing climate and the isostatic land subsidence, the Netherlands is also confronted with a subsidence in peat areas. Since the Middle Ages as much as 2 ~ 3 m of land subsidence has occurred in some peat areas. This land subsidence is correlated with the drainage of the peat; as a result the peat shrinks and oxidizes, disappearing as carbon dioxide (CO_2) into the atmosphere. Depending on the water level, this land subsidence can be up to 1 cm per year. At this rate, a subsidence of 0.5 m will occur in some of the peat areas until 2050. If land subsidence continues, areas with thick layers of peat—in particular in the western parts of the Netherlands, where there are local depositions of peat up to 12 m thick could, over the long term, be subjected to increased flood effects, increased surface water salinity and a water system that is increasingly difficult to manage. In several areas (for example, around Slochteren in the north – eastern part of the country) land subsidence also occurs as a consequence of gas extraction. In these areas an extra subsidence of about 60 cm is expected by 2050.

The rising temperature, the longer summer season and a greater difference between wet and dry conditions (oxidation pump) will most likely result in a faster oxidation of peat. This in turn may lead to accelerated subsidence.

The rates of land subsidence are the same everywhere due to variation in peat soils and differences in water management. For example, agriculture requires a relatively deep drainage level, whereas urban areas in peat areas require a relatively high water table in order to prevent wooden pile foundations from decaying. Land subsidence in the peat areas therefore leads to an increasingly fragmented water management system, to a stronger salt seepage (detrimental for agriculture) and to damage resulting from the subsidence of roads and buildings. Various provinces— especially in the western part of the Netherlands — have consequently included measures to counteract land subsidence. These measures, however, only affect 4% of the total peat land area (Fig. 3).

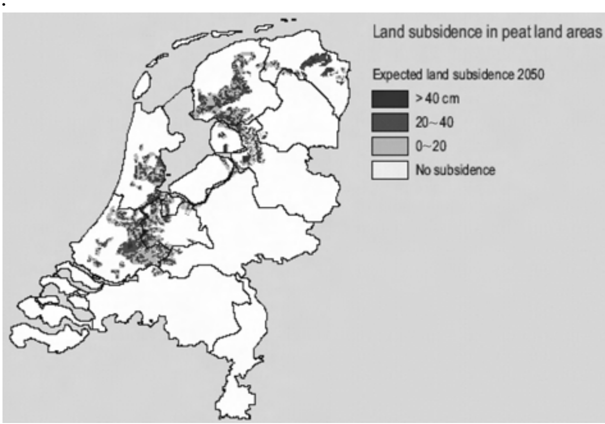


Fig. 3 Land subsidence in peat land areas

2.4 Storm surge hazard

Since 1962 the number of storms per year has decreased. The Fig. 4 shows the distribution of the 700 most extreme storms in the Netherlands over the past 41 years. The wind speed associated with these storms was, depending on the location within the country, more than 11 ~ 16 m/s; this is equivalent to a wind force of 6 ~ 7 on the Beaufort scale. Moreover, even if only the 300 or 500 most exceptional events are considered (heavier storms), the picture does not change: the number of storms in the Netherlands is decreasing. To what extent this decrease is correlated with rising temperatures is not clear.

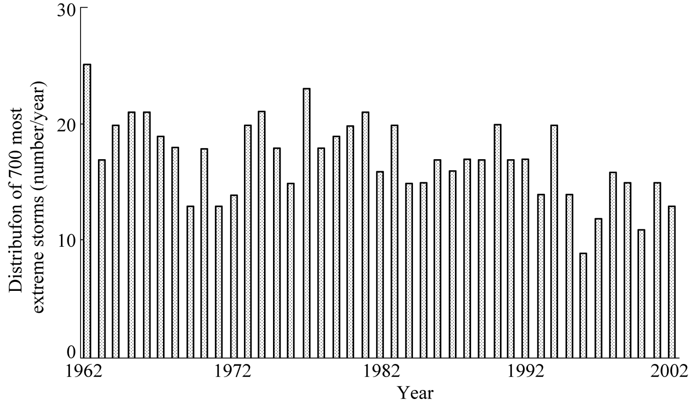


Fig. 4 Distribution of the 700 extreme storms in the Netherlands over the past 41 years

The large uncertainty in the effect of climate change on the storm patterns in the Netherlands means that an understanding of changes in the likelihood of storm floods is far from complete. Recent research with large – scale models indicates a possibility of "super storms" occurring within the orders, with the chance of significantly higher wind speeds than the Netherlands have experienced in the 20th century. Further research with more refined models is necessary in order to understand the underlying processes.

3 Measures on flood risk management

3.1 Room for river

3.1.1 Storage of water along the Rhine Branches – detention measures

By detention it means that a segment of the discharge peak is shaved and is temporarily stored in a diked – in area. Once the worst has passed, the temporarily stored water is released again and discharged. Detention limits the quantity of water to be discharged for the section located downstream of one (or more than one) of the Rhine Branches. This means that detention must occur upstream if it is to fulfill its purpose. For The Netherlands, this translates into as close to Lobith as possible.

This may be understood as follows: the difference between the current design discharge of 15,000 and the expected discharge of 16,000 m^3/s is 1,000 m^3/s. In order to prevent dike raising downstream exclusively through the use of detention methods, this amount of 1,000 m^3/s must be allowed in via intakes into one or more detention areas. The total storage capacity necessary is determined by the difference in the height of both tops in relation to the shape (and especially the duration) of a flood wave. In this way, it may be calculated how much water must temporarily be stored within one or more dike rings (see Fig. 5).

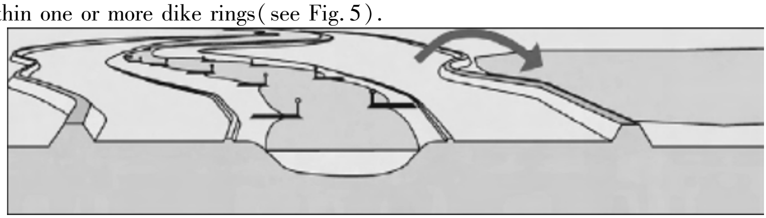


Fig. 5

For the 1,000 m^3/s mentioned here, a storage capacity of some 170 million to 200 million m^3 is required for a flood wave lasting several days and having an "average shape". At a depth of 5 m, this means a necessary surface area of some 3,500 to 4,000 hectares. Similar depths are conceivable in the relatively low – lying areas within the dikes along the Boven – Rijn and the Waal, but along the Neder – Rijn and IJssel much shallower water depths would have to be realised. The higher the storage areas lie, the less the water depth will be and proportionately larger the surface area will be.

3.1.2 Discharge of water via the Rhine Branches

In comparison with storage, the most important difference is with storage, the amount of discharge is reduced; and with measures to increase the discharge capacity, only the water level is lowered while the discharge remains the same. Storage, provided it is carried out for long enough, is beneficial for the region downstream of where the measure is being implemented and for only a very short distance upstream. Increasing the discharge capacity is advantageous for the section of river upstream from where a measure is being executed. The reason for this is that the backwater effect of a narrowing, another type of obstruction, or a substantial 'hydraulic roughness' is diminished, or that the cross – sectional profile is increased. The creation and implementation of measures which increase the discharge capacity must be first carried out downstream, with subsequent measures carried out in an upstream direction.

There are many measures to achieve the purpose, we can divide these up into three large groups: ①measures in the low flow channel; ②measures in the flood plains; and ③measures in the areas protected by the dikes (setting back dikes, etc.)

Within each group there are then specific types of measures as following.

(1) Lowering of low flow channel. From the calculation it appeared that dredging of the low flow channel bed can produce a water level reduction between 20 ~ 30 cm over a distance of some 50 km (see Fig. 6).

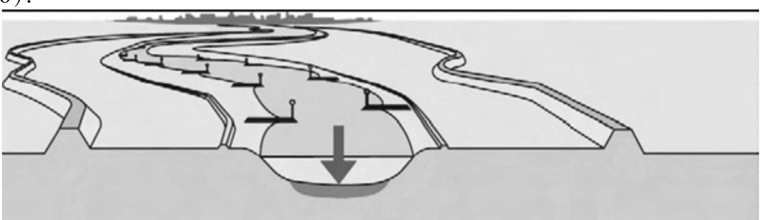


Fig. 6

(2) Lowering of groynes. By reducing the height of groynes, more water flows over them and less flows through the low flow channel. This can result in a decrease in erosion and a delay in the occurrence of erosion in the low flow channel. The contribution of groyne height reduction to counteracting unwanted erosion is then considered a favourable incidental circumstance (see Fig. 7).

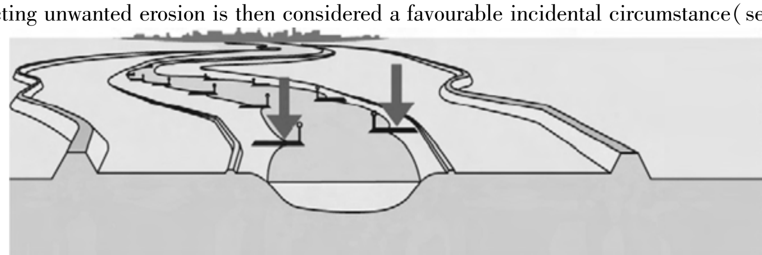


Fig. 7

(3) Flood plain excavation. Flood plain excavation is a measure by which the gradual development of heightening by sedimentation on flood plains may be counteracted. It may be combined with clay mining, as was recently applied within the framework of the most recent dike

reinforcements, and/or with nature development(see Fig. 8).

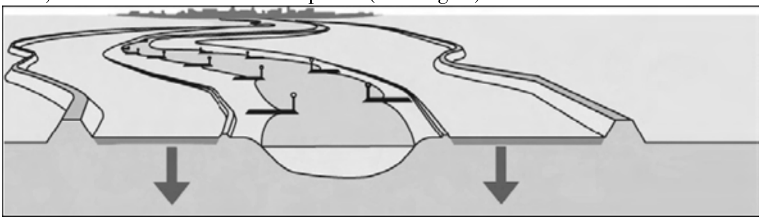


Fig. 8

(4) Removal of hydraulic bottle necks. Based on the water level slope line in all three Rhine Branches, it was first determined where the hydraulic bottlenecks were to be found. Using this method, 254 bottlenecks were found(see Fig. 9). Next, with the aid of topographic maps, these were identified as flood – free areas, bridge abutments, ferry ramps, etc. Some of these bottlenecks comprise a considerable surface area, such as floodfree (factory) areas. Ferry ramps, bridge abutments and summer embankments are, conversely, much smaller.

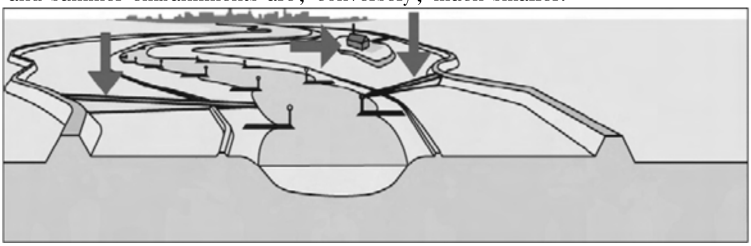


Fig. 9

The water – level lowering effect of the measures varies so much that the efficiency also differs greatly. At that point, two criteria were applied to select 60 measures (including 18 small – scale dike relocations) that were taken into consideration in the further study, namely: ①a water – level reduction effect of at least 1 cm ("otherwise it's not worth the effort"); and②an efficiency grade of at least 2 mm/million Euro ("otherwise it is a relatively expensive measure").

(5) Large – scale setting back of dikes. The options for setting back dikes are rather expensive, but sometimes also extremely effective. Despite the costs which vary from 4 million to 50 million Euro, the setting back of dikes all surpass the efficiency level of 2 mm water level reduction per 1 million Euro. The achieved water level reduction of individual setting back of dikes can run into several tens of centimetres, but in contrast there are measures in this category that only produce several centimetres worth of reduction; nevertheless, these also satisfy the criteria that were formulated earlier as the minimum for measures at hydraulic bottlenecks.

Setting back dikes is particularly effective in cases of real narrowing of the flood plain which cause backwater effects quite a distance upstream. This is why the consequences of setting back dikes for the water level also continue to work relatively far upstream. A local reduction of some 10 cm to 20 cm is realisable per measure. Along the Waal and the Neder – Rijn/Lek, all of the settings back of dikes together can result in a maximum reduction of 60 cm(see. Fig. 11).

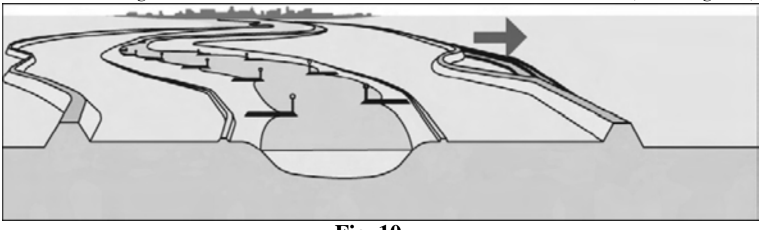


Fig. 10

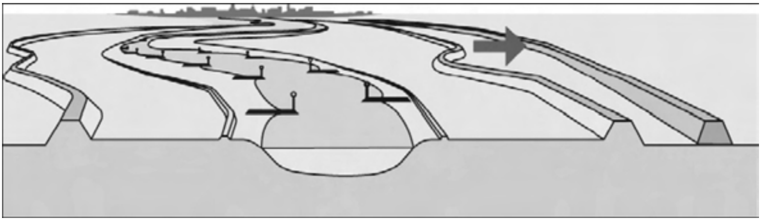


Fig. 11

(6) Green river for urban bottlenecks. River widening and deepening measures upstream of such a narrowing do not offer a solution, since widening and deepening as it were occurs in or around a "reservoir", without the valve which empties the "lake" being opened. Measures downstream of such a narrowing have little effect on the water levels since this would be comparable to drawing water using a closed valve. And even this does not help. This means that the urban bottlenecks do harm the effectiveness of the other measures and may work unfavourably in terms of the costs of combined alternative strategies.

It is obvious that the only thing that can offer relief for these urban bottlenecks are measures in the dike – protected areas; after all, flood plains are (almost) entirely lacking. As has been mentioned, similar measures were not taken into consideration in an earlier stage in connection with the expected futility of administrative feasibility, seeing as the measures involved would have to be executed in a relatively densely built – up area. For this reason, the green rivers have been created for measures involving urban bottlenecks.

Green rivers are in fact flood plains between two (guiding) dikes where water does not flow through during low discharges, but does flow during floods. They may be used for agricultural purposes or may be designed for nature and(or) recreational areas: they are, in short, "green" (see Fig. 12)

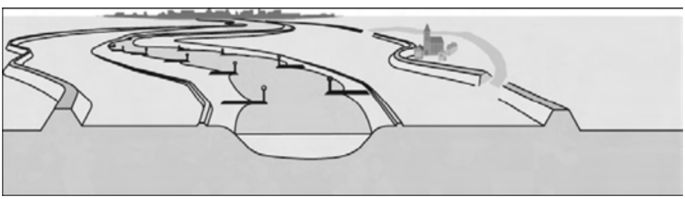


Fig. 12

3.2 Combined functions in Coastal defence zones —"ComCoast"

3.2.1 Concept and aims

In the coming years climate change will increase the physical loads on coastal defences all over the world. Traditionally the Netherlands has protected it selves against the growing threat of flooding, by heightening the dikes. However, with the continuing sea level rise, it becomes more and more evident to find alternative and innovative strategies, without just heightening the dikes. ComCoast develops such flood risk management strategies, with gradual transitions from sea to land, in order to create integrated defensive zones including wider environmental functions, such as recreation, fisheries, tourism and nature creation.

The ComCoast concept aims to create multifunctional flood management schemes with a more gradual transition from sea to land, which benefits the wider coastal community and environment whilst offering economically sound options.

The aim of ComCoast is as following:

(1) To explore the spatial potentials for coastal defence strategies for current and future sites in the North Sea Interreg IIIb region;

(2) To create and apply new methodologies toevaluate multifunctional flood defence zones from

an economical and social point of view;

(3) To develop innovative technical flood defence solutions to incorporate the environment and the people and to guarantee the required safety level;

(4) To improve and apply stakeholder engagement strategies with emphasis on public participation;

(5) To apply best practice multifunctional flood management solutions to the ComCoast pilot sites

(6) To share knowledge across the North Sea region.

3.2.2 Technical functions and components

The ComCoast project searches for alternative coastal defensive solutions using a multiple line of defence strategy. In comparison with a single line defence, a coastal defence zone has a range of components (lines) each with its own function. First these technical functions and its components are formulated from which the main ComCoast solutions can derived.

(1) Water retaining. The primary dike retains high sea levels and wave run – up, up to the design level. The inner slope can have an overtopping – resistant revetment, which permits a greater overtopping discharge.

(2) Water storage. The area behind the primary dike is a transitional area able to store the overtopping seawater. A secondary dike or higher grounds, encircles the transitional area. Or the water is handled by large ditches or pumping stations.

(3) Water control / management. During storms and in normal weather conditions the coastal defence zone should be able to drain off water when necessary. First, a drainage system facilitates water control in the transitional area. For larger quantities of water, a pump installation can be installed to support the discharge of water by the drainage system. If desired, a culvert can be added to increase tidal influence in the transitional area. A culvert can also be used to drain off excessive salt water after a storm.

(4) Wave reduction. Several elements in front of a dike yield wave reduction. First, a shallow foreshore creates a moderate wave climate in front of the dike. In addition, wave reduction can also be achieved when there is a previously constructed lower dike, a breakwater or a summer dike.

(5) Multifunctional use of area. The transitional area can be used for several purposes, for example aquatic sport, recreation, the development of aquatic areas and to enhance environmental values. This is only the case when the area is flooded regularly. This can also be obtained by Managed realignment.

3.2.3 Comcoast solutions

The distinguishing of the functions and components as discussed in the previous paragraph has led to five main ComCoast – concepts:

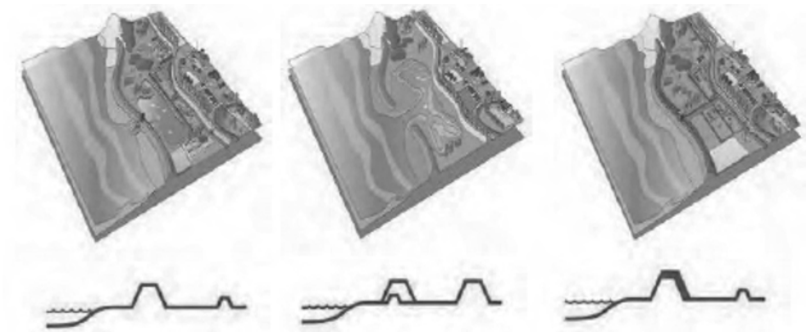
(1) Regulated tidal exchange is the regulated exchange of seawater to the an area behind fixed sea defences, through engineered structures such as sluices, tide gates or pipes to create saline or brackish habitats (see Fig. 13).

(2) Managed realignment involves the placement of new Managed realignment flood defence landward of the existing flood defences. This would be achieved trough the partial or complete removal of the existing flood defences.

(3) Overtopping resistant dike involves the replacement of the top of the dike and its inner slope with a revetment that will not wear away by severe overtopping. The overtopped sea water will be handled in the coastal zone at the landward side of the dike (drainage/storage).

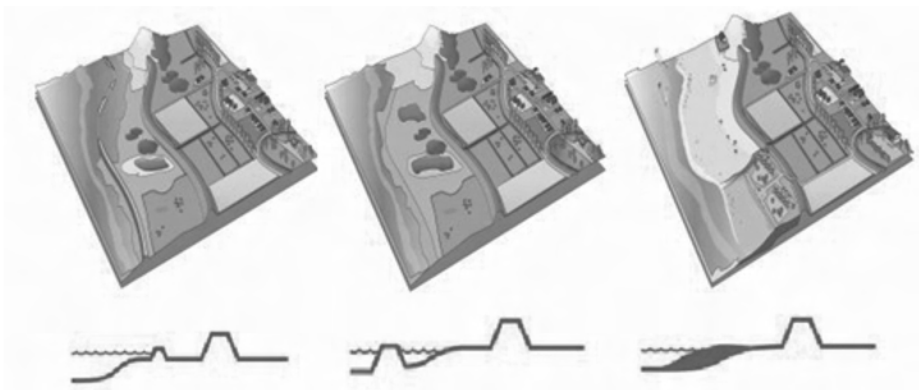
(4) Foreshore protection involves reclamation works to maintain or to create higher ground and in some situation small dikes in front of the primary dike, which act as breakwaters in case of a big storm (see Fig. 14).

(5) Foreshore recharge involves the placement of material in front of the existing coastal defence system. It includes to restore the coastline and to advance the line.



(a) Regulated tidal flooding (b) Managed realignment (c) Overtopping resistant dike

Fig. 13



(a) Foreland protection (b) Foreshore recharge (restore the coastline) (c) Foreshore recharge (advance the line)

Fig. 14

3.3 Live on mound

Living on mound is a very traditional solution which was in use in the early Middle Ages in the Netherlands. These are artificial hills which are high enough to remain dry during floods. Rotterdam is a good example in such way (see Fig. 15). Rotterdam is the largest port in the world, and the combination of the harbors along the Westerscheldt in both the Netherlands and Belgium could be considered the second – largest harbor in the world. So, huge investments have been made in this area. But they have shown that captains of industry will not accept any risk of flooding at all. Refiners, oil terminals, nuclear plants, chemical industries, container terminals had to be entirely secure. If the darkest situation occurs, and the safety limit of the dams (one in 10,000 years near Rotterdam and 1∶4,000 years in other areas) is overtaken by an enormous storm, even these dams will break and the lands behind will become drowned in water meters deep. The damage will take many months to repair and the losses would be amazing great. However, the industrial complexes on their artificial mounds, in the same worst case scenario, suffer a few centimeters of flooding during the few hours of high tide.

The industry made a partial return to the safest possible strategy for flood prevention: large – scale artificial mounds. Why don't use this measure in urban planning?

Fig. 15 Refiners on artificial mound in Rotterdam

3.4 Living with flood

Living in close proximity to water is attractive but has come at the price of land that could have been allocated to water. The possibilities of living near water are good, as long as the demands for safety and water storage are taken into consideration, now and in the future. With the increase of population and development of society and economy, more land and space are claimed for industry, housing and recreation. The area which has relatively high risk of flooding should keep preparation to live with flood by taking some individual measures, although the dike system has keep a certain safety level(see Fig. 16).

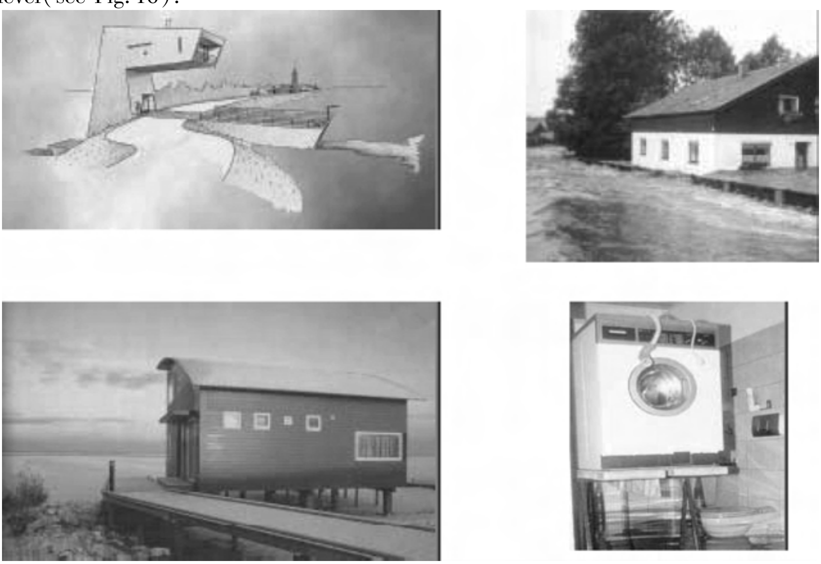


Fig. 16 Measures for decreasing flood damage

Inhabitants of high – risk area can take precautions to protect their homes and property and prevent a great deal of damage. In addition to the efforts extended by different level of government citizens themselves must protect their property or even take into account the heightened risk of floods in the design of buildings. Examples given include:

(1) Raising the elevation of the ground floor: building the house on the pile or on a heightened foundation according to the suggestion of the local flood protection department;

(2) Installing indoor heating, power and telecommunications systems as high as possible;

(3) Use of water – resistant building materials;

(4) Making cellars water proof.

4 Conclusions

The strategies presented above are the result of lengthy debate and years of study. The experiences and views described in this paper are already influencing The Netherlands' water – management policy and some measures have been implemented in some areas. Resilience strategies (detention measures) require that a large surface area which is now protected by dikes is occasionally lent to the river, in order to perform essential hydraulic functions. However, this room is not permanently lost for human land use or other ecological functions, as it is only temporarily and/or incidentally needed for storage or discharge. Many types of adapted land use can be fitted in. so flood risk management based on resillence is possible. Green rivers, though small in size, are presently often considered as a possible measure to increase the discharge capacity of the rivers, which was inconceivable some years ago. Likewise, the controlled flooding of some compartments (so – called "emergency polders") in order to enhance the safety of downstream dike – rings is presently being studied by a government committee.

The Netherlands is just one example of a large number of densely – populated deltaic regions, where climatic change and social developments interact and sometimes conflict. However, The Netherlands is also well – known for its sophisticated water management. The fact that the strategy on how to deal with river floods is now subject to debate might be food for thought for other regions, which may still avoid making the same mistakes.

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The View on the Effect of Water Temperature on the Sediment Capacity

Zheng Chunmei*, *Cao Yongtao*, *Jang Enhui* and *Li Ping

Yellow River Institute of Hydraulic Research, Zhengzhou, 450003, China

Abstract: The analysis of the effect of water temperature to sediment capacity was based on the fact that water temperature changes viscosity of water. The effects can be divided into two aspects. One is the effect of viscosity of water on the sediment settling velocity, and on the other hand, the effect on Reynold number of flow and then result the changing of water resistance, and both of them affect the sediment transport. The researches and achievements are analyzed in this paper and the research thinking is put forward based on that.

Key words: water temperature, settling velocity, water resistance, sediment capacity

1 Introduction

Because of the substantial differences water temperature between winter and summer globe, such as, in the river of the north china, the water temperature is close to 0 ℃ in the winter while surpass 25 ℃ in the summer, the effects that water temperature take on the sediment capacity are focus concerned by the researchers.

The researches on the effects began in 1930s, as voted on the paper of Johnson, J. W. "The Importance of Considering Side - wall Friction in Bed - Load Investigations". At that time, the effects were researched on the flume study by He Rongbang. But because the boundary function were disregarded, the conclusions were not reasonable. At 1949, it was observed by Lane etc, that at the same flow discharge, the sediment transport was 2.5 ~ 3.0 times in the winter which water temperature was 4 ℃ compared to summer which water temperature closed to 27 ℃. And Qian Ling convinced it based on the Einstein equation. At 1955, Strauble observed in Mississippi River and found that, as to the similar flow discharge, suspended sediment discharge in winter was more than that in summer. At even more, the effect relationships were built up on the base of the field data at diversion channel on Yellow River(The People's Victory channel, irrigation ditch of Da Yu Zhang etc.) by Duan Xueqi at 1985, which showed that the sediment capacity was 28 times in water temperature 2 ℃ compared to 28 ℃.

The analysis of the effect of water temperature sediment capacity was based on the fact that water temperature changes viscosity of water. The effects can be sought in two aspects. The effect of water viscosity on sediment settling velocity and the effect on water Reynold number and then result to the change of water resistance, and both of them affect the water transport.

The researches and achievements are analyzed and the research thinking is put forward based on that.

2 The effect of water temperature on sediment settling velocity

Many researchers were carried on the research on it.

As Yu Yanan, Ye Peilun's regard, the effect of settling velocity with temperature, mostly due to settling particle size decreased with the temperature, and in this way result to the change of settling velocity. Settling size changes with temperature, but the change rate is little. As to settling velocity calculation, it can be taken as constant when water temperature changes in a little range.

It pointed by Wang Liang, Jin Ying, Li Yu that, the character of the low sediment concentration flow was affect by temperature greater comparatively than that of high sediment concentration when they researched on the factors that effect the characters of the cohesive sediment settling. As to the same loaded flow, when the temperature greatly differenced, then the character of settling velocity greatly changed, thus substantially affect the precision of the reduplicate experiment. In order to sure the reliability of the experiments, one should control the room temperature as well as water temperature revise to the surveyed loaded water sample.

2.1 The effect on the individual sediment particle

As to the individual sediment particle, a lot of formulations were exposed by both national and international researchers, such as Zhang Ruijing expression, Dou Guoren formulation and criterion formulation etc. Based on the former formulations, the effect was calculated, with sediment γ_s = 2,650 kg/m^3, and grain size $d = 0.1$mm for laminar zone, $d = 0.2$ mm for transition zone, and $\omega_T / \omega_{T_0=2}$ shows the ratio of settling velocity at any temperature to that of 2 ℃.

At laminar zone, the velocity is inverse proportional to water kinematics viscosity in each researcher formulation. Due to the same temperature changes, the final result was $\omega_{T=28} / \omega_{T_0=2}$ = 1.982. At transient zone, the difference dispositions result to diverse effects of water temperature on settling velocity. At turbulence zone, the effects of temperature were disregarded by all the formulations.

2.2 the effect on dredged sediment settling velocity

There are two reversed options on the effects.

2.2.1 Settling velocity proportional to the water temperature

Owen researched the settling phenomena at the settling tube use estuary sediment, and reported the researches on the effect of temperature on the sediment velocity at 1972. As it showed that, water temperature only changes the viscosity to affect settling velocity, which consistent to Stokes's Formula, and settling velocity inverse proportional to viscosity thus proportional to water temperature. Thus far, the thinking are sustained by mostly researchers.

2.2.2 Settling velocity inverse proportional to the temperature

It is comparatively complexes when flocculation exists. At 1994, the sediment settling in the tube were again experimented by Y. L. LAU, Canadian, and showed that the conclusions by Owen may be discontent using to the turbulent flow because water in the tube are static and of no turbulence. Sediment with cohesive fall depends on flocculate, which the flow turbulence and shear strength pay role importance. In the turbulent flow, sediment may assemble and flocculated and fell. But the flocculation are not compact, and may be smashed at the near bed where shear strength are high, and then re-suspended. Because this condition can not be simulated in the tube, Y. L. LAU carried out the experiment in the round flume where room temperature was controlled. The distilled water, brine and sediment in the river were used for the experiment, the result was gotten that the temperature do affect to the settling velocity, and velocity comparatively low with low temperature. The conclusion is inversed to that of Owen's. Although the difference cannot be rigorous theoretical explained, it is qualitative explained as:

The fall of cohesive sediment depend on flocculating. At turbulent flow, the process that the sediment flocculate, and is smashed by the function of turbulence and shear strength is continuous, especially at near bed, where shear strength is high. The function of flocculate changes with attractive force and resistance force.

It is convinced that, the resistance is low at low temperature by Rees and Rainville based on the observation of the colloid sample at Mississippi River and its tributaries.

With the temperature increased, the resistance force increased but the attractive force stained. Thus, the flocculations are comparatively soft and easy to smash into fragments and suspended, especially at the near bed. The affects by this on settling velocity is higher than the effects of viscosity, and subsequently result to the settling velocity decreases with temperature.

Water Reynold changes with temperature, but the measurements by Nezu and Rodi at 1986 as well as Blinco and Partheniades at 1971 showed that, the intension of turbulence depends little on Reynold.

It should be noted that, the settling velocity rely on flocculate process which exposed by Y. L. LAU is some extent sensible. The effects on flocculate by temperature directly taken to settling velocity, and thus the conclusion of Y. L. LAU that the settling velocity decreases with temperature need careful consideration. Nowadays, the effects of temperature on flocculate are not decided yet.

3 The effect to water resistance

Water temperature changes the resistance to vary the sediment transportation. The viscosity decrease with temperature and thus, particle settling velocity and size is comparatively high when temperature is high. As shown in figure1, at near critical zone which is between the low velocity zone and transition zone, the change of the fell size with temperature will result to the big change of the bed configuration resistance. As to natural river, the bed configuration is more marked in summer than winter, and thus the frictional coefficient evidently affected by temperature, as found by Colby and Scott (1965) at Robe River. The United States Army Corps of Engineers (1969) reported there is evident relationship between water temperature and water level versus discharge at Omaha near Missouri River. Their researches on Omaha showed that, when temperature decreased at fall, at the same discharge, the sand ripples were scoured, and the bed became flat. And at the same time, because the water resistance decreased, water level fell. If the bed configuration closed to the transition bed configuration between sand ripple bed and flat bed, the frictional coefficient changes evidently, which pay role importance to sediment transportation?

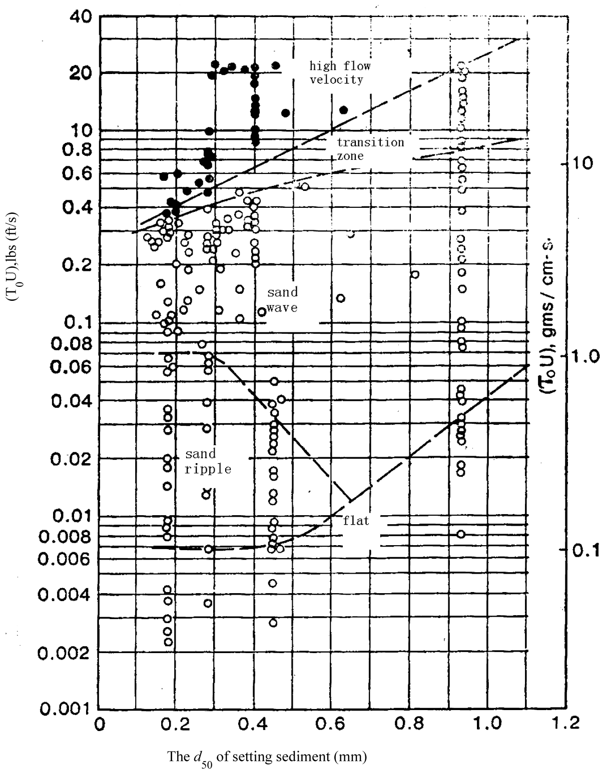

Fig. 1

4 The effect on water capacity

4.1 The achievements of Hong

Hong etc carried out their experiment with fine sand which $d_{50}=0.11$ mm, and temperature ranged from 0 ℃ to 30 ℃. It is found that, as to the high flow velocity which Froude number equal to 0.5 and 0.8, temperature decrease result to comparatively higher increase of concentration of near bed sediment, more uniform vertical sediment concentration distribution, and increase of resistance coefficient. As to flow which Froude number equal to 0.3, water temperature make little effect to sediment capacity. These experiments answered the inquiry of how temperature affects sediment capacity, but at the low water depth (0.24 ft), the sand ripple did not exist, and the effect cannot be measured. And the transition bed configuration between sand ripple bed and plat bed aroused by temperature do much effects to sediment transport, did not measure.

4.2 The achievements of Qian Ning

The change of the flow condition and sediment transport with the change of water temperature is analyzed by Qian Ling based on Einstein formulation. The conclusion of Qian Ning is that: the viscosity is a function of temperature. The change of temperature affects the thickness of laminar layer to change the bed – load and affect fall velocity to change the vertical sediment concentration distribution. The function of laminar layer thickness may present in three facets: ① comparative roughness of river bed; ② the change of outside force operate on sediment particle; ③ the shield function of bed sediment particles. The three facets interrelated and thus the effect of temperature may be varied (see Fig. 1).

The vertical sediment concentration distribution restricted to bed – load movement as well as the ratio of fall velocity and vertical turbulent flow velocity. As the temperature decreases, sediment particles fall slowly in the flow with high viscosity. The functions do much more effect than the effect of temperature on bed – load movement in the river with fine sand.

In consider with the diverse function of the water viscosity, at river with fine sand with the same discharge, the transportation in the winter is 3 times to that of summer is possible. The data of Thaler ferry at Colorado River that sediment transportation is 2.5 times with water temperature increases 16.5 ℃ convinced it. And based on the Einstein bed material equation, one can get the similar result.

It may be pointed out that, the data of Thaler ferry at Colorado River used for the analyses by Qian Ling is non – saturation transport. In the field data, the max discharge close to 708 m^3/s, and surface slope is 2.4‱, sediment concentration is low, which the max concentration is only 2.03 kg/m^3.

4.3 The achievements of Duan Xueqi

The graphic method was introduced to sought the mostly factors affect the sediment capacity by Duan Xueqi at 1985, and the field data of 1953 ~ 1958 of Yellow River is used.

Regard that "the ratio of sediment concentration and discharge can be used as the yield sediment of river basin". As to channel, the boundary condition is constant; the yield sediment compare to discharge can be used as one of the factors of sediment capacity. On considerate of temperature, the viscosity is a function of it and directly affects flow velocity and fall velocity, and some times affect the bed configuration. In one word, with the change of temperature, varies factors self – controlled, and take fall velocity as the only factor to study sediment capacity is not enough. And thus, water temperature and S_*/Q are used in the sediment capacity research, and S_*/Q was plotted against T. Three conditions are classified on them: $T<13$ ℃, $S_*/Q>0.2$, low temperature high sediment concentration; $T>13$ ℃, $S_*/Q<0.2$, mean temperature low sediment concentration; $T<13$ ℃, $S_*/Q>0.2$, low temperature low sediment concentration. As the former analysis, it can be found thattemperature do considerable effect on sediment capacity, and the empirical formula as:

When $T > 13$ ℃ and $\frac{S_*}{Q} > 0.2$, $S_* = k_1 = \frac{V^{2.91}}{H\omega^{0.335}}$ (1)

And others: $S_* = k_2 \frac{V^{3.9}}{H}$ (2)

in which, T is mean temperature at a cross – section, ℃; S_* is mean sediment capacity at a cross – section, kg/m^3; Q is mean discharge at a cross – section, m^3/s; V is mean velocity at a cross – section, m/s; H is mean depth at a cross – section, m; ω is mean fall velocity at a cross – section, cm/s; k_1、k_2 is the function of temperature, which

$$k_1 = 513.6 \frac{1}{(\gamma_s - \gamma)^{3.575}} \cdot \frac{1}{(1 + 0.033,7T + 0.000,221\ T^2)^{3.575}}$$

$$k_2 = 1,035.4 \frac{1}{(\gamma_s - \gamma)^{4.9}} \cdot \frac{1}{(1 + 0.033,7\ T + 0.000,221\ T^2)^{4.9}}$$

in which, γ_s, γ is the sediment and water specific weight respectively.

Based on the data analyze, the capacity of low temperature is higher than that of high temperature. Calculate with equation (2), the capacity of 2 ℃ is 28 times than that of 28 ℃. But as Duan Xueqi confessed that, the former research was just a trying, a lot of questions need to solve, such as how to explain the settling velocity ω present in equation (1) but not in equation (2); And the interpretations of water temperature affect the sediment capacity need further researches.

4.4 the achievement of Yang Guolu

Based on the principle of the premise "sediment restrain the turbulence", and energy equilibrium, the k group size sediment was researched, and the equivalents water and sediment exchange in the weak equilibrium and heavy equilibriums were taken into consider. Non – uniform grain size fraction sediment capacity formulation was built up respectively. Based on the analyses to the factors affect the sediment capacity, the effects of the upstream sediment input and bed sediment are different. Hence, the mend coefficient a should be inserting before bed grade P_{bk}, and get the sediment capacity expression as:

$$S_{vk}^{vim} = k\mu_r^{\alpha} \left[\frac{\omega_k}{\omega} (P_k + aP_{bk}) \right]^{\beta} \left(\frac{U^3}{\frac{\gamma_s - \gamma}{\gamma} gR\omega_k} \right)^{\gamma} \tag{3}$$

in which, S_{vk}^{vim} is the sediment capacity of group k, μ_r is viscosity coefficient, ω_k is the fall velocity of group k, ω is mean fall velocity, P_k is the grade of upstream sediment, P_{bk} is the grade of native bed, a is the differential coefficient between effect of upstream sediment and native bed on sediment capacity, U is flow velocity, γ_s, γ is the sediment and water specific weight respectively, R is hydraulic radius.

The viscosity coefficient μ_r is used to represent the effect of temperature on sediment capacity. Based on the Yang Guolu formulation, viscosity coefficient μ_r decreased with temperature, thus sediment capacity decreased with temperature too.

4.5 achievement of SULEYMAN AKALIN

As analyzed on the field data of Lower Mississippi by SULEYMAN AKALIN, it is conclude that, the amount of sand transported by the river falls down by apporximately 3.09% for every 1 ℃ increase in water temperature and as far as the individual sand fractions are concerned, a water temperature increase of 1 ℃ result in approximately 2.79%, 3.40%, 1.42% and 1.49% decrease in the suspended very fine, fine, medium and coarse sand transport, respectively. The biggest effect is on the transport of fine sand size fraction.

5 Conclusions

Sediment capacity are affected by flow as well as upstream sediment input, bed component and fine particle adhesive force, fine particle flocculate and water temperature. The effect of temperature on the sediment capacity can be reflected on fall velocity and bed resistance. Hong think that water temperature make little effect to sediment capacity. At river with fine sand with the same discharge, Qian Ning think the transportation in the winter is 3 times to that of summer is possible. Duan Xueqi think that the capacity of 2 ℃ is 28 times than that of 28 ℃. Based on the Yang Guolu formulation, sediment capacity decreased with temperature. As analyzed on the field data of Lower Mississippi by SULEYMAN AKALIN, it is conclude that, the amount of sand transported by the river falls down by apporximately 3.09% for every 1 ℃ increase in water temperature A lot of researchers had analyzed the effect on sediment movement and sediment capacity in diverse factors, but not comprehensively, which need further researches.

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The Riverbed Evolution of Shenzhen Bay and its Influence on the Wetland Ecosystem

Wang Fuyong[1], ***Wu Liangbing***[1] and ***He Yong***[2]

1. Shenzhen River Regulation Office, Shenzhen, 518033, China
2. Changjiang Institute of Survey, Planning, Design and Research, Wuhan, 430010, China

Abstract: Shenzhen Bay, which is located at the border of Hong Kong and Shenzhen has a very important ecological value. Based on the marine charts, the survey maps and the remote sensing images from the satellite, the features of the riverbed and coastline evolution of Shenzhen Bay are analyzed in details. The results indicate that the sediment was continuously accumulating at the riverbed of Shenzhen Bay and the tide flux decreased gradually in the last century. From the 1980s, the coastline of Shenzhen Bay was moving outward in greatly due to the massive sea – filling along the coastline. The sedimentation in Shenzhen Bay will not change under present conditions. So, this paper investigates the influence of the riverbed evolution of Shenzhen Bay on the wetland ecosystem of Mipu in Hong Kong and Shenzhen Futian Mangrove Reserve, including the influences of beach area change and beach siltation on mangrove species and distribution, habitation and reproduction of zoobenthos, hydrobiont and birds. Furthermore, the paper put forward suggestions on the ecosystem protection.

Key words: Shenzhen Bay, riverbed evolution, mangrove, wetland ecosystem

Shenzhen Bay is a semi – closed coastal ecosystem connected to the outer sea; consists of the properties of both estuary and bay. In two sides of the Bay there is a wide mudflat, which provides a very good topographic condition and physical environment to the mangrove. The mangrove, one of the most important components of the wetland in the Shenzhen River mouth, forms a complete ecosystem together with large amount of invertebrate, seabirds and migratory birds,. whose core portion are Futian Natural Mangrove Reserve in Shenzhen and Mipu Wetland in Hong Kong. The location of Shenzhen bay is shown in Fig. 1.

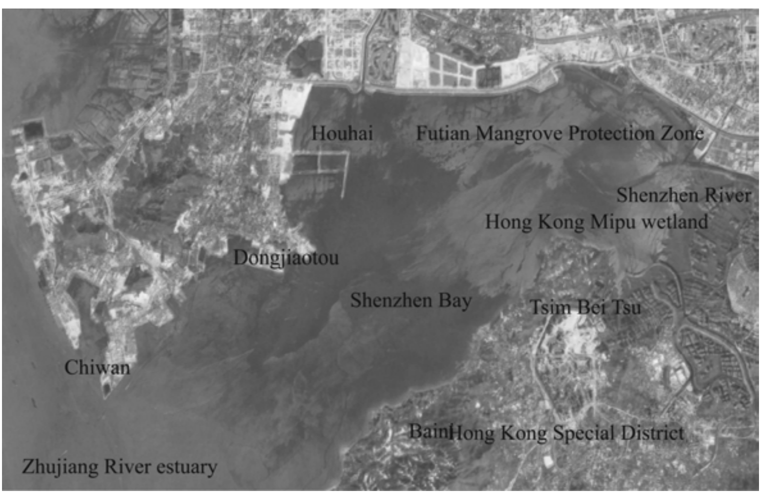

Fig. 1 Shenzhen Bay

Shenzhen Bay is a shallow bay that silt up slowly, which is determined by the dynamic conditions and water and sand properties of Shenzhen Bay. Since 1980s, human activities such as the large scale reclamation works speed up the siltation process of the Bay. The change of riverbed and coastline directly lead to the changes of mudflat and mangrove, then influence the whole ecosystem. Therefore, it is necessary to study the riverbed evolution characters and its influence on the wetland ecosystem to provide a reference to the ecological construction of Shenzhen bay.

1 Basic conditions of Shenzhen Bay

Shenzhen Bay locates between longitudes 113°53′06″E ~ 114°02′30″E and latitude 22°24′18″N ~ 22°32′12″N to the south - west of Shenzhen Special Economic Zone. It is also semi - concealed at the central eastern side of Lingdingyang within the Pearl River Estuary with its inner bay much wider than the gulf. Shenzhen Bay is 17.5 km long in total and varies in width. The surface width of Shenzhen Bay between the north shore near Shenzhen University and the south shore near Hang Hau Tsuen exceeds 10 kilometers. The narrowest surface width is 4.2 km between Dongjiaotou and Pak Nai. Shenzhen Bay between its near and far ends is generally divided into three parts, i. e. the gulf, the inner bay and the outer bay. The gulf extends from Shenzhen River to Tsim Bei Tsui, the inner bay extends from Tsim Bei Tsui to Dongjiaotou, and the outer bay from Dongjiaotou to Chiwan. Their lengths are approximately 3.7 km, 6.3 km and 7.5 km respectively.

Lingdingyang within the Pearl River Estuary is characterized with irregular semidiurnal tide, where two high tides and two low tides occurs everyday, and the heights and durations of the two high tides are unequal. According to the tidal statistics at the Chiwan Station between 1964 and 1984 (Yellow Sea Datum), the highest high tide is 2.386 m, the average high tide is 0.886 m, the lowest low tide is -1.664 m, and the average low tide is -0.474 m. The yearly highest difference in tide levels is 2.47 m rise, 3.44 m fall, and 1.36 m on average. The average durations of tide rise and fall over the years are 6 hours 24 minutes and 6 hours 14 minutes respectively.

The key factor maintaining Shenzhen Bay is the nature of its current force, which is supported by its storage level to tide. By observation made in the last two decades, sediments have been rapidly deposited at the seabed of Shenzhen Bay. Its surface area has been decreasing yearly and so has its storage level to tide. From 1977 to 1999, the storage level to tide decreased by approximately 15.6%. Apart from the sediments being delivered by the rivers connecting to the inner bay, the main source of sediments comes from the outer bay. If the average storage level to tide of Shenzhen Bay is 124 million m^3, the rate of total sediment transport from the gulf of Shenzhen Bay into its inner bay will be approximately 9.176 million tons per year.

2 Characters of Shenzhen Bay riverbed evolution

2.1 Shenzhen Bay riverbed evolution from 1907 to 1949

Comparing the marine charts of Shenzhen Bay from 1907 to 1949 (Fig. 2), the silt deposit at Shenzhen Bay had obviously increased. A shoal was formed at the estuary and the river was divided into north and south channels. From Baishi Island to Houhai of the inside - bay, both the intensity and the area of sediment were great. The change in riverbed contour was obvious. For the outer - bay, sediment mainly occurred at a deeper level. As such, the width of the deep trough at the riverbed was reduced. However, the riverbed contour remained more or less unchanged.

In the 42 years between 1907 and 1949, the deep trough at the riverbed along the southern side of the bay has drifted to the northeast by 8 km. The total volume of silt deposit below 0 m isobath was 6,580 m^3. The annual increase rate was 156.7×10^4 m^3. The average deposit depth was 0.8 m and the maximum depth was less than 1.5 m. The annual increase in depth was 1.9 cm. For the shallow area near the shoreline, the depths of silt deposit were usually less than 0.5 ~ 1.0 m with an average rate of increase of 1.2 ~ 2.4 cm per annum. The depth of deposit was generally greater at the deep trough in the middle of the river, with a maximum thickness of 2.7 m, an average thickness of 1.3 m and an increase rate of 3.1 cm per annum.

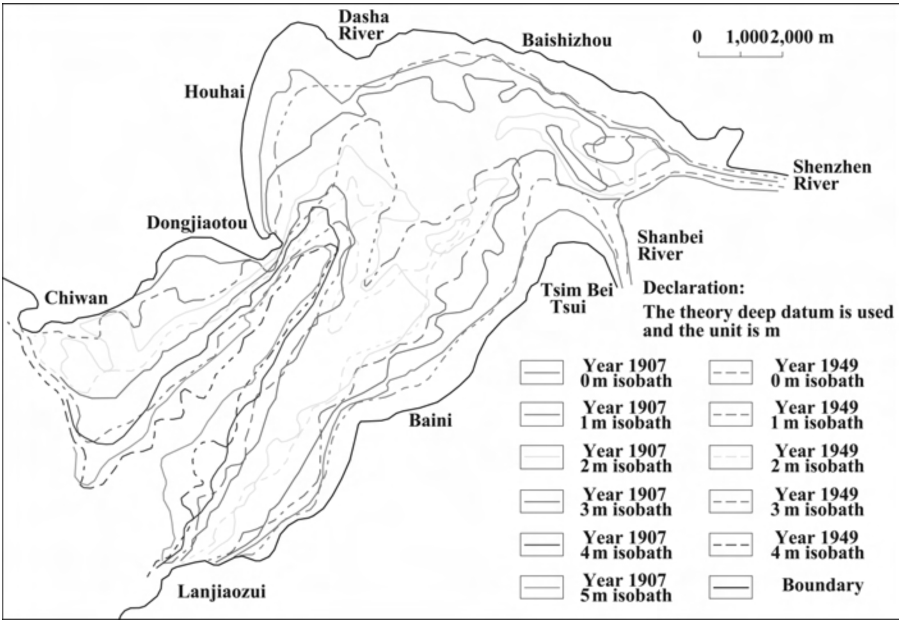

Fig. 2 Seabed contour of Shenzhen Bay from 1907 to 1949

2.2 Shenzhen Bay riverbed evolution from 1970 to 1999

Looking at the marine charts from year 1970 to year 1999 (Fig. 3), the estuary shoals combined, enlarged and prolonged. The division of the south and north channels were intensified. Due to the enclosure effect at Houhai area, sediment was serious along the northern coast at inside – bay. The cross sectional area of the river course below 0 m isobath was reduced by about one – third. The capacity to resist the tidal effect was greatly decreased. There was not much change in contour at the outside – bay. The silt deposit rate was obviously reduced and the river bed contour was becoming steady.

As shown in the measurements, sedimentation occurs relatively quicker between year 1985 and year 1996. The depth of silt deposit below 0 m contour was 0.46 m at the inner – bay of Shenzhen Bay, with an annual increase of 4.2 cm. The capacity of the river was reduced by 20,350,900 m^3 and the volume of silt deposit was increased at 1,850,100 m^3 per annum. The depth of silt deposit below 2 m contour was 0.06 m, with an annual increase of 0.5 cm. The capacity of the river was reduced by 7,979,000 m^3 and the volume of silt deposit was increased at 725,400 m^3 per annum.

2.3 Recent changes in inner Shenzhen Bay

The riverbed contour of the inner – bay of Shenzhen Bay in year 2002 ~ 2005 is shown in Fig. 4 to Fig. 7. The silt deposit at –1 m contour at the northern channel of the estuary disappeared between years 2002 to 2005. Water only flew through the northern channel at times with high water levels. The channel bed became zigzag in shape. For the southern channel, there is no major change in bed contour at –2 m and –3 m, –1 m contour, but the width and the cross – sectional area of the channel were reduced.

As shown in the scouring and sedimentation distribution diagram (Fig. 8), both scouring and sedimentation occurred in the inner – bay in 2002 to 2005. However, the amount of sedimentation

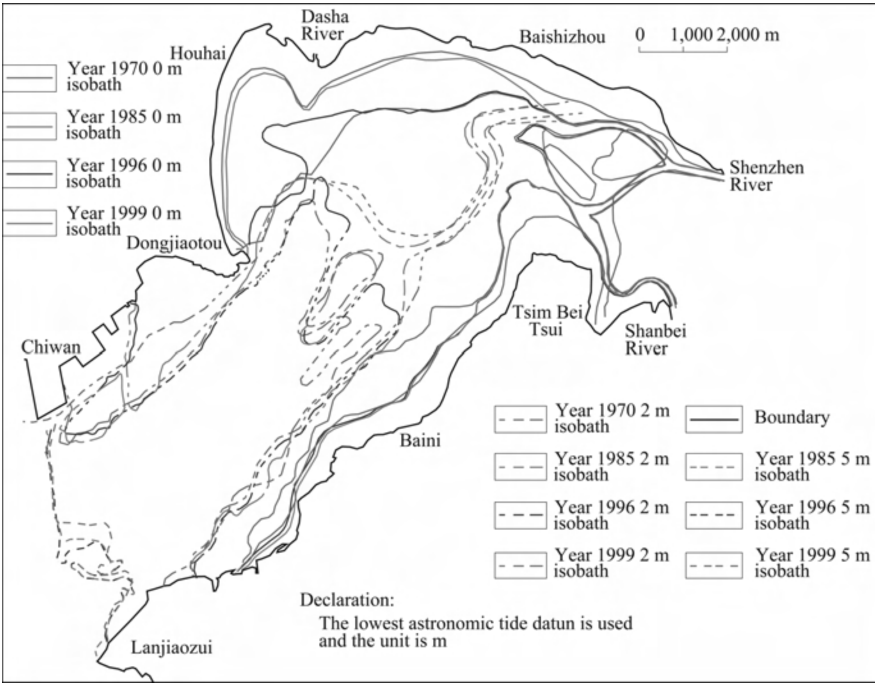

Fig. 3　Seabed contour of Shenzhen Bay from 1970 to 1999

was larger than that of scouring. The average sedimentation rate was 1.5 cm per annum and the total volume accumulated in three years was 2,148,200 m^3. It can be seen from the scouring record that the flow velocity at deeper levels (including the south channel of estuary, the 3 m deep trough at riverbed and the white mud area) was relatively greater and more scouring took place at deeper levels. The flow velocities at other areas such as the shoal at the estuary, side bays of Baishi Island and Houhai were usually smaller. Obviously, sedimentation occurred mostly at these areas.

In conclusion, from year 2000 to year 2005, the contour of the riverbed at Shenzhen Bay was affected both by scouring and sedimentation. However, since the amount of sedimentation was greater than scouring, silt deposit increased continuously at Shenzhen Bay in general. It can be seen from various sections of Shenzhen Bay that the size of the north channel at the estuary was gradually reducing and the capacity became about 8% ~ 10% of the southern channel. The southern channel was relatively steady. At the inner – bay, scouring occurred and followed by sedimentation. Following the direction of water flow, the level of the side bay was increased due to sedimentation. The base of the deep trough at the riverbed was further lowered. – 3 m deep and zigzag shaped channel was gradually formed.

3　Changes of Shenzhen Bay coastline

The coastline used to change a little in its natural state and there is less effect to the sedimentation. Due to the large – scale reclamation in the Shenzhen Bay, the coastline moved outward and led to sedimentation. This is the main reason of the change of the riverbed of Shenzhen Bay.

From the images of satellite and marine charts between the years of 1977 and 2000 (from the set up of special area to 1988), (Fig. 9, Fig. 10), there is no obvious change of the coastline of

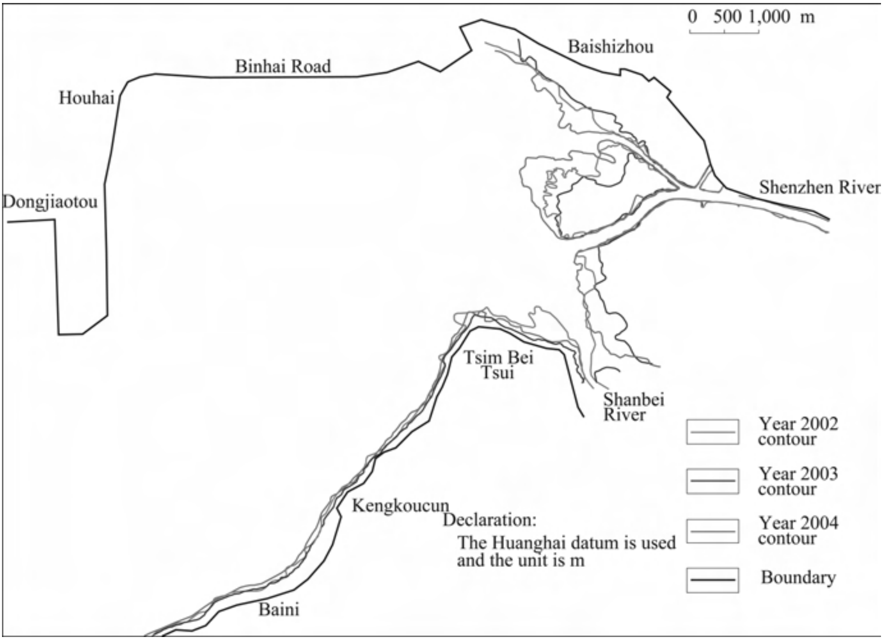

Fig. 4 The change of the 0 m contour from 2002 to 2005 in Shenzhen Bay

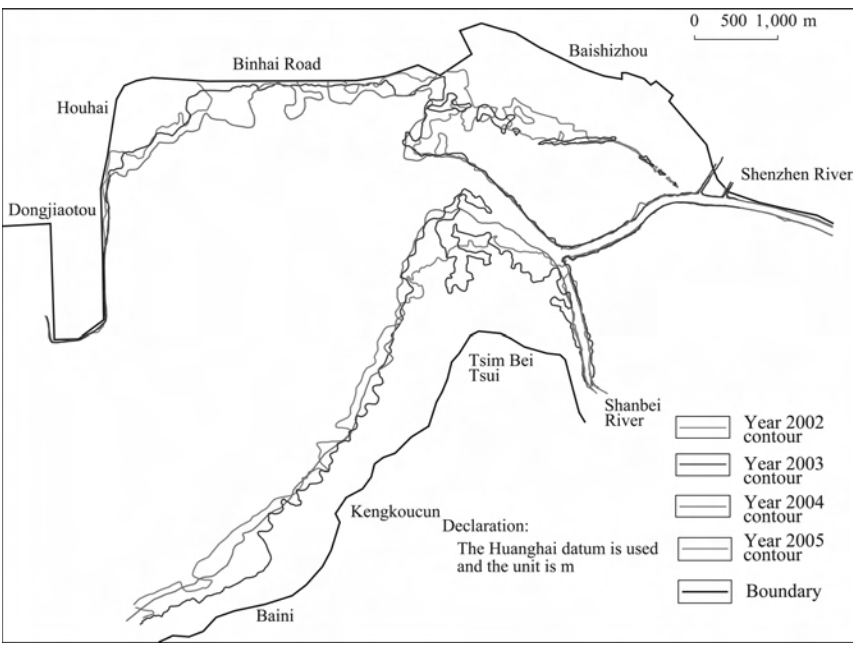

Fig. 5 The change of the – 1 m contour from 2002 to 2005 in Shenzhen Bay

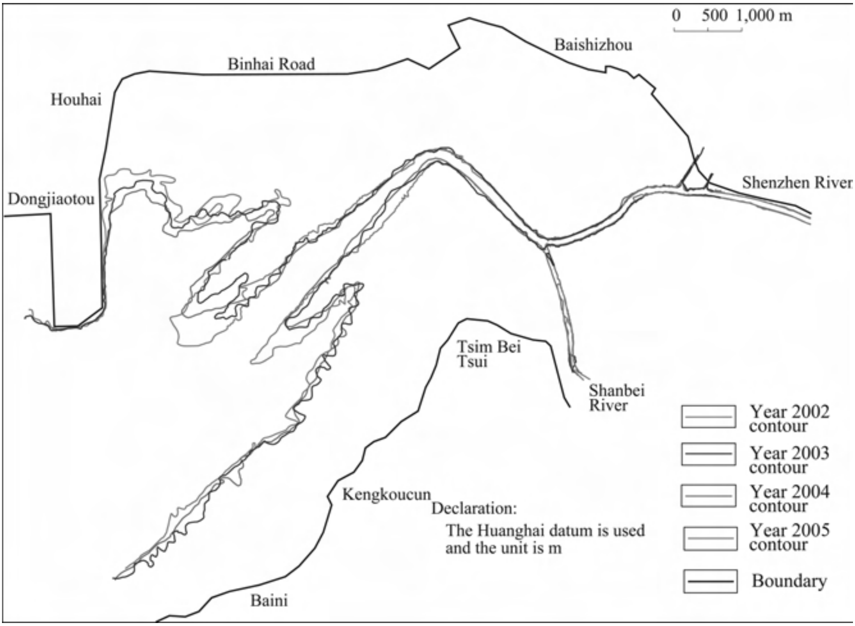

Fig. 6 Change of the −2 m contour from 2002 to 2005 in Shenzhen Bay

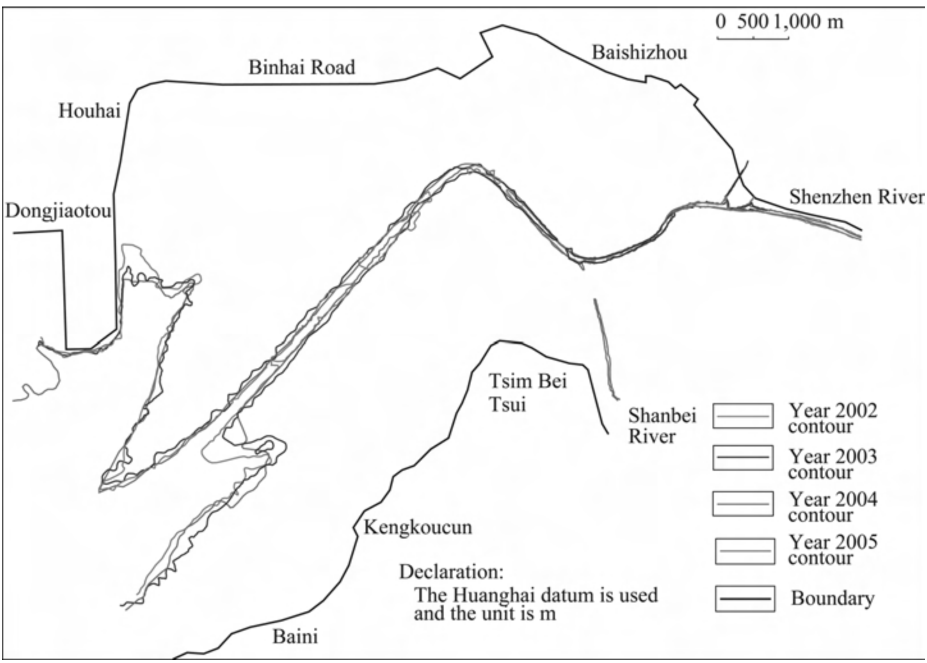

Fig. 7 Change of the −3 m contour from 2002 to 2005 in Shenzhen Bay

Shenzhen Bay. From 1988 to 1944, the reclamation area extended from the northeast part to the

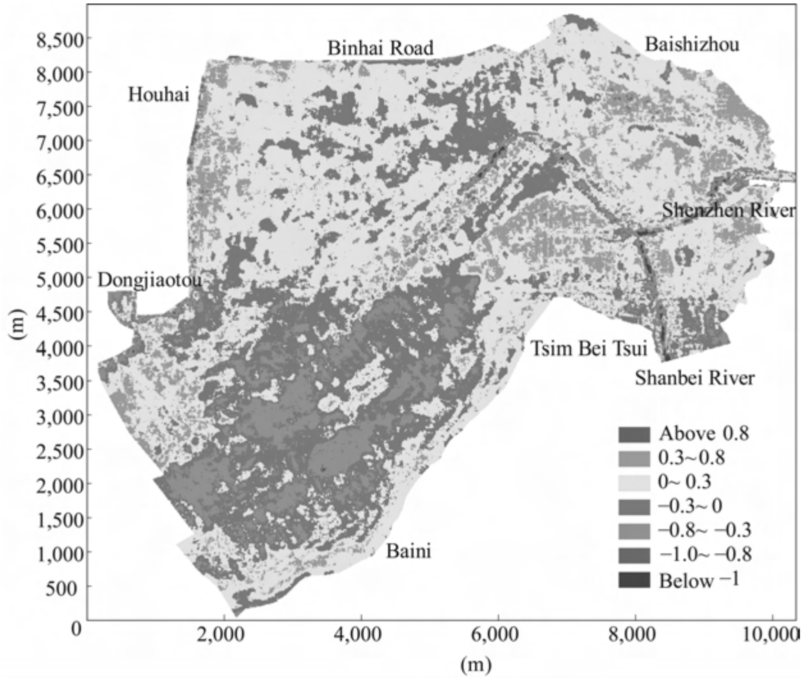

Fig. 8　Sediment distribution of the inner Shenzhen Bay from 2002 to 2005

southwest part of Shenzhen coastal area. The reclamation areas were mainly for traffic and commercial purposes such as the outer part of South Chiwan, the southern part of the seafront of Shekou Dongjiaotou, Yiulian Dockyards (Shekou) Limited, Shekou Container Dock etc. They are founded on the reclamation areas formed in that period. From 1995 to 2000, the use of reclamation areas varied a lot. The land uses mainly consisted of industrial, commercial, residential and traffic etc. At the later stage, the High Technology and Science Industrial Area at the northern part of the sea, Nanshan Commercial and Cultural Centre District and Binhai Road etc were all founded on the reclamation areas. Among them the Binhai Road, Guangshen High Speed Road and Fungtong River Flood Protection Works etc occupied 15.4 km^2 of the Northern Shenzhen Bay. The large area from Dongjiatou to baishizhou became one part of the city. The coastline was moving rapidly outwards by 2 km started from western coast, then from south to north and finally from west to east along the west of the mangrove and bird protection zone. The reclamation area formed an "L" and lying on the Shenzhen Bay.

4　Influences of Shenzhen Bay riverbed evolution on wetland ecosystem

4.1　Influences of Shenzhen Bay riverbed evolution on mangrove species and distribution change

Mangrove has unique ecological properties including viviparous propagation, salt excretion and special root system. There are 13 families and 18 kinds of mangrove in Shenzhen Bay mangrove area, mainly Kandelia candel, Bruguiera gymnorrhiza, Aegiceras corniculatum, Avicennia marina, Sonneratia caseolaris, Avicennia marina, Canavalia maritime, Euraphia withersi, Excoecaria agallocha and Acanthus ilicifolius.. According to the research of Zhang Qiaoming, mangrove was angiosperm, and it evolved into woody plant flora when it moved and habited in the coastline. The periodic submergence in tidal sea water is the essential condition for mangrove growth. Mangrove

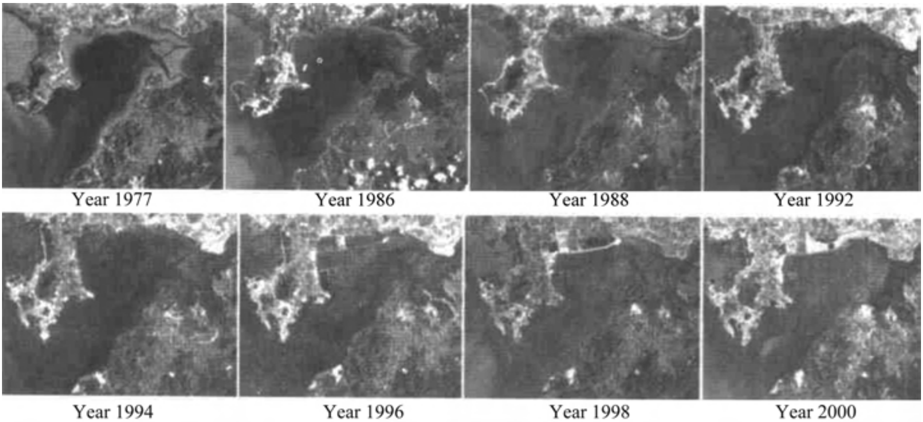

Fig. 9 Images from satellite of Shenzhen Bay from 1977 to 2000

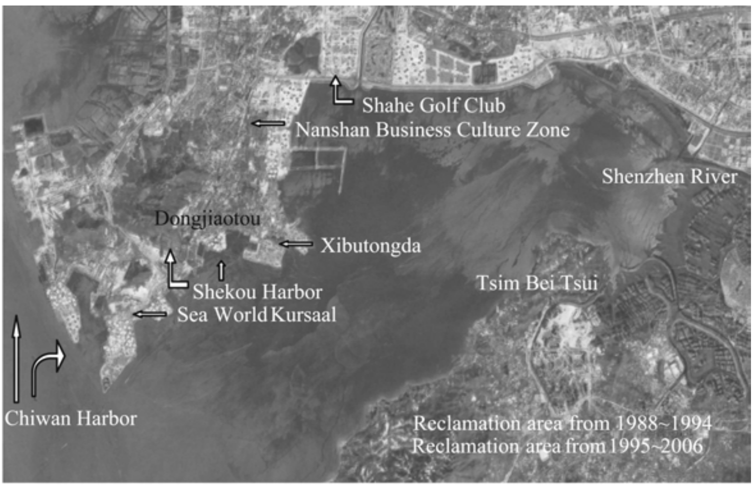

Fig. 10 Reclamation area of Shenzhen Bay from 1988 to 2006

cannot expose to dry ground or immerse in sea water for a long time. Mangrove can grow significantly when the beach rises to the level higher than the average sea level. The degree of beach and the submergence in sea water are the key factors to control the distribution and community structure of mangrove.

From the previous paragraphs concerning the evolution of Shenzhen Bay, it could be seen that the riverbed of Shenzhen Bay is becoming shallower due to sedimentation in last century. Since the 1980s, the massive sea reclamation has pushed the Shenzhen coastline to the inside – bay progressively. Under current boundary conditions, the trend of cumulative sedimentation will remain unchanged. The widely spread muddy beach on both sides of Shenzhen Bay is the key component of wetland and the essential living environment for mangrove.

Two influences will be developed on the mangrove's population and distribution due to the riverbed evolution of Shenzhen Bay. ①A new beach will be formed with the accumulated silt along the inner bay of Jianbizui and Houhai at Shenzhen Bay, especially near Shenzhen estuary. When the height of the beach formed above the sea level, a new mangrove community will be developed on the beach. This can be found between the north and south sand bars of Shenzhen estuary.

Originally, there was no mangrove on the sand bars of Shenzhen estuary. With the increase of area and height on the sand bar, mangroves had grown on the sand bar with height up to 0.5 m. ②Shen zhen contains a lot of reclamation along the coast. The development at Shenzhen coast had destroyed a lot of mangroves which originally growth on the beach. According to Shenzhen Forestation Committee survey, the area of wetland in Shenzhen Bay has reduced 50% in 20 years. The survival rates of mangroves planting is less than 40% and require 50 to 60 years to form a mangrove community. Furthermore, the ecological benefit of mangrove planting is far less than nature mangrove due to the single mangrove species.

In general, the sedimentation in the inner part of Shenzhen Bay helps to create the beach along the coast. This generates essential conditions for the growth of mangroves. At the same time, large amount of beachs have been reclaimed and become dry. Many mangroves die due to the loss of growing conditions. In long term, the rate of reclamation is much quicker than sedimentation. These result in reduction of wetland size, unitary mangrove species, and high influence on ecological effect.

4.2 Influences of Shenzhen Bay riverbed evolution on zoobenthos, hydrobiont, and bird habitation and reproduction

The evolution in the riverbed of Shenzhen Bay may affect some zoobenthos which live and crawl on the riverbed, such as sermyla riqueti, stenothyra divalis, cucullata and so on. Sediment deposition can lead to crawl difficulty, even death by asphyxia. It causes difficulty for cucullata to digest food as the food is mixed with sediment. Besides, sedimentation may encourage the growth of Capitella capitata, Limnodriloidessp and earthworm etc. Since their lifecycles are short, they can easily occupy the surface area of the newly deposited surface layer. As for benthic animals such as Dendronereis pinnaticirrus, Neanthe glandicincta, Nephtys oligobranchia, Sarcodina, Apseudes mortoni and so on , they are troglodytism or live below riverbed. As such, they are not affected by fine clay deposit. However, if the main clay deposit layer is replaced by a sand deposit layer, the zoobenthos living at the riverbed will change from clayey to sandy species. In addition, after the mudflat be silted up and its submerge time be decreased, the quantity and distribution of Nephtys oligobranchia, Sarcodina, Apseudes mortoni and etc which the species require higher salinity would be affected if the salinity falls below 15‰. On the other hand, there is no obvious affect to the zoobenthos such as Dendronereis pinnaticirrus, Potamilla acuminata, Neanthe glandicincta, Capitella capitata and Limnodriloidessp because they are all euryhaline species which can inhabit in an environment with salinity ranged between 6% and 28%.

The changes of structure of hydrobiont community are mainly affected by temperature, salinity and tide. The silted zone of mangrove provides a suitable temperature, salinity and tidal environment for the hydrobiont and then becomes the "Promised Land" for growth of hydrobionts. However, with the silt up of riverbed and the coastline pushed towards the inner of the Shenzhen Bay, the hydrobiont population and distribution decreased dramatically as they lost the protection from mangrove. The silt up of riverbed and the coastal pushes toward the inner of Shenzhen Bay also directly decreased the tide flux and delayed the exchange of water body in Shenzhen Bay. It goes against diffusion of contamination in the Shenzhen Bay and it increases the possibility of occurrence of red tide. Once the red tide occurs, it will make a destructive strike to the hydrobionts. As such, the riverbed evolution affects the hydrobionts more directly and sensitively.

The good natural environment of Shenzhen Bay and rich food resources made the Shenzhen Bay the birds' paradise. From the recorded 194 bird - kinds of Shenzhen Bay, the main zoology community is the bird communities along the mangrove coastal and shoal land, such as Anasacuta, Larusridibundus, Tringatotanus and so on. As for the two zoology community living and find food at the mangrove coastal and shoal land area, the river evolution of Shenzhen Bay have significant influence to the two kinds birds. The main influences are as follows: ①birds in breeding period are sensitive to the change of environment, the decrease of mangrove has destroyed the reproduction place of birds directly, in which it worsened the reproduction and survival of the birds. It is found that the number of the nide of ardeinae in mangrove has decreased gradually from 1992 to 1997. At the same time, the total amount of the ardeinae at peak period has also decreased by 69.45%. ②the decrease of beach and mangrove has cut off the food source of birds. The decrease of tide flux, the worse of water pollution, and all kinds of diseases threatened the bird's lives. ③Due to the moving outward of the shore line, the city is getting closer to the mangrove. The high buildings, noise from industry areas and human activities interfered the ecological environment of birds. Eventually, the birds were forced to leave their habitat.

5 Conclusions

Combining the characteristics of the riverbed evolution of Shenzhen Bay and its influences on wetland ecosystem, the conclusions can be drawn as following:

(1) During the past century, the Shenzhen Bay riverbed was silted continuously and the tide flux decreased gradually. Under present topographical conditions, the trend of durative sedimentation of Shenzhen Bay will not be changed.

(2) Since 1980s, with the large land reclamation in the Shenzhen side, the coastline of Shenzhen Bay has been pushed towards the inner bay greatly, which became a major factors affecting Shenzhen Bay evolution.

(3) The riverbed evolution consists of not only silted land but also dry land through reclaimation. Druing a long period, the area of reclaimed land was much larger than that of silted land. As a result, the area of mangrove was gradual reduced, species tend to be single, which influence the ecological effect of the mangrove.

(4) Shenzhen Bay riverbed evolution dis – benefits zoobenthos which crawl on the bottom but benefits ephemeral and eugonic zoobenthos. At the same time, lifted beach may affect the quantity and distribution of zoobenthos which requires higher salinity.

(5) Shenzhen Bay riverbed evolution has more direct and sensitive effect on hydrobiont. Without mangrove's protection, the hydrobiont species and quantities will decrease rapidly.

(6) Mangrove Birds living at coastal waters and beach take the mangrove zone and beach as their habitat and multiplication plot and food sources. Therefore, the riverbed evolution has a obvious effect to these two ecologic groups of birds.

6 Recommendations

(1) Coastwise beach is a physical basis for survival of mangrove and other species. Hence, aiming at the riverbed landform in Shenzhen Bay, a dynamic monitoring system should be established. Total area of land reclamation in Shenzhen Bay should be controlled stricterly to ensure beach silted and extended naturally.

(2) To study the ecological behaviour of mangrove and to improve the surviving rate of the cultivated mangrove, to resume the mangrove vegetation at beaches with appropriate conditions.

(3) As the river and sea affect each other, fresh water and slat water are mixed in Shenzhen Bay, the ecological factors are complicated. Specific monitoring spot at different mangrove zones should be established so that the changes of mangrove wetland ecosystem could be grasped momentarily.

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Study on Application of Apron Geomembrane Tubes to Interception Branch River of the Yellow River

Deng Yu[1], ***Xie Zhigang***[1], ***Yue Yusu***[1] and ***Si Baojiang***[2]

1. Yellow River Institute of Hydraulic Research, Zhengzhou, 450003, China
2. North China Institute of Water Conservancy and Electric Power, Zhengzhou, 450008

Abstract: According to the current situation of branch river of the lower Yellow River, a new method of apron geomembrane tube is presented. The design scheme is introduced and the model is analyzed. The advantages and reliability of the tube structure are demonstrated to regulate the branch river. The field experiment indicates that the new product has the characteristic of easy to be applied, convenient, stable and low cost. Also it can meet the requirements of mechanically regulating branch river.
Key words: apron, geomembrane tube, branch river, the Yellow River, interception

1 Introduction

The branch river is the outlet drain, which is formed by flow scouring the beach face. It is parallel to the main river. Some branch rivers are evolved in drain along the dike, others are evolved in branch. Some branch rivers have water only in flood reasons; others have water also in non – flood seasons. There are many branch rivers in the floodplain of the Lower Yellow River, so the problems are serious. On the one hand, the river channel has the characteristic of wide, shallow, loose and disorder, so it is easy to form transversal river or diagonal river; on the other hand, it is possible to form rolling river during floods because of the large amount of branch river in the floodplain. There are many examples about many floodplains were flooded or dike broken for the river piracy of branch river. Therefore, it is very important to intercept branch river. Many rush repair measures have been researched on intercepting branch river, but the infection factors are complicated, the decisions are difficult to be made, the occasions can not been mastered, work condition is bad, technical request is high standard. In past, the problem could not be regarded in occurrence, frequently lose the optimally rush repair occasion, lead to problem severity. At present, the conventional interception technology can not meet the modern flood control and rush repair need, and the larger geocontainer and the larger net – cage need a large of man power and material resources. In contrast, geomembrane tubes are increasingly applied to river regulation as a new material and a new technology. The apron geomembrane tubes are improved tubes in the general tubes base. The hydraulic characteristics of the Yellow River are considered in the tubes design, the scour can be slowed up, and stability can be hold, favorable condition can be offered for intercepting branch river. So the purposes are catered for quickly intercepting branch river in flood reason and reducing flood loss.

2 Design schemes of tubes

Unanchored inflatable tubes, commonly known as geomembrane or geosynthetic tubes. Most of these tubes are inflated with water, or mud fluid. These tubes are used for control of spills, for water diversion, and as cofferdams for temporary dewatering of construction sites. Some failures have occurred due to slipping and rolling of the tubes. A stabilizing technique is examined here. It involves the attachment of a piece of material, called an apron or skirt, to the tube and placing it along the ground on the headwater side. A couple of manufacturers incorporate such and apron in their designs. Frictional resistance between the apron and the ground inhibits large deformations of the tube and helps to prevent failure, see Fig. 1. The style tubes are chiefly used for interception branch river of the Lower Yellow River, the depth of water is no more than 2 m, the current velocity of water is no more than 2 m/s. The tube and apron were constructed from 0.51 mm thick polyvinyl chloride membrane with polyester reinforcement. The tube circumference was 9.42 m, and the apron lengths were 3 m. The apron was glued to the top of the tube. A drainage system consisting of a geonet enveloped by a woven monofilament filter was placed on the river bed surface. The upstream edge of the drainage system was 1 ~ 2 m upstream from the tube, and the downstream edge of the drainage system was downstream of the tube. The drainage system reduced pore water pressures beneath the apron and tube in order to control erosion and to increase the stability effect of the apron by increasing the effective stress beneath the apron. After inflating the tube, a small sand berm was placed along the upstream edge of the apron. Its purpose was to produce a small effective stress at the upstream (headwater) edge of the apron to ensure contact of the apron with the underlying sand at that location. The berm was sufficiently small so that it did not significantly increase the overall shear resistance of the apron.

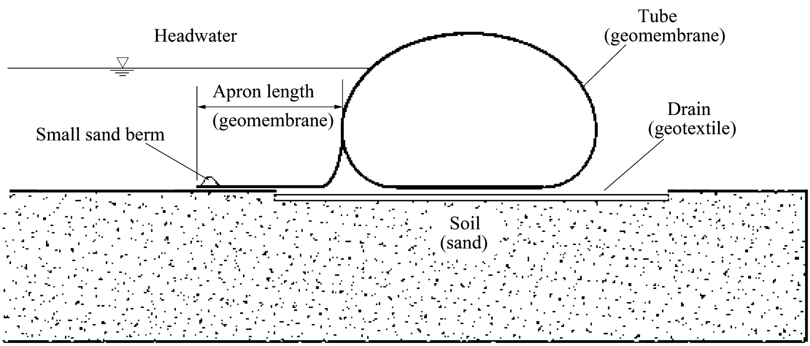

Fig. 1 Tube cross section, apron, drain, and foundation

3 Analytical model

The tube and apron are assumed to be comprised of a membrane material (i. e., with no bending stiffness) that is inextensible, and the foundation is assumed to be rigid. The weight of the tube is neglected. A two – dimensional analysis of the equilibrium of a cross section is carried out. The cross section is shown in no dimensional terms in Fig. 2. In dimensional terms, the circumference of the tube is L, the contact length of the tube with the foundation is B, the specific weight of water is γ, and the internal water pressure head and the headwater level are H_{int} and H_{ext}, respectively. The constant tensions in the tube section AE, apron section CE, and tube section EG are T, T_a, and $T + T_a$, respectively.

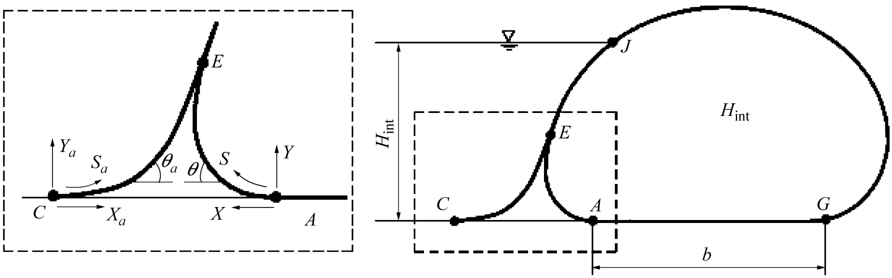

Fig. 2 Corrdinates and variables for analytical model

The analysis is carried out in terms of the following non – dimensional variables

$$x = \frac{X}{L}, y = \frac{Y}{L}, s = \frac{S}{L}, x_a = \frac{X_a}{L}, y_a = \frac{Y_a}{L}, s_a = \frac{S_a}{L}, h_{\text{int}} = \frac{H_{\text{int}}}{L}, h_{\text{ext}} = \frac{H_{\text{ext}}}{L}$$

$$b = \frac{B}{L}, t = \frac{T}{\gamma L^2} \tag{1}$$

In the tube section AE, the governing geometrical and equilibrium equations are

$$\frac{\mathrm{d}x}{\mathrm{d}x} = \cos\theta, \frac{\mathrm{d}y}{\mathrm{d}s} = \sin\theta, \frac{\mathrm{d}\theta}{\mathrm{d}s} = \frac{h_{\text{int}} - y}{t} \tag{2}$$

Since the curvature dy/ds is positive, the solution is :

$$y = h_{\text{int}} - u, x = t\int_0^\theta \frac{\cos\theta}{u}\mathrm{d}\theta, s = t\int_0^\theta \frac{1}{u}\mathrm{d}\theta \tag{3}$$

where,

$$u = \sqrt{h_{\text{int}}^2 - 2t(1 - \cos\theta)} \tag{4}$$

In the apron section CE, Equations (2) ~ (4) are valid if the subscript a is placed on the variables and if h_{int} is replaced by h_{ext}. In section EJ of the tube, the curvature is constant and given by

$$\frac{\mathrm{d}\theta}{\mathrm{d}s} = Q, \text{where} \quad Q = \frac{h_{\text{int}} - h_{\text{ext}}}{t + t_a} \tag{5}$$

With the use of the first two of Equations (2), the solution is

$$\theta = \theta_E + Q(s - s_E), x = x_E + \int_{s_E}^{s} \cos\theta \mathrm{d}s, y = y_E + \int_{s_E}^{s} \sin\theta \mathrm{d}s \tag{6}$$

For the tube between points J and G, t is replaced by $t + t_a$ in Equation (2), and the solution is

$$y = h_{\text{int}} - v, x = x_J + (t + t_a)\int_{\theta_J}^{\theta} \frac{\cos\theta}{v}\mathrm{d}\theta, s = s_J + (t + t_a)\int_{\theta_J}^{\theta} \frac{1}{v}\mathrm{d}\theta \tag{7}$$

where,

$$v = \sqrt{(h_{\text{int}} - h_{\text{ext}})^2 - 2(t + t_a)(\cos\theta_J - \cos\theta)} \tag{8}$$

By putting θ equal to θ_E, θ_J or θ_G, as appropriate, one can obtain formulas for x, y, and s at points E, J, and G, and for x_a, y_a, and s_a at point E. The following conditions exist:

$$y_E = y_{aE}, \theta_E + \theta_{aE} = \pi, y_J = h_{\text{ext}},$$
$$x_G = -b, y_G = 0, s_G = 1 - b, \theta_G = 2\pi \tag{9}$$

Another condition is obtained by the requirement that the area of the tube cross section remains constant as the tube deforms, since the internal water is incompressible. The area is computed by integrating the height y appropriately and making use of the relation. For the initial area, with no external water, $h_{\text{ext}} = t_a = 0$ and the profile is symmetric. In addition, from a free body diagram of the tube section in contact with the foundation, the tension on one end is t and on the other end is $t + t_a$, so that the friction force acting on this section is the difference t_a. Now consider a free body diagram of the whole tube and the apron section above the ground, as shown in Fig. 2. No dimensionally, the horizontal forces are the tension t_a in the apron at point C, the friction force t_a on the tube, and the external water resultant force $h_{\text{ext}}{}^2/2$. Hence, from equilibrium,

$$t_a = \frac{h_{\text{ext}}^2}{4} \tag{10}$$

For this analytical model, the resisting forces due to friction of the tube with the foundation and due to friction of the apron with the foundation are equal. The quantities h_{ext} and h_{int} are specified. With the use of Equations (9) and (10), and the constraint of constant area, numerical solutions for, $t, t_a, b, x_{aE}, y_{aE}, \theta_{aE}$ and the unknown values of x, y, s, at points E, J, and G are obtained.

This analysis assumes that the friction forces acting on the tube and on the apron that lies on the foundation are large enough to resist the lateral force of the external water. If the apron is long enough, this will be true. In dimensional terms, let L_d and L_s be the lengths of the apron lying on the drain and on the soil, respectively. Let ϕ_d and ϕ_s be the friction angles between the apron and the drain and between the apron and the sand respectively. The effective normal stress acting on the bottom of the drain is assumed to be equal to γh_{ext} for the portion of the apron above the drain, and for the portion of the apron above the sand, it is assumed to vary linearly from γh_{ext} at the end of the drain to zero at the end of the apron. Therefore, the total friction force is

$$T_a = \gamma H_{ext}(L_d \tan\phi_d + 0.5 L_s \tan\phi_s) \text{ and } T_a = \gamma H_{ext}^2/4 \tag{11}$$

The friction force can be eliminated between these two equations, giving the relation

$$H_{ext} = 4L_d \tan\phi_d + 2L_d \tan\phi_s \tag{12}$$

which can be used to determine the minimum required apron length to prevent slip of the apron as the headwater level increases toward the top of the tube. Substitute correlated value, the least lengths of the apron is given, which is 2.05 m. So it is concluded that the design of tubes is stable.

4 Experiments on tubes

According to correlated tests and model calculations, the conclusion can be obtained that the design scheme of apron geomembrane tubes can meet the basic require of intercepting the branch river of the Lower Yellow River. For further verifying the reliability and stability of tubes, a simple test was executed in a sluice of the Lower Yellow River. The length of the tube is 30 m; the distance is 150 m between the gate and the tube. After the tube was placed, the sluice was opened. As the water height was continually raised, the tube occurred deformation and inclined to the lower river, the apron was strained, but the whole of tube is stability. At last, current overflowed the tube, but the tube was not damaged. The whole test course is simple, but the result has been verified that the apron tubes have marked effect in interception branch river or as atemporary water holding cofferdam.

5 Conclusions

A new method of apron geomembrane tubes has been put forward through introducing the branch river cases in the Lower Yellow River. The tube can be used for resisting branch river flood instead of sand bags. It has the characteristics of portable installation, easy disassembly, repeat utilize. One method is adopted to prevent slipping and rolling of the tubes, which involves the attachment of a piece of apron to the tube and placing it along the ground on the headwater side. Frictional resistance between the apron and the ground inhibits large deformations of the tube and helps to prevent failure. A drainage system consisting of a geonet enveloped by a woven monofilament filter was placed on the bed surface, it reduced pore water pressures beneath the apron and tube in order to control erosion and to increase the stability effect of the apron by increasing the effective stress beneath the apron. The site test has indicated that the apron tubes have better effect in intercepting branch river or as a ponding cofferdam.

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The Study Actuality and Current on River Ecological Water Requirement

Li Qiangkun[1], ***Sun Juan***[1], ***Ding Xianbao***[2] and ***Hu Yawei***[1]

1. Yellow River Institute of Hydraulic Research, YRCC, Zhengzhou, 450003, China
2. Survey Bureau of Hydrology and Water Resourses of Sanmenxia Reservoir, YRCC, Sanmenxia, 472500, China

Abstract: Based on the present research condition of river ecological water requirement, set out from the inside mechanism of the ecosystem water requirement, inquiry into the meaning of the river ecological water requirement. Aimed at the estimating methods used in common presently, carry on a commentary and analysis from different angles such as physical meaning, applicable conditions and applicable scope etc. Combined with the development need of eco-hydrology, prospect the development trend of river ecological water requirement.

Key words: river, rcological water requirement, eco – hydrology

From coming into being the continuable development mentality in 1980s, the continuable development estimate theories and means have been developed and perfected continually. In 1990s, the globalitical water resource shortage and water condition crisis urged people paid much more attentions to water continuable utilization problem, especially that the biological diversity decrease and species die out are very graveness because the water resource shortage and water environment crisis resulted in. So the relativity research of water resource and entironment, especially the research of the river ecological water requirement is one of the hotspots present. The paper discusses the river ecological water requirements combined with the present research actuality.

1 The meaning of river ecological water requirement

Ecosystem is one of ecological concepts. It is an entia that refers to continuously carry through substance circle, energy flow and information contact between biology communities and their survivable conditions mutual relations reciprocity each other together. Ecosystem is a homeostasis system that consists of biology communities and their survivable conditions, including 4 groups: producer (main of green vegetable), consumer (including vegetarian, carnivore, omnivorous animal, parasitical animal, gnawer animal etc.), disintegrator (main of bacilli and epiphyte), non biology environment (it is survivable condition that biology depend on survivable active ground and headspring of substance and energy, including biologic habitat, breed terrain, and migrate terrain). The core element of ecosystem is the ecological community which is consisted of producer, consumer and disintegrator.

The river ecosystem not only is a kind of freshwater ecosystems and but also is a complex ecosystem. Main elements are earth strand ecosystem, aquatic ecosystem, correlative marsh swamp ecosystem etc. Main characteristics of the river ecosystem includes:

(1) Take on longitudinal zonal phenomena, species longitudinal displace is not symmetrically continuously changed, especial community can reappear in whole river.

(2) The biology has special form frame adapt to rushing survivable condition.

(3) Complex mutual restrict by else ecosystems. One side the climate, vegetation and jamming intensity can affect river ecosystem a certain extent, on the other hand the river ecosystem can affect form and evolvement of alongshore ecosystem, such as people setup barrier to interdict changes by seawater and freshwater for preventing seawater enter reach. This action may lead to different degrees change of environment condition in bayou nearby, biologic circumfluence gets restrict

between river and sea, bayou environmental condition occurs change because river nutrimental substance unable export so lends to fish, shrimp, seashell reduce alongshore.

(4) The ecosystem has strong self – depurate ability, restoration quickly by disturbed.

The river ecological water requirements is necessary water quantity that maintains the river ecosystem definite ecological function that, i. e. refers to requisite water quantity that maintain ecosystem balance between biology communities and their survivable conditions in river. The river ecological water requirements have two meanings: one meaning is life water requirements that can maintain lives of the core elements of ecosystem consist of producer, consumer, disintegrator in river ecosystem; the other meaning is environment water requirements that can protect ecological community survivable environment whole. The life water requirements and environment water requirements are not isolated in the river ecosystem. The river ecological water requirements are not simple addition by the life water requirements and environment water requirements, the life water requirements and environment water requirements are superposition or part superposition at some time contrarily.

2 The calculation methods of river ecological water requirement

The calculate methods of the river ecological water requirements domestic and overseas general are:

(1) Standard flux: include ①7Q10: this method adopts 90% guarantee rate and least flow average water quantity continual in 7 days to the least design flow of the river. ② Tennant: based on the predefined percent of annual average flux, usually used in research the priority low breach or used a kind of test in other method.

(2) Hydraulics: include ①R2CROSS: based on manning formula, thinking about depth of water, width of river and velocity of flow that the geometrical form determined in calculating watercourse flux. ②Wetted perimeter: taking wetted perimeter as ecological community habitat quality target then to estimate the watercourse flux, collecting the watercourse geometrical form size and flux data in critical habitat district (many bank usually) and taking critical habitat type qua the rest part habitat target.

(3) Habitat: ①Increasing flux inside of watercourse method (IFIM): based on present data such as water depth, base material types, velocity of flow etc., adopts PHABSIM model to simulate the relation between the change of velocity of flow and habitat type, combined with hydraulics data and biology information, then decide main aquatic biology and habitat that can fit certain flow. IFIM is more used in estimating influence of the aquatic biology habitat downriver because of the water resource exploit construct. ②CASIMIR: depended on the flow change in time and special, adopts FST to build revelation between the hydraulics model, change of flow and selected biology type, estimated amount and scales of main aquatic biology.

(4) domestic usually methods: the method of the least month average flow in decade. This method meaning take use the least month average flow in decade or 90% guarantee rate least flow average flow as the river ecological water requirements, it was used prime estimate environment influence of water conservancy construct. Otherwise, taking water quality target as restriction to calculate ecological water requirements, this method main calculate water requirements that pollution water dilute self – depurate and the calculation is recognized as the city reach least flow that can satisfy surroundings quality target restricted.

Above – mentioned calculation methods have offered certain convenience for people preliminary estimated the river ecosystem ecological water requirements under specific condition, present some methods still apply extensively. Above – mentioned methods just discussed the ecological water requirements through the geometrical form about river and the hydraulic conditions such as the current, depth of water and velocity of flow of watercourse, and just applied information is also the hydrological data of velocity of flow and the water level that reflects the water quantity of watercourse, therefore, the calculating result is deemed to have the meaning of hydrology greatly, at the same time, the calculating results also have certain discrepancy if the different information series are selected. Because can not establish the respond mechanism between the survivable conditions of the ecological community (or key species) and hydraulic conditions (the current, depth of water and velocity of flow etc.), can not explain the corresponding relation between the survivable conditions of the ecological community, can not show the quantification index of the hydraulic conditions influencing degree when the survivable conditions changed, therefore, such calculating results still haven't the meaning of ecology so it can't reflect the river ecological water requirements index scientifically. (Key species refer to that have very disproportionate influence for other species in ecological community to relative their abundance, that have pivotal effect on defending the biological diversity, structure, function and stability of ecosystem, and entire ecosystem or ecological community would occur ultimate change once they disappearing or weakening).

Additionally, according to the research results of ecological, the factor that influences the ecosystem health includes mainly:

(1) The hydraulic conditions which include water circular state or rainfall, velocity of flow and flow form, water quality etc.. It is the basic element of life in ecosystem.

(2) Carbon, nitrogen and phosphorus etc. important nutrition material condition, which are framework element, metabolic element and information element of ecosystem respectively.

(3) Using way of Land. Especially the using way of the land near marsh which directly influences the structure and scale of marsh.

(4) Air quality. Air quality has important influence for biology survivable environment.

(5) Climate changes.

(6) Foreign biological species invasion. Thus if it can be see, if no water, ecological community in ecosystem can not survival and succession; But if only there is water, it can not far still satisfy the requirement of ecosystem health. Therefore, the hydraulic condition is not the only factor to decide the river ecosystem health.

3 The healthy indexes and standards the of river ecosystem

Health of ecosystem is the burgeoning research field of international academia in 1980s, the definition academic has not gotten common cognition in academia now. Generally acknowledged, it is the field of studying the correlation of mankind action, social organization, natural system and human health. What they call "health" points to the property that the system could maintain relative steady state of structure and function, constantly perfect and develop in various bad environment influences. The healthy ecosystem has following feature: Do not have maladjusted symptom, have very good restorable ability and self maintains ability, not have harm for other near ecosystem, have sustaining and stimulative function for human health and society economic development.

The standard of ecosystem health mainly includes vigor, restorable ability, organization, keeping the service function of ecosystem, manage choice, decrease of external input, the influence for near system and human health etc. 8 aspects. The 8 aspects respectively belong to biological physical category, society economic category, human healthy category as well as certain time, space category. The foremost is from first to third aspect in 8 standards. Vigor meanings nutrition circulating capacity and the energy input of ecosystem, idiographic indexes are circulation of material and the elementary productivity of ecosystem. The vigor will turn higher if more and more energy input and material circulation in certain scope, but this does not signify that the ecosystem would more healthy because of more energy input and nutrition material circulation quickly, especially more energy input high will lead to eutrophication effect in water ecosystem; Restorable ability denotes to the system surmounts pressure and the capacity of the rebound when the intimidation disappeared, specific index is the restorable rate of natural interferential and natural interferential resistance of ecosystem. Generally acknowledged, restorable ability of ecosystem that received intimidation less than that don't received intimidation; Organization is systematic complexity, this feature will occur change along with the secondary succession of ecosystem, specific indexed are the rate of the short - lived species and the long - lived species ecosystem, the rate of external species and local species, commensal degree and the die out degree of local species etc.

Anti – jamming and stability are the two important indexes of ecosystem health. Jamming is the cause that resulted in community or ecosystem feature beyond the normal fluctuant scope, such as species diversity, nutrition material output, biomass, vertical and horizontal structural etc., jamming system includes in the frequency, the type, the intension and time etc.. Ecosystem stability is the ability to maintain normal dynamic of ecosystem, includes restorable ability and resistance mainly. Now, people still argue the relation of ecosystem stability and complexity. Normally, steady ecosystem is healthy, but healthy ecosystem is not always steady; Jamming can cause ecosystem instability or sickness in steady ecosystem or healthy ecosystem, under certain intension scope, the ecosystem disturbed is sickness but still steady; Healthy ecosystem is not disturbed , but steady ecosystem may be disturbed.

Because of the research complexity of ecosystem health and the different ecosystem type estimated, therefore coming into being various estimative methods and index systems, divided 3 kinds mainly: ① ecological index: design index in ecosystem level and community arrange; ②human health and society economic index: it is applied the ecosystem those have close relation with mankind, as the ecosystem in valley; ③materialize index: explore non biological reason that influenced ecosystem change.

4 The ecological restoration of rivers

It is very important for the estimating of ecological water requirements and the appraisement of ecosystem that ecosystem restorable level. Therefore it is to determine river ecosystem restorable resumes before appraise for the level of ecological water requirements first, also is to determine the achievable standard after river ecosystem restored present.

Definition of the river ecological restoration have different descriptions in current academic, sum as :"complete renewing": structure and function of ecosystem could recover completely the state before disturbed; "renovation": function and structure of the ecosystem could return partially the state before disturbed; "strengthen": Environmental quality has the certain degree improvement; "creation": Developing a new river ecosystem which was insurvivable originally, forming new river physiognomy and river biological community; "naturalness" : Because the human has long-term development of water resource so formed a new river ecosystem, the new system is different to original natural dynamic ecosystem. When human has recognized the need of water resource development, they emphasized to protect the quality of natural environment at the same time. Thus it can be see, people have different understanding about the ecological restoration of river. Confirming the goal of ecological restoration of river not only is a issue of technology but also is a social one, it depends on the value tropism of people at that time greatly.

In 1990s, the ecological environment of the Yellow River district arises a lot of problems once because of a series of artificial and natural factor such as water resource excessive development and continuous arid etc., most river part water resource is lost using value because of serious water pollution; shrinking of main groove, reducing of drain flood ability, form and development of "secondary suspended river", the runoff into sea is serious insufficient since the lower reaches of the Yellow River dried up frequently; The marsh of bayou is gradually subsidizing so biological diversity is reduce; The coast of bayou is eroded seriously, seawater invasion is aggravated, soil secondary salinization area is expanded etc.. According to these problems, at the beginning of 21st century, persons of Yellow River has put forward brand – new conception of the Yellow River training "on Keeping Healthy Life of the Yellow River and Modern River Basin Management" at the right moment, and formed the theoretical frame of "1493" preliminary. A ultimate aim of the Yellow River training: "on Keeping Healthy Life of the Yellow River and Modern River Basin Management"; 4 main signs: "no embankment breaching, no river course running dry, no pollution over standard, no riverbed rising"; 9 training ways are in the following:

(1) Reduce sediment that comes into the Yellow River;

(2) Effectively manage water resource utilization of the Yellow River basin and related area;

(3) Increase water resources of the Yellow River through water transfer master plans from other rivers;

(4) Construct water and sediment regulation projects;

(5) Set up and realize a scientific and reasonable training plan for the lower reaches of the Yellow River;

(6) Regulate favorable hydrological process to mitigate the shrinking of the main channel in lower reaches;

(7) Take measures to protect water resources to meet the demand of water quality function;

(8) Manage Yellow River delta area to reduce seawaters' impact on the lower reaches;

(9) Model the runoff process to meet the demand of keeping the ecosystem of the estuary delta virtuous.

The core of these 9 training ways lies in the solution of Yellow River "water shortage", "sediment affluence" and "water and sediment disequilibrium", as well as how to keep the river ecosystem, of which the center is Yellow River healthy development. 3 essential ways: nature Yellow River, digital Yellow River and model Yellow River. "Three Yellow Rivers" construction is basic measure in order to ensure the nine ways' scientific and rational.

5 Concluding remarks

About the synthesize knowledges mentioned above, the author thinks: First, people should know the ecological restoration goal of river and the main quantifiable index before evaluating the ecological water requirements level of river; Secondly, think the ecological community diversity, the changes of specific river situation and difference of river, according to the purpose of the appraisement of ecological water requirement of river analyzing the composition; Third, should select possibly more indexes that have ecological meaning, establish corresponding relation between ecosystem and hydraulic conditions in calculating process; Finally, suggest that reinforced field basic research work because of current research situation.

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Analysis on Management and Operation Mechanism of the Yellow River Engineering after the Separation of Management and Maintenance

Yue Yusu[1,2], ***Fan Junchang***[3] and ***Cui Yanfeng***[4]

1. Graduate Student Institute of Chinese Academy of Science, Beijing
2. Yellow River Institute of Hydraulic Research, Zhengzhou
3. Yellow River Yanggu Bureau, Liaocheng
4. Henan Yellow River Engineering Bureau, Zhengzhou

Abstract: During the trial period of the reform on water management system, the study on establishment of new operation mechanisms matched to new systems has been initiated by YRCC, and relating methods been issued. At present, the reform of water management system has been finished, the management and maintenance has been separated in the setup of engineering management organization, and appropriated system framework of operation mechanism has been initially established. However, there are still some existing problems, which mainly presents in the harmony between engineering management and flood control and flood fighting, as well as water administration and water resources; the management department is difficult to run independently due to the low fund for administration which can not guarantee the expense of retired staff; the maintenance is difficult to run in market mode due to low professional level.
Key words: separation of management and maintenance, engineering management, operation mechanism

The reform of water management system concentrating on separation of management and maintenance conducted by YRCC, which is related to the further development of 76 water management departments under YRCC, has very important significance. The trial work in 25 departments has been finished by 2005, and the reform task for all water management departments under YRCC has been finished by 2006. This reform broke the conventional administration system which combined the maintenance, prevention, management and prosecution. Labour, finance and material has been preliminarily separated in water management department, maintenance department, construction enterprise and water supply bureau. Institution and enterprise were separated and new administration system was established preliminarily. Facing the total new system, how to establish matching operation mechanism which is "management scientifically and running canonically", has been paid much attention by each sides from the beginning of reform and specially studied by YRCC following the issue of related regulations and large – scale training. At present, the system framework of new operation mechanism has been established preliminarily and the level of engineering management was improved dramatically. However, there are still some existing problems, which mainly presents in the harmony between engineering management and flood control and flood fighting, as well as water administration and water resources; the management department is difficult to run independently due to the low fund for administration which can not guarantee the expense of retired staff; the maintenance is difficult to run in market mode due to low professional level.

1 The overall idea of the research on management and operation mechanism of the Yellow River engineering

The research on management and operation mechanism of the Yellow River engineering should be under the guidance of "the implementation proposal of the reform on management system of hydraulic engineering" issued by the state council, and the precondition of guaranteeing the integrity and safe – operation after the separation of management and maintenance. The unified, scientific and canonical criteria system which is "management scientifically and running canonically" should be formed step by step, and restriction mechanism including trade restriction, restriction between departments and restriction inner department should be established, to establish the supervision mechanism in which the quality safety, fund spending and schedule of engineering management work and maintenance processing were supervised by superior administrator, water management department and supervision department according to related regulations; to establish the stimulation mechanism with the core of competition and the measures of engineering check, bidding and bid, integrated appraisal, strict and impartial reward and penalty, as well as encouraging innovation; to establish the guarantee mechanism including organization guarantee, fund guarantee, system guarantee, labour resources guarantee and benefit keeping.

2 Specific measures implemented by YRCC

Consulting to the experiences of construction management of infrastructure in the Yellow River and other trades as highway maintenance, focusing on the characteristics of maintenance processing and requirements of the present work in the Yellow River harnessing, YRCC established the overall framework of the research on management and operation mechanism of the Yellow River engineering, and worked out matching management regulations and methods. As a result, the work processing and crucial stages of the management and maintenance of the Yellow River engineering were standardized effectively, and the further performance of the reform on water management system were promoted, founding the base of the transformation of management and maintenance work of the Yellow River engineering running under new mechanism. Specifically, including:

(1) Dividing the range of professional work responsibility between engineering management and maintenance definitely, working out demonstration text of maintenance contract, making the authority clear, privilege and responsibility definite in both sides.

(2) Key stages related to maintenance work such as contract sign, plan workout, maintenance criteria, engineering supervision, quality monitoring and project acceptance were standardized systematically.

(3) Systematic quality management system of engineering maintenance were established, moreover, supervision and quality monitoring mechanism were imported into maintenance work.

(4) Eleven training classs on operation mechanism were held, staff of water management department and maintenance enterprise were trained in large scale.

3 Effect of implementation

3.1 Standardized system has been preliminarily established and taken effect

The issue of standardization method for management effectively stipulated the work process and main stages of the management and maintenance of the Yellow River engineering. The departments under YRCC matched and constituted detailed implementing rules according to their own situation, which further stipulated the development of operation management, and realized the canonical operation of engineering management and well running of the maintenance market.

3.2 The status of water management department as non – profit institutional department has been confirmed, the way of fund is smooth

The water management department has been defined as complete non – profit institutional department, the fund of engineering maintenance is considered into the budget of national finance. Both the management and maintenance fund are guaranteed, which can financially guarantee to keep engineering intact and improve flood control capability.

3.3 The professional team is on duty, the management of contract is enhanced

The well management mode of maintenance for the Yellow River engineering has been established, the on – duty of professional team changed the way of segmental contract by employing and quickened the process of professional team construction and standardized management, which effectively promoted the further development of engineering management. Simultaneously, contract management between water management department and maintenance company is implemented, so that contact sign, supervision and acceptance is enhanced, and the engineering strength and quality are so that guaranteed.

3.4 The work passion of staff is improved, the appearance of engineering has been improved dramatically

Broad and further propaganda made the staff know the further significance of reform and realize the care of nation to the Yellow River affairs is also the care to their work; the increase of various fund in the reform scheme will greatly change the past condition of which income was less than expense, so the work confidence of the staff was enhanced. The reform insisted on the principle of "publicity, justice and equity" and performed "sunlight processing", and the establishment of endowment insurance system after retirement released the further misgivings of the enterprise staff, so the condensation strength of the staff is enhanced. Management system and measures of reward and penalty have been established and perfected in management department and maintenance enterprise respectively, the passion of staff for working well on own duty has been improved.

The improvement of passion in both maintenance enterprise and their staff, with the refining of the regulations in check, evaluation, reward and penalty, which has made the forming for good work phase of changing "passiveness" into "initiative", changing "let me do" into "I would do". The daily management of engineering has been enhanced and the appearance of engineering as been improved greatly.

4 The existing problems

4.1 The problems of implementing the responsibilities in engineering maintenance and flood control and flood fighting

"The ration criteria for the maintenance of hydraulic engineering" clearly stipulates that it is applicable for working out and ratifying fund budget of the annual daily maintenance of the hydraulic engineering for water management department after the separation of management and maintenance. The cost of engineering repair and rescue, hydraulic engineering reconstruction and other special cost caused by abnormal flood and great danger should be applied and authorized individually. Meanwhile, The ration criteria defines maintenance task of the hydraulic engineering as "the maintenance and annual repair for the accepted and handed over engineering; to maintain, recover and partly improve the appearance of the original engineering; to keep the designed function of the engineering, guarantee the integrity, security and normal application of the engineering".

Under the condition of non – abnormal flood, the task and objective of the engineering maintenance is identical to that of flood contro and flood fighting during wet season, and essentially, the purpose of engineering maintenance and flood rescue are both for the integrity, security and benefit exertion of the engineering. Therefore, under the new mechanism, it is actually difficult to differentiate the general flood fighting and engineering maintenance. Especially for the Yellow river, the great danger maybe occur even under the low water level. It is necessary to further study on the concerted questions between the flood control department and engineering management department, as well as the solution for the fund of flood fighting.

4.2 The problem of fund for the water management department

The standard of basic cost for the in – service staff in the water management department is low, the ration criteria ratified by the Ministry of Finance for each people is 25,600 Yuan per year, but the actual necessary cost is 30,200 Yuan per year, the average deficiency for each person is 4,600 Yuan per year. There is large fund deficiency for the retired staff in the water management department. The fund for retired staff was not ratified individually during the reform of water management system, the allotment criterion is the same as before, in addition, the number of retired staff was increased after the reform, which increased the burden of water management department greatly.

Most of the water management departments under YRCC are complete non – profit departments, which have low ability of earning money, so it is difficult for them to make up the deficient fund. To a large extent, this condition directly affects the normal running of the water management department and the complete realization of "separation between management and maintenance".

4.3 The competition ability of the maintenance enterprise is not strong

After realizing separation between management and maintenance in water management department, the maintenance enterprise was separated from the institutional department. Most of the staff in the new – established maintenance enterprise are separated from the water management department, as a whole, their quality is low. Most of the transferred asset and registered capital during separation are estate, lacking of current fund and mechanical facilities for construction. It is difficult for the maintenance department to separate from the original department and enter the market for competition completely due to poverty, small scale, excess supers and non – ability to purchase facilities for maintenance, which is blocking the reform going further.

5 Recommendations

5.1 Clarifying the responsibility of water management department, realizing harmonious and unified management

After the reform of "separation between management and maintenance", focusing on the reality of engineering management of the Yellow River, it should implement the mode of "large water management" by integrating the responsibilities of engineering management, water administration supervision, flood control and drought fighting. As the legal entity of hydraulic engineering maintenance project, the water management department should be in charge of the functions of hydraulic engineering maintenance management, water administration supervision, flood control and drought fighting. It should divide work task rationally, define the responsibilities, divide and cooperate in the water management department, so as to realize the harmony and unified management for each work.

5.2 Supply and revise related standards and methods, improve the management and operation mechanism of the Yellow River engineering

Focusing on the real operation status of water management department and maintenance department after reform, the present standards and criteria should be revised, which includes: to supply some maintenance items into the ration criteria, add "the management measure of maintenance qualification" and "the management measure of maintenance bidding and bid", etc. increase the basic cost standard of the on – duty staff, realize the fund for retired staff, enhance the extent of supervision and check, continuously improve the management and operation mechanism of the Yellow River engineering which can adapt the requirement of market economy.

5.3 Improve the cognition to market, enhance the management of contract

The reform of water management system is the necessity of the development of market economy, and the contract management is the necessity of the market economy. Contract management is the dynamic management through the process of project, which directly affect the actual effect of the project management. In order to do this work well, firstly, it is necessary to enrich and perfect "demonstration text of maintenance contract for the Yellow River engineering" continuously, the contents of the demonstration text should be guaranteed as legal and effective, objective and justice, comprehensive and high operable. Secondly, the maintenance contract and related supervision contract and designing contract should be signed on the base of the principles of equity and justice, the responsibilities of the management side and the maintenance side should be defined rationally, each right and obligation for the work content, quality demand, fund payment, breach burden of the maintenance should be clarified. Thirdly, after signing the contract, both sides should work according the contract stipulation consciously, legally and strictly, enhance the consciousness of fulfilling the contract. In addition, the superior administrator should enhance the supervision and the check on contract signing and performing, study the new instances and problems during contract performance, establish necessary mechanism for issue intercession.

5.4 Enhance team training, improve the modernization level of management

In order to adapt the necessity for running new system and new mechanism, enroll undergraduates planningly to enrich water management department and maintenance enterprise. Enhance technical training for the professional maintenance team, study professional knowledge as criteria of engineering management, contract management, regulations of maintenance, etc, so as to improve the work skills. From the point of practical techniques for management, emphasize research, import and findings conversion of new technique, new mechanical tools and new technics, improve the mechanical level of the maintenance. And the last, perform informalization construction for engineering management, continuously increase the content of science and technology in management, and promote the improvement of technique level for integrated management.

The Preliminary Study of Safety Assessment System of Sluices along the Lower Yellow River

Yu Guoqing, ***Xie Zhigang*** and ***Zhang Xiaohua***

Yellow River Institute of Hydraulic Research, Zhengzhou, 450003, China

Abstract: The paper presents the general situation, the questions facing with, the actualities and development trending of sluice safety monitoring and safety assessment. According to the situation in the lower Yellow River, the method of developing sluices safety assessment system of the lower Yellow River, the primary analysis of the system requirement, and the development target are also introduced in details. In addition, the paper preliminarily studies the assessment method based on monitoring data of the lower Yellow River sluices according to the current status of sluice safety assessment.

Key words: the Lower Yellow River, sluice, monitoring, safety assessment, Web

1 Introduction

The Yellow River hydraulic engineering includes dikes, critical levee section, river control works, hydraulic key projects, and sluices. At present, many sluices have been built and used, including 96 water supplying sluices (33 pieces in Henan Province, 63 pieces in Shandong Province), 12 flood sluices, 31 sluices in QinHe river dikes, 17 sluices in DaQing river dikes and Dongpinghu lake dikes, 17 irrigating sluices in Qihe north spreading area and Kenli south spreading area, the Muli sluice, and the Kendong sluices.

Most of the sluices which were built in 1970s and 1980s are aging and disease after years of operation and many of them have not been tested by flood or catastrophic floods. The combining site of earth and stone are able to be differential settlement, and both sides of sluices maybe have incipient fault. The dangerous situations, such as cracking, seepage, and piping, are all able to happen in the flood approaching because of prolonged immersion in floods and pressure.

As a pilot project, there are five sluices that have built remote monitoring or safety monitoring system, such as Yangqiao and LiJia'an sluices. The systems can real – timely monitor the operation situation of the project. "Digital Yellow River" project not only requires the building of sluices safety monitoring system, but also requires providing decision support of flood prevention and project management, by building the assessment model based on monitoring data.

As the parts of "Digital Project Management", the "Project safety monitoring system" and the "Safety Assessment System" are also important components of "Digital Yellow River". Meanwhile, the "safety assessment model" is the key technology of "Digital Project Management", and is becoming the working focus of Yellow River water management.

2 Research status and development trend

2.1 Safety monitoring

Safety monitoring of hydraulic engineering began with the dam prototype observation in our country. The dam prototype observation had developed into the dam safety monitoring since 1970s. At present, the objects of safety monitoring are no more limited to the dams; other projects also apply safety monitoring and safety assessment, such as the sluices, the dikes, the tunnels and the critical levee sections.

It is becoming the development tendency that gathering and processing monitor data, real – time recognizing the situation of projects, assessing the safety situation of dam, forecasting the carrying capacity and the service life, by using "3S" technology, computer network, modern communication and mathematical model.

With the needs of safety monitoring technology development and security management, the remote – control and safety monitoring system are gradually introduced in the sluice projects. The safety monitoring of sluice derived from the dam safety monitoring technology, and were rebuilt according to the sluice features.

As the pilot projects, the safety monitoring system of 5 sluices have been built, including Yangqiao sluice, Liuyuankou sluice, and Heigangkou sluice in Henan Province, and Daiwangmiao sluice, Lijiaan sluice in Shandong Province. The sluice remote video monitoring system and safety monitoring system play an important role in flood control and safety protection.

2.2 Safety assessment

Around the National Natural Science Fund Project – "The Research of the Hydraulic Concrete Buildings Aging Disease Prevention and Assessment", the researches have been undertaken in the sluice aging and disease prevention and assessment. Applying reliability theory, Qiaorunde and Wuchengqing proposed a fuzzy analysis method about sluice durability, according to the sluice of Shilianghe Reservoir in Jiangsu Province. Zhangazhijun proposed a method of sluice aging assessment which is very easy and accurate. Nuqiguang analyzed the influencing factors of sluice aging, including time, environment, design and construction, and management. Based on assessing the reliability of buildings and structures, Jinchuyang and Keminyong classified the sluice disease detection as field safety testing, recomputation, and indoor supplementary analysis, and applied an assessment method which has greater operability. Zhulin and Wangrenchao proposed a fuzzy comprehensive assessment method which was based on the group weight decision – making and variable weight.

All of the studies focused on the reliability of sluice, evaluated its aging disease and security situation, and are mainly based on safety testing data, referenced to part of the monitoring data when necessary. The evaluation model needs more fundamental data, more time, additional charge, and has more technical difficulty. Considering safety, applicability, and durability, the evaluation model more rely on safety testing data, and less used the acquisition data of the safety monitoring system, which made waste in the project investment. With the development of safety monitoring technology and the needs of safety management of the sluices, it is very necessary to research how to increase and prefect the monitoring items, and build safety evaluation model based on monitoring data by using the system.

3 The needs analysis to the sluices safety assessment system of the Lower Yellow River

To real – timely, correctly, and effectively assess the internal and external quality and the security situation by using the monitoring data, the key is the evaluation model. Whether "The Digital Project Management" is successful is related to the evaluation model. According to the construction needs of "The Digital Project Management", the paper proposed the thought of building the safety assessment model and developed the safety assessment system in the Lower Yellow River based on the monitoring data of the sluices.

In order to construct the safety assessment system of the Lower Yellow River, to monitor and assess the situation of the sluices, we should base on monitoring data, and integrate the automatic hydrological forecast system, the water allocation system, and other built system. It should be the final target that ensuring the levee safe of the Yellow River, and providing scientific, real – time, and visual decision – making for flood prevention and water allocation.

3.1 The research of the sluices safety monitoring

The research includes analyzing monitoring items which should be set at the sluices in the Lower Yellow River, selection and configuration of monitor hardware, the framework of the monitoring system, and so on. Its conclusion should be come up in the end.

In the process, in order to discriminate the reliability and exception of the monitoring data, the following items should be studied in details: systematically collecting and analyzing the acquisition data of the typical sluices, building the analysis model, the precision model, and the controlling model of monitoring data.

3.2 The research of the safety assessment model

It is the final target to build the safety assessment model of the sluices, and to assess the safety situation of sluices comprehensively, to construct the indicator system of the sluices assessment based on safety monitoring data.

3.3 Software development

On the base of the advanced computer software and hardware technology, domestic and foreign results and experiences of the sluices safety monitoring, the safety monitoring analysis and assessment system will be developed, which is advanced, reliable, common, and scalable. The system can automatically monitor the sluices of the Lower Yellow River, analyze and feedback manually intervention to real – time monitoring data and artificial observational data, correctly describe the situation of the sluice, and save, test, sort out, analyze the monitoring data, finally ensure the sluices safety and the levee safety, improve the operation efficiently of the sluices.

The system will achieve "3A" target (Anybody/Anytime/Anywhere), use Visual Studio 2005 as development tool, use SQL Server 2005 as the background database which is efficient, easy to use, advanced example, by applying the .NET technology.

4 Methods of assessment

4.1 Indicator system

The safety assessment of sluices is the assessment to complex system, and its indicator system is fuzzy, including multi – factor (quantitative and qualitative), multi – levels, multi – target. The indicators selected should reflect the internal safety situation, and have comparability and popularity. The principles below should be followed:

(1) The assessment indicators should be able to reflect the safety situation and development trend of sluices in whole or in parts.

(2) The bottom indicators can be directly got from safety monitoring system or other built system.

(3) The numbers of indicator can't be too much, and should be able to quantified and facility to be integrated composite index.

(4) It is easy to operate, technically feasible, and economically reasonably.

The indicator system preliminarily can be divided into four levels below: The first level is the final target and it is the general need for the safety of the sluices; indicators of the second level are specific requirements for individual factors (e.g. stability, over water, energy dissipation, and concrete structure) of the sluices safety; indicators of the third levels are the refinement of the individual factors (e.g. the stability includes seepage stability and resistance to overturning); the forth level are the fundamental factors, convenient to quantify and describe, and it is can't be divided. The data are come from the safety monitoring system, and reference to the water scheduling system, the hydrological forecast system, and the safety testing.

4.2 Assessment criteria

According to the existing data, the specification of the sluices in the Lower Yellow River, the results and certifications of design, construction and acceptance, and the opinions of experts, the assessment criteria and weight of all indicators can be determined.

Indicators in the four levels can be divided into four grades – A, B, C, D. Grade A is the best, and grade D is the worst. Every grade indicator is described qualitatively or noted quantitatively by ranges. The four grades at the top of the general target goal are corresponding to the first grade sluices, the second grade sluices, the third grade sluices, and the forth grade sluices, whose grade is determined in "The Specification of the Sluices Safety Verification". According to the actual flow situation in the Lower Yellow River, Quantitative determination of the appropriate range of values and reviews collected.

4.3 The assessment model

After selected the weight and reviews set of every indicator, the multi – level, fuzzy, and comprehensive assessment model will be built to assess the general target and the individual indicators.

4.3.1 The assessment of the individual indicators

The No. 1 individual indicators in the second level can be assessed by the formula (1), after determined the fundamental indicators and the detailed indicators according to the reviews set of the measured data.

$$V_i = \sum_{j=1}^{m} Q_{ij} W_{ij} Y_a(x)/A + \sum_{j=1}^{m} Q_{ij} W_{ij} Y_b(x)/B + \sum_{j=1}^{m} Q_{ij} W_{ij} Y_c(x)/C + \sum_{j=1}^{m} Q_{ij} W_{ij} Y_d(x)/D \quad (1)$$

In formula (1), m is the numbers of the indicators; $Y(x)$ is the characteristic function; Q is the weight of the refinement indicators to the individual indicators; W is the weight of the fundamental indicator to the refinement indicators, and $\sum_{j=1}^{m} Q_{ij} W_{ij} Y_z(x)\ (z = a, b, c, d)$ are the degrees of membership. The grade of the greatest degree of membership is the safety situation of the sluice.

4.3.2 Comprehensive assessment

The comprehensive safety can be determined by the formula (2), according to the assessment criteria of the individual indicators and its weight.

$$E = \sum_{i=1}^{n} P_i V_i = \sum_{i=1}^{n} P_i \sum_{j=1}^{m} Q_{ij} W_{ij} Y_a(x)/A + \sum_{i=1}^{n} P_i \sum_{j=1}^{m} Q_{ij} W_{ij} Y_b(x)/B$$
$$+ \sum_{i=1}^{n} P_i \sum_{j=1}^{m} Q_{ij} W_{ij} Y_c(x)/C + \sum_{i=1}^{n} P_i \sum_{j=1}^{m} Q_{ij} W_{ij} Y_d(x)/D \quad (2)$$

In formula (2), n is the numbers of the individual indicators in the indicator system; P is the weight of the individual indicators to the general target; $\sum_{i=1}^{n} P_i \sum_{j=1}^{m} Q_{ij} W_{ij} Y_z(x)\ (z = a, b, c, d)$ are the degrees of membership of the general target. The grade which is the greatest algebraic value of the assessment results E just is the safety situation of the sluice.

5 Conclusions

The safety assessment system of the sluices in the Lower Yellow River based on the monitoring data, should fully use the existing monitoring systems and data, and develop for "3A" application, to achieve cyberization and automatization of the safety monitoring and assessment, and to ensure the safety of the levee of the Yellow River. When the safety assessment model and the system based on the monitoring data had been built, the costs of software developing can be reduced, and more importance is to achieve the lower reaches of the Yellow River water quality security monitoring and analysis, forecasting and evaluation of automation, networking, and make running water management to a new level.

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Simple Discussion on the Whole Process Quality Control of Flood Control Engineering Works Construction of the Yellow River

Liu Shuli [1] and ***Wang Weijun*** [2]

1. Jiaozuo Yellow River Bureau, Jiaozuo, 454001, China
2. Construction and Administration Department of Yellow River Conservancy Commission, Zhengzhou, 450003, China

Abstract: Since it is difficult to control the quality of flood control engineering works of the Yellow River due to the restriction of natural and social conditions, the whole process quality control during construction has become extremely important. Usually, the Employer entrusts the Engineer to conduct the whole process quality control, monitoring and supervision of construction, which include the control of technical preparation status, control of operational process of technical activities, control of technical activity results and the means of quality control of construction process.
Key words: flood control engineering works of the Yellow River, construction, whole process, quality control

Usually the flood control engineering works of the Yellow River have the characteristics of great investment and high quality requirements. Restricted by natural and social conditions, the key factors that may affect the quality during construction involve material, machine, method, management and so on, which makes the quality control very difficult. Therefore, the quality control in the whole course of construction has become even more important. The Employer, for the purpose of ensuring the quality of construction, usually entrusts the Engineer to conduct the quality control, monitoring and supervision in the whole process of construction, which shall include the control of technical preparation status, control of operational process of technical activities, control of technical activity results and the means of quality control of construction process.

1 Control of technical preparation status

The control of technical preparation status means that whether each preparatory work has been implemented according to the scheduled plan before officially starting the activity. It should pay special attention to the following works.

1.1 Setting up quality control points

1.1.1 Concepts of quality control point

The quality control point means to decide an important control target, key position or vulnerable spot in order to guarantee the quality of operational process.

The Contractor should prepare a detailed statement of quality control points according to the requirements and submit it to the Engineer for approval before construction, and based on which, the quality control should be conducted.

1.1.2 General principles for quality control point selection

The quality control points should be selected from the targets that may be difficult to guarantee the quality, may produce great influence to the quality or great jeopardy when a quality problem occurs.

(1) Key classified projects, such as earth filling of an embankment project and reinforced concrete placement of a sluice project.

(2) Key positions, such as the joining position between the new and the old of embankments

strengthening works and foundation of sluice gates.

(3) Vulnerable spot of construction, or working procedure and position of unstable quality, or the position or link where new techniques and new material have been used.

(4) Key working procedures, such as earth roller compaction of an embankment project, concrete vibration of a reinforced concrete project and borehole of grouting piles.

(5) Characteristics of key quality of key working procedure, such as the indexes of amount of earth compaction of an embankment project and strength and anti – seepage of concrete.

(6) Key factors of key quality characteristics, such as moisture content of filled earth of an embankment project and curing temperature of concrete in winter.

1.1.3 Key controlling targets of quality control points

(1) Worker's action: It has higher requirements on the technical level of workers for the operation with greater difficulties or higher requirements on precision.

(2) Quality and function of material: Construction equipment and material are the main factors to directly affect the quality and safety of a project. It is extremely important for some hydraulic works, such as impervious grouting of foundation works, degree of fineness of grouting material, performance of key equipment and quality of measuring instruments that are the main factors of affecting the quality and effect of grouting.

(3) Technical parameters: The control of such parameters as grain – size analysis of soil, compactness and moisture content is the key in controlling the quality of earth filling during construction.

(4) Key working procedure: Especially for the working procedure, section or target that may have great influence to the follow – up construction or follow – up procedure quality or security.

1.1.4 Preparing countermeasures for pre – controlling of quality

The quality pre – control is to analyze the quality problems and hidden troubles that probably happen during construction in advance in the built quality control points or subprojects, analyze the reasons that might be arisen from, put forward corresponding countermeasures, adopt effective measures for pre – control to prevent from occurrence of quality problems in construction. The quality control and countermeasures are mainly expressed by words, forms and analytic graphs.

1.2 Control of telling technical intentions

Telling technical intentions is one of the premises for achieving good quality of construction. In order to conduct telling technical intentions, the technical intention report must be drafted by the person in charge of technical aspect and approved by the chief engineer of the project. The report should include construction methods, quality requirements, acceptance standard, matters needing attention during construction, measures for unexpected things that probably happens and an emergency program.

It should arrange the activities closely around operators, machine, equipment, material, techniques, method, construction environment and concrete management measures that are related with the construction. It should also make such things clear as what to do, who will do, how to do, when will be completed, and standards and requirements for operation.

Before the construction of key sections or any component and subproject that may be difficult in technology and be complicated in construction, the Contractor's report of technical intentions should be submitted to the Engineer. After examining by the Engineer, the Contractor should make revision and supplement if the requirements of operation have not been met. It is not allowed to officially implement if the work of telling technical real intentions has not been done.

1.3 Quality control of on – site materials

(1) Before transporting to the site, all the raw and processed materials that would be

transported to the site should be provided with "Receipt Issued after Examination and Acceptance of Building Materials", a certificate of inspection of delivery and a technical manual, and the inspection or test report that is conducted by the Contractor according to requirements, all of which should be submitted to the Engineer who should check and affirm the quality, then the materials can be transported into the site.

(2) Control of storage condition of raw and processed materials. It should strictly control the materials that are greatly influenced by the natural environment and climate, such as cement, additives, waterproof materials and geotextiles.

(3) It requires the contractor to conduct tests in advance for some local materials and in – situ made products that can be used only after reaching to the standard.

1.4 Control of environment

1.4.1 Control of construction environment

The so – called construction environment condition mainly indicates water supply, power supply, lighting for construction, safety and protective equipment, space and access conditions for construction, transportation and roads. The Engineer should check the preparation by contractors and make sure all the related preparation are reliable and effective, then the construction can be started.

1.4.2 Control of construction quality management environment

It mainly indicates whether the quality management system and self – examine system of quality control of contractors are in good condition; whether the institutional structure, management rules, testing regulation and standard and staffing are completed and clearly identified; whether the system of quality responsibility is ready and. The inspection on quality management environment of contractors and supervision conducted by the Engineer are important preconditions for guaranteeing the operation effects.

1.4.3 Control of field natural environmental conditions

The Engineer should inspect that whether the contractor has fully understood, prepared and adopted effective measures and countermeasures in advance for ensuring the construction quality that may be adversely affected by natural environmental conditions in future. Such as, flood control and drainage of the site, and protecting of pilling against windy waves.

1.5 Control of on – site machine and equipment performance and working conditions

The technical performance and working conditions of on – site machine and equipment are very important to the quality of construction. Thus, the Engineer should well conduct on – site control. It includes the inspections of mobilized machine and equipment, the working conditions of machine and equipment, safety operation of special equipment and large – scale temporary equipment.

1.6 Control of on – duty qualification of a on – site organization and workers

1.6.1 Control of an on – site labor organization

Labor organization involves operators, supervisors and corresponding management systems.

(1) The number of operators should meet the requirements. The number of operators should meet the requirements of activities and the corresponding types of work should be arranged so as to guarantee operation in order.

(2) Supervisors are in place. The direct person in charge (including person in charge of technology), full – time quality inspector, safety watch person, surveyor, materials person and test person all should be on duty.

(3) The related systems should be amplified, such as post responsibility for various persons,

regulations for the safety, fire fighting and environmental protection of the activity site, related regulations for inspections of laboratory and in – situ tests and regulations for an emergency situation.

1.6.2 Qualification of on – duty workers

The workers who are doing special work, such as electric welding, electric engineering, crane operating, scaffolder and dynamiter, should go on – duty with certificates.

1.7 Performance and precision control of surveying and measuring instruments used in construction

1.7.1 Establishing a site laboratory

Before starting construction, the contractor should establish a site laboratory that should have the qualification authenticated by competent measuring authorities. If it is a branch organization of the center laboratory of the contractor, it should show an official power of attorney.

1.7.2 Checking the site laboratory

Before starting construction, the Engineer should check the documents of qualified certificate, testing equipment, quantity of examining instruments, whether the precision can meet the construction requirements, whether there are the data demarcated by measuring department, whether the management system of the laboratory is completed and tallies with actual situation and, whether the testing staff has on – duty certificates.

1.7.3 Checking surveying instruments

Before starting survey in construction, the specifications, model, technical index and precision grade of measuring instruments of the construction unit should be examined.

2 Operational process control of technical activities

The construction quality is formed in the process of construction rather than the final inspection. The process of construction is made up by a series of interrelated and restricted operational activities. Thus, guaranteeing the effects and quality of activities is the foundation for quality control of construction process.

2.1 Monitoring and supervision of contractor's self – checking and special checking

2.1.1 Self – checking system of contractors

The Contractor is the direct person for implementation and responsibility of construction quality, and the purpose of quality supervision and control of the Engineer is to make the contractor to establish a perfect quality self – checking system and operate it effectively.

The self – checking system of the contractor includes:

(1) Self – checking after operation;

(2) Inspection of handing over and taking over of different working procedures must be done by related staffs and;

(3) Special inspection by the contractor's inspectors.

2.1.2 The Engineer's inspection

The Engineer's inspection of quality is to check and affirm the quality of contractor's activities. The Engineer's inspection can not replace the self – checking of the contractor and must be conducted based on the contractor's self – checking that has been qualification confirmed.

2.2 Technical rechecking control

Technical rechecking is the technical responsibility that should be implemented by the contractor. The rechecking results should be submitted to the Engineer for review and confirming. After doing that, the follow – up related construction can start. The Engineer should put re – checking into a monitoring plan and a quality control plan, taking as day – to – day work and running through the whole process of construction.

The common re – checking of survey is positioning survey of hydraulic structures, survey of foundation construction, survey of building site control, plane and elevation control above foundation and observation of settlement and deformation of structures during construction.

2.3 Implementation control of witness points

2.3.1 Concepts of witness point

Witness point supervision is also called W point supervision. All the quality control targets listed as witness points should be conducted by the Engineer who is informed by the contractor in advance within the appointed time and supervises the construction before starting the stipulated key working procedures. If the Engineer could not arrive at the site within the appointed time for witness and supervision, the contractor should be entitled to start the corresponding operation and construction of W points.

2.3.2 Implementation procedure of witness point monitoring

(1) The contractor should inform the Engineer by a written notice the planned date and time of construction of the witness point at a certain time before construction and invite the Engineer to come to the site for witness and supervision within the appointed time.

(2) The Engineer, after receiving the notice, should notify the date and sign his name.

(3) The Engineer should arrive at the site for witness within the appointed time.

(4) If the Engineer could not be at site within the appointed time, the contractor can deem that the Engineer has tacitly approved and has the right to start the construction.

(5) If the Engineer had been to the site before construction and written down his comments on "Construction Annal", the contractor should write down his improved measures that he has adopted according to the comments or write clearly his specific ideas by the side of the comments.

3 Control of technical activity results

3.1 Contents of control of technical activity results

The control of technical activity results is a way of quality control of intermediate product during construction and final product, the quality of final project product can be guaranteed only the quality of all the intermediate products can meet the requirements. The main contents include:

3.1.1 Inspection of foundation pit

The inspection of excavation quality of foundation pit involves check and confirmation of carrying capacity of foundation, check and confirmation of geological conditions and check and confirmation of the stability of excavated slopes and supporter's condition. The related survey and design departments should participate in the inspection on a foundation pit due to its importance, together with the quality monitoring agency concerned. It should confirm whether the carrying capacity of foundation has reached the design requirements and whether the geological conditions tally with the design through in – situ inspection.

3.1.2 Inspection of the works to be covered up

The inspection of the works indicates that it is inspected before the subprojects covered up by the follow up projects. This is the final inspection for the completed subprojects. Because it will be covered by other works and makes inconvenience for inspection and improving in the future, thus, it has become especially important. This is a key process of quality control.

3.1.3 Inspection of unit (sub – item and sub – section) works

The unit works should be inspected based on ensured items, basic items and error accepted items. After the completion of unit (sub – item and sub – section) works, the contractor should firstly conduct self – inspection based on design documents and related regulations. Then, submit an application to the Engineer for inspection and confirmation. If it is confirmed that has met the requirements, it will be accepted. If there is a quality problem, the Engineer will ask the contractor to handle and inspect again after meeting the requirements. The subprojects that involve structure security and operation functions will be inspected by sampling.

3.1.4 Completion inspection

After project completing, the contractor should firstly conduct self – inspection of completion, then submit an application report of inspection to the supervising agency as the self – inspection is qualified. The Chief Engineer will organize the professional engineers to conduct preliminary inspection. The inspection contents are as follows:

(1) Check the documents and data needed for inspection submitted by the contractor, including various quality control data, test reports and various related technical documents.

(2) Check the completion drawing submitted the contractor and examine with the completed works and related technical documents.

(3) The Chief Engineer organizes the professional Engineer to examine the site that is planning to be completed and should order the contractor to handle if it finds a quality problem.

(4) The Chief Engineer will sign on the application report after the preliminary inspection qualified, and submit it to the Employer.

(5) Participate in the official completion inspection organized by the Employer.

3.2 Checking procedure and method of technical activity results

3.2.1 Checking procedure

After completing the activities, the workers should firstly conduct self – checking, re – checking and final checking according to regulations. The Engineer will check after the above checking qualified.

3.2.2 Main methods for quality examination

Usually the examination of raw materials, semi – finished products, working procedures or quality of project products can be divided into three types, i. e. method of eye observation, method of measurement and method of test.

(1) Method of eye observation, i. e. checking by sense organ that also can be called impressions observation.

(2) Method of measurement: i. e. to judge whether the quality tallies with the requirements by using measuring tools or instruments and comparing the actual measured results with the stipulated standards or specifications.

(3) Method of test: i. e. use physical and chemical testing means of in – situ test and laboratory test to analyze and judge the quality. It includes physical and chemical tests and harmless test.

3.2.3 Types of quality inspection

(1) Overall inspection. It is mainly used for the section of key working procedure or covered – up works and the objects that are clearly requested for overall inspection by technical rules, quality inspection standard or design documents.

(2) Sampling inspection. It is mainly used for large quantity building materials, semi – finished products and project products.

4 Means of quality control during construction

4.1 Verifying technical documents, reports and statements

This is an important means for overall quality monitoring, supervision and control. The contents are detailed as follows:

(1) Examine and approve the application of construction commissioning submitted by the contractor. Examine, verify and control the quality of construction preparation.

(2) Examine and approve the construction plan, quality plan and construction design that are submitted by the contractor for reliable technical guarantee.

(3) Examine and approve the related data, quality certificates (delivery certificate of inspection and reports of quality examination or test) of semi – finished products and fittings for ensuring reliable material provision.

(4) Examine the qualification certificate of sub – contractors and control the quality of sub – contractors.

(5) Check the dynamic statistic data or management charts that reflects the construction quality submitted by the contractor.

(6) Check the certificates (inspection record and testing reports), reports and data of handing over examination of working procedure (self – check), examination of subterranean works, examination of sub – item works submitted by the contractor for ensuring and controlling the quality of construction process.

(7) Check and sign on – the – spot documents related to the quality and technology.

4.2 On – site monitoring and inspection

4.2.1 Contents of on – site monitoring and inspection

(1) Inspection before construction. It mainly inspects the preparation quality before starting the project to make sure whether it can guarantee the normal construction and construction quality.

(2) Tracking monitoring, inspection and control during construction. It mainly monitors and checks whether the workers, machines, equipment, material, method, technology, operation and environment condition of construction are all in good condition, whether accords with the requirements of project quality during construction. Any problems that may appear should be timely corrected and controled.

(3) In order to guarantee the quality of material use and technological process, it should monitor and control by – standing for important working procedures and sections.

4.2.2 Methods of on – site monitoring and inspection

(1) By – standing and perambulation. By – standing refers to an on – the – spot monitoring activity of the Engineer during the construction of key sections or key working procedures. The location of by – standing or working procedure is decided according to the characteristics of the project and the internal quality control level and technical operational level of the contractor. Usually, by – standing is conducted for concrete injection, pre – stress tensioning, soft foundation treatment of pressure grouting and foundation works, compound foundation construction (such as agitating pile and suspension jetted pile), asphalt road pavement, process of well – sinking, piling of foundation, water – proof construction, backfill of overcutting part during tunnel lining and slope anchoring. Perambulation indicates regular or irregular monitoring activities of the Engineer at the in – situ location or working procedure. Perambulation is an "area" activity, not limited to a certain location or process, while by – standing is a "point" activity which is aimed at a certain location or a working procedure.

(2) Tracing check and parallel check. Tracing check is to monitor the whole process of implementation during the sample testing conducted by the contractor, to confirm the validity of the

procedure and method, and the reliability of inspection results, and confirm the results by the Engineer.

Parallel check is an inspection means used by the Engineer to check or inspect independently according to a certain proportion based on the self – check of the contractor. It verifies and inspects the examination results of the contractor through a parallel check.

4.3 Instruction document

Instruction document is a concrete type of instruction control right operated by the Engineer. So – called instruction document is a written document of instruction or order put forward by the Engineer to the contractor, belonging to a document of forced execution. Each order of the Engineer should be in written form or recorded by a document and kept in the archives as technical documents.

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Discussion on Implementation of Agent Construction Model in Water Project Construction

Cui Qingrui, *Zhao Min* and *Zhai Laishun*

Yellow River Liaocheng Bureau, Liaocheng, 252000, Shandong, China

Abstract: Public welfare water projects funded by the government differ from non – welfare water project in responsibility and organizational structure of the project legal entity. The project legal entity, at the present stage, has three types. It can be an administrative unit, an institution or an enterprise with various organizational structures. The institution type, as a construction managing organization, is the main stream in the establishment of water project legal entity; the specialized project legal entity is a supplement. The construction agent, such as project management company and consultant company, is a trend of that public and quasi – public welfare water project corporation are established.

Key words: water projects, public welfare project, agent construction model

1 Responsibility of the project legal entity

Most of the water projects are public welfare that funded by the government. The responsibility of such construction entities is different from the non – public welfare projects. For the non – public welfare projects, the legal entity is responsible for project plan, fund raising, construction implementation, production management, debt repayment, assets maintenance and increment. In contrast, for the public and quasi – public welfare water project entities, there is no need to take the responsibility of production management, debt repayment, assets maintenance and increment, construction and operation are undertaken by different responsible entities. The public welfare projects only produce social effect. Thus, the debt can be repaid by indirect economic benefit that produced by social benefit. Therefore, the responsibility for public and quasi – public welfare water project entities is project planning, construction implement and investment risk.

2 Types of project legal entity and their problems at the present stage

2.1 Types of project legal entity

Water project legal entity is strictly organized according to the relevant state regulations. At present, the government investment project entities are of three types. They can be an administrative unit, an institution, or an enterprise. The establishing forms are various, and the main form are temporary project managing department, construction administration bureau, self constructing and running of construction department. The whole process of establishment of the project entity and project implementation is under supervision and inspection by the project responsible authority.

2.2 Problems

At the present stage, the implementation of the project entity responsibility system has obtained huge achievement, but there still exist some inevitable problems, which gives rise to some difficulties in water project construction and management. The main problems are as follows: the organization of the project entity is not standard, conflicting with The Company Law of the People's Republic of China; the responsibility, right and profit are not unified; the main – body of responsibility is not clear; there is no distinction of right between government and institution or enterprise, and exist government interfering in enterprise affairs; project legal entities are not qualified for a civil – legal relationship main body; controlling and stimulating mechanism has not been established; project legal entity's lawful benefits have no explicit source; project legal entities are not supervised efficiently, with no effective measures to arouse the entities' initiative; some project legal entities' initiative and self – consciousness are not high. In view of these problems, effective ways to realize project entity's responsibility is being explored. Agent construction system is being approved as one of establishing forms of the project entity.

3 Discussion about implementation of agent construction system

3.1 Conception Agent construction model

The A Decision on Investment Mechanism Reform issued by the Chinese State Council, requests that the implementation of agent construction system should be sped up in the construction of non – profit project invested by government. Namely, through public bidding and direct entrusting, a professional project management company is chosen to be responsible for the project construction, and to control the investment, quality and construction period, and then the project is turned over to the user after it is checked and accepted. The decision also requires enhancing investment risk awareness and consummating the mechanism of risk management of government investment in public and quasi – public welfare water projects. According to Methods for Managing the Implementation of Agent Construction System in the Construction of Projects Funded by the Beijing Municipal Government (trial implementation), agent construction system must be implemented in the construction of the public and quasi – public welfare water project in which government investment occupies 60% of the total investment. Water project construction is characterized by big investment, high public welfare, engineering complexity and long cycle. Therefore, it is an inevitable trend to implement agent construction system in the construction of public and quasi – public welfare water projects.

3.2 Advantages of implementing agent construction model

Implementation of the agent construction system in non – managerial water projects funded by government is to turn the task of project construction over to professional and permanent – setting agent construction unit instead of to the project user. That is, the projects are properly centralized and managed in a unifying way. This will enhance professional management level, function positively in controlling the project progress, quality and investment, and increase investment returns.

Thus, the agent construction system is an effective way to control construction scale, time and investment.

Specialized department take responsibility that the project entity is difficult to fulfill, e. g. rational allocation, specialized management, specified responsibility, right and profit, and transparent operation. It guarantees the project quality, enhances the investment benefits and operating efficiency, constrains corruption from the source, and reduces administrative cost. As a result, it can solve the problems such as the unclear line between the government and enterprises, unclear responsibility, slackness in supervision. It enables the government department to focus on examination and approval of project investment, supervision of construction markets and the project entity to be responsible of project construction. What's more, it clarifies the responsibility between the government and users, separates their benefits, and avoids ultra scale and ultra standard construction. Through effective supervision, violations of regularities will be corrected by the government. Implementing the agent construction system means that a huge temporary management organization is replaced by the special project management company with a large number of specialists who are rich in project construction management knowledge and experience, and familiar with the entire construction flow. Through drawing up the overall project implementation program, designing predetermined risks plan, coordinating construction unit's relationship and arranging jobs reasonably, they could promote the project management level and working efficiency, and control the quality, fund and progress more effectively. By means of the agent construction system, the project is constructed and managed in an all round way according to the contract signed between the government and the project management enterprise. The project management enterprise undertakes the engineering construction economical responsibility and the quality responsibility, enhancing the project construction efficiency and investment benefits, increasing engineering construction management's binding force and government supervising and managing, the fairness of rule formulating of and execution transparency. The implement of agent construction system stimulates the construction market's development. A large number of high project management level agent construction system enterprises and projects arises, some of which are even in professional ability.

3.3 The operating pattern of the agent construction system

The agent construction system is operated when the project has certain intention; the government department chooses the agent enterprise to carry on the project. The agent construction system project entity is established earlier than the project. The agent construction enterprise carries on the organization and management of the project. Therefore, the agent construction system is in fact an institution as well as an enterprise project entity. It has three operating patterns.

3.3.1 Professional government agent enterprise

The Company Law of the People's Republic of China stipulates that the national authorized investment organization or department may become main body of the state investment. The investment main body can act as the authority instead of the state property investor and legally use stockholder's rights to manage the national assets. It doesn't practice economic management function of the government. Obviously, the essence of the state asset investment main body is the state asset property right operated organization. It deals with the state asset property right in the government authorized scope. It's a business entity with strong economic potentiality. The document of establishment of modern enterprise system also point out, property right operation group company. According to the actual situation of the water sectors, in order to separate government from enterprise and make good use of the national fund to the water infrastructure, all levels of water conservation state asset entity, representing the government to be responsible for maintenance and increment of the state asset. According to The Company Law, by share – holding create project entity with local or other enterprises, in order to be responsible for the fund raising and management of the water project. On the basis of management to the state asset commercialization, realize marketing of water conservation state asset and the separation between the functions of the state asset administration and operation, and the separation between the state asset property rights and the entity property rights. The project management company assigned by the government carries on proxy construction to implement and manages according to enterprise operation.

3.3.2 Professional government managing organization

The government establishes the agent construction system management structure, manages according to the institution and carries on proxy construction to all government. Its merit is that it's facilitating to coordinate various kinds of questions in construction easy for the government to manage. The short coming lies in that it must suppose new organization. The government management structure is unable to undertake the ultra budgetary estimate responsibili3ty.

3.3.3 Competitive mechanism among the agent enterprises

The government set up the admittance condition. The enterprises which conform to the condition participate in the cooperation of the project generation construction and are chosen by the government in a tender way according to their qualification. It can reduce the investment. The short coming is the government which responsible for the work must have strong economic, law, and technical ability in order to carry on negotiation with the specialized company and avoid the supplement fund of the company.

3.4 Problems existing in the agent construction system

The key to carry out agent construction system lies in choosing project management company. To develop the project management company having both the intelligence and the ability to construct is the point to promote the agent construction system to formulate the connected legal laws and regulations is the foundation for the implementation of the agent construction system and to consummate the agency agreement is the safe guard of the agent construction system management. Due to the separation between construction and management, the agent construction system is unable to fully consider the management demand after the completion of the project, does not have the environment coordination function and is unable to finish the fund collection, solve coordinately the problems including draft, the immigration placement and the social security and so on. The company under the agent construction system does not have construction managed capacity to meet the engineering construction need and related policies, values and regulations are not perfect and thus the pilot need to according to its own situation gradually sum up the experiences to formulate the concerned supporting policies in order to promote the pursuit of the agent construction system. According to recent year's agent construction system implementation situation in various fields, there are still many problems.

3.4.1 The contradiction between the benefits of the agent enterprise and the quality of the construction

Most of the agent construction enterprises are profit – oriented. In some places, besides the management fee for the construction, the agent construction enterprises also collect profits of various percentages. Probably, to earn the profit or pursue the maximized profits these enterprises reduce the investment one – side and lower the standard of the construction which affected the quality and efficiency of the government investment.

3.4.2 The contradiction between the agent enterprise survivability and life – long system of the quality

Because of some kind of instability of the agent construction company naturally, especially when the related laws and regulations are imperfect, once abolished or changes to other fields, they are unable to carry out the responsible duties for the life – long system of the quality.

3.4.3 The poor capacity of the agent construction enterprise

At present, there are few agent construction enterprises in most places. In addition, their developments are unbalanced and capacities are low on the whole level . A vast majority of agent construction enterprises have only the week and quite limited strength and they do not have enough ability to be engaged in the construction project management. At the mean time, under the market economy, the agent construction enterprises focusing on their own profits will be sure to scramble the business deals blindly which will cause the competition more and more serious ,leaving passive impact on the tender bid and the daily project management.

3.4.4 Lack of employees in the agent construction enterprise

Looking from the domestic situation that at the present the size of the agent construction organization are generally too small in the areas the projects with the government's investment are managed intensively. These small scaled organizations most of which in general seriously lack of the staff confront the challenges for fulfillment of the efficient and high efficient construction and management.

3.4.5 Low standard in implementing the agent construction system

When the enterprises take the government invested projects, the transparency is not enough and it is hard to avoid some factors concerning personal relations such as the operation under the desk, which cause the corruption easily and are not favorable to the fight against corruption and the promotion of the honesty. One organization is in charge of all the items. The power is so intensified that this kind of pattern is actually one kind of turn – key primary contractor form, having neither the unit being acted for nor the agent construction system unit.

3.4.6 Unclear responsibility, rights and benefits

The responsibility, rights and benefits between the project administration and agency are unclear; as a result, confusion of different degree appears in the process of operation.

4 Suggestions

4.1 Active implementation of the agent construction system

The agent construction system of the water project includes the following type: enterprising construction management structure, the entity of the special project, the company of the project management and the consultant firm. At present, the first type is the mainstream of the setting of the water project entity. The second type is the supplement of the water project entity. The last two types are the direction of the setting of the project entity deals with the public fare and accurate public welfare. During the construction of the setting of the public welfare and accurate public welfare, we should create proper conditions positively formulates corresponding norm, develop the construction of the agent construction system gradually so as to lay the foundation for the agent construction system.

4.2 Regulating agent construction enterprise activities

According to the public and the accurate public welfare, a series of measures should be taken to standardize the operations of the agent construction enterprise, and let it fully develop without sacrificing the quality of the project and we should also implement the life – long system of quality responsibility. Furthermore, it is important to encourage part of the outstanding enterprise to develop first. Then ,expanding the strength of the agent construction system and promote the agent construction system in a high level so as to make it as a guide when the market promise. at last it will make stronger enterprise to be the agent construction system form. It is vital to increase the transparency and know the responsibility, right and benefits cleanly. Then we can restraint the operation of the agent construction enterprise and avoid monopoly.

Practice and Discussion on Inspection of Completion Documents of Yellow River Flood Control Works

Liu Shuli[1] and ***Wang Weijun***[2]

1. Jiaozuo Yellow River affairs Bureau, Jiaozuo, Henan, 454001
2. Department of Construction and Management, YRCC, Zhengzhou, 450003

Abstract: According to the construction management practice, and in the light of problems found in the past inspection of completion documents of Yellow River flood control works, the author presents a set of effective methods, i. e. firstly, get to know clearly the aim, content and requirement of the inspection, then do the work step by step. The inspection comprises general inspection, main point inspection and specialized inspection. The content to be inspected mainly includes whether the items are present, the content is complete, true and consistent, the format is normative, and the formalities are complete.
Key words: flood control works, completion document, inspection, practice

The completion documents of flood control works refer to those materials that are formed through the whole process from preparation, decision making to completion and that should be placed on file, including written materials, drawings, charts, calculation materials, audio and video materials, etc. formed in the activities such as project proposal and confirmation, feasibility study, reconnaissance and design, planning, bidding, construction, checking and acceptance, and preparation for operation management.

For years, since all the participators in the flood control works construction differed in the level of compiling the completion document, the quality of completion documents was uneven. Some documents are not satisfactory such as the items are not complete, or the content is not normative, some even have falsehood. Since there is no definite regulation on inspection, even experts were invited to make special inspection to the document, it is still impossible to insure that there in no problem in the completion documents. Therefore, inspection of completion documents of flood control works has been a headache for construction management personnel. According to years' practice of construction and management of flood control works, and focusing on the problems found in the past inspection of completion documents, the author presents a few points of understanding.

1 Get to know the aim, content and requirement of inspection clearly

Inspection of completion documents is a very important step in the check and acceptance, is the most important work in technical check and acceptance, and is also an effective post – supervision.

1.1 Get to know the aim of inspection clearly

Through inspection of completion documents of flood control works, it is possible to find and reveal problems, and what is more important, to help construction – participating departments to solve the problems, to guarantee the quality of completion documents and guarantee quality of flood control works.

1.2 Get to know the content of inspection cleary

Inspection of completion documents comprises inspection of completeness, content normalization, authenticity, consistency and formality completeness, inspection of the main content of the completion documents in accordance with the fundamental requirements of directive rules, criteria and technical standards, and inspection of rationality of technical specifications the builder accepted while implementing the directive rules, criteria and technical standards.

1.3 Qualification requirement of inspecting personnel

Inspection of completion documents is comprehensive work that is highly professional covering multiple fields and multiple specialities, therefore, it requires that the inspecting personnel be familiar with the State policies in construction management, master knowledge in specialities such as planning and design, bid, bidding and contract management, construction supervision, quality check, project check and acceptance, and have corresponding speciality ability. Inspecting personnel should be professional personnel with senior professional titles or with intermediate titles but with certain special knowledge.

2 Make full preparation for pre – inspection

2.1 Professional training

Before inspection of a project, collect relevant laws and regulations, directive rules and technical standards, and make a stress study of content relating to the project to be inspected, mainly including:

(1) Laws and regulations: "Construction Law", "The Bidding and Bid Law", "Contract Law", "Regulations on the Quality Management of Construction Projects", and "The Compulsory Provisions of Engineering Construction Standards (Water Engineering Section)";

(2) Directive rules, criteria and technical standards released by the Ministry of Water Resources: "Dyke Project Design Standard", "Dyke Project Construction Standard", "Specification of Construction Acceptance on Water Resources and Hydroelectric Development", "Standard of Quality Evaluation and Acceptance of Dyke Construction (trial)", "Specifications for Construction Supervision of Water Resources Projects" and "Regulation on Archive Management for Water Resources Construction Projects";

(3) Relevant regulations of higher authorities: "Regulation on Acceptance of Yellow River Flood Control Works", "Rules on Acceptance of Henan Yellow River Flood Control Works (trial)", and "Regulation on Archive Management for Henan Yellow River Flood Control Construction Projects (trial)".

2.2 Browse before inspection

(1) Mainly look through the design report of shop drawings to find out the design intention and get to know construction standard and scale of the project.

(2) Look through the work report of construction, supervision and building to have a grasp of the whole construction process.

3 Carry out inspection step by step

Inspection of completion documents of flood control works usually comprises three steps: general inspection, key point inspection and speciality inspection. The general inspection is procedural inspection, while key point inspection and speciality inspection are both technical inspection.

3.1 General inspection

General inspection is the most fundamental demand on the quality of completion documents of flood control works. To pass the general inspection, the completion documents of all sides participating in the construction should be of item completeness, content integrity, format normalization, authenticity, consistency and formality completeness.

3.1.1 Item completeness

Inspection of item completeness of completion documents refers to checking to see whether the documents are whole and complete according to relevant regulations on archive management for flood control construction projects.

While inspecting, first list the documents that should be placed on file and make a standard table, then seriatim check the existing documents following the listed items, and fill in the inspection table.

3.1.2 Content integrity

This includes inspection of content of the nine kinds of reports: construction management report (including great events record of the construction), design report, building management report, construction supervision report, quality evaluation report, operation management report, primary check and acceptance report, final accounts report and audit report.

Inspection of content integrity of completion documents uses the format of standard tables. While inspecting, seriatim compare with the items in the tables and fill in the inspection tables.

3.1.3 Format normalization

This mainly includes:

(1) Whether the format of the documents sent and received between construction and supervision departments is in accord with the format requirements of common tables in construction and supervision listed in "Specifications for Construction Supervision of Water Resources Projects".

(2) Whether the format of all kinds of work reports, acceptance documents and quality evaluation tables is in accord with the requirements of "Standard of Construction Quality Evaluation and Acceptance of Dykes" and "Specification for Check and Acceptance of Yellow River Flood Control Works".

3.1.4 Authenticity

Inspection of authenticity of completion documents mainly includes:

(1) Inspection of authenticity of self – checking record for dry density of earthwork;

(2) Inspection of authenticity of supervision spot – checking record for dry density of earthwork;

(3) Inspection of authenticity of original record for stone and concrete construction;

(4) Inspection of authenticity of signatures of main personnel from all sides participating in the construction.

3.1.5 Consistency

Consistency inspection of completion documents mainly includes: consistency inspection of starting and completion dates, consistency inspection of construction volume, consistency inspection of design budget, approved budget, contract price and finished investment.

(1) Consistency inspection of starting and completion dates. This includes check of starting and completion dates of the construction project. Mainly check to see whether the records of the project duration are consistent in all reports, whether they are in accord with logic, and whether the explanation for the reason why there is difference between the contract project duration and real project duration is justice, reasonable and in accord with logic. Check the starting and completion dates in all kinds of reports and records and fill in the inspection table.

(2) Consistency inspection of quantities. This includes: check of two sets of quantities of the main work derived from the design drawings and completion drawings respectively, and check of quantities recorded in the above – mentioned nine kinds of reports of the project.

Here is the procedure for quantities inspection: check design quantities: request the design company to provide quantities calculation sheet and check the quantities of the main work according to the design drawings; check the finished quantities of the builder: request the builder to provide the quantities calculation sheet and check the quantities of the main work according to the completion drawings; check to see whether the finished quantities listed in the self – checking record of the builder are consistent with that of the completion drawings; check to see whether the finished quantities confirmed by the supervision department are reasonable; and check the quantities recorded in the above – mentioned nine kinds of reports and the quantities listed in the bid documents, fill in inspection tables and carry out checking and analysis.

(3) Consistency inspection of contract prices and investment. This includes inspection of investments in all stages recorded in the above – mentioned nine kinds of reports of the project. While doing inspection, check the design budget, approved budget, contact prices and finished investment listed in the nine kinds of reports, fill in inspection tables and conduct checking and analysis.

3.1.6 Formalities completeness

Inspection of formalities completeness of completion documents mainly includes checking to see whether the signatures and seals of all participants in the construction and related personnel are complete and in accord with rules.

In addition, check to see whether the main personnel sent to the construction site by the construction – participating departments are in accord with personnel specified by the bid documents and contract documents, and if there was a change, whether the change formalities are complete, and whether the personnel's qualification meets the requirements. Main personnel sent to the site by the builder include project manager, project chief engineer (technical chief), and quality control chief; the personnel from the supervision department include chief supervising engineer and spot supervising engineer.

3.2 Key point inspection

Key point inspection of the completion documents is check of key points in the completion documents for accordance with directive rules, criteria and technical standards. This includes:

3.2.1 Inspection of the rationality and operability of the quality guarantee system of the builder

including: ① Whether a special quality control department has been set up and special quality control personnel have been appointed. ② Whether quality guarantee system documents have been compiled. ③ Whether rules and regulations on quality control have been formulated. ④ Whether quality check standards have been definitely stipulated. ⑤ Check to see whether the "Three checks" system has been operating in a normalized way.

3.2.2 Check to see whether the laboratories of the builder are in accordance with relevant regulations

This includes: ① Certificates of qualification grade and test scope of the laboratories. ② Metrological appraisal certificates and equipment calibrating documents issued by legal metrological appraisal departments for the test instruments and equipment of the laboratories. ③ Qualification certificates of laboratory workers. ④ Numbers and kinds of test instruments.

3.2.3 Inspection of the rationality of project division

Check to see whether the project division is in accord with the following principles: ① Unit project division should be done according to design, construction arrangement and the principle of facilitating quality control; ② Partitioned project division should be done according to functions; ③ Element project division should be done according to the construction methods, arrangement and the principle of facilitating quality control and assessment; ④ Earthwork filling should be divided according to layers and sections, and each element construction volume should be 1,000 ~ 2,000 m^3; ⑤ The difference between all the partitioned projects of the same type neither should be larger than 50% , nor should the difference in investment between all the partitioned projects of different types be larger than 50% ; ⑥ Stonework and concrete project should be divided according to positions and construction methods.

3.2.4 Inspection of the normalization of quality assessment

For the quality self – assessment documents of the builder, mainly check to see whether quality self – assessment comments have been made for the unit projects and partitioned projects strictly according to quality assessment standards.

Whether, while verifying the quality self – checking comments of the element projects written by the builder, the supervising department give the comment on the quality re – check of unit projects and partitioned projects strictly according to the quality assessment standards; whether they write down their different opinions in the element project quality assessment tables, if there are any, about quality self – assessment comments of the builder.

3.2.5 Inspection of normalisation of completion drawings

This includes: ① Whether the data marked on the completion drawings are accurate; ② Whether the illustration are full and accurate; ③ Whether the lines and signs in the completion drawings are normalized; ④ Whether the legend box in the newly – made completion drawings are fully filled in; ⑤ Whether the items in the original design drawings seals for project completion have been fully filled in, and whether the names of the project and the builder were filled in with their full forms.

3.2.6 Inspection of rationality of the reason for additional project

Check to see whether the additional projects applied for by the builder are in accordance with the clauses of the construction contract, and whether the reason is objective, real and reasonable.

3.3 Specialized inspection

Specialized inspection of completion documents is mainly inspection of the rationality of technical specifications that the builder adopt while implementing directive rules, criteria and technical standards. Since the builder vary in technical ability and management level, the technical specifications chosen for different construction items are not the same completely. Through inspection, the technical ability and management level of the builder can be reflected and constructive opinions and suggestions can be presented to the builder and other participants in the construction. This inspection includes: ① Inspection of the rationality of earthwork quality control targets for earthwork. ② Inspection of the rationality of the number of the quality check personnel, the number of quality check. devices, the quality check positions and check frequencies for earthwork. ③ Inspection of the rationality of the number of the construction machines and the time limit for earth filling arranged in the organizing design for the earthwork construction. ④ Inspection of the rationality of the number of the construction machines and the time limit for stonework arranged in the organizing design for the stonework construction. ⑤ Inspection of the rationality of the number of machines and the time limit in the organizing design for the construction of common concrete work, reinforced concrete work and asphalt concrete work. ⑥ Inspection of the rationality of the quality check record and test result of raw materials such as steel bars, cement, sandstone and earthwork composite material, and inspection of the rationality of quality check record and test result of intermediate materials such as concrete mixes and mortar mixes.

4 Timely correction and archiving

For the completion documents going thorough inspection, all the sides participating in the construction should make correction according to the filled inspection tables, records and correcting requirements by the inspecting personnel, write correction report and sent to the inspecting personnel for final re – check.

For the completion documents that have been inspected and corrected, all the sides participating in the construction should determine the keeping time limit and organize them in volumes according to regulations on the management of documents of flood control capital construction projects, then the file clerk should be responsible for the check, acceptance and handover.

Development and Application of a Sweeper with Multi – windhole

Song Yanping, ***Ren Xiaohui***, ***Wang Lei***, ***Ren Yumiao*** and ***Xing Honglei***

Mengzhou Yellow River Bureau, Mengzhou, 455750, China

Abstract: After many tests and improvement on the blower with a single air hole in terms of air – out, outlet location and height, we have successfully manufactured a new type sweeper with multi – windhole, by which the problem that there are more leaves and sundries influencing the tidiness of the dikes can be resolved. The newly developed sweeper can make the dikes clean, enhance the working efficiency and reduce the labor intensity, furthermore, it has been widely applied in society and obtained a good effect.
Key words: sweeper with multi – windhole, development and application, blower, road, cleaning

With the development of the technology in control of the Yellow River, the repair and maintenance of the works for water conservancy have been gradually stepping towards mechanization and specialization. The level of the servicing and engineering management has been enhanced markedly. Through many calculation and tests, we found the solution to the problem that there are more leaves on the dikes, that is, a new type sweeper with multi – windhole was successfully manufactured, with the advantageous of remarkable reduction of labor intensity.

1 The process, method and content of manufacture

1.1 The background

There are many trees planted on the dikes, connections of vulnerable spots and training works of the Yellow River, the leaves falling down from them and other sundries on their top greatly influence the landscape there. Every year, many workers have to sweep the sundries on the dike, but the efficiency is too low and the labor intensity is too large. Many workers fall in a faint frequently in hot summer. So, we tested with single – windhole blower on the dike. The result was not good, a 15 – horsepower tractor with the blower made more soot, the leaves were blown to the edge of the road, but 20% of which retuned to the road, thus the blower couldn't clean the leaves.

1.2 Development process

We got elicitation from the single – windhole blower. Firstly, when blowers remove the leaves on the mud – macadam roads, the wind force should be large and the wind pressure should be small. Secondly, the exits of the blowers can not be centralized, the size of the exits, the length and the location of the windholes should somewhat differ. Thirdly, the leaves affixing on the ground should be swept. According to these new ideas, we successfully manufactured a new type sweeper with multi – windhole after many tests.

The researches of the sweeper focus on three aspects, the wind quantity of the blower, the number of the exits and the location. The wind from the blower is designed to be able to blow the leaves and the sundries, but not to blow the gravels of the road, and send them to the kerbstone so that the aim of cleaning the road on the dike, keeping the works' tidiness, enhancing the efficacy and reducing the worker's labor intensity can get.

1.2.1 Choice of the blower

The function of a blower is to produce wind that blows out sundries through air passage. There are three types of blowers: centrifugal blower, slender airflow and mixed airflow. Since the centrifugal blower has the advantageous of higher efficiency, equably sendout, simple structure and easy – made, we choice it as the source of the wind, with the minimum blowing rate of 1,688 m^3/h.

1.2.2 Design of air pipe

1.2.2.1 The length of the air pipe

The air pipe is made of the iron sheets to be welded together. The air pipes are designed to have three length based on the varying requirements.

The No. 1 air pipe is 30 cm in length, the No. 2 is 100 cm, and the No. 3 is 130 cm.

Because the pipe is not long, the wind lost in the pipe can be ignored.

1.2.2.2 Sectional area of the outlet of air pipe

According to many measuring data with anemometers, if the No. 1 air pipe blow away the sundries on the dike and then the No. 2 and No. 3 air pipes blow away the sundries farther, the best wind speed of the No. 1 air pipe will be 12.2 m/s and that of No. 2 and No. 3 air pipes is 20 m/s. If the wind quantity of the blower is 1,688 m^3/h($L_{总}$), L_1 accounts for 20%, it is 337.6 m^3/h, $L_{2,3}$ accounts for 40%, it is 675.2 m^3/h.

(1) No. 1 air pipe's section area

$$L_1 = 337.6\ m^3/h$$
$$V_{s1} = L_1 \div 60\ min \div 60\ s = 0.094\ m^3/s$$

$$S_{1\ Exportation} = V_{s1} \div V_{Leaves\ the\ wind\ 1} = 0.094 \div 12.2 = 0.007,7\ (m^2)$$

(2) No. 2 and No. 3 air pipe's section area

$$L_{2,3} = 675.2\ m^3/h$$
$$V_{s2,3} = L_{2,3} \div 60\ min \div 60\ s = 0.188\ (m^3/s)$$
$$S_{2,3\ Exportation} = V_{s2,3} \div V_{Leaves\ the\ wind\ 2,3} = 0.188 \div 20 = 0.009\ (m^2)$$

where, $L_{1,2,3}$ is the wind quantity of the No. 1 – 3 air pipes in m^3/h; $V_{s1,2,3}$ is the wind speed of the No. 1 – 3 air pipes, m^3/s; $V_{Leaves\ the\ wind1,2,3}$ is the exit speed of the No. 1 – 3 air pipes, m/s; $S_{1\ Exportation}$, $S_{2,3\ Exportation}$ is the section area of the No. 1 – 3 air pipe exit, m^2.

1.2.3 The size design of the air pipe's section

The section area: $S_{1出口} = 0.007,7\ m^2$, $S_{2,3出口} = 0.009\ m^2$

The section area of the No. 1 air pipe: the width

$a = 0.11$ m, the height, $b = S_{1出口} \div a = 0.007,7 \div 0.11 = 0.07$ (m)

The section area of the No. 2,3 air pipe: the width

$a = 0.15$ m, the height, $b = S_{2,3出口} \div a = 0.009 \div 0.15 = 0.06$ (m) (Fig. 1).

1.3 Structure and components

The sweeper is made up of a multi – windhole and a small mobile machinery car. The blower is bound with bumper at the back of the mobile machinery car that can generate electricity and walk. A switch controls the blower and a long brush made of steel wire sweeps the leaves and the sundries on the road, so the multi – windhole blower can blow them away easily.

The multi – windhole blower is made of impeller, shell, wind entrance and driver (Fig. 2). The impeller is made up of ten vanes like airfoil, a front tray and a back plane tray. The impeller is made of steel. It is revised more times and has good capability. The shell has three parts and divided into two parts along the level of the shell, the half part above is divided two parts along the center, connected with bolts. The wind entrance as an entirety lies by the side of the blower.

The driver is made up of principal axis, axletree box, roll axletree and strap wheel.

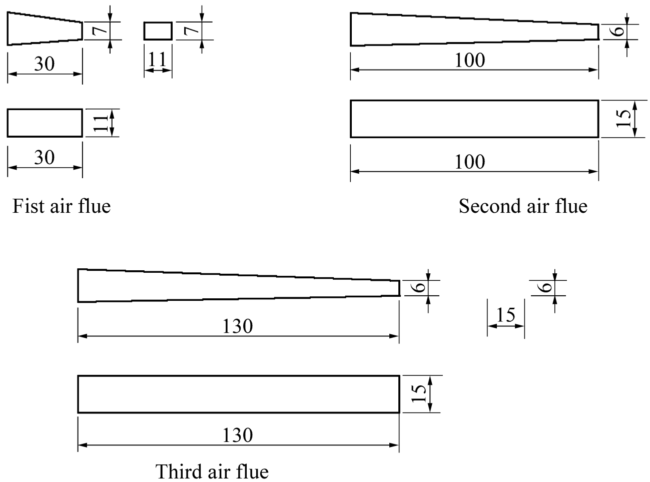

Fig. 1 Blast pipeline schematic drawing

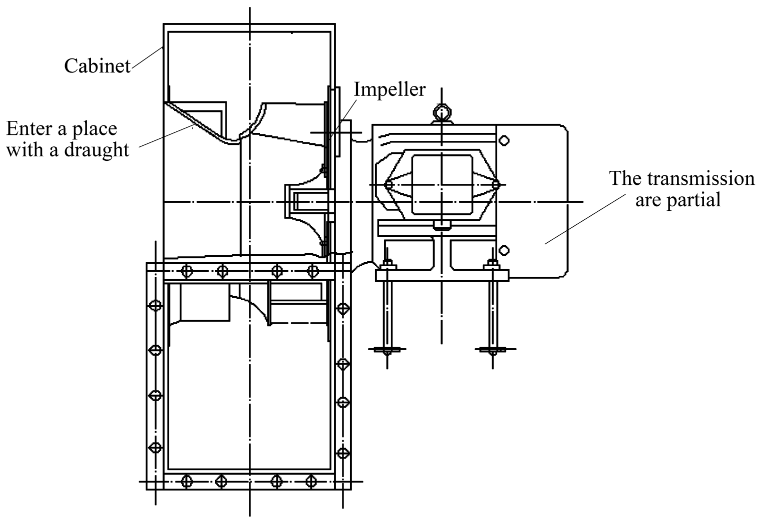

Fig. 2 Multi – air flue crest clean machine structure schematic drawing

1.4 Working principle

Under 380 V, a blower's electromotor whose power is 2.2 kW and 2,800 r/min drives the wind leaves to turn, the wind quantity is 1,688 ~ 3,520 m^3/h, and the wind pressure is 1,300 ~ 792 Pa. Tthere are three wind holes which have different length, different height and different diameters (Fig. 3).

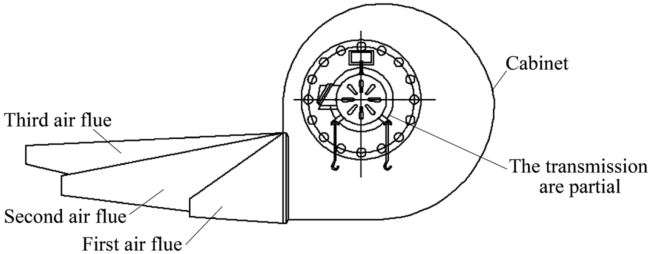

Fig. 3　Multi – air flue crest clean machine schematic drawing

The No. 1 windhole is 30 cm, the exit is low, the wild quantity takes up 20% , and it blows the leaves and! sundries to the edge of the road.

The No. 2 windhole is 100 cm, the exit is flat, the wild quantity takes up 20% , and it blows the leaves and sundries to the edge of the road.

The No. 3 windhole is 130 cm, the exit is flat, it lies back and it is high. The wind quantity accounts for 40% . It can blow the sundries from the ground and send them to the side of the curbstone. so it resolves the problem that the leaves return to the top of the dike when using single windhole blower(Fig. 4).

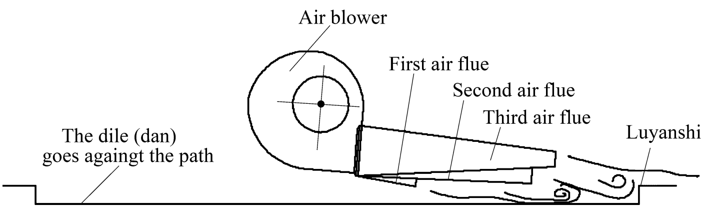

Fig. 4　Multi – air flue crest clean machine work schematic drawing

2　Sketch map of assembling prcedure

Assembly order schematic drawing see Fig. 5.

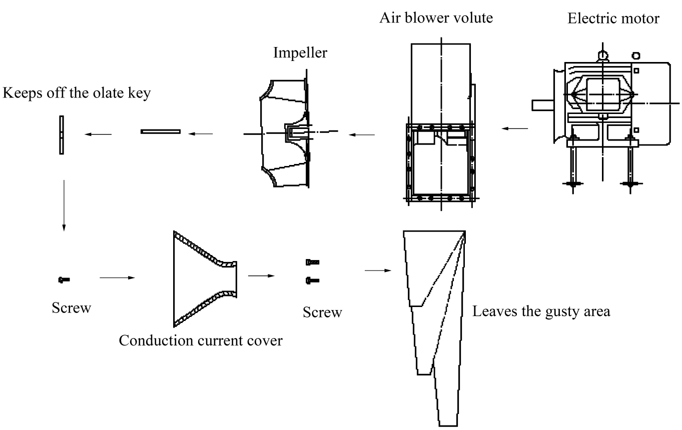

Fig. 5　Assembly order schematic drawing

3 Operational procedures and maintenance

3.1 Operational steps

(1) Adjust steel wire brush when get ready;
(2) Adjust the windholes rationally according to the road width and the curbstone's height;
(3) Check the components and the screws, stars the machine, increase the accelerograph, close the knife switch and begin to work;
(4) Control the speed according to the quantity of the leaves and the sundries.

3.2 Maintenance of a blower

(1) Operate the blower only it is in good condition;
(2) When the blower stars after checking, pay attention to the condition of the blower's parts;
(3) Clean the dirt and water in the windholes regularly and avoid rusting;
(4) Do not maintain the blower when it is at work.

4 Benefit analysis

After the blower was successfully developed in August 2003, the sweeper began to sweep on the top of the dikes, and got high efficiency that 95% leaves were blew away when the road is dry, consuming oil of 1.5 kg in one hour and 500,000 m^2 area were cleaned. We made a contrast between cleaning by man and by sweeper.

A worker can sweep 0.66 km every working day; the sweeper can sweep 66 km every working day, it is the 100 times of the former.

The cost of a worker is RMB 30.96 yuan every work day, that is to say, sweeping 1 km costs RMB 46.91yuan. The cost of a sweeper is RMB 101.28 yuan. Sweeping 1km road costs RMB 1.53 Yuan. It is the 96.7% of the former.

The dike in Mengzhou is 51 km long, we should sweep twice every month, so we should sweep 14 times if we work 7 months every year, the length is 714 km in all. We should speed RMB 335,000 yuan every year if the workers sweep the dike. But if the sweeper sweep the dike, we only spend RMB 1,100 yuan. So we may save almost RMB 32,400 yuan every year for the Yellow River Mengzhou Bureau. The productive efficiency and benefits of manpower and machinery are compared (see Table 1).

Table 1 The productive efficiency and benefits of manpower and machinery are compared

Form	Unit price	Working efficiency contrast	Length (km)	Benefit contrast RMB yuan		
				sweep 1 km	Sweep once	One year
Manpower	30.96 RMB yuan/workday	0.66 km/ workday	51	46.91	2,392.41	33,493.74
Machine	101.28 RMB yuan/shift	66 km/shift	51	1.53	78.03	1,092.42

5 Application

The sweeper has many characters, such as lower energy consumption, lower cost, higher efficiency, easier operation and better adaptability. It enhances the working efficiency and has been widely applied in water conservancy and traffic sectors. It has good economic benefit and is worthwhile generalizing.