INTERNATIONAL NETWORKS of BASIN ORGANIZATIONS

Debrecen (Hungary) June 2007

Flood Management in Spain: case of Tagus River

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Spanish Ministry of Environment

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Flood risk, prevention and control in Spain: the case of Tagus basin

I Flood risk management

Driving forces affecting floods

- Risk of flooding results from a combination of **natural** factors and **human** interferences
- **Natural** factors are more related with meteorological ,topographic, vegetation,soil... conditions, specially rainfall
- **Human** actions can influence flooding:
  - Affecting the run-off patterns (e.g. deforestation, urbanisation,)
  - Increasing the possible impact of flooding (e.g. occupation of flood plains)

BEST PRACTICES

(Draft Water Directors UE)

- **Integrated river basin approach**
  - Need for a river basin approach
  - Need for an integrated approach
  - Need for an integrated and comprehensive action plan
  - Need for international and tranboundary cooperation
  - Need for financial instruments
- **Public awareness, public participation and insurance**
  - Public awareness
  - Public participation
  - Insurance
- **Non-structural measures** and retention of water
  - Structural measures and their impact
- **The main preventive non-structural measures should be** :
  - **Land use, zoning and risk assessment**
  - **Prevention of pollution**
  - **Early warning and forecast systems**
  - **Flood Emergency**

FLOOD RISK MANAGEMENT DIRECTIVE RISK ASSESSMENT OOD MANAGEMENT

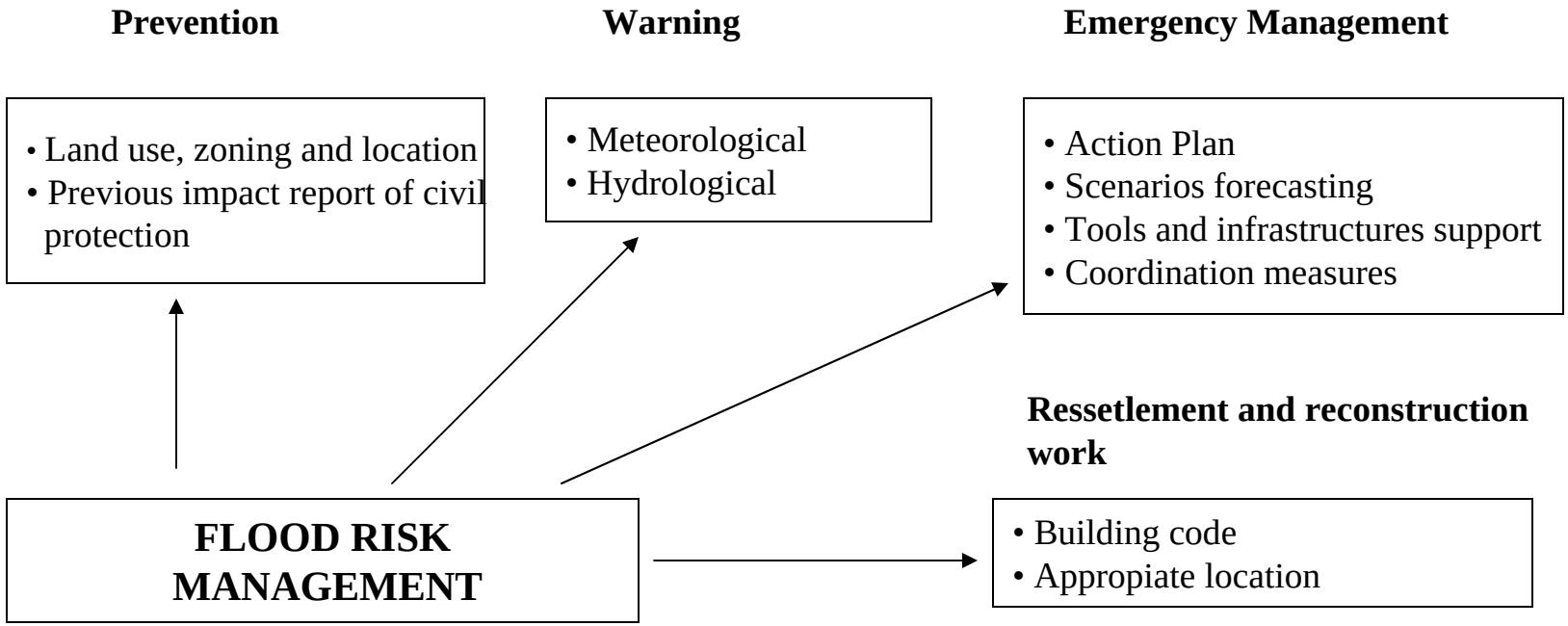
-Risk preliminary assessment

-Hazard maps

-Risk maps

- -Inhabitants affected
- -Economic damages

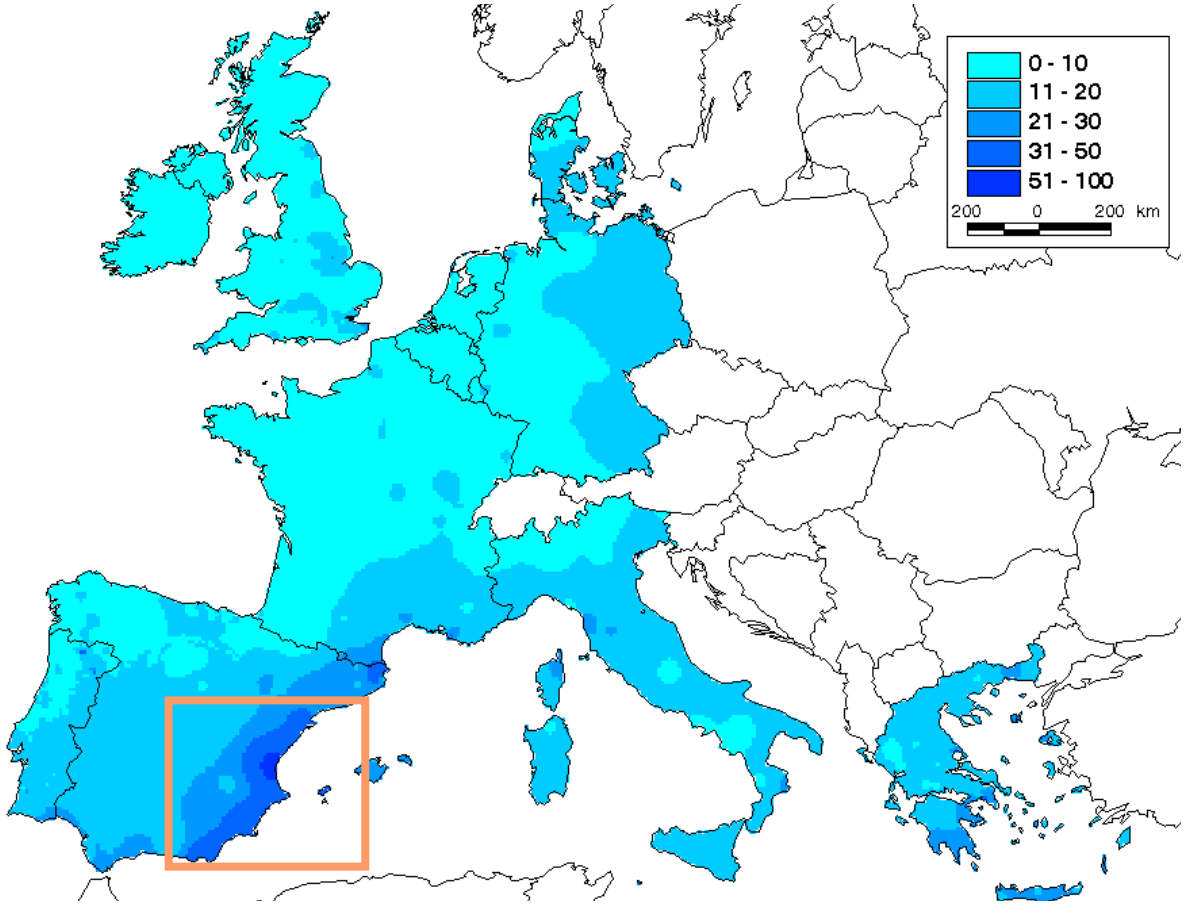
-Flood Risk Management Plans



Flood risk, prevention and control in Spain: the case of Tagus basin

II Flood in Spain

Natural driving forces: Rainfall



Ratio (%) between maximum daily precipitation and mean annual precipitation (period 1940/41-1995/96). Source: CEDEX with data from Eurostat

Flood risk, prevention and control in Spain: the case of Tagus basin

III Flood prevention and risk management in Spain

III Flood prevention and risk management in Spain

- Land use
- Dams coordinated management
- Civil Protection Plan
  - Risk mapping
- Early Warning System
- Insurance
- International bodies

III a. Land use

Land use (Spain)

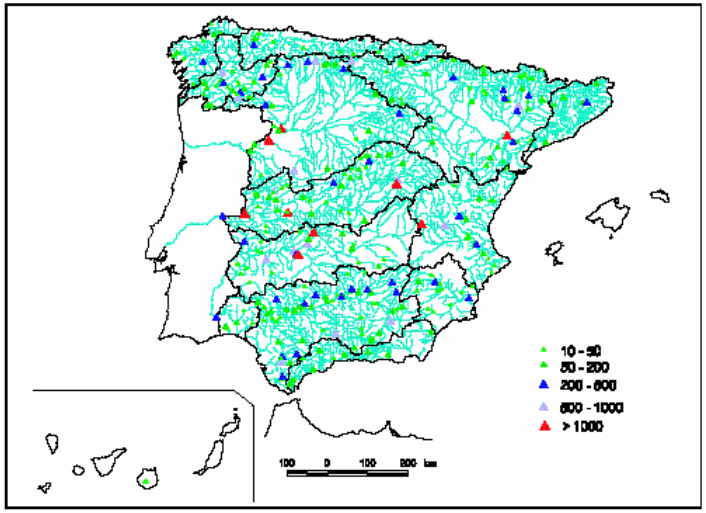
- It is necessary improve the coordination between Public Authorities at National, Regional and Local level
- Administrations with different responsibilities are involved: land planning management (Autonomous Communities), building authorisations (municipalities),Civil Protection
- It is not allowed (Land Use Act) to build at the areas classified as risked according with specifically regulations
- It is necessary **link urban plans and flood risk** plans (Civil Protection)

III b. Dams coordinated management

It is a important issue in Spain (more than 1.200 large dams)

Dams Safety

- There are special regulations
- Inspection by Water Directorate
- Require to be approved by Ministry of Environment
  - Operational Rules
- By Ministry of Environment and Civil Protection
  - Emergency Plans in case of heavy failure



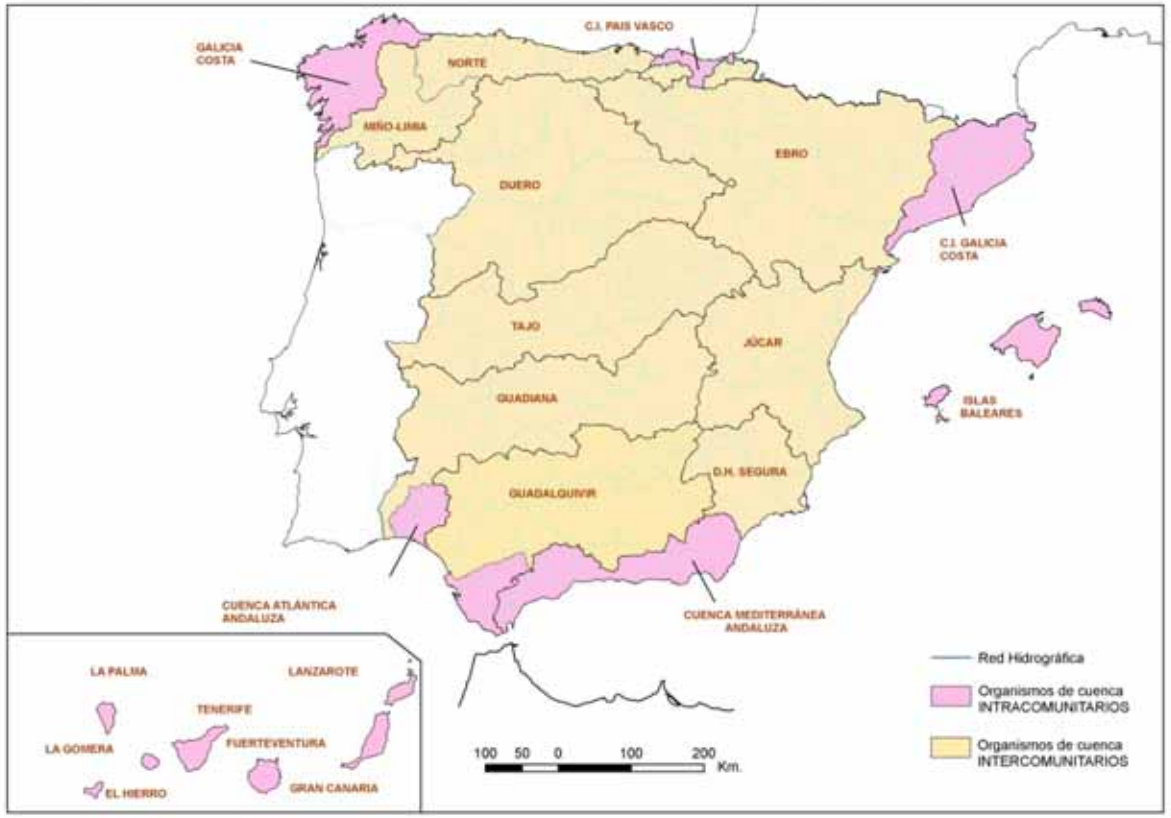
HIDRAULIC INFRASTRUCTURES

Data of the operating reservoir and inconstruction (September 1996)

Reservoirs with storage capacity >10 hm3

Plan	Número de embalses en explotación	Capacidad de los embalses en explotación (hm^3)	Superficie inundada (ha)	Capacidad de los embalses en ejecución (hm^3)	Capacidad total (explotación y ejecución) (hm^3)
Norte I	53	3.040	11.771	0	3.040
Norte II	27	559	2.913	0	559
Norte III	32	122	712	0	122
Duero	67	7.654	35.417	13	7.667
Tajo	198	11.131	58.806	4	11.135
Guadiana I	90	8.508	48.039	335	8.843
Guadiana II	36	684	4.654	92	776
Guadalquivir	107	8.208	43.293	659	8.867
Sur	37	1.160	5.212	159	1.319
Segura	27	1.144	6.580	79	1.223
Júcar	47	3.343	17.263	6	3.349
Ebro	151	6.761	40.294	941	7.702
C. I. Cataluña	14	692	2.450	80	772
Galicia Costa	22	688	4.446	0	688
Total península	908	53.694	281.850	2.368	56.062
Baleares	2	11	119	0	11
Canarias	114	101	477	0	101
Total España	1.024	53.806	282.445	2.368	56.174

PUBLIC ADMINISTRATION OF WATER IN SPAIN



Basin territories – CCHH

Basin Authorities

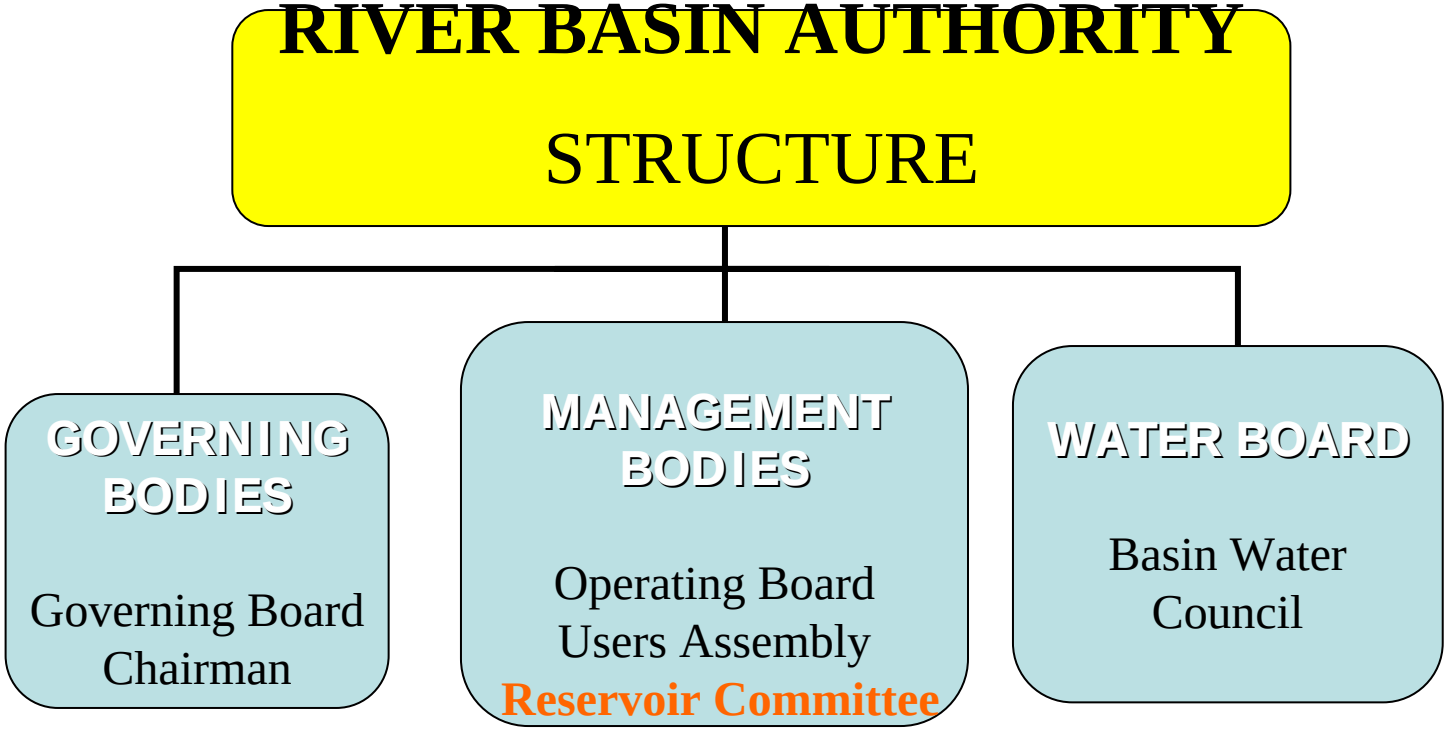
➢ **1. Attached to Ministry Of Environment**

CONFEDERACIONES HIDROGRÁFICAS :

Northern Basin
Duero
Tajo
Guadiana
Guadalquivir
Segura
Júcar
Ebro

➢ **2. Attached to Autonomous Regions**

Cuencas Internas de Cataluña
Galicia Costa
Cuencas Internas del País Vasco
Cuencas Internas Andalucía
Atlantics
Mediterranean
Baleares Islands
Canary Islands



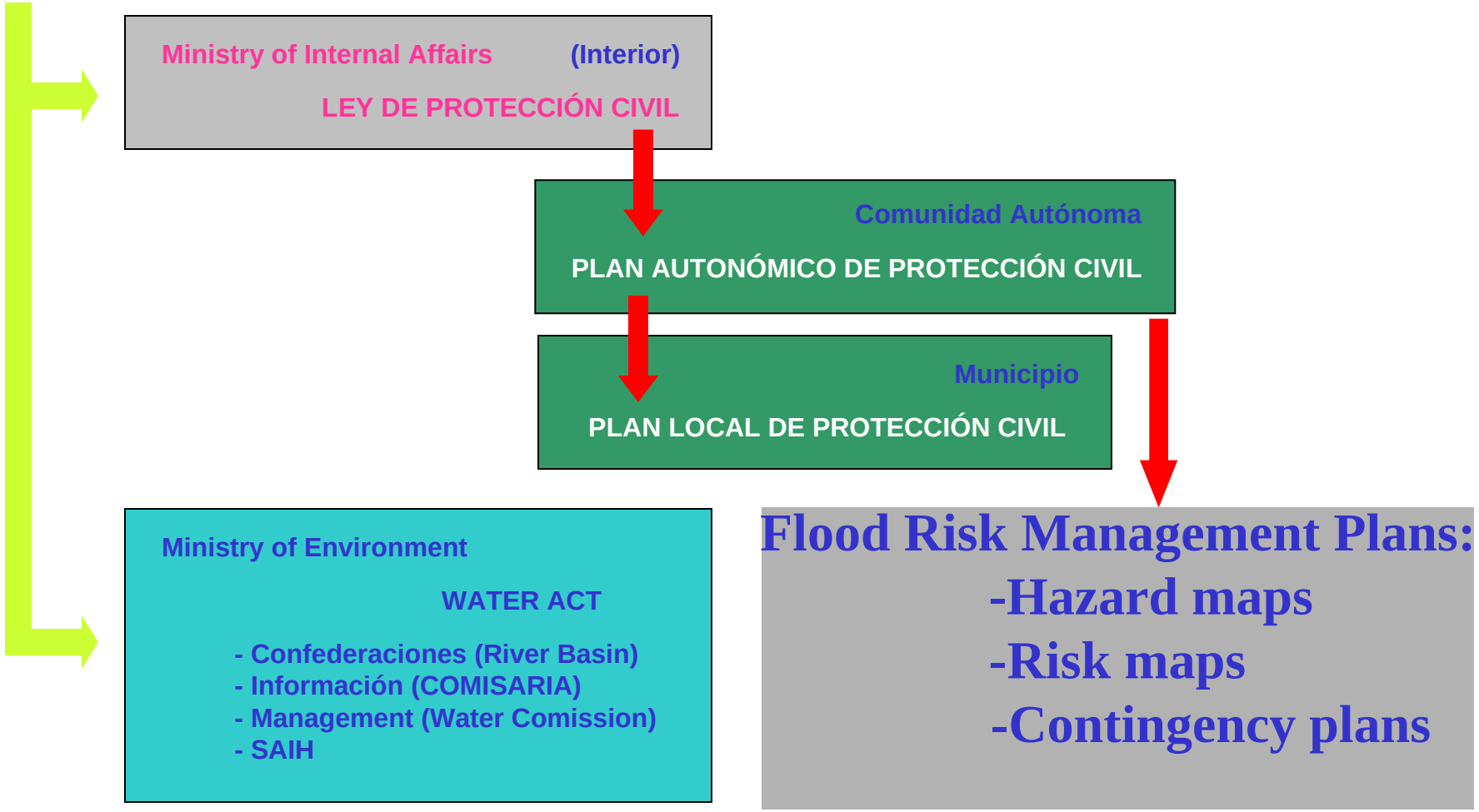
Reservoir Committee : in case of flood the PERMANENT COMMITTEE coordinate the operation at basin level, providing information to Civil Protection

IIIc. Civil Protection Emergency Plans

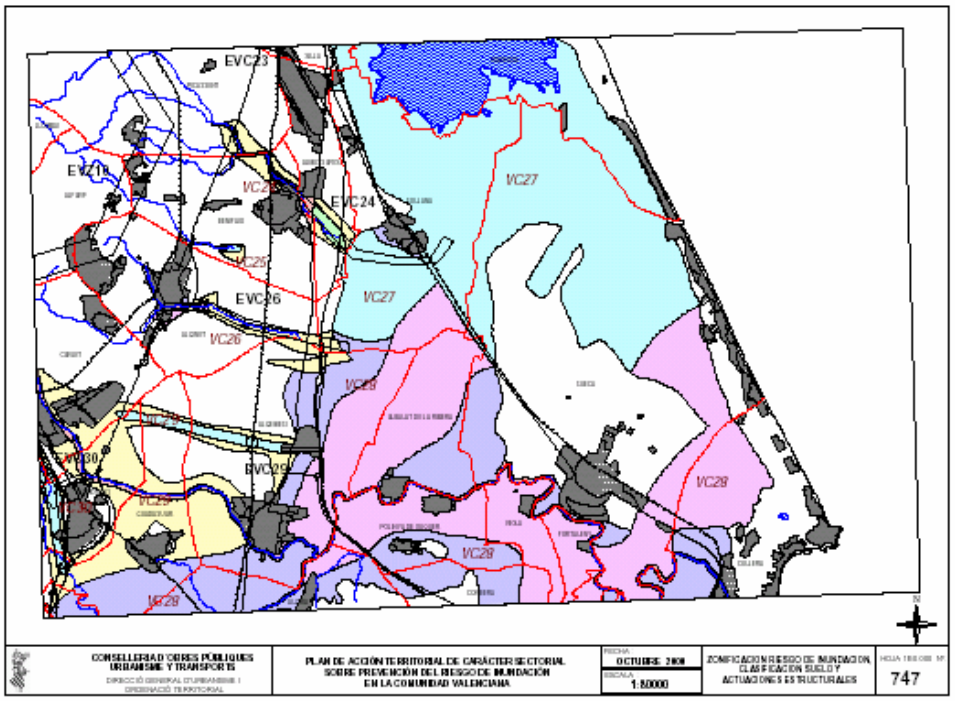
Risk mapping

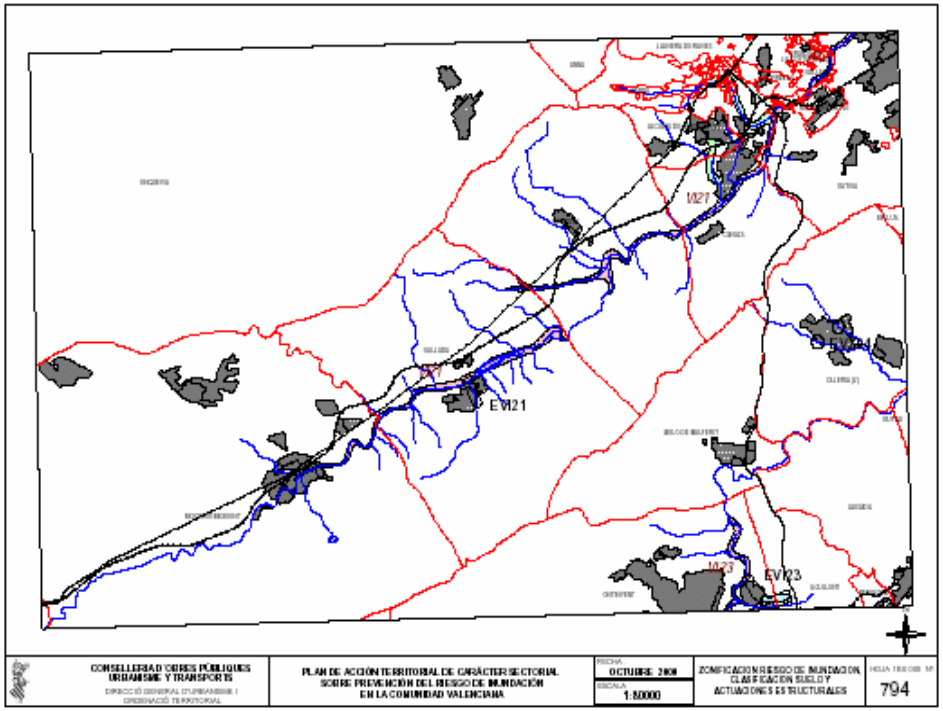
LEGAL FRAMEWORK

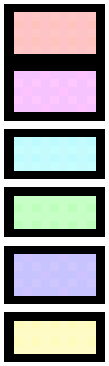
CENTRAL ADMINISTRATION - GOVERNEMENT



Risk mapping

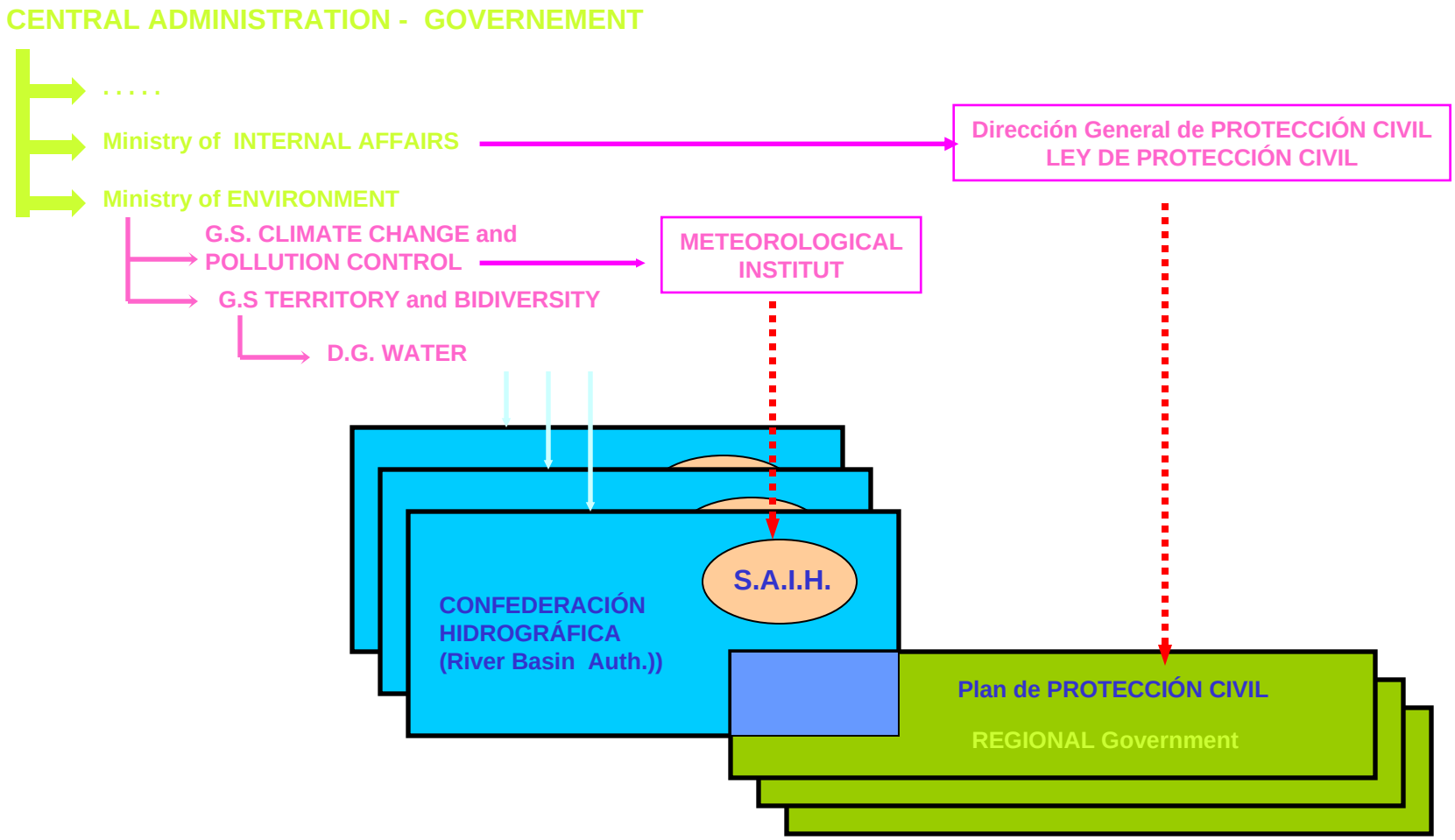






Zone 1: Frequency < 25 years water level>0.8 m.
Zone 2: Frequency 25 to 100 years water level>0.8 m.
Zone 3: Frequency < 25 years water level<0.8 m.
Zone 4: Frequency 25 to 100 years water level<0.8 m.
Zone 5: Frequency 100 to 500 years water level>0.8 m.
Zone 6: Frequency 100 to 500 years water level<0.8 m.

SCHEMATIC STRUCTURE



III d. Early Warning System

CURRENT SAIH NETWORK

Automatic Hydrological Information System (SAIH) main objectives:

-Supply of information automatically in real time

-Forecasting in short term the evolution of levels and flows

-Management of the exploitation of the reservoirs and canals

1.775Control Points
- Reservoirs
- Flow gauges rivers
- Flow gauges in channels
- Rain gauges
- Booster station

- Investment updated(2006) : 374 M€
- Operational cost updated: 18 M€/year

SAIHs Working

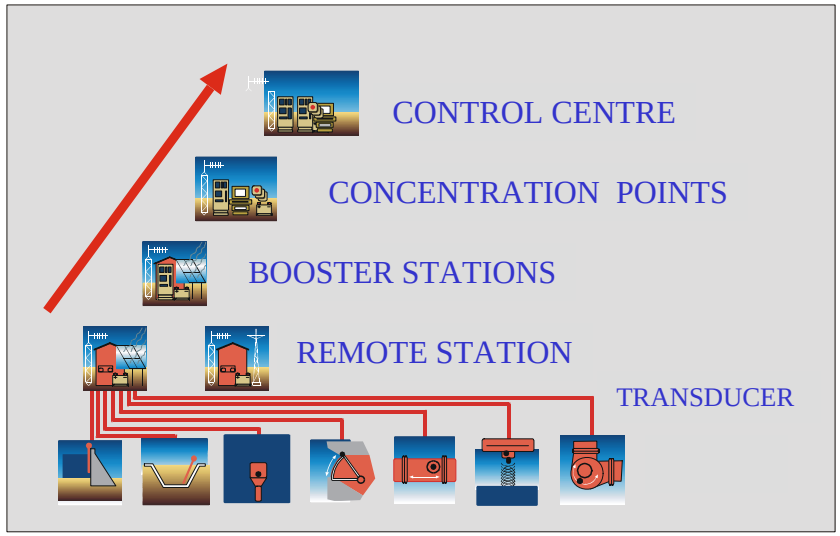
SAIHs Building

SAIHs Project

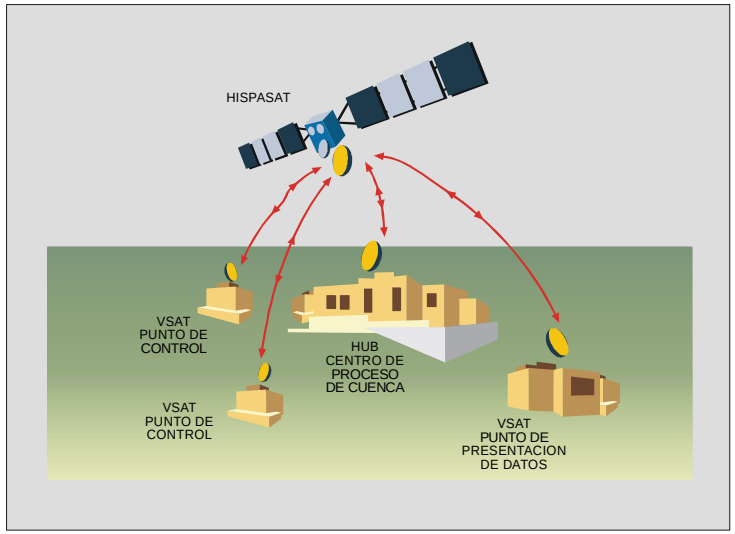
Cuencas intracomunitarias

BASIC DIAGRAMS OF SAIH NETWORKS

Radio Links



Satellite Links



FUNCTIONS

- Data Acquisition : TRANSDUCERS
- Data Communication : TELECOMMUNICATION NETKORKS
- Data Procesing : CONTROL CENTRE
- Aided Models for DECISION MAKING

INSTRUMENTATION

HYDRAULICS-HYDROLOGICS VARIABLES

Transducers Types

DAMS

Water Level	Submerged Quartz Transducer Hydrostatic-Pneumatic Balance Float-Counterweight Hydrostatic-Pneumatic Quartz Transducer
Water Flow	Electomagnetic Flowmeter Ultrsonic Flowmeter
Gates-Valves Position	Angle measurement Mechanics Optics Capacitive Resistives

RIVERS-CHANNELS

Water Level	Float-Counterweight Resistives Pneumatic Ultrasonics

CHANNELS

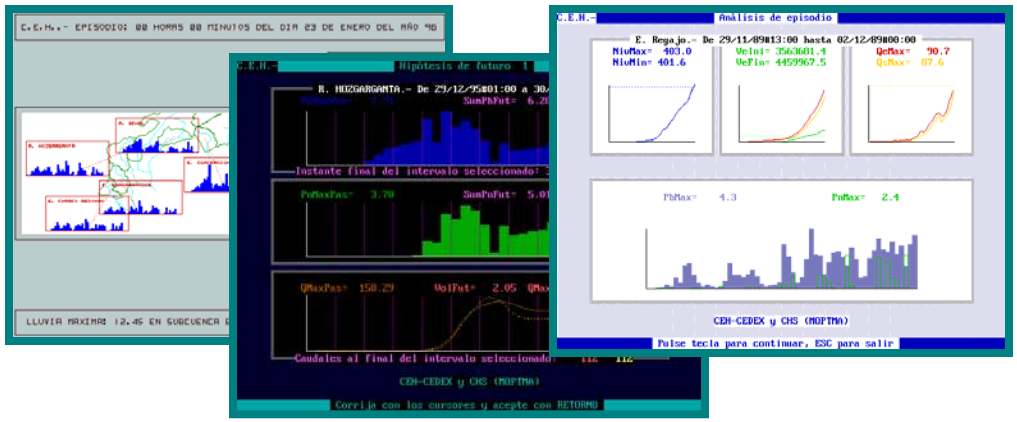
Water Flow	Ultrasonics Electromagnetics

CLIMATIC AND ENVIRONMENTAL VARIABLES

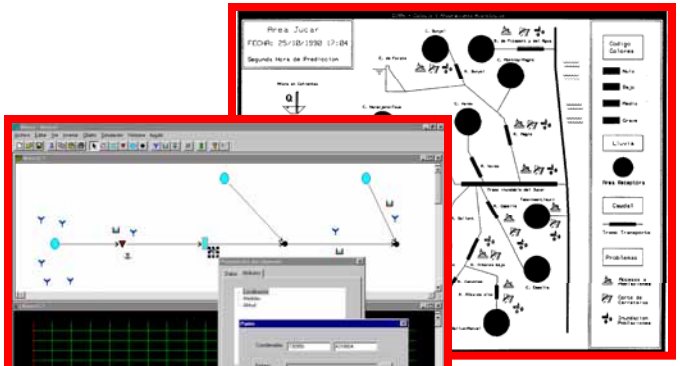
RAINFALL	Rainfall Gauges
SNOW	Heat Rainfall Gauges Weight Rainfall Gauges
TEMPERATURE	Resistance Temperature Detectors RTD
SNOW COVER	Nyvometer

- **Data Acquisition Systems**
- **Energy Suply Systems**

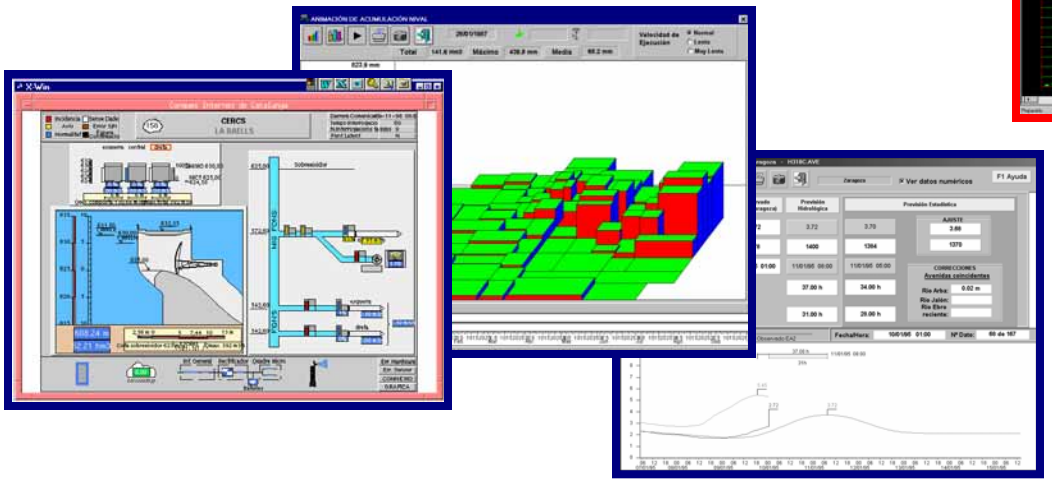
MODEL ENVIR0NMENT FOR DECISION MAKING



HYDROMETEOROLOGIC GENERALS



EXPERT SYSTEMS

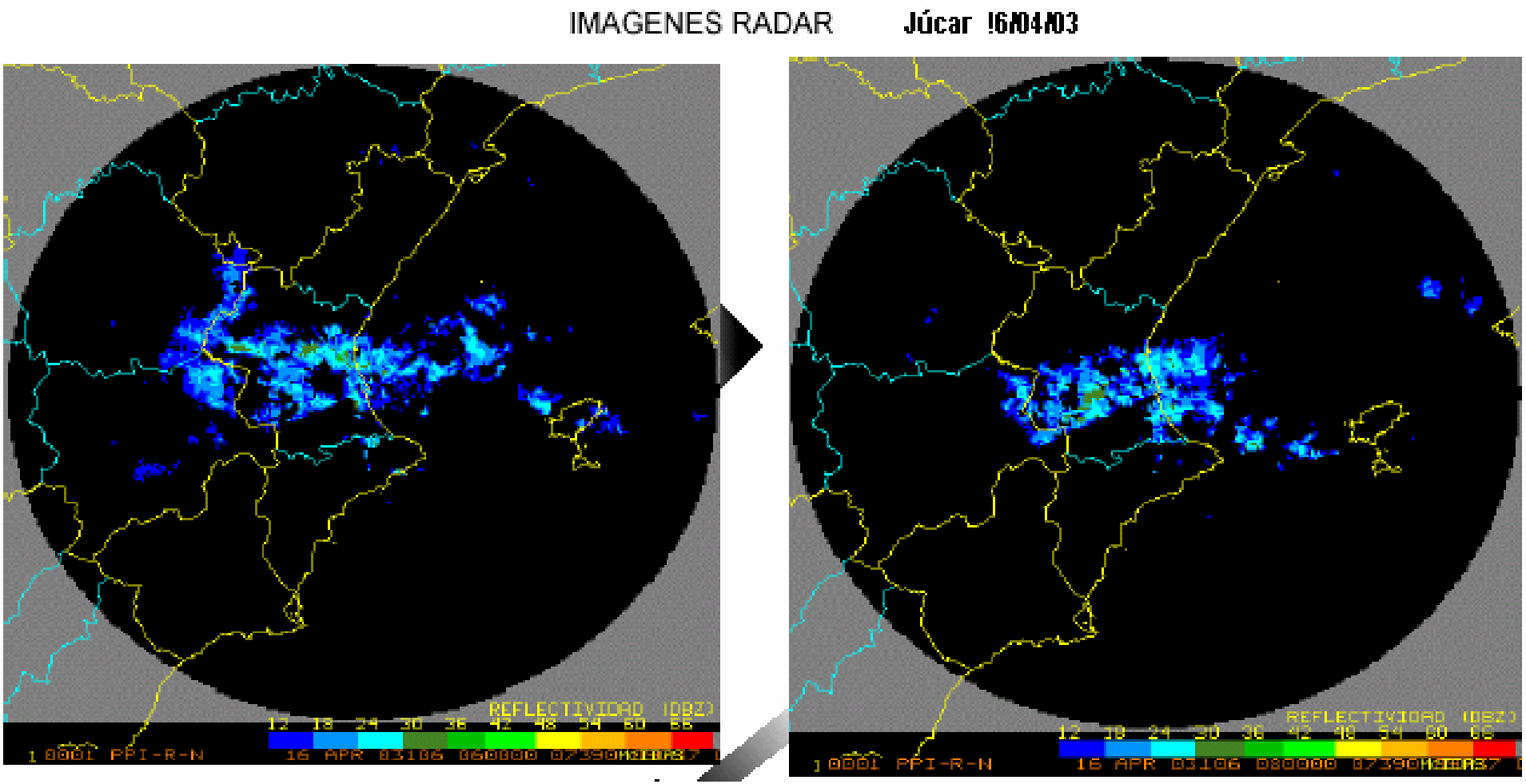


SPECIFICS

Flood: Hydrological basin response

- Slow: time to transforming rainfall excess into an outflow hydrograph > 6 hours
  - It’s possible hydrological forecasting
  - It’s possible reaction (civil protection, public warning,..)
- Fast: t < 6 hours
  - No time reaction
  - Radar utilities
  - Preventative measures

Clouds radar images:Rainning prediction and hydrological forecasting



MINISTERIO DE MEDIO AMBIENTE

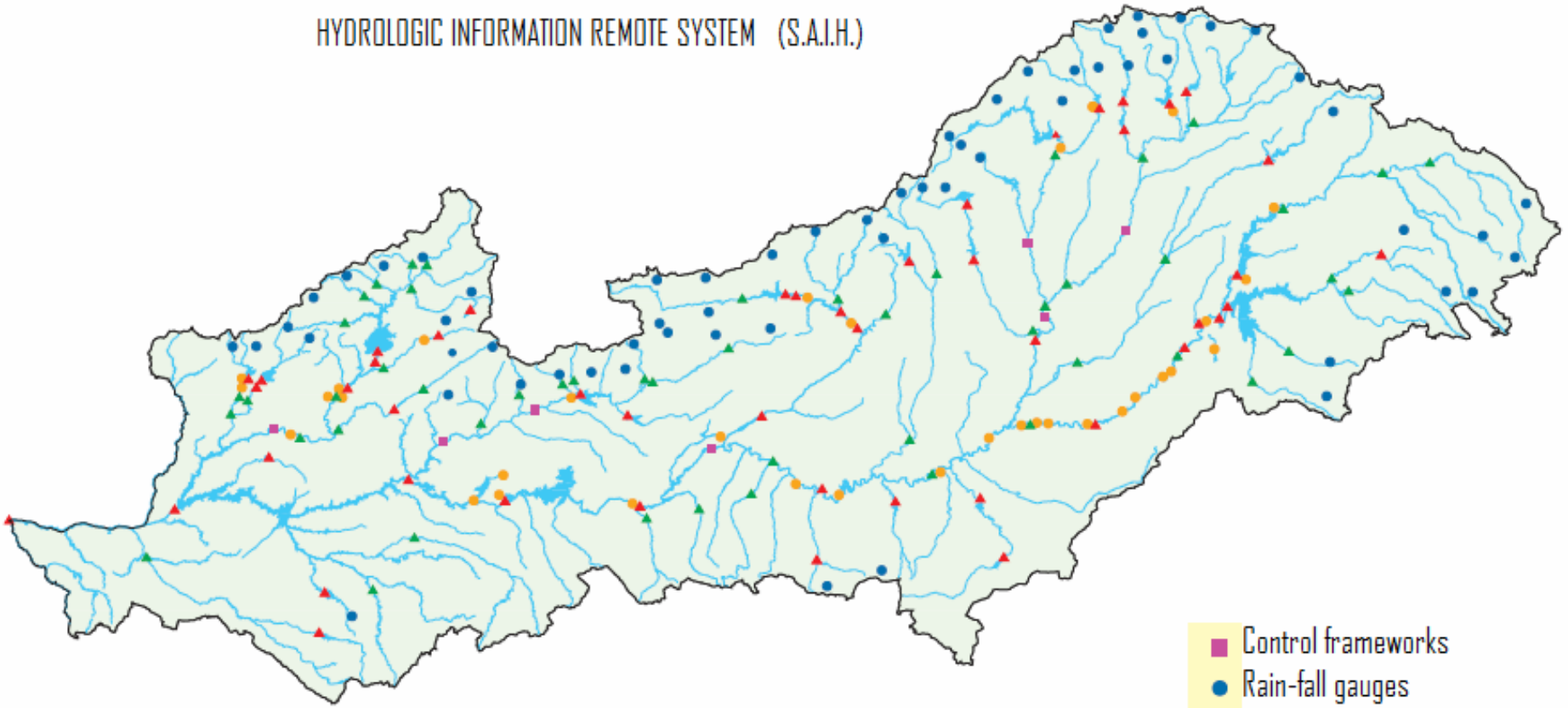
CONFEDERACIÓN HIDROGRÁFICA DEL TAJO

Dato	Unidades	Tajo en España	España	% Tajo/España
Superficie	Km^2	55.870	506.470	11,03 %
Población en habitantes	en miles	6.094	39.238	15,53 %
Precipitación media	mm	655	684	95,76 %
Recursos hidráulicos régimen natural	hm^3	11.235	113.812	9,87 %
Aportación específica	hm^3/km^2	0,219	0,225	97,33 %
Capacidad de embalse	hm^3	12.000	56.063	21,40 %
Escorrentía subterránea	hm^3	1.565	20.881	7,49 %
Reservas subterráneas	hm^3	4.700	180.000	2,61 %

MINISTERIO DE MEDIO AMBIENTE

CONFEDERACIÓN HIDROGRÁFICA DEL TAJO

HYDROLOGIC INFORMATION REMOTE SYSTEM (S.A.I.H.)

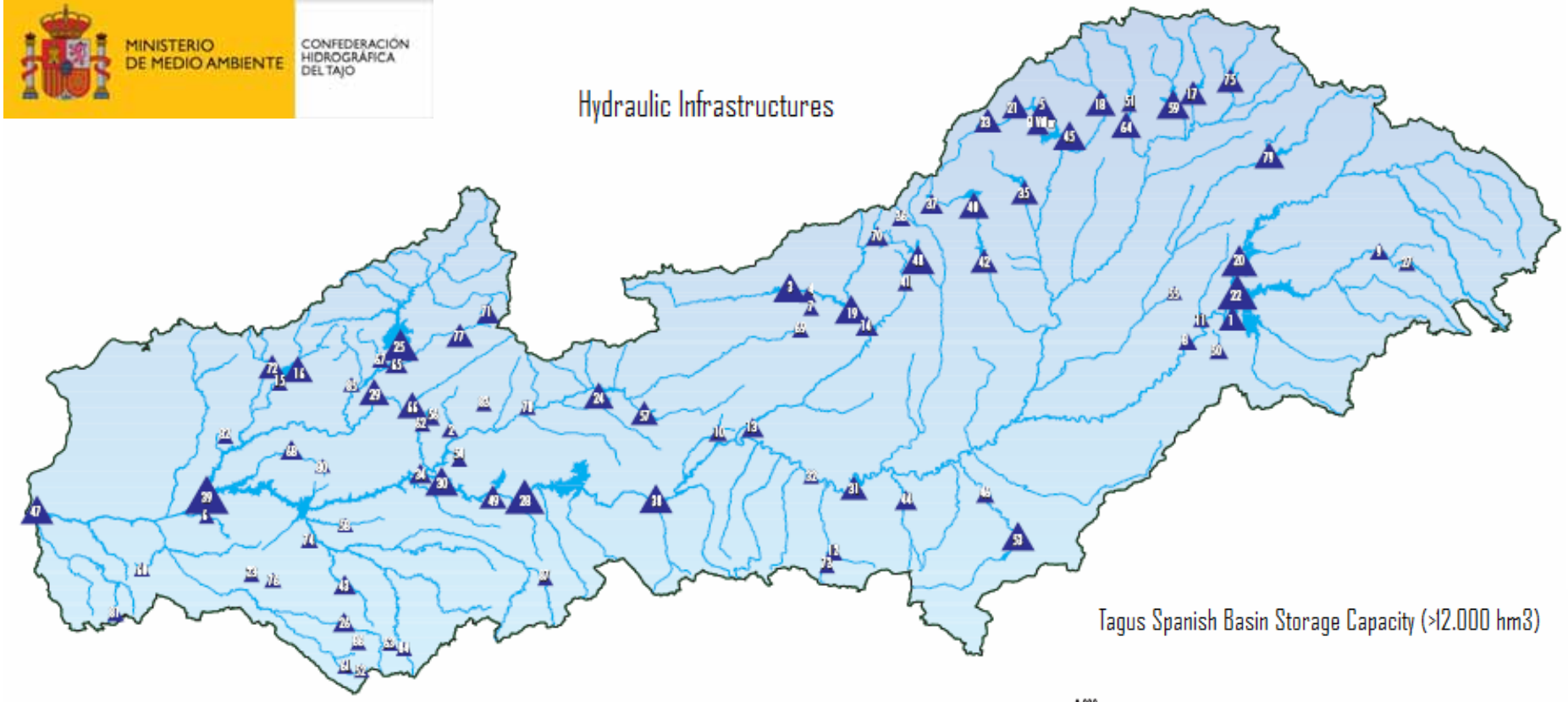


PUNTOS DE CONTROL	
1. De control pluviométrico	43
2. De control pluvionivométrico	18
3. De control en embalses	47
4. De aforo en río	53
5. Marcos de control	7
6. De control en conducciones	22
7. De control en impulsiones	12

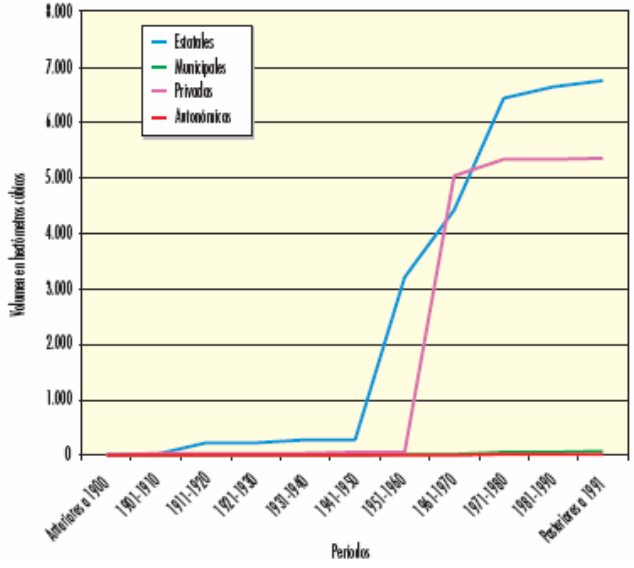
MINISTERIO DE MEDIO AMBIENTE

CONFEDERACIÓN HIDROGRÁFICA DEL TAJO

Hydraulic Infrastructures



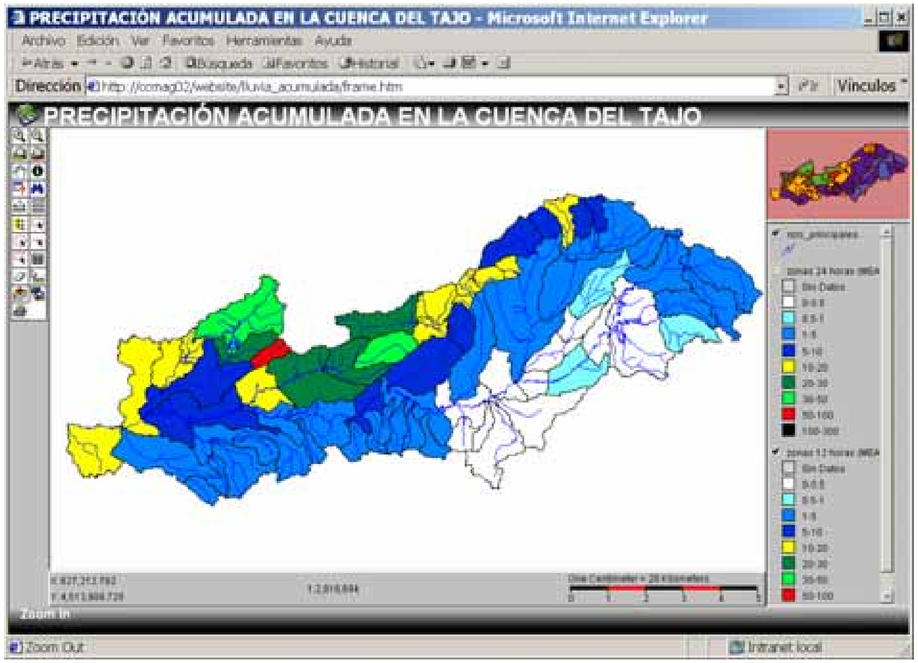
Tagus Spanish Basin Storage Capacity (>12.000 hm3)

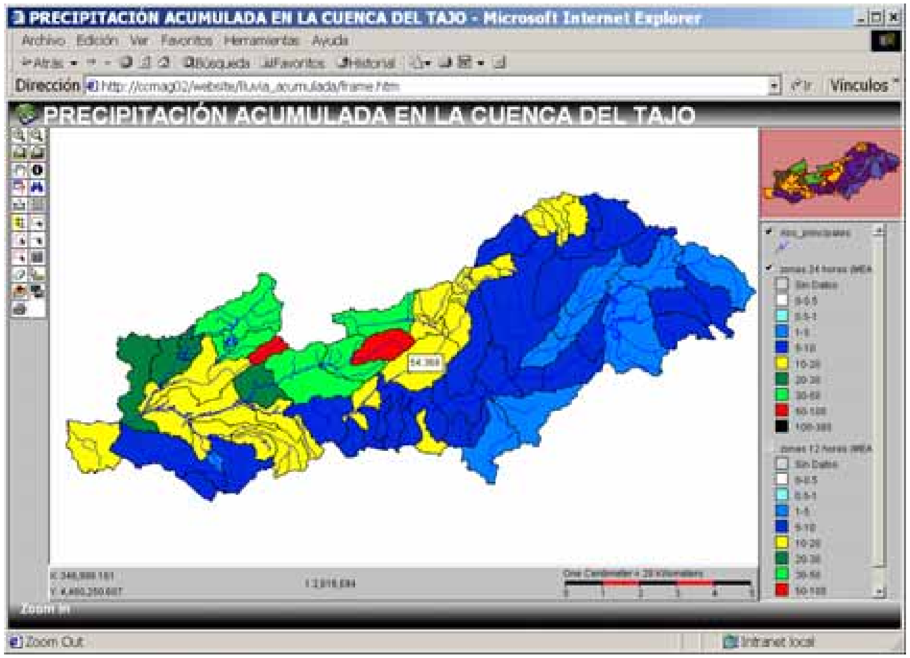


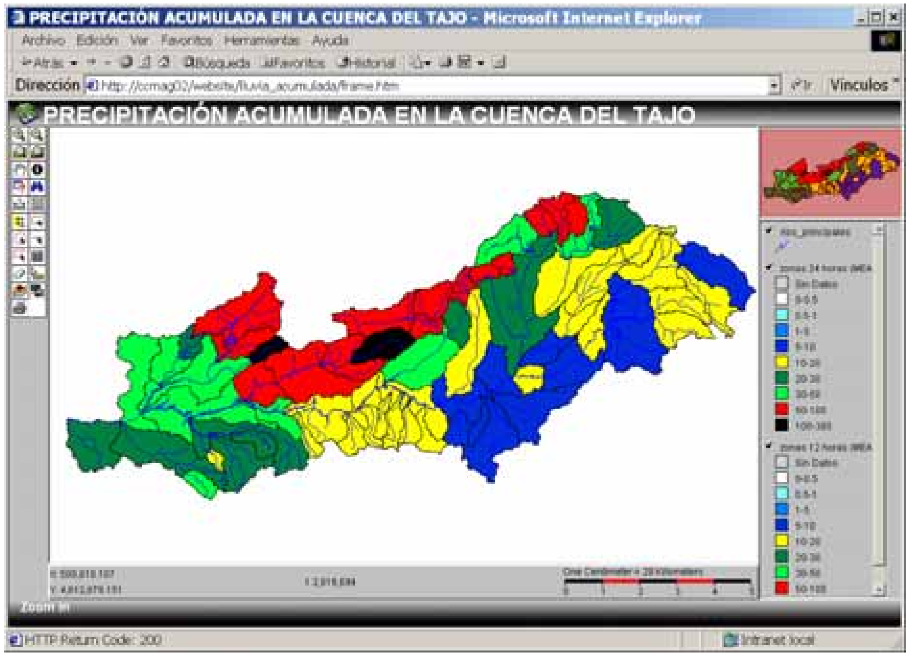
87 Large Dams

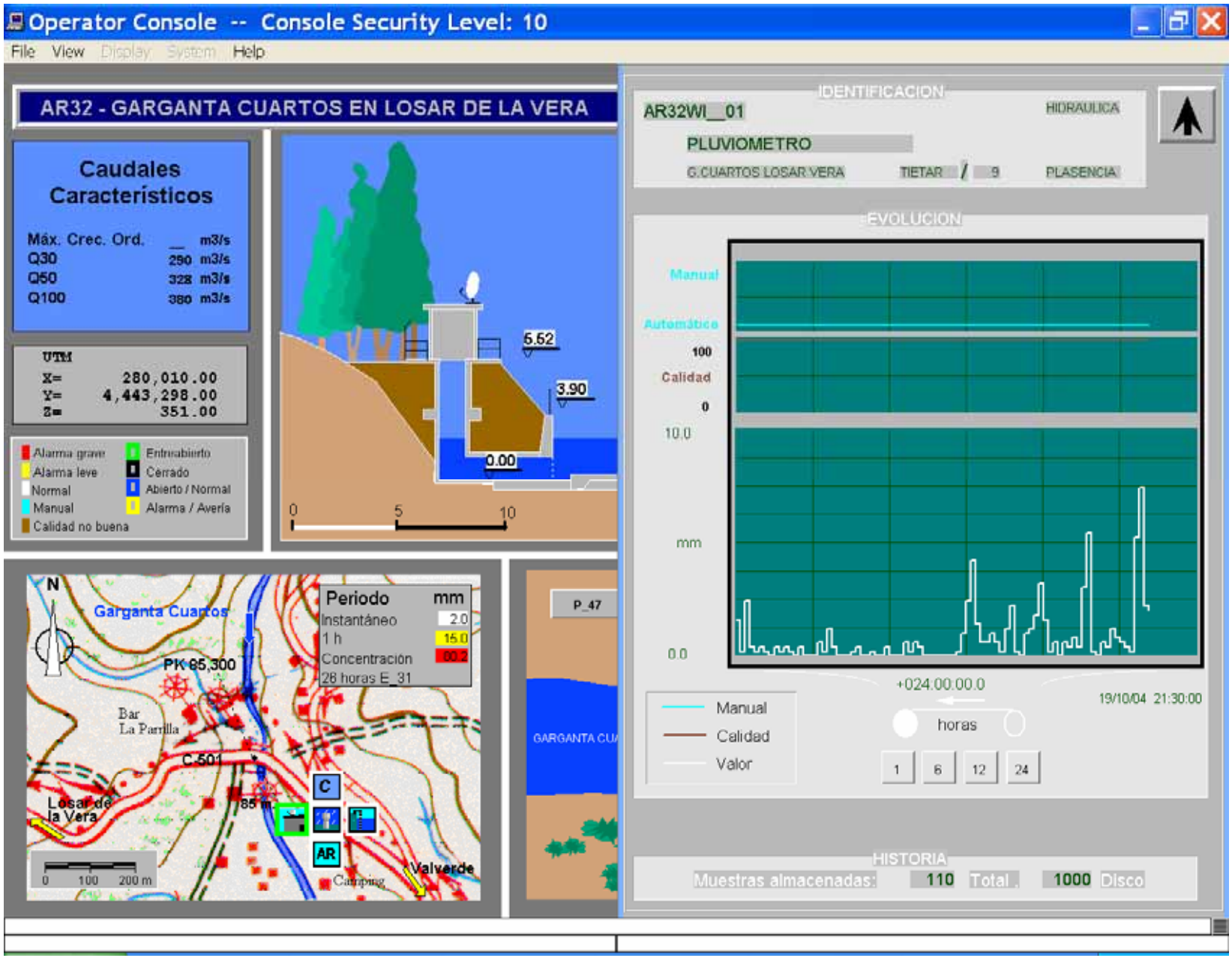
- 1-2 hm³
- 2-5 hm³
- 5-10 hm³
- 10-25 hm³
- 25-50 hm³
- 50-100 hm³
- 100-500 hm³
- 500-1000 hm³
- 1000-2000 hm³
- >2000 hm³

Areal rain fall in sub basins








Operator Console -- Console Security Level: 10
File View Display System Help
AR32 - GARGANTA CUARTOS EN LOSAR DE LA VERA
Caudales Característicos
Máx. Crec. Ord. __ m3/s
Q30 250 m3/s
Q50 328 m3/s
Q100 380 m3/s
UTM
X= 280,010.00
Y= 4,443,298.00
Z= 351.00
Alarma grave
Alarma leve
Normal
Manual
Calidad no buena
Entreabierto
Cerrado
Abierto / Normal
Alarma / Avería
5.52
3.90
0.00
0
5
10
N
Garganta Cuartos
PK 85,300
Bar La Parrilla
C-501
Losar de la Vera
85 m
C
AR
Valverde
Camping
0 100 200 m
Periodo mm
Instantáneo 2.0
1 h 15.0
Concentración 00.2
28 horas E_31
P_47
GARGANTA CUA
IDENTIFICACION
AR32WI__01
HIDRAULICA
PLUVIOMETRO
G.CUARTOS LOSAR VERA
TIETAR / 9
PLASENCIA
EVOLUCION
Manual
Automático
100
Calidad
0
10.0
mm
0.0
Manual
Calidad
Valor
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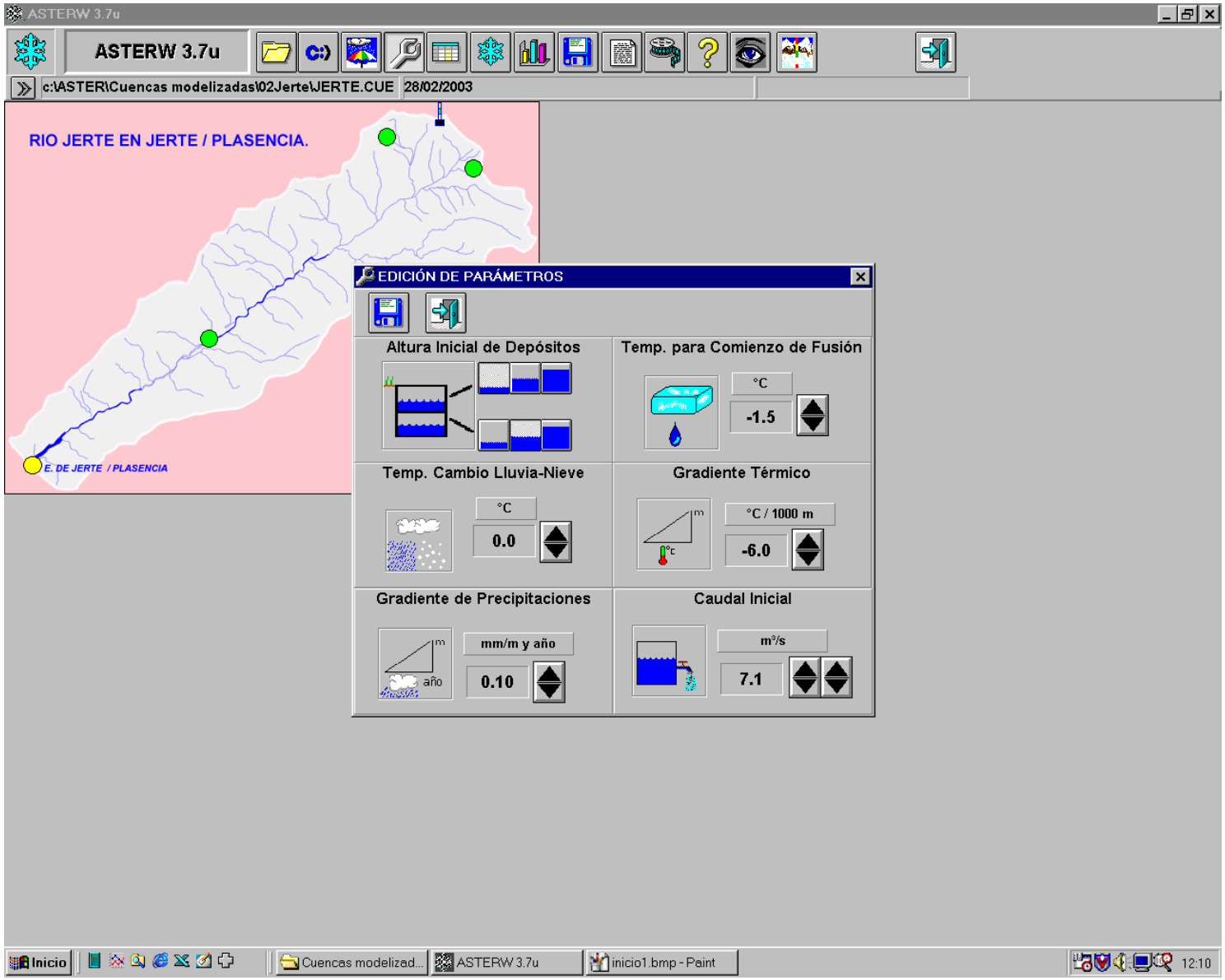
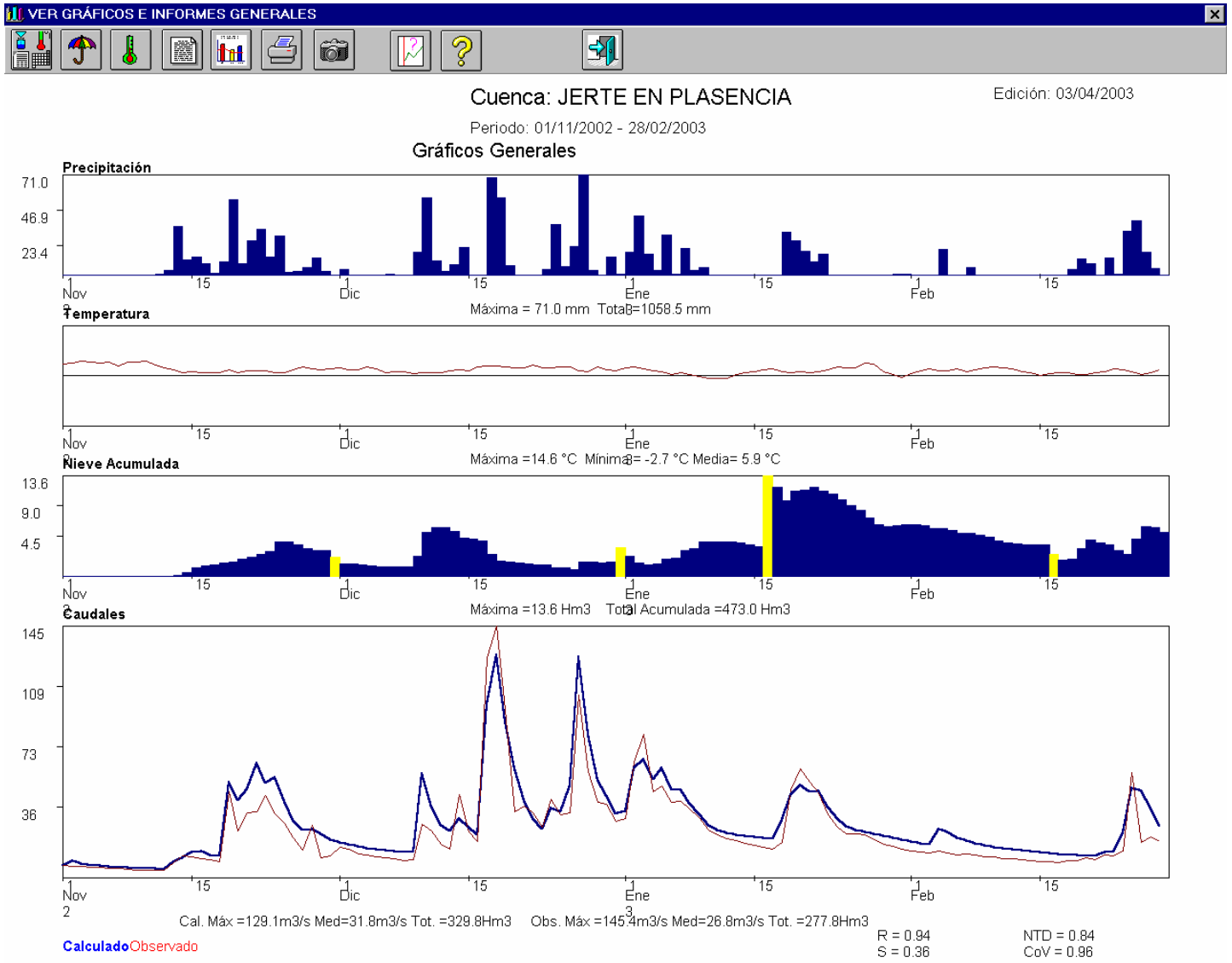
horas
1
6
12
24
HISTORIA
Muestras almacenadas: 110 Total 1000 Disco


ASTERW 3.7u
ASTERW 3.7u
c:\ASTER\Cuencas modelizadas\02Jerte\JERTE.CUE
28/02/2003
RIO JERTE EN JERTE / PLASENCIA.
E. DE JERTE / PLASENCIA
EDICIÓN DE PARÁMETROS
Altura Inicial de Depósitos
Temp. para Comienzo de Fusión
°C
-1.5
Temp. Cambio Lluvia-Nieve
°C
0.0
Gradiente Térmico
°C / 1000 m
-6.0
Gradiente de Precipitaciones
mm/m y año
0.10
Caudal Inicial
m³/s
7.1
Inicio
Cuencas modelizad...
ASTERW 3.7u
inicio1.bmp - Paint
12:10


VER GRÁFICOS E INFORMES GENERALES
Cuenca: JERTE EN PLASENCIA
Edición: 03/04/2003
Periodo: 01/11/2002 - 28/02/2003
Gráficos Generales
Precipitación
71.0
46.9
23.4
Nov
Dic
Ene
Feb
Máxima = 71.0 mm Total=1058.5 mm
Temperatura
Máxima =14.6 °C Mínima= -2.7 °C Media= 5.9 °C
Nieve Acumulada
13.6
9.0
4.5
Máxima =13.6 Hm3 Total Acumulada =473.0 Hm3
Caudales
145
109
73
36
Cal. Máx =129.1m3/s Med=31.8m3/s Tot. =329.8Hm3 Obs. Máx =145.4m3/s Med=26.8m3/s Tot. =277.8Hm3
Calculado Observado
R = 0.94
S = 0.36
NTD = 0.84
CoV = 0.96

III f. International bodies

International bodies: Albufeira Agreement

Cooperation Agreement for protection and sustainable use of international basins between Spain and Portugal (**Albufeira** 11/30/98). Rivers included:

- Miño y Limia (Norte)
- Duero
- Tajo
- Guadiana

In case of flood a continuous data interchange is produced between INAG (Portugal) and Spanish River Basin Authorities (Norte, Duero, Tajo and Guadiana)

Conclusions (1/2)

- It is necessary to develop a **long-term strategy** in order to reduce territory vulnerability. Keys:
  - Preparedness.Prevention and mitigation measures
  - Early warning systems
  - Civil protection plans

  → Small and medium basins are prone to **flash flood**. At these conditions early warning systems are less efficient (no time for contingent plans response). **Radar utilities** could be appropriate .

- At long time **preventive measures** are economic and ecological more efficient. But some times **structural solutions** could be required.
  - Dams play a important role dealing with flood management in Spain. Must be operated in a adequate way for a successful flood management

Conclusions (2/2)

- **Land use allocation** should be treated with a proper approach, according to **risk criteria**. Coordination among different authorities (territory management, municipalities, civil protection, water authorities…) is required
- **Flood risk maps** could provide a important information for a appropriate **land planning**
  - Greater transparency on land management under the perspective of a better knowledge of risks for the location of different land uses
- **International rivers** Flood Risk Management Plans should be **coordinated** at basin level

Thank you for your attention