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Protection of the whole catchments providing drinking water

Study of practices in Europe

Part I: Cross-Analysis

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This study is a translation of the French report "*Protection des aires d'alimentation des captages en eau potable – étude de pratiques en Europe*". It is composed of the two following parts:

- Part I: Cross-Analysis

In this part are presented the context, the methodology put in place and the results of this study. These results consist of an analysis of all the information gathered in the four countries studied. In this first part of the report, you will also find the whole references used.

- Part II: Annexes

This part is constituted by all the annexes of the complete report with: the country factsheets (one per country, about 15 to 25 pages each one), data about DWS catchment protection in many countries (not only the 4 which were studied in-depth) and explanations about the methodology put in place to realise this study.

Only the part I of the complete report has been translated in English. So, the English version does not include the annexes (presenting country factsheets gathering the national information available in the French report). It rather includes the context and objectives of the study and the cross-analysis of all the good practices found in France, Spain, Germany and United Kingdom concerning the protection of drinking water abstraction points against diffuse pollution.

Parts I and II written in French and this English Part I are all available at:

http://documentation.oieau.fr/notice/Synthese-technique-Protection-des-aires-alimentation-des-captages-en-eau-potable-en-Europe

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Abstract

This study, carried out in 2015 by the International Office for Water (OIEau), with the support of the National Agency for Water and Aquatic Environments (Onema) and the Water and Biodiversity Directorate (DEB) of the French Ministry of Ecology, Sustainable Development and Energy, aimed at identifying and analyzing the strategies put in place by Member States in order to protect drinking water abstraction points against diffuse pollution. Diffuse pollution, mainly due to agricultural activities, is one of the biggest environmental challenge faced by European waters, which will not reach a good ecological status. This was underlined by the European Commission in its recent report (March 2015) on the progress in implementation of the Water Framework Directive (WFD). Ninety per cent of European river basin districts are thus affected and the measured impacts are increasing.

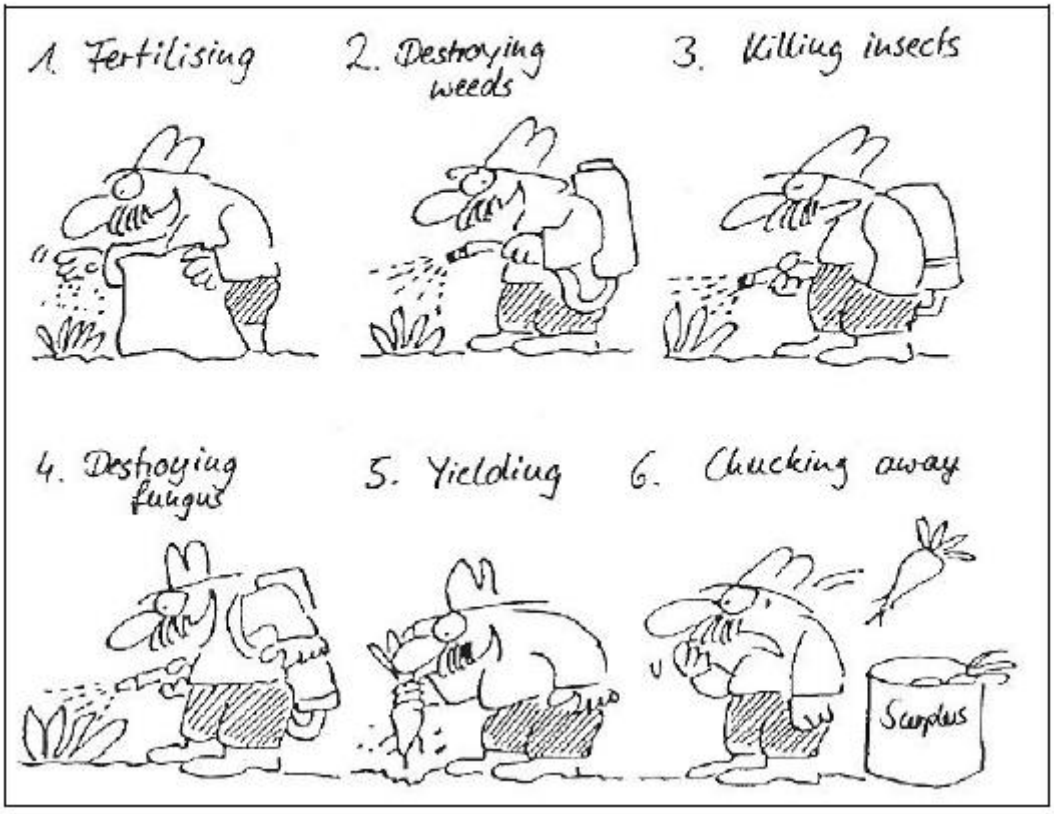
The main objective of this study was to identify the good practices developed to control diffuse pollution, in order to consider potential application in France. This compilation of knowledge is also embedded in Onema and OIEau Science-Policy Interface activities (SPI) and knowledge brokering carried out for many years. The results of this study were used to feed a workshop on diffuse pollution, which was held during the annual conference of EUROPE-INBO (EUROpean group of the International Network of Basin Organizations). This event, which occurred on October 21st 2015, in Thessaloniki (Greece), gave the opportunity to the participants to exchange on their own practices. The main ideas of these exchanges will be edited in an Onema's official publication.

Four countries were studied: France, Spain, United Kingdom and Germany. The results presented in this report resulted from a review of literature. The document presents the method and the cross-analysis based on information gathered for each country.

Key words

Abstraction points, drinking water, water catchment, diffuse pollution, nitrates, pesticides, sustainable agriculture, national strategies, action plans, mitigation measures, stakeholders involvement, regulatory or voluntary initiatives, founding

„Modern Agriculture“



Source: Renate Ald (Prüter and von Nordheim, 1992, p. 2)

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Abbreviations

AAC	*Aire d'Alimentation du Captage*
AC	Autonomous Communities of Spain
AEMt	Territorial Agro-environmental Measures
ASTEE	*Association Scientifique et Technique pour l'Eau et l'Environnement*
BMP	Best Management Practice
CFE	Campaign for the Farmed Environment
COST	COoperation in Science and Technology
CPP	Catchment Protection Perimeter
CSF	England Catchment Sensitive Farming Project
DRWPAs	Drinking Water Protected Areas
DUP	*Déclaration d'Utilité Publique*
DW	Drinking water
DWS	Drinking Water Supply
EUROPE-INBO	European Group of the International Network of Basin Organisations
LAWA	*Länderarbeitsgemeinschaft Wasser* Collective working group between German lands for the water sector)
MS	Member State
NVZ	Nitrate Vulnerable Zones
NWRM	Natural Water Retention Measures
OF	Organic Farming
Onema	*Office National de l'Eau et des Milieux Aquatiques* The French National Agency far water and aquatic environments
OIEau	*Office International de l'Eau* International Office for Water
SgZ	Saveguard Zone
SPZ	Source Protection Zone
SUDS	Sustainable Urban Drainage System
VI	The Voluntary Initiative
WHO	World Health Organization
WFD	Water Framework Directive
WPZ	Water Protection Zone
ZSCE	*Zones Soumises à Contraintes Environnementales*

Terminology

French terms	English or Spanish related terms
Captage	Water abstraction Water catchment Catchment for drinking water
Champ captant	Water catchment area (the wellfield)
Point de prélèvement	Abstraction point
Prélèvement d'eau destinée à la consommation humaine	Abstraction of water for human consumption Water withdrawal (American English)
Forage	Borehole
Puits	Well or drill
Source	A natural source, a water spring
Périmètre de protection	Water protection zones Drinking water protected areas Drinking water safeguard zones **Dwsz** (RU) Surface water safeguard zones **Swsz** (RU) Groundwater safeguard zones **Gwsz** (RU) Groundwater source protection zones Water supply protection areas Intake water zones Source Protection Zones **SPZ**
Aire d'alimentation du captage	Whole catchment
Bassin d'alimentation du captage	Área de alimentación Whole catchment
Pollution diffuse	Diffuse pollution Nonpoint pollution
Mesure d'atténuation	Mitigation measures
Plans d'action (au sens large)	Catchment Action Schemes Water Catchment Action Plans

I. Introduction

In Europe, several types of resources are used to produce drinking water. The supply of drinking water for citizens being a major public health issue, it is then crucial to preserve the quality of raw water used to produce safe water for human consumption. However, in France, as it is also the case in all the Member States (MS), many surface water and groundwater bodies are affected by pollutions linked to nutrients (nitrogen and phosphorus) or to pesticides, mainly due to agricultural activities.

To ensure both the quality of water intended for human consumption and the drinking water standards, public bodies usually tend to give preference to curative methods. However, only preventive measures aiming at protecting raw waters from diffuse pollution may help to protect water resources in a sustainable way and to limit water treatment costs. This notably implies the implementation of better agricultural and non-agricultural practices in the whole catchment areas that provide drinking water.

In France, several tools and initiatives exist to ensure this protection. However, the implementation of these measures turns out to be complex, owing to numerous parameters such as technical, human and socio-economical. The objective of this study is thus to realise a review of literature on the practices put in place in several member states to protect drinking water abstraction points, in order to compare their strategies and initiatives, at national as well as local levels, and then to draw good practices that could be applied in France.

The report begins with a presentation of the method used to realise this comparative study of European practices, then it goes on with a cross-analysis of the main good practices before concluding. [1]

Note for the reader:

Some bibliographic references available in the different studied countries, concerning the protection of drinking water abstraction points against diffuse pollution, are mentioned all along this document. This is not an exhaustive list, but a gathering of the whole documents that have been used to realise and write this study.

We also do want to specify that in part IV, in which is presented a cross analysis of experiences collected in the 4 studied countries, the bibliographic references are not systematically mentioned, on the one hand because they can be found is the country sheets (available in annexes of the French version) and on the other hand because this chapter results of synthetic analysis made by the authors of this report.

II. Context and objectives of the study

II.1. Context

This study falls within the framework of a work carried out from several years by Onema and OIEau to promote an interface between scientists and politics of the water sector in Europe. For 2015, the action on the SPI thematic (Science Policy Interface) was more focused on the step of knowledge transfer, with several missions: notably the comparative studies about Member States experiences and practices about different issues all dealing with the implementation of the water framework directive (WFD). Given the recent publications from the European Commission concerning water resources quality in Europe, it appears that one of the major issues today is diffuse pollution. This is why the first study on European

[1] All the initiatives and practices identified in France, Spain, United Kingdom and Germany are gathered in detailed "country sheets" (available in the annexe 1 of the French version of the study). In addition, more information about the examples presented in the report, all the bibliographic references and useful links have been listed in annexe 3 and all the documents used are recorded in the CD accompanying the French report.

practices concerning the implementation of WFD, was focused on the protection of water catchments used for the production of drinking water, in particular against diffuse pollution.

II.2. Objectives

Diffuse pollution of European water resources is one of the current major issues, which was already mentioned in the Blueprint to Safeguard Europe's Water Resources in 2012. Moreover, in its communication of March 2015 relative to the progress of the WFD and the flood directive implementation and to the assessment of the Programmes of Measures (PoM), the European Commission pointed out the increasing effects of diffuse pollution, which are now obvious and measurable in the water quality of all MS. 90% of the European hydrographic districts are thus impacted by diffuse pollution: 50% of surface water bodies and 33% of groundwater bodies.

The control of non-point source pollutions and the protection of water catchment areas against these pollutions (from agricultural, human and industrial origins) are crucial and the aim of this study was to identify the national or local instruments and strategies developed in several MS to carry out this mission. The main goal of this study was therefore to identify successful experiences, related ways of implementation but also to highlight the potential bottlenecks with the potential aim of finding practices of which France could take inspiration.

This study is also carried out by OIEau to support the Research and Development Department of Onema on projects with European extent. The conclusions of this report have hence feed a workshop on diffuse pollution organised by Onema with the support of OIEau during 2015 EUROPE-INBO annual conference.

III. Method used to carry out the comparative study

III.1. Selection of the countries

This study is based on the analysis of 4 countries[2] France, Spain, United Kingdom and Germany.

These countries were selected for their geographical and political proximity with France, but also because some studies and some contacts led us to think that these MS could have a quite advanced reflection on the thematic.

According to the statistical data on water produced by Eurostat[3] (from March to July 2014), several observations can be made on each of the studied countries:

- Although none of these countries is in a water stress situation (volume of freshwater available per inhabitant superior to 1700 m^3 per person), France, United Kingdom, Spain and Germany belong to countries having the lowest level of annual freshwater resources (< 3000 m^3 per inhabitant).
- There are considerable differences in the total quantities of abstracted water, which shows the volumes of available resource, but also the practices of abstraction which vary according to the climate and the predominant activities of each country (agriculture, industry).
- Some differences appear in particular if we look at the type of abstracted resource (surface water, groundwater or non-freshwater) (cf. Figure 1).

[2] The information related to each country is presented in the annex I of the French report composed of country sheets which describe the national actions put in place to protect the catchments used for drinking water supply, particularly those implemented to control diffuse pollution

[3] Report and data available online :
http://ec.europa.eu/eurostat/statistics-explained/index.php/Water_statistics

These differences in the main type of activities (industry or agriculture) in the different countries, combined with the differences linked to the available resources, lead to different national behaviours regarding the control of diffuse pollution, as mentioned in part IV (page 17).

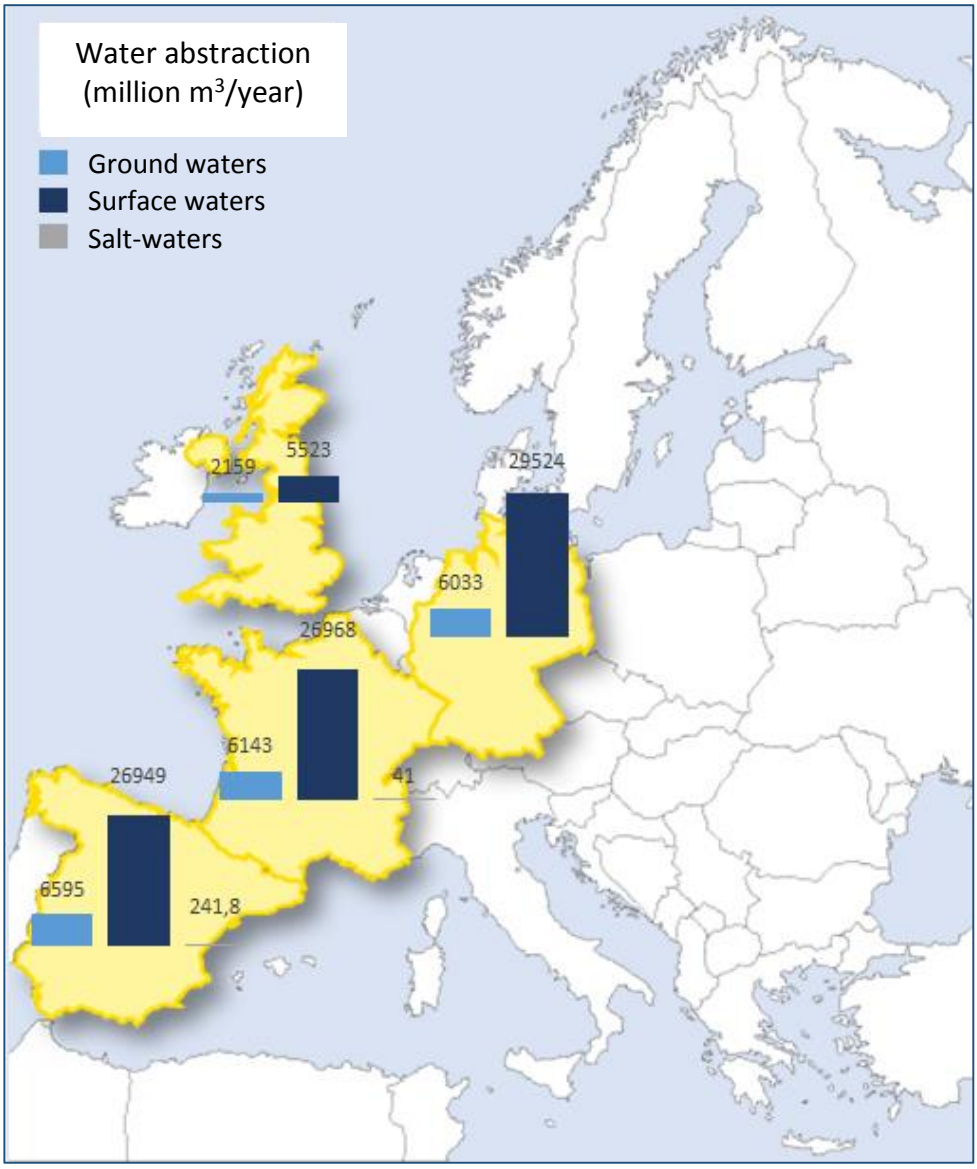


Figure 1: Map showing the annual volumes of abstracted water per type of resource (OIEau, 2015)

III.2. Source of information

Several options were possible to complete this study: a bibliographic research, interviews or both.

The thematic being quite complex, with many legal texts, guides and documents, we choose to begin with the literature's review in each of the studied countries before gathering stakeholders' contact details. Finally, regarding the time allocated to carry out this study, it was not possible to make interviews but we participated to meetings gathering the whole stakeholders of the thematic, in France, that provides us a clear view of the reality and of the difficulties encountered on the field. Moreover, it allows us to gather additional experiences which are presented in this report.

As the diffuse pollution control is mainly related to the protection of water resources against nitrates and pesticides from agriculture, a lot of information was found by focusing our researches on the existing regulations on these types of pressures.

To study France and United Kingdom, we had to make researches in numerous sites because the information is not centralised in a unique place. For Germany and Spain, we were moreover facing the problem of the availability of documents in English. Indeed, as we were looking for reports or guides applicable at the river basin level, these documents were written in Spanish or German. In this cases, we asked native people to translate relevant data and tables. Sometimes, we found (rarely) documents in English when the countries wanted to communicate about some examples of good practice for the WFD implementation.

III.3. Presentation of the results

To tackle the study issues while adapting to the information available through the literature review, the following content was used for each country.

- Key figures
- National regulatory framework
- Guides and national plans for the protection of DWS catchments
- Delimitation of the different protection areas
- Diagnosis tools to identify 'water-sensitive' areas
  - Cartography of the vulnerability
  - Territorial diagnosis of pressures
- Action Plans or other strategies implemented
  - Stakeholders and organisation
  - Incentive and regulatory tools
  - Grants and funding
  - Type of measures
  - Implementation of action plans
  - Assessment of the long term efficiency of the measures

According to the quantity of information found, it was sometimes not possible to fill in all the fields.

All the initiatives identified during our literature review are listed in the Table 1.

Table 1: Summary table of tools and approaches identified in the 4 studied countries (OIEau, 2015).

		Studied countries			
		France	**Germany**	**Spain**	**United Kingdom**
Technical support for stakeholders	Software tools for farmers				PLANET, MANNER-NPK et ENCASH
	Software tools for other stakeholders	CoClick'Eau			
	Technical factsheets				SWARM Farming & Water Scotland Project PINPOINT Tried & Tested
	Agricultural Councils				The Farming Advice Service The Agriculture & Horticulture Development Board Professional Nutrient Management Group The River Trusts Campaign for the Farmed Environment
	Others	Re-Sources Programme "Eau en Saveurs" ACT'EAU			The Yellow Fish Demonstration Test Catchments
Approaches dedicated to water abstraction catchments	Tools	3 Catchment Protection Perimeters "Aires d'Alimentation d'un Captage" "Zones Soumises à Contraintes Environnementales" Territorial Diagnosis of Pressures	3 protection zones for water abstraction points (p. 61)	3 CPP to protect water quality 1 CPP to preserve water quantity 1 CPP to prevent from saline intrusion 1 safeguard zone to protect from diffuse pollution	Water Protection Zones Safeguard Zones Source Protection Zones

	Actions and measures	Action Plans in AAC Programmes of actions in ZSCE	Measures detailed in PoM "Cooperation" project Restrictions of activities in abstraction protection zones Land purchases and conversion to organic farming (cities of Leipzig and Munich,) Collective agreements in the Weser-Ems district	Restriction of activities in CPP	Limitation of potentially polluting activities Action Plans in SgZs Drinking Water Safety Plans and Water Catchment Schemes of the Water companies responsible for DWS, ex. Scamp of the company United Utilities and Upstream Thinking of the company South West Water's
Initiatives to support diffuse pollution control **(indirect protection of catchments)**	Diffuse pollution in general		Subventioned and voluntary-based agro-environmental schemes, ex. : MEKA, KULAP	Codes of Good Agricultural Practices	Pollution Prevention Guidelines Codes of Good Practices SuDS Agri-environmental Schemes Catchment Sensitive Farming Catchment Action Plans The 4PointPlan, Scotland
			Compulsory programmes Ex. : SchALVO	Measures detailed in PoM	
	Nitrates	Programmes of action in Nitrates Vulnerable Zones Operations "Ferti-Mieux" and "Agri-Mieux"			NVZ
	Phytosanitary products	Plan "Ecophyto" "Phyt'Eaux Cités"			The Voluntary Initiative

IV. Results and cross-analysis

IV.1. Regulatory framework for the protection of water abstraction catchments

IV.1.a. European framework

The protection of catchments dedicated to produce water for human consumption is part of the objectives of the **WFD (2000)** aiming at reaching a good ecological status for all the European water resources and at preventing them from any deterioration of the quality, as it is described in article 4, through the establishment of all necessary measures needed to recover the quality of the resource (article 11). In addition, the article 7 explains that the MS must protect the DWS catchments so as to improve the quality of raw water abstracted and to anticipate any deterioration of their quality to reduce water treatment costs.

In each studied country, the WFD was transposed to the national law in the form of a water law in which the rules concerning the protection of water abstraction points are set up. However, instead of establishing new protection strategies, it rather had restated or completed already existing rules; more or less applied by now, as it is discussed in the following chapter.

The protection of water abstraction points from diffuse pollution is also made through the application of the **Nitrates Directive (12th December 1991)** which aims at reducing nitrates pollution, caused by agricultural activities. In this context, each MS had to define and produce maps of areas so-called « nitrates vulnerable zones » (NVZ) in which programs of action must be implemented to reduce nitrates pollution linked to agricultural activities. Among the numerous initiatives dealing with the protection of DWS catchments against diffuse pollution which were identified, several are therefore linked to the application of this directive.

IV.1.b. National framework

In France, catchments protection perimeters were established by the law of 1964 and additional tools were then created to protect DWS catchments, such as the designation of ZSCE (« *Zones soumises à Contraintes Environnementales* », meaning « Areas With Environmental Restrictions ») in the LEMA law of 2006 (law on water and aquatic environments). This law had also established the delimitation of AAC (« *Aires d'Alimentation des Captages* ») which corresponds to the whole area in which water from infiltration or surface runoff will feed the abstraction point. This term, only used in France, seems to be equivalent to the term "Whole Catchment" used in the UK. The delimitation of such areas aims at identifying the zones in which actions should be focused (through the establishment of an action plan) so as to control diffuse pollution.

In Germany, the law on Water Regime of 1957 is the framework law enacting the rules to be respected in each land. This law was modified several times: in 2010 for the last time, so as to transpose the WFD into the national law. Concerning the DWS catchments protection, each land establishes then its proper law (*Land Water Act*), which takes or complements the national rules. Moreover, so as to coordinate the action of each land and to ease the collaboration between lands in the field of water resources protection, a working group was created: the *Länderarbeitsgemeinschaft* (or LAWA).

In Spain, catchments protection zones were already mentioned in the Spanish water law (*La Ley de Aguas*) of 1985, revised in 2001 to transpose the WFD. An official guide for the creation of these protection zones was published in 1991 and updated in 2003, by IGME (*Instituto Geológico y Minero de España*). In addition to the national law, applied through royal decrees, the DWS catchments protection is ensured by the application of the legislation of each autonomous community.

In the United Kingdom, the three following laws are governing the water resource protection: the Environmental Protection Act (1990, revised in 1995), the Water Resources Act (1991) and the Water Act (2003). In addition, some plans and national strategies, written by the Environmental Agency, are also relevant for each of the four nations comprising the United Kingdom: such as for example the strategy for England and Wales of 2009.

IV.1.c. Incitative and/or statutory tools

In France and in Germany, the protection of water resources and in particular of the DWS catchments is done via obligatory measures and/or plans, but also via initiatives and local or national plans based on a volunteer involvement. Voluntary actions is different from charity. These actions can be supported in order to accompany changes of practices recommended by the plans. In the United Kingdom, all the actions carried out are mainly based on a voluntary commitment. Finally, in Spain, despite less available information, it seems the actions carried out (restriction of activities around DW abstraction points) are compulsory.

In all the studied countries, mandatory restrictions of activities have been enacted inside the protection perimeters or zones delineated around water abstraction points[4].

Later in this report, we tried to gather on one hand the initiatives and tools for direct protection of DWS catchments (chapter IV.2), i.e. the actions whose goal is to protect directly the abstraction points and also the whole DWS catchments, and on the other hand the initiatives whose objective is to control diffuse pollution.
These last approaches whose focus is not directly to protect the DWS abstraction points, but which contribute indirectly to protect them, are gathered in chapter IV.3 and are called « action plans to control diffuse pollution » or « measures for indirect protection of abstraction points ».

IV.2. Which approaches for direct protection of the water abstraction points?

As just said, the first way set up to protect the quality of raw water and the abstraction systems is the delineation of more or less concentric protection zones or perimeters. Direct protection is described in this chapter.

IV.2.a. Delineation of protection zones

In all the studied countries, the delimitation of protection areas is based on the prevention of the potential impact of human activities which can pollute water resources. Although the denomination of these protection areas is different in the four countries, the object is similar.

The delimitation of these zones, areas or perimeters is generally linked to the desired degree of protection and includes the following areas:

- an immediate protection area around the abstraction points to avoid direct pollutions of the source and to protect the abstraction systems,
- a protection area based on the estimated time needed to reduce the presence of a pathogen at a tolerable degree,
- a protection area based on the estimated time necessary to permit the dilution or the attenuation of the amount of pollutant before it reaches the resource,
- a fourth larger area is sometimes added to protect the whole river basin in order to avoid a long-term deterioration of the resource.

The different approaches used to delineate these protection areas are based on (i) the distance from the abstraction point, the aquifer drawdown (ii) the time for a contaminant to move towards the resource, (iii) the time needed for attenuation processes reducing the quantity of pollutant and (iv) finally the natural hydrogeological limits. Therefore, according to the country and to the amount of available data, the delineation of these protection areas is done either using somewhat arbitrary criteria or following more complex approaches with calculations and modelling.

The main tools and initiatives for direct protection of water abstraction points are summarised in Table 2.

[4] More information is available in the annexe 1 of the French report on the restrictions of activities

Table 2: Principal protection tools of the DWS catchments in the 4 studied countries (OIEau, 2015)

	Tools/policies of protection	Description and extent	Objective	Means of action	Regulatory scope
France	Catchment Protection Perimeters, CPP	3 CPP : - immediate PP: some m² - close PP: 10 to 100 ha - distant PP	Mainly to control point source and accidental pollutions	Restrictions of activities, Financial compensations, land purchase, easements.	Obligatory for all abstraction points. Validated by an official document: the DUP.
	Aires d'Alimentation du Captage, AAC	Catchment area feeding the abstraction point (can vary from 50 to more than 150 000 ha)	To control diffuse pollutions.	Action plans: measures and prescriptions of activity changes which could be financed the first 3 years, land purchase	Non-compulsory. The measures can be enforced if necessary
Germany	Protection zones around water abstraction points	3 areas (radius of 2 km around the catchment)	Zone 1: facilities protection Zone 2: protection against bacterial pollutions Zone 3 : protection against chemical or radioactive pollutions	Restriction of activities.	Obligatory with financial compensations set out in the water law
Spain	Protection zones around water abstraction points	3 areas to which are associated 3 protection perimeters	To protect water quality from microbiological and chemical pollutions	Restriction of activities.	Obligatory in the immediate PP. Obligatory or adjustable in the 2 other areas
		1 extra area	To protect water quantity		
		1 additional area if necessary	To protect from saltwater intrusion		
	Zonas de Salvaguarda	Larger than the protection perimeters	To protect the water body in its wholeness (not only the	Restriction of activities depending on the pressures identified in the territory	Obligatory.

			catchment), in particular from diffuse pollutions.	Encouraged measures.	Non-compulsory (decided case by case by each basin agency).
United Kingdom	*Source Protection Zones* (SPZ)	3 concentric areas: SPZ1 (the closest of the catchment), SPZ2 and SPZ3	To protect from point-source and accidental pollutions. Raise awareness of citizens about the importance of protecting groundwater quality	Advice through guidelines on *Pollution prevention advice and guidance*. Codes of good practices. Activities subjected to the delivery of *Environmental Permitting Regulations.*	Non-compulsory. SPZ1 is however always delineated around catchments.
	Saveguard Zones (SgZ)	Around the resources where pollution is increasing	Delimited around resources already affected by diffuse pollution. Control diffuse pollution.	Voluntary measures promoted, in collaboration with the water supply companies and mainly focused on agricultural practices.	Non mandatory.
	Water Protection Zones (WPZ)	For polluted sources	Control against diffuse pollution, when other means of protection have failed.	Regulatory measures decided by the Environment Agency concerning all polluting activities (not only agriculture).	Obligatory.

Table 3 gathers the zoning methods used by several countries, among which the 4 countries studied in this report.

Table 3: Comparison of the protection areas established in several countries

Countries	1st Area	2nd Area	3rd Area	4th Area
Germany	10-30 m	50 d	Entire river basin	
Austria	< 10 m	60 d	Entire river basin	
Belgium	10-30 m or 1 d	100-1000 m or 50-60 d	2 km (chemical protection) or Entire river basin	
Denmark	10 m	60 d or 300 m	10-20 years	
Spain	1 d (100-400 m²)	60 d	4-10 years	Area to protect water quantity and sometimes to control saltwater intrusion
United-States	30 m	165 m or 50 d	15-20 years	
France	10-20 m	50-60 d	Entire river basin	
Holland	10-150 m or 50-60 d	~800 m. 10 years	~1200 m 25 years	Entire river basin (50-100 years)
Italy	10 m min	200 m min	Entire river basin	
Ireland	100 d or 300 m		Entire river basin or 1000 m	
Portugal	20-60 m	40-280 m or 50 d	50-2400 m or 3500 d.	Optional, in the form of specific satellite areas
Quebec	1-30 m	100 m or 200 d	200 m or 550 d	
United Kingdom	50 d or 50 m min	400 d 250-500 m	Entire river basin	Optional, linked to a particular activity
Switzerland	10 m	100 m or 10 d min	Size of 2nd area doubled	

Comment: We produced this table by combining several sources over our readings and bibliographical searches.

For the protection perimeters, which target the protection from point-source and accidental pollutions, calculations are often based on the time that would take a contaminant, which would be discharged at a certain distance of the catchment, to reach the groundwater reserve. This is the reason why, in the table above, it is either radius (in distance) or times (of transfer) that are indicated for the delineation of the protection areas. For a same country, there are sometimes different distance intervals for the same area (example: 50-2400 m for area 2, in Portugal) due to different calculation models according to the type of aquifer: karstic, porous, fractured aquifers, etc.[5]

In addition to these protection perimeters, some countries define further protection zones, with different goals, as for example: the delimitation of AAC in France and the *Water Protection Zones* in the UK to control diffuse pollution or the larger safeguard zones in Spain (cf. Table 2).

Furthermore, depending on their history, their geography and their climate, some countries have developed specific strategies to cope with the variability of resource availability: mainly the lack of water in certain regions of Spain. Thus, referring to the above table in Italy and in Spain, additional areas are defined to protect the quantity. In the UK, in order to protect both the quality and the quantity of

[5] An illustration of such zonings is presented in Annex 3 for several countries in the French report

abstracted water, each river basin writes a CAMS (Catchment Abstraction Management Strategy) which aims at regulating abstractions for the different uses.

Finally, in several of the studied countries, we found that the perimeters which had sometimes been delimited some decades ago are being re-delineated in order to adapt the protection to diffuse pollution: in Germany and in Spain, in particular.

As stressed by the publication of the World Health Organization (WHO, 2006), the establishment of such areas to protect catchments is particularly effective in protecting them from diffuse pollution. However, it is also said that control of this type of pollution is particularly problematic for groundwater, because the pollution sources are less obvious to identify and the impact is therefore less easily predictable. This is the reason why the control of diffuse pollution is based on the restriction or proscription of certain type of activities in these specific areas.

IV.2.b. Restriction of activities in protection areas and perimeters

Restriction of activities exists in the four studied countries. The closer the area is from the abstraction point, the more important are these restrictions, which reflects an increase of the risk of pollution. These restrictions are applied to agricultural, urban and industrial activities and also to other specific activities such as transport and tourism.

They are mandatory and regulated in France, Germany and Spain, but not in the United Kingdom where volunteer initiatives, advices and good practices are promoted.

In Germany, restrictions are established at national scale, and then generally declined in a more detailed and stricter way in the legislation of each land. In the end, local authorities (counties) publish these restrictions in the Official Gazette.

In Spain, the restrictions of activities are enacted at the national scale in a National Hydrographic Plan and in the Water Law, and then declined with more details in each river basin management plan. However, the Autonomous Communities (AC) are not the authorities competent to enforce land use restrictions; these ones are therefore decided by each community, in accordance with the rules of each AC and with the river basin agencies.

In France, any activity not related to water services is forbidden inside of the immediate protection perimeter, which must be fenced. In the close protection perimeter, activities which could affect directly or indirectly the quality of water are either forbidden or subject to special requirements. These rules for land-use, regulations or prohibition of activities result in easements, which are established after a public survey, in a "*Déclaration d'utilité publique*" (DUP), i.e. Declaration of Public Utility. Finally, in the distant protection perimeter which is not systematically delineated, some polluting activities can be regulated, but it is mainly used to inform about the vulnerability of this sector which corresponds to the whole catchment area.

IV.2.c. Which other actions in these perimeters or areas?

As we have just seen, the main action in these protection perimeters, whose aim is to protect the catchments from point source and accidental pollutions (most of the cases), consists in restricting potentially polluting activities. Only the UK rather promotes advices, education, prevention guides and good practices.

For the monitoring and verification of the implementation of the rules of activities restriction, the responsibility generally goes to local stakeholders: the ARS (Regional Agency for Health) and territorial facilitators in France, the municipalities in Germany. However, this level of information could not be found in our literature review.

Specific measures are also implemented in WPZ in the UK and in AAC in France, with the purpose of controlling diffuse pollution, as it is discussed in the following chapter. In addition, we found several

examples of land purchase in the first 2 perimeters, of conversion to organic farming, of rural tenancy agreements under certain conditions or of afforestation (cf. case studies of the Water4All project).

IV.3. Which action plans and policies to control diffuse pollution?

Aside from this direct protection, several of the studied countries have elaborated action plans and/or programmes of measures dedicated to control diffuse pollution. Several approaches, regulatory or based on volunteerism, and more or less subsidised, were identified in our literature review. This chapter is dedicated to present them.

IV.3.a. Action plans and initiatives

As written in the dictionary on environment and sustainable development, « ***diffuse pollution*** *is a pollution of water which is not due to point-source and traceable discharges, but to loads coming from the whole surface of a territory and reaching aquatic environments indirectly by or through the ground, under the influence of the driving force of water from rainfall or irrigation. Agricultural practices on a cultivated area may be the source of diffuse pollution by the traction of pollutants in percolation waters or storm waters* ». Diffuse pollution can also be due to industrial and urban activities and the main pollutants covered under the protection of catchments are: **nitrates** and **pesticides**. The concentrations of these two parameters determine most often the proper or improper nature of a raw water to be used to produce drinking water.

We therefore focused a part of our literature review on examples of actions aiming at reducing pollution by nitrates and pesticides. We have not really identified in Spain, in Germany or in the UK, strategies or tools similar to the French Action Plans developed in AAC. We have however gathered many schemes, plans and initiatives whose purpose was either to protect directly the catchments, or to control diffuse pollution in general.

Strategies dedicated to control nitrate pollution

First of all, we want to mention the **programme of actions** implemented by each country **in the NVZ** (Nitrate Vulnerable Zones), in accordance with the Nitrate Directive. Such a programme is usually written at the national level and is then validated and monitored by the European Commission. Local programmes of actions are then elaborated on the basis of this national plan, but with adaptations to the specificity of each territory and with the reinforcement of some measures for the most polluted areas.

In addition to these programmes, some countries have developed national plans of actions, such as ***Opération Ferti Mieux***, launched in 1991 in France. Its aim was to limit and control the risk of diffuse pollution by nitrates from agricultural sources by changing the practices of farmers in the catchment areas, on the basis of voluntary measures and local partnerships. This operation has stopped since 2000, but the work has continued through the ***Opérations Agri-Mieux***. These two operations have demonstrated their effectiveness in reducing nitrate concentrations in raw water and were mentioned as examples in DEFRA guides, in the UK.

In Germany, to control the increasing pollution of water bodies in highly cultivated areas, mandatory agro-environmental schemes (with financial compensation) were established in some lands. The best known example is the **SchALVO**, introduced in 1988 in the land of Bade-Wurtember. This programme mainly focuses on the limitation of nitrate inputs and on the implementation of measures which are imposed to farmers in certain sensitive areas.

In Germany, in the south of the land of Saxony, the municipal water service of the city of Leipzig organised a dual strategy with the purpose, in the long term, of reducing nitrate concentrations in their raw water to 25 mg/L. First, they bought and converted to **organic farming** a large proportion of lands

located in the groundwater catchment area. Then, they signed contracts with the local farmers to protect DWS catchments[6].

Strategies dedicated to control pesticide pollution

The EU Framework Directive 2009/128/CE of 2009/10/21 had established a European common framework for action in order to promote a sustainable use of pesticides. In this context, each MS must develop and implement a national plan for the reduction of pesticides on its territory. Several countries have thus developed plans to tackle this particular issue.

In France, we can name the example of the **Ecophyto plan** aiming at reducing the use of pesticides, with a 50% reduction target by 2018. This plan aims at reducing the use of pesticides in order to improve water quality, to preserve biodiversity and to reduce the risk of exposure for operators and consumers.

In the UK, one of the best-known initiatives is the **Voluntary Initiative** launched by the government in 2001 to promote good agricultural practices in terms of reduction of pesticides use. This initiative, which was originally developed as an alternative to the introduction of a pesticides tax, has developed greatly in the UK. Nevertheless, in 2005, the Environment Agency concluded that none impacts on water quality could be measured in relation to the implementation of the Voluntary Initiative.

Other policies dedicated to control diffuse pollution in general

In the four studied countries, the control of diffuse pollution goes first through writing **Guidelines of good agricultural practices** (cf. bibliographic references in each country). Some measures dedicated to control agricultural pressures are also present in the **programmes of measures** accompanying their river basin management plans.

Moreover, plans and tools were sometimes developed in some countries, from national to local scale, as shown in the table below.

Table 4: Examples of initiatives to control diffuse pollution - not systematically dedicated to protect water abstraction points (OIEau, 2015)

Countries	Scale	Initiative	Objectives
France	*National*	**Action plans** in AAC (can be supported by the **ZSCE** process, which has a regulatory value)	To protect catchments against diffuse pollutions through the implementation of measures in accordance with all concerned stakeholders: farmers, watershed managers, mayors, etc.
	Regional	The **Re-Sources** programme, realised voluntarily by the communities supplying water	To bring all the local stakeholders together, with aid of a facilitator, in order to look for solutions and stimulate changes of practices.
United Kingdom	*National*	The **Environmental Stewardship** scheme	Regulated system with 3 levels of requirements (3 entry levels), which allow delivering subsidies to farmers who implement measures to protect environment, while respecting very strict rules of compliance. Some of these measures specifically concern the protection of water resources. One of the entry levels corresponds to OF.

[6] As presented in details in the Germany "country sheet" in annexe of the French report, the city of Munich also opted for the conversion to OF, with a different approach but with equally satisfactorily results.

	Regional	**Drinking Water Safety Plans**, developed by water companies	The plans, which are elaborated by water companies responsible for the supply of drinking water, contain measures dedicated to control diffuse pollution.
	watershed	**Water Catchment Scheme or Catchment Action Plan**, developed by water companies	This programme of action's goal is to work at improving the quality of raw water through an integrated approach for managing water resources. This new approach for water companies was driven by the government who published in 2011 the strategic document "*Water for Life*", notably reflecting their strategy to address diffuse pollution. These plans are not dedicated to the protection of water abstraction plans; they deal with the protection of the resource as a whole.
	Local	Project CSF: **Catchment Sensitive Farming**	This project was led by *Natural England*, in partnership with DEFRA and the Environment Agency, in order to reduce diffuse pollution through training and advising for farmers, in areas classified as presenting a "high environmental risk ", in England.
Germany	*Länder*	The **agro-environmental programmes** (13 subsidized voluntary programmes)	Example of the programme of the land of Baden-Württemberg, which is composed of two plans: the **MEKA** and the LCR. The MEKA is used to finance a more sustainable agriculture and comprises measures classified by themes of action, of which is the protection of water resources.
	Länder	The **Kooperation Project**, in the land of Lower Saxony	The main objective was to use a cooperative and interdisciplinary approach to solve the conflict of interest between groundwater protection and intensive farming, in areas of water abstraction. Such agreements include the establishment of agro-environmental measures in exchange for subsidies and technical training for farmers.

IV.3.b. Stakeholders and types of partnership

In **Germany**, the direct protection of catchments by the delimitation of protection zones is carried out by drinking water companies and by the municipalities. The decision and the respect of activity restrictions in these areas fall under the responsibility of local municipalities.

Concerning the control of non-point source pollution, several examples of agreements were also found at the Länder scale. Some contractualised agreements are thus signed locally between municipalities and farmers to protect the whole catchments feeding groundwater resources used by water companies to produce DW for this municipality (cf. Munich). In the case of Leipzig, the city also opted for purchasing sensitive land that they converted to OF.

Several agro-environmental programmes (volunteers and subsidized) were also set up in the lands (ex.: the MEKA), in addition to the mandatory and regulatory measures already put in place to protect the catchments (ex.: the SchALVO). In these 2 cases, the government of each land provides subsidies to farmers who implement some more environmentally friendly practices. These subsidies are funded by taxes paid by consumers and their payment is subject to control.

In the district of Weser-Ems of the land of Lower Saxony, cooperative groups (advisory structures) were created thanks to the money coming from the tax on water abstraction, introduced in 1992. These groups bring together local water authorities (leadership), water producers, farmers and agricultural organizations. Today, 17 groups exist and include almost all the farmers and water suppliers. Moreover, about 50 voluntary agreements were established to change farming practices so as to reduce diffuse pollution. The change in practices goes along with a financial assistance and free technical advice. The tax is also partly used to purchase lands that water producers then lend or rent to farmers only on condition that they respect certain rules.

In **United Kingdom,** most of the action to control non-point source pollution from agriculture is based on volunteering. Agro-environmental programmes are highly developed and many plans are elaborated by public or private water companies, as for example: the Drinking Water Safety Plans and the Catchment Action Plans.

We also found an interesting initiative in the UK which is intended to raise awareness of citizens about the potential impact of human activities on the pollution of water resources. Several initiatives were therefore developed in all the nations of the UK, on the basis of the Yellow Fish programme. The idea is to paint a yellow fish in areas where pollution due to human activities is likely to affect the environment and therefore to pollute water reserves, such as a sewer drain. This initiative goes together with educative actions in schools.

More than knowing which stakeholders were involved in the different countries, we have also heeded the means used to motivate and involve all these stakeholders.

IV.3.c. Key Factors for the mobilization of stakeholders

Our literature review enabled us to identify some key factors which were decisive in the success of actions programmes set up to control diffuse pollution:

- Involve all the stakeholders right from the start of the elaboration of the programmes of measures or the action plans.

We can quote here the example of the cooperative groups created in the land of Lower Saxony which gave birth to 50 voluntary agreements. In France, the programme Re-Sources and the tool CoClick'Eau[7] also illustrate this need for help, from the various stakeholders, to build action plans.

- Provide technical and free advice to farmers, achieved by agricultural experts through many different formats: face to face, in-situ, group sessions, site demonstrations directly in the fields, etc.

It is one of the key messages that emerged during the "Feedback" workshop which we attended in April 2015. This message was echoed by many other initiatives presented throughout our report. Many organizations and associations ensure therefore the technical training for farmers, such as for example the AHDB (The Agriculture & Horticulture Development Board), the Professional Nutrient Management Group and campaign CSF (Catchment Sensitive Farming) in the UK.

- Support farmers in those changes of practices by the development of dedicated tools and technical documentation.

Several websites have been developed to provide technical information to farmers and also trainers, with summary technical sheets. We can cite as examples: Farming & Water Scotland for Scotland and Swarm (cf. the UK country sheet).

Tools to help farmers implementing balanced management of nutrient, pesticides or fertilizers inputs were also developed and are essential to support farmers in their changes of practice. We can mention as examples the free software used in the UK: PLANET, MANNER-NPK and ENCASH.

- Demonstrate that the effectiveness of the measures and of the changes of practice that are proposed to farmers, have been proven (ideally based on scientific results demonstrating the reduction of diffuse pollution).

To this end, many research projects are funded in the four studied countries to prove this efficiency:

- the MOPS project concerning measures to reduce levels of P and N in water (UK)
- the SOWAP project testing different cultivation techniques to reduce leaching into water resources (UK)
- the WAgriCO project concerning measures to reduce nitrate concentrations in raw water to reduce treatment costs for water companies (UK / Germany)
- the Life NIRATES project (2011-2015) whose aim is to estimate the effectiveness of the programmes of actions introduced in vulnerable areas to reduce the levels of nitrates in waters (Spain),
- the Life sigAGOasesor project (2012-2015) whose aim is to produce a GIS tool allowing farmers to manage their crops more optimally (Spain),

[7] http://coclickeau.webistem.com/bac/

- all the research programmes funded by the government of Lower Saxony to support their volunteer programmes on different themes such as forest conversion or encouraging organic farming (Germany).

We present later (paragraph IV.7, page 32) a very interesting example in which the efficiency of all the attenuation measures proposed was estimated (case of Chesapeake Bay, USA).

- Identify, with all the stakeholders, indicators to assess the effectiveness of the measures implemented

Defining quantifiable goals would be the best way to gather all the stakeholders around a shared objective which they can be proud of, such as for example: the reduction of inputs (30%), the decrease of nitrate concentration in raw water abstracted (reach 0.25 mg/L in 10 years), the decrease of nitrogen levels in soils, etc.

This is done in the Action Plans developed in AAC in France. But the objectives are often too oriented on the means of actions rather than on the results themselves. We can highlight here the good example of the land of Lower Saxony in which all the stakeholders managed, after lengthy debate, to establish 4 goals: 1 objective on the acceptability of voluntary agreements and 3 measurable ones.

- Do not promote AEMt or changes in practices (OF, crop rotation, etc.) for themselves but as a means to manage water resources sustainably.

This is one of the lessons learned from the cities of Leipzig and Munich. Indeed, it is not about promoting the OF for OF only, but it is about promoting it as a sustainable means of managing water resources and also more generally of managing environment sustainably.

Another similar initiative, with the same concept of promotion, is presented in details in the France country sheet: the label « *Eau EN SAVEUR* » developed by the *Syndicat mixte des eaux du bassin rennais*. Indeed, with the slogan “Eat well or protect my water, why shall I have to choose?”, the idea is to promote agricultural products’ consumption based on more environmental friendly techniques, regarding the protection of water quality (OF, conversion to OF, coherency charter).

- Financing the changes in practices and the proposed measures.

This condition actually emerged as essential in several studies on the acceptability of action plans, such as notably the DTC (*Demonstration Test Catchments*) realised by DEFRA in the UK. Farmers were interviewed and said that their adherence to AEMt was conditioned to the compensations which were allocated. In fact, changes in practices such as the conversion of arable lands, have direct financial consequences on farmers’ incomes.

Several initiatives and programmes of actions mentioned in this report also highlight the importance of the provision of technical advice to farmers in order to demonstrate that these changes in practices do not necessarily imply decrease in their incomes but may also permit to save money, particularly regarding the purchase of raw materials (such as highlighted by *CFE or Tested* & *Tried* in the UK).

IV.4. Measures composing action plans and similar initiatives

The measures constituting these plans generally concern agricultural activities, but also industrial and urban ones, and finally spatial planning. The key measures encountered are summarized in Figure 2 below. We could not exhaustively list in this figure all the measures. For example, the second indent of the box "Agriculture" indicating changes in agricultural practices includes a wide range of technical measures that we didn’t detail: autumnal coverage, choice of one culture or another according to the climatic conditions or the type of geology, promotion of extensive cultivation systems, tillage of compacted soils, seeding nitrate-fixing intermediate crops, sloping sowing, etc. More detailed lists are presented in the country sheets and in the bibliographical references mentioned throughout this report.

Agriculture

- elaboration of good agricultural practices, communication to the farmers (training, exchange workshops, individual training, field demonstrations...)
- changes in practices (land use, crop rotation, farming and grazing, manure management, rational irrigation ...)
- verification of equipments and training to a good use of them
- bringing up to standards facilities and equipments
- limitation of pesticides and nitrogen inputs (including livestock food)
- developement and provision of tools to facilitate a rational management of inputs (MANNER-PLANET or NPK in the UK) and of available technical documentation (SWARM in the UK)
- encouragement of OF
- implementation of NWRM (natural water retention measures)

Industry

- improvement of stormwater management
- better management of aqueous effluents (identification of discharges, storage and pre-treatment or in situ treatment)

Urban activities

- rational management of weedkillers in public green spaces and around road axes
- training of municipal staff to alternative weeding methods
- specific training of citizens to the sensible use of fertilizers and pesticides + raising awareness of the population on this issue (cf. the experience of the Yellow Fish, school awareness programs ...)
- compliance with standards for on-site non-collective sanitation system - implementation of SuDS (Sustainable Urban Drainage Systems)

Spatial planning

- afforestation of vulnerable areas
- purchase of land in close proximity to catchments in order to monitor the activities
- rehabilitation of wetlands
- setting up of buffer zones around watercourses

Other measures

- maintenance of protection perimeters and monitoring of the implementation of plans and measures
- filling of abandoned catchments
- bringing to standards the existing catchments

Figure 2: Summary of the main measures to control diffuse pollution around DWS catchments (OIEau, 2015)

IV.5. Main identified barriers relative to the implementation of the plans against diffuse pollutions

IV.5.a. Complexity of the regulatory framework

In France, as indicated in the 2014 report of the ministry of ecology, health and agriculture (« *Pour une meilleure efficacité et une simplification des dispositions relatives à la protection des captages d'eau potable* » - FR3), the complexity of the regulatory framework surrounding the protection of catchments is a factor that may explain the low implementation of the devices provided by the law.

This complexity results in a difficult setting of action plans by the various stakeholders; communities (contracting authorities) are sometimes lost to know and design all the administrative approaches leading to the drafting of an action plan.

The assignment of roles for each stakeholder is also complicated and not necessarily clarified in the regulations. This is the case in France to identify projects managers for the development of action plans, (as we could notice during the meeting we attended in April 2015, but also in the UK, as indicated in the report of the *National Audit Office* in 2010). It indicates that the delegations of Environment Agency provide the link between the authorities and local stakeholders for the protection of catchments at the watershed scale, but in case of absence of national protocols, the role of each stakeholder is not clear.

The organization seems more framed in Germany; we did not find any hint or reference to any regulatory complexity problem.

Concerning Spain, they seem less advanced in terms of implementation of plans or local/national initiatives referring to the control of diffuse pollution.

IV.5.b. Difficult dialogue among all the actors

The very fact that there could be some uncertainty about the role that each stakeholder should have to play in the elaboration, implementation as well as monitoring of action plans or similar initiatives is in itself a source of difficulty for the development a dialogue among all the stakeholders. Moreover, as it was pointed out in the report on the experience of the Weser-Ems district (land of Lower Saxony, Germany), one of the main barrier to establishment of their voluntary agreements was the stakeholder's perception for one another. Indeed, water producers identified farmers as being the "main polluters" whereas farmers saw water producers as "those who despoil them of their resource."

IV.5.c. Lack of farmers' awareness about the impact of their activities

In many documents assessing the progress of the various initiatives mentioned in the country sheets (mainly for Germany and the UK), we could notice that references were often done concerning the lack of farmers' knowledge on the impact their activities can have on the environment and on water resources. As they have the feeling of being systematically blamed, they tend to be suspicious concerning the advice which could be provided to them. They are often not aware neither of the negative effects of their activities on water resources, nor of the very positive effects that some small changes in their practices could have.

Among the studies carried out in the UK, especially the DTC project, one of the main conclusions following the interview of volunteer farmers, was that those who have never implemented any AEMt were not necessarily aware neither of the extent of the diffuse pollution problem (at both national and European scale) nor of the means to act, despite the free options available which is widely developed in the UK.

It was also evidenced that even when they were trained, farmers were more inclined to apply some measures than others: measures concerning for example their infrastructures rather than measures concerning a modification of their farming methods. As a consequence, some measures like autumnal coverage was weakly implemented, while it is part of the measures whose effectiveness has been scientifically proven, maybe due to the extra workload generated.

Training is a good way to accompany changes in agricultural practices, and it should have to continue over the long term, because some practices (related to agricultural infrastructures) are easier to change than others (those related to cultivation methods).

IV.5.d. Lack of knowledge concerning the behaviour and fate of pollutants

Another issue sometimes makes it difficult to elaborate action plans, as it was especially reported during the meeting we attended in April 2015: the insufficient knowledge of the behaviour and fate of nitrates and pesticides (as well as their degradation in by-products) in soils and waters. This last point concern the farmers but also more generally the whole stakeholders. A lot of studies and scientific projects allowed to have a rather good understanding of nitrates transfer mechanisms, but the behaviour of pesticides is much more complex to establish, even nowadays.

Moreover, it is difficult, if not impossible for now (depending on the pollutant), to predict the necessary time to see the first positive effects of the measures implemented to protect DWS catchments from diffuse pollution and to decrease the levels of nitrates and pesticides (individual and aggregate concentrations) in raw water. Although prediction models developed at a water body could demonstrate evidence-based results (mainly about nitrates), they could not necessarily be applied in other hydrogeological contexts. Indeed, many parameters interact and behavioural prediction models are often linked to a particular context, which also implies to have a clear understanding of how rivers function and how groundwater, rivers and water abstractions are interlinked. The results already available show that it could take a few years to several hundred years to observe the positive impacts of action plans implemented today.

It is therefore difficult to define quantifiable targets to associate with action plans aiming at controlling diffuse pollution, which however would help rallying all the stakeholders around a common goal. The objectives to achieve, when they are defined (case of action plans in French AAC or example of the Weser-Eims district in Germany) are therefore more often targeted means of actions (are the measures applied? by how many farmers? etc.) than targeted results to reach (recovery of raw waters quality). An alternative is to establish objectives with definite figures showing a decrease in the use of the incriminated product (nitrates and pesticides) either by following the quantities of products purchased (as it is done for example in the Voluntary Initiative) or by measuring nitrogen concentrations in agricultural soils at different times of one year's worth of crops.

Some examples of positive impacts of measures established to reduce diffuse pollution have however been highlighted in several countries and it could be interesting to produce a handbook of good practices and experiences showing the effectiveness of these measures on the recovery of water resources quality. This type of document would then be very useful to convince all actors to implement such measures.

In this report, the following examples were found:

- decrease of nitrate levels in raw water of the catchment areas surrounding the cities of Munich and Leipzig (Germany) who opted (since several decades) for OF,
- decrease in measured levels of pesticides, observed under the CSF project in the UK,
- decrease of nitrate levels observed in the raw waters abstracted to produce drinking water under the SchALVO Programme (Germany).

To take a bit further the idea of collecting good examples of quality recovery of raw waters thanks to the implementation of measures aiming at controlling diffuse pollution, which can help to motivate the different stakeholders, we gathered in the following paragraph key drivers having made easier the development, implementation or success of action plans.

IV.6. Drivers that enabled / made easier the action for catchment protection

IV.6.a. Mobilization of stakeholders through dialogue, training and motivation around a shared objective

In the UK, to prevent water pollution and protect water resources, the action is mainly based on volunteering, with subsidies. So to encourage farmer's participation in the various voluntary programmes, the government funded the DTC study (Demonstration Test Catchments) between 2012 and 2013. This study allowed the collection of the opinion of many operators on these programmes and the following lessons have been learned:

- the best known measures are those which are part of the necessary requirements for the payment of financial supports,
- the less applied measures are those which induce the most radical changes in practices,
- certain measures, although having proven effectiveness (such as autumnal cover crop), are rarely carried out; this observation emphasises the need to pursue the training of farmers,
- farmers who do not implement any measure have indicated that they would be more likely to adopt measures related to their infrastructures than those related to the management of their cultures.

Paradoxically, while the CSF campaign has shown similar results regarding the increase of farmers' involvement in the UK, the *National Audit Office* wrote on the contrary, in its report of 2010, that the stakeholders' awareness about their role in preventing from diffuse pollution remains a weak point in the UK.

One of the key drivers to mobilize all the stakeholders is therefore to make them aware about the importance of their involvement and the positive impacts of their actions. Moreover, the co-benefit of this should be to increase their acceptability of the plans that are sometimes imposed on them. Training, advice and dialogue are thus essential and the collaborative groups established in Germany are a good example of means to involve all the stakeholders.

IV.6.b. Financial support in changes of practices

As already said in previous chapters, the fact that farmers receive compensations for changing their practices is essential and is often key to success (cf. in particular the results of the DTC survey or the example of establishment of ZSCE in France which are often the guarantee of the implementation of measures because of the financing it implies). Compensation schemes for measures implementation were therefore found in the 4 studied countries.

Changes in practices may need time to be accepted and implemented, so that the financing accompanying action plans must be sustainable. This point was proven to be, in several initiatives, a key argument to encourage farmers to engage themselves in such initiatives. This is really important because it is now well known that the measures should be embedded in a lasting time frame given their positive impact are likely to be visible in the medium to long term.

In order to convince farmers of the interest - not only for environmental protection but also for themselves - to change their practices, advice are given on the two following points:

- on the technique related to the implementation of the measures constituting action plans,
- on the possible financial savings directly resulting from a reduction in the use of pesticides or fertilizers, while maintaining or increasing their productivity, or in the case of OF to an increase in the selling price.

We can mention here the example of the Upstream Thinking Programme (UK) which worked to help farmers improving their environmental performance and which received in 2012 the award for the *Best Partnership Initiative of the water industry*, in particular for its funding approach based on ecosystem services provided.

Some other interesting studies have also shown that the implementation of preventive actions by communities would cost meaningfully less than the increase of raw water's curative treatment. A study in France shows that the measures composing the action plans developed in AAC to control diffuse pollution will, at last, cost less than what would cost curative treatments of raw water. This study "Does preventive cost more than curative?"[8], which was carried out by the Seine-Normandy Water Agency (July 2011), presents economic arguments in favour of catchments protection, based on the study of 21 case studies. The drinking water public service in Leipzig (KLM) reaches similar conclusions and announced that the financial compensation they paid to implement their strategy (for land purchases and conversion to OF) would have cost 7 times less than what would have cost increased curative treatment of abstracted raw waters (mostly because of the big investments they should have supported).

A very simple and useful tool was developed for farmers, under the PINPOINT project in the UK, allowing them to know the financial savings they could achieve by implementing such measures. On the technical and attractive factsheets they produced for each of the AEMt, farmers can find pictures, concrete examples, very technical boxes and also indication on potential saved money.

Finally, several countries have implemented, or at least tested, economic incentives or deterrents, such as:

- compensations for changing agricultural practices - subsidies or compensatory payments,
- pesticides tax in France (under the Ecophyto plan),
- a tax on fertilizers in Germany.

When a tax is brought, it is based on the "polluter-pays principle" and it is intended to act as an economic lever for changing behaviours.

Other examples of economic tools are given in the case studies described under the EC initiative called EIP Water[9].

To conclude this sub-section on the importance of financially supporting the changes of practices and also on the need to develop economic tools to control diffuse pollution by giving priority to preventive actions, we want to stress the very good and complete examples proposed by the EIP Water project we have already mentioned. They give examples of economic instruments put in place to protect water resources[10].

IV.7. Other examples of good practices

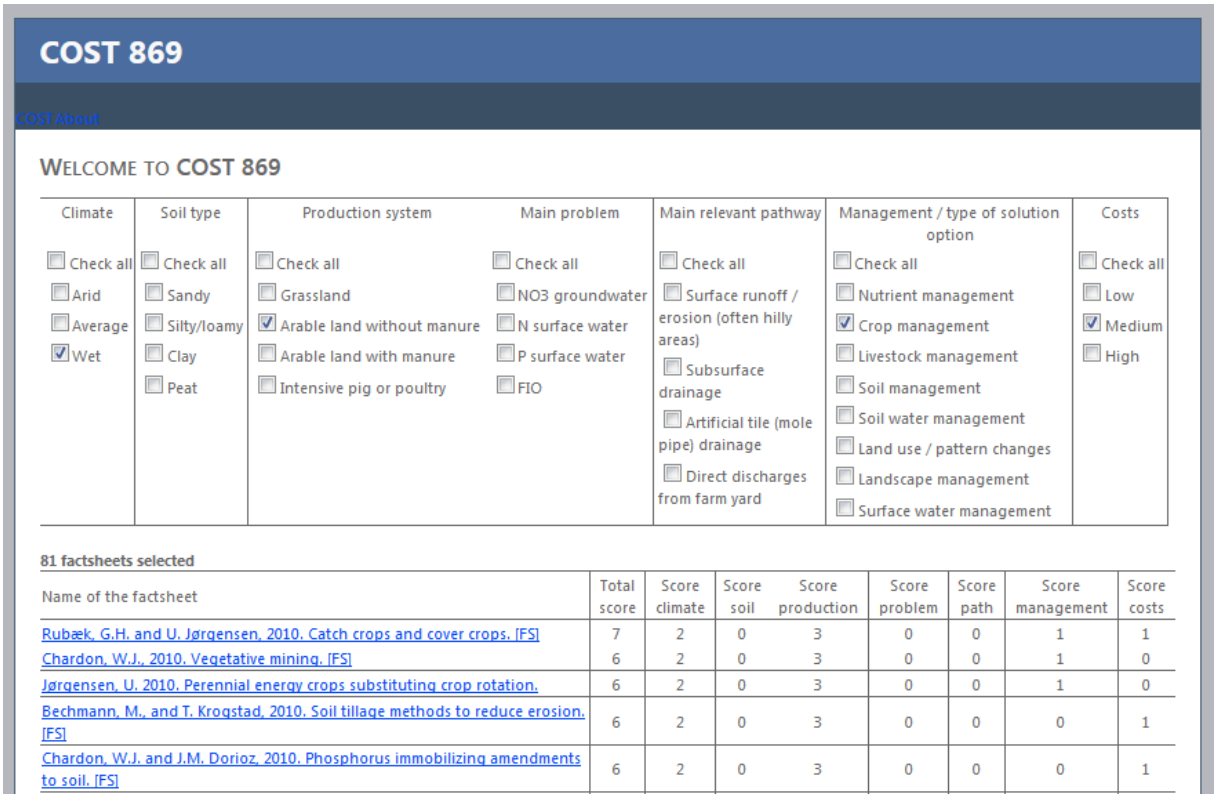
In addition to the initiatives mentioned in each country sheets, which constitute examples of good practices which could inspire France, we have also observed, throughout our literature review, two other projects of great interest:

- a Scientific and Technical Cooperation Action (COST) in Europe, about the mitigation measures dedicated to reduce nitrogen and phosphorus concentrations in surface waters and groundwater .
- a programme of measures aiming at controlling diffuse pollution in the Chesapeake Bay in the United States; this initiative is very interesting because of the model they developed to estimate the effectiveness of measures.

The COST 869 « *Mitigation options for nutrient reduction in surface water and ground waters* » - which ended in late 2011 after 5 years of activity, produced a series of very detailed factsheets on the measures to reduce the inputs of N and P in agricultural activities. What is particularly interesting is

[8] Report available at:
(http://www.eau-seine-normandie.fr/fileadmin/mediatheque/Expert/Prix_de_leau/PreventifCuratif.pdf
[9] For more information: www.eip-water.eu/
[10] Several case studies are mentioned in the country sheets or in the "Bibliographical References" chapter (available in the French version), such as a case study in Denmark on the implementation of a pesticides tax to finance actions to control diffuse pollution

their measures Database (http://www.cost869.alterra.nl/dbase/) which permit to show all the possible measures that can be implemented, depending on the type of climate, the type of soil, the production systems used (drainage, runoff, etc.), the type of solution (crop or soil or manure management, etc.) and costs. The following print screen allows to see the database.



COST 869

COST About

WELCOME TO COST 869

Climate	Soil type	Production system	Main problem	Main relevant pathway	Management / type of solution option	Costs
☐ Check all	☐ Check all	☐ Check all	☐ Check all	☐ Check all	☐ Check all	☐ Check all
☐ Arid	☐ Sandy	☐ Grassland	☐ NO3 groundwater	☐ Surface runoff / erosion (often hilly areas)	☐ Nutrient management	☐ Low
☐ Average	☐ Silty/loamy	☑ Arable land without manure	☐ N surface water	☐ Subsurface drainage	☑ Crop management	☑ Medium
☑ Wet	☐ Clay	☐ Arable land with manure	☐ P surface water	☐ Artificial tile (mole pipe) drainage	☐ Livestock management	☐ High
	☐ Peat	☐ Intensive pig or poultry	☐ FIO	☐ Direct discharges from farm yard	☐ Soil management	
					☐ Soil water management	
					☐ Land use / pattern changes	
					☐ Landscape management	
					☐ Surface water management	

81 factsheets selected

Name of the factsheet	Total score	Score climate	Score soil	Score production	Score problem	Score path	Score management	Score costs
Rubæk, G.H. and U. Jørgensen, 2010. Catch crops and cover crops. [FS]	7	2	0	3	0	0	1	1
Chardon, W.J., 2010. Vegetative mining. [FS]	6	2	0	3	0	0	1	0
Jørgensen, U. 2010. Perennial energy crops substituting crop rotation.	6	2	0	3	0	0	1	0
Bechmann, M., and T. Krogstad, 2010. Soil tillage methods to reduce erosion. [FS]	6	2	0	3	0	0	0	1
Chardon, W.J. and J.M. Dorioz, 2010. Phosphorus immobilizing amendments to soil. [FS]	6	2	0	3	0	0	0	1

Figure 3: Extraxt from the database created by the COST Action 869

This COST illustrates the international cooperation in the issue of control diffuse pollution. This action gathered 21 countries, those indicated in brown in the map below.

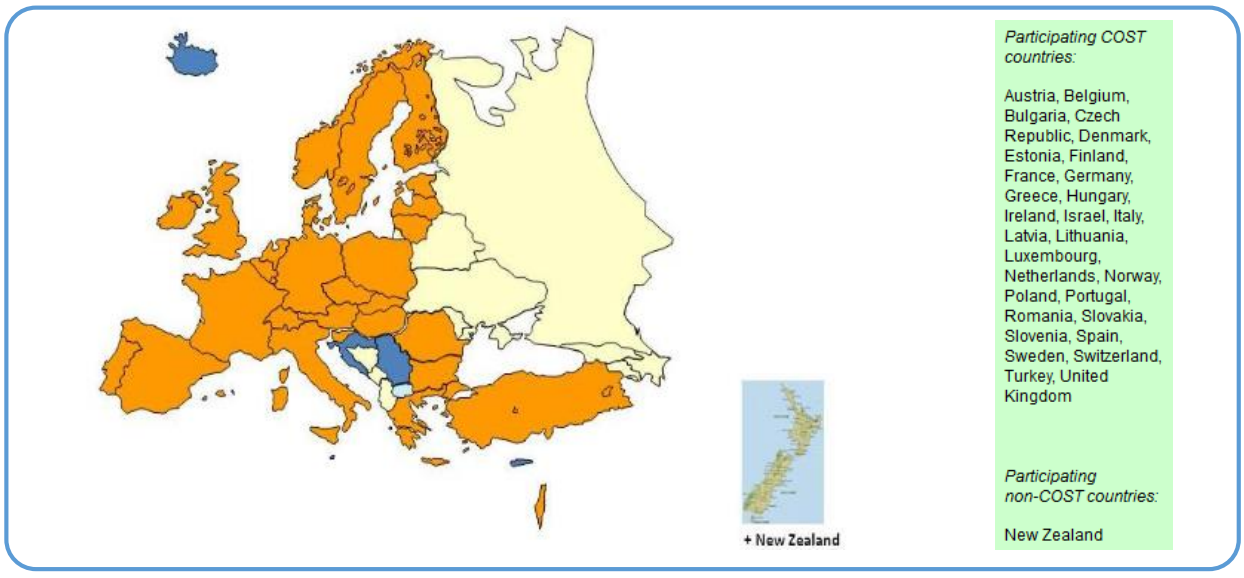


Figure 4: Countries which particpated to the COST Action 869

This international working group also produced a number of scientific publications and documents, such as:

- a **collection of publications** resulting from the final conference of the COST action « *Proceedings of International Conference on Realistic Expectations for Improving European Waters* » (October 2011); this compendium provides scientific support and proofs of the importance of implementing these measures and on their effectiveness in reducing diffuse pollution of waters in Europe,
- the **final report of the action** published in February 2011 (147 p) and containing all the measures used in the 21 countries participating in the COST (one hundred has been identified). One of the working groups (WG3) specifically worked on the assessment of measures effectiveness. Thus a final list of 80 measures was completed. These measures have been gathered in the 8 following categories:
    - Management of nutrients (28)
    - Management of crops (1)
    - Management of livestock (7)
    - Management of soil (18)
    - Management of water (11)
    - Modification of land use (1)
    - Management of landscape (8)
    - Management of surface water (9)

One factsheet per measure was developed by a group of researchers, and then checked by other participants from all the MS participating in this COST action. Each sheet contains the following items:

- General description of the measure
- Summary / principle of action
- Applicability
- Efficiency (including uncertainty)
- Schedule
- Environmental co-benefits / pollution flows
- Potential target
- Costs in terms of investment and workforce
- References

This COST action brought together the knowledge available in many MS on the mitigation measures that can be taken in agriculture. It also revealed the lack of numerical data expressing their efficiency in improving the quality of raw water. Indeed, if we only consider the item "efficiency" of these factsheets, we can see that the data show a reduction of N and P in cultivated soil or dirty water, but the impact on water resources (surface or groundwater) is not measured in itself.

Available resources:

- **EU1** – Collection of publications from the du COST 869 Final Conference *« Proceedings of International Conference on Realistic Expectations for Improving European Waters »* (2011)
- **EU2** - Final Report of the COST 869 action *« Mitigation options for reducing nutrient emissions from agriculture - A study amongst European member States of Cost action 869 »*, Report Alterra, O.F. Schoumans (Ed.), W.J. Chardon (Ed.), M. Bechmann, C. Gascuel-Odoux, G. Hofman, B. Kronvang, M.I. Litaor, A. Lo Porto, P. Newell-Price and G. Rubæk (2011)
- **EU3** - « *Mitigating diffuse pollution from agriculture: International approaches and experience* » A.L. Collins, M. Stutter and B. Kronvang. Science of the Total Env. 468-468, p. 1173-1177 (2014)

Best Management Practices implemented in the Chesapeake Bay Watershed: a basin wide framework[11], (October 2014)

During our literature review, we found a particularly interesting study. Although it describes a feedback outside Europe (Maryland - United States), it could provide examples of good practices applicable in Europe and France.

Figure 5: Localisation of the Chesapeake Bay

Having observed eutrophication problems in the Chesapeake Bay, linked to different pollution sources (point source and diffuse), local authorities have decided to carry out an in-depth study to identify and characterize these different sources of pollution. From this overview, they established an action plan to reduce this pollution. Regarding diffuse pollution, a series of measures and practices were listed: *agricultural, forestry and urban storm water best management practices (BMPs).* The implementation of these BMPs is referred annually to the US Environmental Protection Agency (EPA) so as to feed a model, acting as a management tool and enabling to estimate the progress in terms of reduction of nutrient and sediment levels ("*effectiveness estimates*") associated with these BMPs.

V. Conclusions and perspectives

This study aimed to collect examples of good practices set up by four European countries as part of their strategy to protect DWS catchments from diffuse pollution, in order perhaps to highlight ideas on what could be replicated in France. The three following aspects were addressed: stakeholders and governance, technical measures composing action plans and diagnostic tools.

The work carried out was almost entirely based on a literature review and helped to produce one "country sheet" per studied country which provides a complete (but not exhaustive) overview of the strategies and tools developed in four European countries to control diffuse pollution and to protect DWS catchments. Examples of good practices that are proven to be effective were thus collected in Germany, United Kingdom or Spain and are presented in the country sheets (in annexe 1 of the French report) and a cross analysis of them helped to provide opportunities for reflection that may be useful in France. However, some concrete information, mainly about governance and stakeholders - their identity and role in developing, implementing and monitoring action plans to control diffuse pollution, at the catchment scale - could not be found. To obtain this kind of information, we would have had to identify the stakeholders in each of the countries, at different scales, and to conduct interviews. Unfortunately, the time needed to realise this study did not allow us to perform this additional work.

The results of this work were used for the 13th annual conference of the EUROPE-INBO in October 2015 in Thessaloniki (Greece). A workshop was organized ahead of the conference on the theme of the struggle against diffuse pollution. The results of this study feed part of the debates. The objective of the workshop was to enable representatives of European basin organizations to share their practices and experiences. Most of these exchanges will be the subject of a publication "Onema meetings."

[11] For more information: http://www.chesapeakebay.net/