WFD and Agriculture –
Analysis of the Pressures and Impacts
Broaden the Problem's Scope

Interim Report

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Foreword

As a result of a process of more than five years of discussions and negotiations between a wide range of experts, stakeholders and policy makers, the Water Framework Directive (or the Directive 2000/60/EC) of the European Parliament and of the Council established a framework for Community action in the field of water policy. The Directive, which entered into force on the 22nd of December 2000, sets a framework for the protection of all waters with the aim of reaching a "good status" of all community waters by 2015.

The latest reform of the EU Common Agricultural Policy (CAP) in 2003 increased the opportunities for the implementation of the Water Framework Directive (WFD). A working document prepared by the Environment Directorate General of the European Commission highlighted a number of opportunities where the CAP can help achieve the WFD objectives (European Commission, DG Environment, 2003). However, achieving these objectives remains a challenge. Acknowledging this, the Water Directors, who are the representatives of the EU Member States administrations with overall responsibility on water policy, agreed in June 2004 to take action in the context of a Common Implementation Strategy (CIS). To this aim, they established an EU Strategic Steering Group (SSG) to address the issues of interrelations between CAP and WFD. The timeframe for the SSG work is short given the tight WFD timetable (developing draft River Basin Management Plans by 2008, achieving the ecological status objectives by 2015) and the timing of CAP developments, notably the development of the European Rural Development Policy (implementation by 2007).

The Strategic Steering Group (SSG) on WFD and Agriculture is led by the UK and the Environment Directorate-General of the European Commission with technical support from the Directorate-General for Agriculture and Rural Development. The aim of the group's work is to identify the issues which affect a Member State's ability to meet WFD objectives resulting from pressures from agricultural sources. The group will also put forward suggestions on how to best manage the risk of not meeting these objectives, taking into account the opportunities of the reformed CAP.

As one of its first steps, the SSG has been preparing a report demonstrating the linkages (direct and indirect) between agricultural activities and water resources' status in 2005. Ecologic and Warsaw Agricultural University (WAU) have been commissioned to prepare this report in the context of the EU research project "WFD meets CAP – Opportunities for the Future"[1].

As not all MS have been covered by the 2005 report, the European Commission, DG Environment commissioned Ecologic together with WAU to update this working document, taking into account:

- the comments received from the SSG members on the 2005 report,
- the 2nd phase analyses of the national synthesis of the WFD Article 5 reports for agricultural pressures by the WRc and consortium partners covering 12 MS; and
- the progress made by JRC and EEA in their FATE[2] and LARA[3] projects.

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1 Contract no. SSP-CT-2005-006618 CAP&WFD.

2 Aim of the project is to develop a set of modelling tools putting in relation nutrients pressures from various sources (e.g. agriculture, background losses) and water quality

3 The EEA summarises its activities on integrated assessment in the area of water and agriculture in its work programme under the project "Linkages between agriculture and water quality (LARA)".

In addition, the report is mainly based on:

- the 1st phase analyses of the national synthesis of the WFD Article 5 reports for agricultural pressures by the WRc and consortium partners covering 11 MS and four international river basins;
- the EEA activities on source apportionment of nitrogen and phosphorus inputs into the environment; and
- the IRENA operation on agri-environmental indicators[4].

The following report establishes a foundation for future work on the linkage between the Common Agriculture Policy and the Water Framework Directive.

This report is still a *living document* that will need continuous input and improvements as application and experience build up in all Member States of the European Union and beyond.

For further information on the detailed activities please contact:

- **National synthesis of the WFD Article 5 reports for agricultural pressures**: Anne Gendebien, WRc, 29 rue des pierres, B-1000 Brussels, Belgium; Email: gendebien_a@wrcplc.co.uk
- **LARA project including IRENA assessment**: Jan-Erik Petersen, European Environment Agency, Kongens Nytorv 6, DK-1050 Copenhagen K, Denmark; Email: jan-erik.petersen@eea.europa.eu
- **FATE project**: Giovanni Bidoglio, Joint Research Centre, Institute for Environment and Sustainability, Soil and Waste Unit, Via Fermi, I-21020 Ispra (VA), Italy; Email: giovanni.bidoglio@jrc.it

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[4] The IRENA (Indicator Reporting on the Integration of Environmental Concerns into Agricultural policy) project has been launched in September 2002 in order to improve, develop and compile the agri-environment indicators identified by two Commission Communications (COM(2000) 20 final; COM(2001) 144 final) at the appropriate geographical level. The project is a collaborative research between DG Agriculture, DG Environment, Eurostat, JRC and EEA.

DISCLAIMER

Please note: the data derived from the national WFD Article 5 reports and summarised in this report has not been reviewed by EU Member States.

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The information compiled in this paper may contain gaps and uncertainties. It is subject to rapid change. The official Article 5 reports are available at the WFD CIRCA server: http://forum.europa.eu.int/Public/irc/env/wfd/library?l=/framework_directive/implementation_documents_1/wfd_reports/member_states&vm=detailed&sb=Title

The information presented is the status as of **October 2006**.

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Executive Summary

Across much of the EU, tackling the pressures on water caused by agricultural activities constitutes one of the main challenges in meeting the WFD environmental objectives by 2015. To broaden the problem's scope, this working document analyses the various pressures from agriculture on water bodies. The paper summarises data from various sources: such as, the analyses of the national synthesis of the WFD Article 5 reports for agricultural pressures by the WRc and consortium partners; the EEA activities on source apportionment of nitrogen and phosphorus inputs into the environment; the IRENA operations on agri-environmental indicators; and the results from the FATE and LARA research projects by the JRC and EEA.

From an agricultural perspective, diffuse pollution with nutrients and hydro-morphological modifications seem to be the main pressures on water bodies, leading to a potentially significant risk of failing to meet the WFD objectives. In terms of nutrients, *nitrogen* compounds are considered to have a greater impact on water than phosphorus compound inputs. However, *phosphorus* can also induce pressures from soil erosion. Indeed, phosphorus is mainly linked to particles of soil and can be transferred to aquatic environments in areas particularly vulnerable to erosion. In many agricultural areas phosphorus is accumulating in soil and can eventually reach levels such that significant amounts will leach (or already have leached) from the soil towards the aquatic environment. This is causing eutrophication problems in surface waters. With regard to active ingredients of *pesticides*, the use of these substances is generally higher in western Europe than in Nordic or eastern Europe. According to the EEA, all countries that reported on the pesticide situation in their state of the environment reports, with the exception of Sweden, mention the danger of pesticide pollution in groundwater.

Agricultural activities such as irrigation, drainage and land reclamation can disturb the natural water balance and thus represent important pressures on water bodies. *Irrigation*, as part of intensive agriculture, including horticulture, has often led to the unsustainable use of water in some European regions. Especially in the southern EU Member States, irrigation increases the risk that available water resources will be over-exploited. *Land drainage* can have a variety of impacts on hydrology and water quality, depending, among others, on the techniques used and the type of soil. The Netherlands and Belgium, as can be expected, have made extensive use of artificial drainage.

Furthermore, land drainage, the intensification of farming practices and inappropriate grazing regimes have contributed to the loss of wetlands and floodplains, resulting in the *hydro-morphological modification* of surface waters. Due to the limited information on hydro-morphology available in the national syntheses of the WFD Article 5 reports, it is not possible to derive general findings on the contribution of agriculture to hydro-morphological changes.

The identified linkages between agricultural activities and water protection render it necessary to look for synergies in present agricultural and water policies. They also show that addressing problems of deterioration in the quality and quantity of water bodies related to agriculture requires multidirectional activities and close co-operation between different sectors.

1 Introduction and Background

Water is a key resource for human needs and environmental quality. Both the contamination of water resources and water balance disturbance through the overuse of water can have far-reaching negative consequences: social (e.g. health problems), economic (e.g. reduced capacity to develop economic activities), and ecological (e.g. decreases in biodiversity). These problems are widespread in Europe because of industrialisation, urbanisation, and the implementation of industrial agriculture methods. The EU has been working on the problem of water quality and resources for more than 30 years. This activity has culminated in the adoption of the Water Framework Directive (WFD), in December 2000, and the current work of the enlarged EU on the linkages between agricultural and water policies.

Agriculture has always had a close relation to water, the latter being an indispensable input for both crop cultivation and animal rearing before being filtered by soils on its way back into ground and surface waters. This relationship remained relatively balanced for millennia. The EU Common Agricultural Policy (CAP) was established after the second world war. At this stage, its emphasis was essentially to encourage an increase in agricultural productivity, so that fair standards of living could be ensured for the agricultural population, and consumers could have a stable supply of affordable food. While contributing to its primary objectives, the CAP caused unfortunate side effects that became progressively evident, related to both agricultural intensification and land abandonment.[5]

Indeed, the CAP contributed to significantly increased **pressures on the environment**, and more particularly on water. The pressures and related impacts have been manifold, among which are (Strosser et al., 1999; Karaczun and Indeka, 1999):

- increased pollution of surface waters and groundwater due to nutrients and pesticide leaching;
- reduction of groundwater and river flow levels as a direct result of water abstractions;
- hydromorphological modifications resulting from the construction of dams and the diversion of watercourses for irrigation purposes;
- secondary effects such as risks of erosion, the disappearance of wetlands (also related to the implementation of drainage systems), oxygen deficits in rivers leading to the possible extinction of species of flora or fauna, or the gradual salinisation of groundwater in coastal areas.
- risks of adverse effects on human health and problems related to water treatment (for consumption purposes) due to water pollution;
- epidemiological hazards due to the improper management of liquid manure;
- increased risks of river flooding due to deforestation (as an effect of agriculture land extension) and installation of polders for agriculture purposes.

However, in addition to exerting pressures, **agriculture can also play a positive role** in respect to water resources and related ecosystems (EC, DG Environment, 2003), such as:

- The preservation of farming activities in mountain and hill zones can ensure the maintenance of positive land management in these areas, which can contribute to the prevention of floods and landslides and, by decreasing the rapidity of peak run-off waters, to a better regulation of the flow pattern and more favourable levels of surface water bodies downstream;

[5] For more information on the development of the CAP, please refer to Herbke et al. (2006).

- Certain farming systems can contribute to the build-up of organic matter in the soil and, thus, to the maintenance or even enhancement of the binding, storage and buffering capacity of these soils, which serves to limit the diffusion of pollution from soil to water;
- In some cases, certain farming systems can contribute to the preservation of wetlands and of other terrestrial ecosystems that depend on water bodies.

Against this background, there is a need to identify the current pressures on water bodies from agricultural sources, the possible benefits to the status of water bodies and related ecosystems that can result from agricultural activities, and the areas where these particularly occur, before defining coherent future actions in the fields of water management and agricultural practices.

This report focuses exclusively on agricultural pressures and their impacts on water bodies, and aims to summarise the available data on this matter. The evaluated data include *inter alia* the analyses of the national synthesis of the WFD Article 5 reports from 23 Member States (MS)[6] and of four roof reports by international River Basin Districts for agricultural pressures, the draft results from ongoing research into agricultural pressures on water by the EEA and the JRC, and additional information gathered from other EU reports and documents.

As the Commission has yet to receive the WFD Article 5 reports on the analyses of pressures, impacts and uses of water from approximately 120 river basin districts in the EU-25, and because the full assessment of all of the Article 5 reports is planned for the end of 2005 to 2007, this document has to be updated on a regular basis in order to get a full and detailed picture of the pressures resulting from agriculture. To provide a picture in a short timeframe (the first Article 5 reports were submitted at the end of March 2005), it was decided to exploit the national syntheses rather than the individual river basin district reports. The result is a geographically wide assessment. However, the choice of this scale also leads in many cases to inadequate information. Clearly, the background paper is a ***living document*** and will have to be improved later through the use of a greater number of individual river basin district / national reports and taking into account the River Basin Management Plans.

[6] The first phase review covers Austria, Denmark, Finland, France, Germany, Hungary, Ireland, Latvia, Lithuania, Luxembourg, Sweden, and UK, while the second phase review covers Belgium with Flemish and Walloon regions, Cyprus, Czech Republic, Estonia, Malta, The Netherlands, Poland, Portugal, Slovak Republic, Slovenia, and Spain.

2 Data Uncertainties

The data on pressures and impacts of agricultural activities on water bodies given in this background paper are gathered from a wide range of different studies and investigations conducted at European level. Due to the different methodologies applied it is not feasible to draw a single comparison between the data and thus to deduce general conclusions from them. To clarify the data origin, the following paragraphs give a short overview of the methodological background and the related uncertainties and gaps, where applicable.

The project on the ***Fate of Agrochemicals in Terrestrial Ecosystems*** (FATE), carried out by the Rural, Water and Ecosystem Unit of the European Commission's Joint Research Centre (JRC), aims at developing a set of modelling tools relating nutrients pressures from various sources (e.g. agriculture, background losses) and water quality. The tools are developed to make best use of EU-wide available data taking into account current environmental and socio-economic conditions (Bouraoui et al., 2005). The FATE project compiled a harmonised European-wide database to estimate pressures from point and diffuse sources. However, data availability is the main obstacle to the application of the modelling approach to the EU-25.

In contrast, the project on ***source apportionment of nitrogen and phosphorus inputs*** into the aquatic environment, commissioned by the European Environment Agency (EEA), aims at preparing a literature study by identifying investigations that had performed source apportionment for various catchments and countries in Europe. In the source apportionment studies there are notable differences in the number of sources covered (EEA, 2005a: 14). Some of these studies simply make a distinction between point sources and diffuse sources, while other studies address several different classes of sources such as background atmospheric deposition, urban wastewater treatment plants, industrial discharges and fish farms. The source apportionment approach generally includes those discharges and losses that reach surface waters. The agricultural contribution contains the losses into river systems and not the nutrient surplus at the topsoil level. Some approaches include estimates of the retention in the river system. Due to the focus on agricultural sources, this background paper has generally treated the agricultural contribution to the diffuse sources separately (when possible). In some cases, only the total diffuse loads as a sum of background losses and agricultural contribution were available (EEA, 2005a: 14).

Furthermore, with regard to the ***IRENA project***, the EEA stated that the statistical information on irrigatable area is generally more reliable than reported water abstraction rates for agriculture. However, the trends in irrigatable areas are only a proxy indicator for the water use intensity. Accordingly, the related indicator values need to be viewed with caution (EEA, 2005b and 2005c).

With regard to the review of the national synthesis of the ***Article 5 reports for agricultural pressures***, the summary report and the 2nd phase national review reports prepared by the WRc and consortium partners (2005a, 2006) identify some uncertainties and gaps in the data submitted by the Member States. Accordingly, the majority of the Member States have indicated a low level of confidence in their data. The fact that the Member States classified a significant proportion of surface water and groundwater bodies as potentially at risk can be seen as a sign of the potential uncertainties or gaps in the data. The reasons for these uncertainties are on the one hand the limited base of the review (analysis of national report and some roof reports) and the tight schedule for the analysis (first submission of the reports in March 2005). The national synthesis of the Article 5 review identified the following data uncertainties (WRc, 2005a: 21; WRc, 2006):

1. Lack of data for some key driving forces and pressures

- ***Point sources***: Some key data sets are not available, e.g. data from farmyard storage facility assessments.
- ***Diffuse sources***: Agricultural data are not available at the farm level. Prediction of nutrient loss from agriculture is being developed as well as a farm risk assessment procedure. Improved understanding of nutrient and silt losses from forestry on peat soil or in acid sensitive catchments as well as an improved quantification of diffuse urban and road runoff is needed.
- ***Abstraction***: The number of unregulated water abstracting activities and their impacts is not known but might be significant in certain cases.
- ***Hydromorphological pressures***: Data on hydromorphological pressures are held in disparate organisations, some are incomplete or out of date and others had to be generated from base mapping or aerial photographs. The impacts of activities involving hydromorphological changes including river drainage works is unknown.

2. Lack of data on impacts

- ***Monitoring data*** are not available for all water bodies, especially for some water categories such as coastal waters and groundwater (especially in the case of "transboundary GWBs").
- Data on ***dangerous substances/priority substances*** is lacking for some MS.
- Survey on ***lakes*** is missing for some MS.

In addition, it should be mentioned that some EU Member States only submitted their WFD Article 5 report to the European Commission very recently (for example two Mediterranean countries)[7], and that the national review of the Article 5 reports does not include the data of those Member States. In general, the summary and conclusions that can derive from the national synthesis of the Article 5 reports concerning agricultural pressures on water bodies are limited in terms of general applicability. The integration of further Article 5 reports (including those of the Mediterranean countries) into the review report is likely to lead to a reduction of the uncertainties and gaps. This is especially the case for the alterations of hydrologic regimes (e.g. abstraction for irrigation) and the hydromorphological modifications caused by agricultural activities, and the resulting risk assessment for surface water bodies.

In conclusion, regarding the data uncertainties, this synthesis gathers information from different sources to draw the clearest and the most consistent picture possible.

[7] The WFD Scoreboard of the Environment Directorate General provides an overview of the current status of Article 5 reporting (see http://europa.eu.int/comm/environment/water/water-framework/scoreboard.html).

3 Risk Assessment according to the WFD

As part of a review of the impact of human activity on the status of surface and groundwaters (the ***pressures and impacts analysis***), Article 5 and Annex II of the WFD require Member States to carry out an assessment of the risk that surface and groundwater bodies will fail to meet the Directive's environmental objectives by 2015. The risk characterisation process defines the boundaries around 'good status', recognising the WFD's objective of protecting, enhancing and restoring all non-artificial surface and groundwater bodies with the aim of achieving good status by 22nd December 2015.

The following box summarises the general methodological framework for the pressures and impacts analysis including risk assessment, as provided in the Guidance Document developed under the CIS process (CIS Working Group 2, 2002).

Box 1: Risk assessment of the pressures and impact analysis

1. Baseline ('business-as-usual') scenario: The starting point is a baseline scenario, to be used for interpreting projections of key economic drivers likely to influence the main pressures on the river basin and water usage within it. The focus is on changes in general socio-economic variables such as population growth, the economic development of the main water user sectors and any planned investments linked to existing water regulations. By interpreting these, a view can be taken of likely future patterns of use and their impact on the water bodies and assess the risks looking forward. For instance, in the case of the agricultural sector, what it will enable us to do is superimpose the situation where farming output either decreases or increases in the risk assessment calculation.

2. Identifying driving forces and pressures: In addition to a general description of the water body, the information on driving forces that may be exerting pressures on water bodies has to be collected and maintained and must document the type and magnitude of these pressures in terms of anthropogenic significance. These are categorised in broad sets of pressures: (i) point sources of pollution, (ii) diffuse sources of pollution, (iii) effects of modifying the flow regime through abstraction or regulation, and (iv) morphological alterations for surface water and (v) changes in water levels and flow caused by abstraction or recharge for groundwater. In addition, there is a requirement to consider land use patterns (e.g. urban, industrial, agricultural, forestry etc.) as these may be useful to indicate areas in which specific pressures may be located.

3. Assessing the impacts: Assessing the impacts on a water body requires some quantitative information to describe the state of the water body itself, and/or the pressures acting on it. The type of analysis depends on the data available. Regardless of the particular process to be adopted, and as with the identification of significant pressures described above, the assessment requires a conceptual understanding of what causes impacts.

4. Evaluating the likelihood of failing to meet the objectives (risk assessment): Evaluating the risk of failing to meet the WFD objectives in 2015 should, theoretically, be a straightforward comparison of the state of the water body with threshold values that define the objective. At present, the threshold values are defined for protected areas and dangerous substances (Council Directive 76/464/EEC). However, these values are not yet known for other aspects of the water body status.

Although the Guidance Document provides a general methodological framework for the risk assessment, the applied methodologies vary between the individual Member States. Therefore, the data of the WFD Article 5 reports need to be evaluated in the context of the methodological approaches used.

The following sections summarise the results of the risk assessment related to agricultural pressures on surface and groundwater bodies derived from the review of the national synthesis of the submitted WFD Article 5 reports.

3.1 Risk Assessments for Surface Water Bodies

As mentioned above in chapter 2 on data uncertainties, the methodologies applied for risk assessment vary between individual Member States. Notably, the sectoral distinction, with regard to agriculture, is lacking in most Article 5 reports. However, in most cases, qualitative pressures result from diffuse sources (mainly from agriculture).

Table 1 provides an overview of the data on surface water bodies (SWB) at risk/potentially at risk as reported by the MS in their pressures and impact analysis (see Box 1).

Table 1: Surface water bodies at risk from agriculture

MS level	Quantity	Quality	Hydromorphology [b)]
Austria	None [a)]	No information [a)] (but nutrient input is important factor, with N compounds more significant than P compounds, and 35% N and 30% P of total input derived from agriculture)	42% definitely at risk 20% uncertain (for 62% agriculture is predominant factor)
Belgium - Flanders	No information [a)]	No information [a)] (see information on Scheldt & Meuse RBD)	No information [a)]
Belgium - Wallonia	No information [a)] (but pressure applied on the quantities of surface water by agriculture is low; see information on Scheldt, Meuse, Rhine & Seine RBDs below)	No information [a)] (see information on Scheldt, Meuse, Rhine & Seine RBDs below)	No information [a)] (assessment of hydro-morphological pressures incomplete; pressures are generally not due to agriculture)
Cyprus	No information [a)]	5% at risk due to diffuse source pollution (no sectoral distinction [a)]) 71% at risk due to both point source and diffuse pollution (no sectoral distinction [a)])	No information [a)]
Czech Republic	68.8% at risk from all quantitative pressures (no sectoral distinction [a)])	No information [a)]	No information [a)]
Denmark	None [a)]	*For lakes*: diffuse P-losses from agriculture is a major reason for non compliance of almost all lakes *For coastal waters*: diffuse N- and P-losses from agriculture is a major reason for non compliance for almost all coastal waters	*For rivers:* 50% are impacted due to channelisation to improve agricultural drainage
Estonia	20.7% at risk from all pressures (no sectoral distinction [a)])	45.6% at risk from diffuse pressure (assumed to be mostly from agriculture) 63.3% at risk from point pressures	17.2%
Finland	No information [a)]	No information [a)]	No information [a)]
France	Not significant (but can be regionally important, i.e. Corsica, Guadeloupe, Reunion & Adour-Garonne RBDs)	No information [a)] (but pesticides and nutrients inputs are one of the main factors of risks)	No information [a)] (but primary reason for failing the WFD objectives, except lakes and coastal waters)
Germany	None [a)]	No information [a)] (but nutrient input is likely to be relatively high, since diffuse agricultural sources were listed as the second major cause of failing to achieve 'good status')	
Hungary	No sectorial distinction [a)]	None [a)] (the use of fertilisers and chemicals and animal keeping has fallen to excessively low level)	
Ireland	No information [a)]	No information [a)] (but eutrophication is the most important problem affecting surface water quality, agriculture being one of the main causes for eutrophication, together with population not connected to sewers)	25-79% at risk *For transitional waters*: 31 % at risk
Latvia	0 SWB at risk, 4 SWBs (2%) probably at risk from abstraction (no sectoral distinction[a)])	19 SWBs (9.2%) at risk, 66 (31.9%) probably at risk from diffuse pollution (no sectoral distinction [a)])	43 SWBs (21%) at risk, 63 SWBs (30%) probably at risk from morphological alterations (no sectoral distinction [a)])
Lithu-ania	1 SWB at risk from abstraction (no sectoral distinction [a)])	170 SWBs (22%) at risk from diffuse pollution (no sectoral distinction [a)])	22 (3%) at risk from flow regulations & morphological alterations (no sectoral distinction [a)])

MS level	Quantity	Quality	Hydromorphology [b)]
Luxembourg [d)]	No information [a)]	No information [a)] (but both pesticides and heavy metals can be locally the primary pollutants)	No information [a)]
Malta	3.5% at risk from abstraction (no sectoral distinction [a)])	20.7% at risk from diffuse pressures (no sectoral distinction [a)])	20.7% at risk (no sectoral distinction [a)])
Poland	No information [a)*] (see information on Odra & Wisla RBDs below)	No information [a)*] (see information on Odra & Wisla RBDs below)	No information [a)]
Portugal	No information [a)] (see information on Tejo-Ribeiras do Oeste & Sado-Mira RBDs below)	No information [a)] (see information on Sado-Mira, Guadiana & Ribeiras do Algarve RBDs below)	No information [a)]
Slovak Republic	8% at risk from abstraction (no sectoral distinction [a)])	10.4% at risk from diffuse sources (no sectoral distinction [a)])	26.6% at risk for hydromorphology (no sectoral distinction [a)])
Slovenia	No information [a)]	No information [a)] (see information on Donava & Jadran RBDs below)	No information [a)]
Spain	Information submitted at "RBD basin level" (see below)	Information submitted at "RBD basin level" (see below)	Information submitted at "RBD basin level" (see below)
Sweden [c)]	No information [a)]	*For coastal waters:* 0-38% at risk; 58-88% possibly at risk; 0-41% not at risk; 0-19% unclassified (variation across RBDs with very small proportion of coastal WB being at risk in northern part of Sweden)	No information [a)]
UK, England & Wales [*)]	At risk / probably at risk from abstraction and flow regulation *For rivers*: 11% *For lakes*: 2% *For transitional waters*: 14%	At risk / probably at risk from diffuse pollution *For rivers*: 82% *For lakes*: 53% *For transitional waters*: 25% *For coastal waters*: 24%	At risk / probably at risk *For rivers*: 48% *For lakes*: 59% *For transitional waters*: 89.7% *For coastal waters*: 77.8%
UK, Scotland [**)]	At risk / probably at risk from abstraction and flow regulation: *For rivers*: 24.6% *For lakes*: 36.9% *For transitional waters*: 2.5%	At risk / probably at risk from diffuse pollution: *For river*: 24.3% *For lakes*: 18.4% *For transitional waters*: 45% *For coastal waters*: 13.1%	At risk / probably at risk: *For rivers*: 33.3% *For lakes*: 38.3% *For transitional waters*: 40% *For coastal waters*: 9.6%
UK, Northern Ireland	At risk / probably at risk from abstraction: *For rivers*: 13% *For lakes*: 33% *For transitional waters*: 14%	At risk / probably at risk from diffuse pollution: *For rivers*: 94.4% *For lakes*: 83.4% (mainly from agriculture and forestry) *For transitional waters*: 100% *For coastal waters*: 55%	At risk / probably at risk: *For rivers*: 69% *For lakes*: 62% *For transitional waters*: 100% *For coastal waters*: 80%
RBD level	**Quantity**	**Quality**	**Hydromorphology** [b)]
Andalucia 'basin'	1.6% at risk, 21% 'risk under study' from abstraction pressures (no sectoral distinction [a)])	3.2% at risk, 23% 'risk under study' from diffuse pressures (no sectoral distinction [a)]) (but agriculture seems to be practically the only source of significant diffuse pressures)	0% at risk, 5.6% 'risk under study' from hydro-morphological pressures (no sectoral distinction [a)])
Danube basin [***)]	***Roof report***: none [a)]	***Roof report***: 65 % at risk due to nutrient pollution with a shared responsibilities of waste water & nutrient inputs from agriculture (esp. in lower Danube region & Danube delta)	***Roof report***: no information [a)]
Donava basin	No information [a)]	Agriculture responsible for strong pressures, being the main source of N loads	No information [a)]
Duero basin	2% at risk, 7.4% 'risk under study' from abstraction pressures (no sectoral distinction [a)])	3.4% at risk, 50% 'risk under study' from diffuse pressures (no sectoral distinction [a)]) (but agriculture seems to be practically the only source of significant diffuse pressures)	2.3% at risk, 47% 'risk under study' from hydro-morphological pressures (no sectoral distinction [a)])
Ebro basin	1.7% at risk, 32% 'risk under study' from abstraction pressures (no sectoral distinction [a)])	3.7% at risk, 31% 'risk under study' from diffuse pressures (no sectoral distinction [a)]) (but agriculture seems to be only source of significant diffuse pressures)	1.9% at risk, 60% 'risk under study' from hydro-morphological pressures (no sectoral distinction [a)])

RBD level	Quantity	Quality	Hydromorphology [b)]
Galicia 'basin'	1.2% at risk, 10% 'risk under study' from abstraction pressures (no sectoral distinction [a)])	3.7% at risk, 26% 'risk under study' from diffuse pressures (no sectoral distinction [a)]) (but agriculture seems to be practically the only source of significant diffuse pressures)	4.2% at risk, 10% 'risk under study' from hydro-morphological pressures (no sectoral distinction [a)])
Garonne basin	No information [a)] (but abstraction constitutes one of the main pressures)	No information [a)] (but besides abstraction, pesticides and nitrates constitute the main pressures)	No information [a)]
Guadal-quivir basin	0.3% at risk, 6.6% 'risk under study' from abstraction pressures (no sectoral distinction [a)])	3.6% at risk, 34% 'risk under study' from diffuse pressures (no sectoral distinction [a)]) (but agriculture seems to be practically the only source of significant diffuse pressures)	4.7% at risk, 26% 'risk under study' from hydro-morphological pressures (no sectoral distinction [a)])
Gua-diana basin	***PT***: no information [a)] ***ES***: 5.3% at risk, 3.4% 'risk under study' from abstraction pressures (no sectoral distinction [a)])	***PT***: no information [a)] (but agriculture imposes a very significant pressure as diffuse source pollution) ***ES***: 2.3% at risk, 43% 'risk under study' from diffuse pressures (no sectoral distinction [a)]) (but agriculture seems to be practically the only source of significant diffuse pressures)	***PT***: no information [a)] ***ES***: 15% at risk, 16% 'risk under study' from hydro-morphological pressures (no sectoral distinction [a)])
Jadran basin	No information [a)]	No information [a)] (but agriculture responsible for strong pressures, being the main source of N loads)	No information [a)]
Júcar basin	15% at risk, 10% 'risk under study' from abstraction pressures (no sectoral distinction [a)])	4.8% at risk, 7% 'risk under study' from diffuse pressures (no sectoral distinction [a)]) (but agriculture seems to be practically the only source of significant diffuse pressures)	19% at risk, 8.5% 'risk under study' from hydro-morphological pressures (no sectoral distinction [a)])
Loire basin	No information [a)]	Nutrient inputs, organic matter and pesticides belong to the main factors impeding the achievement of 'good status'.	No information [a)]
Meuse basin	***Roof report***: none [a)]	***Roof report***: But agriculture is one of the main driving forces: classical pollutants (COD, N and P), specific pesticides etc. are within the main determinants for 'at risk' classification for SW ***BE-FL***: all water bodies at risk from all pressures (based on expert judgement) ***BE-WL***: *for rivers*: 19% at risk, 64% potentially at risk due to point and diffuse pollution (no sectoral distinction [a)])	***Roof report***: no information [a)]
Odra basin	***DE***: no information [a)] ***CZ***: no information [a)] ***PL***: 8.6% at risk from abstraction	***DE***: impacts of diffuse sources cause high nutrient load of surface waters, high agricultural land use in the river basin ***CZ***: agriculture (nitrogen) has an important impact on surface waters ***PL***: 24.9% at risk from different diffuse pressures	No information [a)]
Rhine basin	***Mosel-Saar report:*** none [a)] ***BE-WL***: none [a)]	***Mosel-Saar report:*** nutrients inputs are one of the main factors of risk; 90% of nitrogen pollution in Koblenz (where Mosel meets the Rhine) come from diffuse pollutions) ***BE-WL*: *for rivers***: 13% at risk, 75% potentially at risk from point and diffuse pollution (no sectoral distinction [a)])	***Mosel-Saar report:*** mo information [a)] ***BE-WL***: none [a)]
Sado-Mira basin	No information [a)] (but agriculture imposes a very significant pressure through water abstraction)	No information [a)] (but agriculture imposes a very significant pressure as diffuse source pollution)	
Scheldt basin	***BE-FL***: all water bodies at risk from all pressures (based on expert judgement) ***BE-WL***: none [a)]	***BE-FL***: 88% (for N); 84% (for P) at risk from diffuse pollution (based on water quality model 'Pegase' for 2015 scenario) ***BE-WL***: *for rivers*: 29% at risk, 71% potentially at risk from point and diffuse pollution (no sectoral distinction [a)])	***BE-FL***: all water bodies at risk from all pressures (based on expert judgement) ***BE-WL***: none [a)]
Segura basin	0% at risk, 17% 'risk under study' from abstraction pressures (no sectoral distinction [a)])	2.2% at risk, 26% 'risk under study' from diffuse pressures (no sectoral distinction [a)]) (but agriculture seems to be practically the only source of significant diffuse pressures)	5.4% at risk, 54% 'risk under study' from hydro-morphological pressures (no sectoral distinction [a)])

RBD level	Quantity	Quality	Hydromorphology [b]
Seine basin	***BE-WL***: none [a]	***BE-WL***: *for rivers*: 0% at risk, 50% potentially at risk due to point and diffuse pollution (no sectoral distinction [a])	***BE-WL***: none [a]
Tejo-Ribeiras basin / Tajo basin	***PT***: no information [a] (but agriculture imposes a very significant pressure through water abstraction) ***ES***: 0% at risk, 41% 'risk under study' from abstraction pressures (no sectoral distinction [a])	***PT***: no information [a] ***ES***: 3.4% at risk, 58% 'risk under study' from diffuse pressures (no sectoral distinction [a]) (but agriculture seems to be practically the only source of significant diffuse pressures)	***PT***: no information [a] ***ES***: 0% at risk, 77% 'risk under study' from hydro-morphological pressures (no sectoral distinction [a])
Ribeiras do Algar-*ve* basin	No information [a]	No information [a] (but agriculture imposes a very significant pressure as diffuse source pollution)	No information [a]
Wisla basin	7.6% at risk from abstraction	15.9% at risk from different diffuse pressures	No information [a]

Notes: a) "None" means that no significant pressure from the agricultural sector was reported in the Article 5 report; "no information" means that the Article 5 report does not specifically refer to agriculture as being the pressure behind the impact; and "no sectoral distinction" means that no distinction between households, industries and agriculture has been made in the Article 5 report.
b) The results of the risk assessment for hydromorphology refer to the overall pressures on surface water bodies (and not only to the agricultural pressures). For the Spanish RBDs, the risk values on hydromorphological pressures result from adding the risk values of the pressure categories of 'water regulation' and 'morphological alterations' which are most relevant to hydromorphological pressures.
c) The risk assessment is only based on pressures from nutrients, while pesticide use is not included, nor are the other pressures from agriculture such as morphology or abstraction.
d) Information was reported for biological criteria, hydromorphological criteria, and specific substance and not distinguished by point or diffuse sources.

Source: WRc, 2005a: 16; WRc, 2005d; additional information from WRc; WRc, 2006; [*)] EA, 2005; [**)] SEPA, 2005; [***)] ICPDR, 2005.

According to the national synthesis of the Article 5 reports submitted by the EU Member States (Table 1), ***nutrient inputs***, where ***diffuse sources*** are predominant, seem to be a key factor for failing to achieve the WFD environmental objectives. Agriculture (and in some regions, forestry) is generally reported as the predominant source of such inputs. For lakes and coastal waters, nutrient inputs from diffuse sources is the predominant pressure and reason for being at risk. Nitrogen compounds are considered more important than phosphorus compounds in terms of nutrient inputs.

In addition, ***pesticides*** such as atrazine are also referred to as important diffuse pollutants from agriculture, but measuring their impact still poses some difficulties due to lacks of tools and the diversity of substances that need to be monitored. Diffuse inputs of sediments are also reported by some Member States as contributing to the risk of failing (WRc, 2005a:13).

A secondary impeding factor is ***morphological alteration*** due to channelisation, dams and reservoirs linked to flow regulation, irrigation, drainage and flood protection. In some cases, flood protection measures related to gaining and protecting agricultural land (not quantified) are the main reasons (WRc, 2005a: 11).

With regard to quantitative pressures from agriculture, it is not possible to draw a consistent picture for ***abstraction*** due to the lack of data and the late submission of reports (with the exception of France). Indeed, quantitative pressures resulting from agriculture in France can be regionally important, i.e. in Corsica, Guadeloupe, Reunion and Adour-Garonne RBDs. Although Portugal reported no specific information on SWB at risk from abstraction, it stated that agriculture imposes a very significant pressure through water abstraction.

3.2 Risk Assessments for Groundwater Bodies

For groundwater bodies (GWB), the most frequently reported reason for anticipated failures is ***diffuse pollution*** (mainly ***nutrients***). These problems are attributed to diffuse sources, predominantly from agriculture (see Table 2). Minor local contributions include diffuse sources from urban areas or mines (WRc, 2005a: 18). The predominant cause of failure is high nitrate loads. In addition, problems with ***pesticides***, especially atrazine[8], and to a lesser extent chlorinated solvents, exist. Furthermore, due to the long-term nature of groundwater contamination, some water bodies still show an increasing trend in these substances, although some have been banned (WRc, 2005a: 18).

With regard to pesticides, it should be mentioned that atrazine forms part of the list of priority substance according to the Decision No 2455/2001 (established as Annex X of the WFD). [9] In addition, the future daughter directive on groundwater against pollution might refer to active substances in pesticides including their relevant metabolites, degradation and reaction products to define quality standard.

In general, diffuse pollution of groundwater is a difficult issue: the time lag between a decrease of pressure and a decrease in groundwater contamination can be very long, and this increases the risk of failure to achieve 'good status' of water bodies by 2015.

Table 2: Groundwater bodies at risk especially from agriculture

MS level	Quantity	Quality
Austria	None [a)]	5.9% at risk (predominantly due to agriculture)
Belgium – Flanders	No information [a)] (see information on Schelde & Meuse RBDs below)	No information [a)] (see information on Schelde & Meuse RBDs below)
Belgium – Wallonia	No information [a)] (but abstraction is not a significant pressure on groundwater bodies in any of the districts; see information on Meuse RBD below)	No information [a)] (see information on Meuse RBD below)
Cyprus	No information [a)] (but agriculture, and especially irrigation, remains one of the major water consuming sectors, accounting for 69% of the total water demand)	5 GWBs (26%) at risk due to excessive nitrate concentrations (primarily due to urbanisation and agricultural activities)
Czech Republic	No information [a)]	No information [a)]
Denmark	No information [a)]	16% of the intakes (1% of the water supply aquifers) above 50 mg NO_3/l Up to 70% GWBs contaminated by pesticides
Estonia	No information [a)]	100% at risk (only 1 GWB was identified, and it is at risk both from point source and diffuse pressures)
France	Can be regionally important (Rhône and Adour-Garonne RBDs)	Pesticides and nitrates are the main risk factors
Germany	5% at risk from abstraction pressures (no sectoral distinction [a)])	52% at risk; out of these 85% at risk due to diffuse sources (primarily nutrients and pesticides from agricultural activities)
Hungary	No information [a)]	No information [a)]
Ireland [b)]	No information [a)]	29% potentially at risk from diffuse pollution (across RBD: 2% and 58%)
Latvia	None [a)]	Most groundwater bodies at risk from point source and diffuse pressures (diffuse pollution with nitrates and pesticides mainly in intensively used agricultural lands)
Lithuania	No information [a)] (see information on Neumunas & Lielupe RBDs below)	No information [a)] (see information on Neumunas & Lielupe RBDs below)

[8] In some RBDs, pesticide pressures have become one of the main agricultural issues that needs to be addressed.

[9] According to the Proposal for a Directive on environmental quality standards (EQS) in the field of water policy (COM(2006) 397 final) as of 17.7.2006, atrazine is classified as priority substance. The Proposal states that the AA (annual average)-EQS for atrazine should be 0.6 µg/l for both inland surface and other surface waters, and the MAC (maximum allowable concentration)-EQS should be 2.0 µg/l also for both inland surface and other surface waters (see also http://ec.europa.eu/environment/water/water-dangersub/pri_substances.htm).

MS level	Quantity	Quality
Malta	30% at risk from abstraction pressures	56% at risk from diffuse pressures 25% at risk from point source pressures
Poland	No information [a)] (see information on Odra & Wisla RBDs below)	No information [a)] (see information on Odra & Wisla RBDs below)
Portugal	No information [a)] (see information on Cávado-Ave-Leça, Douro, Guadiana, Minho-Lima, Ribeiras do Algarve, Sado-Mira Tejo-Ribeiras do Oeste basin & Vouga-Mondego-Lis RBDs below)	No information [a)] (see information on Cávado-Ave-Leça, Douro, Guadiana, Minho-Lima, Ribeiras do Algarve, Sado-Mira Tejo-Ribeiras do Oeste basin & Vouga-Mondego-Lis RBDs below)
Slovak Republic	8 GWB at risk from abstraction pressures (no sectoral distinction[a)])	17 GWB at risk from diffuse pressures (no sectoral distinction[a)])
Slovenia	No information [a)] (see information on Donava RBD)	No information [a)] (see information on Donava RBD)
Spain	Information submitted at "RBD basin level" (see below)	Information submitted at "RBD basin level" (see below)
Sweden	180 GWBs (17%) at risk , 692 GWBs (66%) possibly at risk from all pressures (no sectoral distinction[a)]) (but 913 GWBs (87%) are affected by agricultural land)	180 GWBs (17%) at risk , 692 GWBs (66%) possibly at risk from all pressures (no sectoral distinction [a)]) (but 14% of groundwater in agricultural fields is above 50 mg NO_3/l, and 72% of groundwater in agricultural fields have levels > 20 mg NO_3/l)
United Kingdom	21% at risk: (across RBD: 4-50%) (no sectoral distinction[a)])	68% at risk from diffuse pollution: (across RBD: 19-91%) (no sectoral distinction[a)])
UK, England & Wales	20% at risk from abstraction by the agricultural sector (across RBD: 16-33%)	38% at risk from *nitrogen* diffuse pollution (across RBD: 19-100%) 12% at risk from *phosphorus* diffuse pollution (across RBD: 6-16%) 14% at risk from total *pesticides* diffuse pollution (across RBD: 4-23%)
UK, Scotland[**)]	0.4% at risk from abstraction	19.8% at risk from diffuse pollution
UK, Northern Ireland	None [a)]	19.4% at risk from diffuse pollution
RBD level	**Quantity**	**Quality**
Andalucía 'basin'	34% at risk, 27% 'risk under study' from abstraction pressures (no sectoral distinction [a)])	30% at risk, 34% 'risk under study' from diffuse pressures (no sectoral distinction[a)])
Baleares 'basin'	40% at risk & 'risk under study' from abstraction pressures (no sectoral distinction [a)])	39% at risk & 'risk under study' from diffuse pressures (no sectoral distinction [a)])
Catalunia 'basin'	55% at risk & 'risk under study' from abstraction pressures (no sectoral distinction [a)])	23% at risk & 'risk under study' from diffuse pressures (no sectoral distinction [a)])
Cávado-Ave-Leça basin	No information [a)]	25% at risk due to diffuse pressures from agriculture
Danube basin[***)]	***Roof report***: quantitative aspects of the groundwater resources are affected by intensive water management activities, including agriculture; in some areas, significant pressures result from over-abstraction	***Roof report***: in some areas, high nutrient levels infiltrating the groundwater intensive agriculture and inadequate waste and sewage treatment are quoted as major threat to groundwater quality
Donava basin	None [a)]	85-95% at risk from diffuse pressures, agriculture being the main driving force
Douro basin / Duero basin	***PT***: no information [a)] ***ES***: 3.2% at risk, 55% 'risk under study' from abstraction pressures (no sectoral distinction[a)])	***PT***: no information [a)] ***ES***: 9.5% at risk, 81% 'risk under study' from diffuse pressures (no sectoral distinction [a)])
Ebro basin	No information [a)]	28% at risk & 'risk under study' from diffuse pressures (no sectoral distinction [a)])
Galicia 'basin'	0% at risk, 5.6% 'risk under study' from abstraction pressures (no sectoral distinction [a)])	0% at risk, 56% 'risk under study' from diffuse pressures (no sectoral distinction[a)])
Guadala-quivir basin	27% at risk, 61% 'risk under study' from abstraction pressures (no sectoral distinction [a)])	30% at risk, 28% 'risk under study' from diffuse pressures (no sectoral distinction[a)])
Guadiana basin	***PT***: no information [a)] ***ES***: 30% at risk, 40% 'risk under study' from abstraction pressures (no sectoral distinction[a)])	***PT***: 11% at risk due to diffuse pressures from agriculture ***ES***: 45% at risk, 55% 'risk under study' from diffuse pressures (no sectoral distinction [a)])
Júcar basin	29% at risk, 0% 'risk under study' from abstraction pressures (no sectoral distinction [a)])	15% at risk, 5.1% 'risk under study' from diffuse pressures (no sectoral distinction[a)])

RBD level	Quantity	Quality
Lielupe basin	2 GWBs at risk or probably at risk from all pressures (most common reasons is water abstraction)	2 GWBs at risk or probably at risk from all pressures (besides water abstraction, the most common reason is diffuse pollution)
Meuse basin	***Roof report***: 6.4% at risk (no sectoral distinction [a)]) ***BE-FL***: 4 out of 10 SWB (40%) at risk from quantitative pressures (no sectoral distinction [a)]) ***BE-WL***: none [a)]	***Roof report***: 61% at risk from diffuse pollutions (mainly from nitrates and pesticides coming from agriculture) ***BE-FL***: 5 out of 10 (50%) at risk from qualitative pressures (no sectoral distinction[a)]) ***BE-WL***: 60% at risk from agricultural diffuse pollution
Minho-Lima basin	No information [a)]	No information [a)]
Neumunas basin	14 GWBs at risk or probably at risk from all pressures (besides diffuse pollution, most common reason is water abstraction)	14 GWBs at risk or probably at risk from all pressures (besides water abstraction, the most common reason is diffuse pollution)
Odra basin	***DE***: no information [a)] ***CZ***: no information [a)] ***PL***: 9.4% at risk from all pressures	***DE***: agricultural use covers 51% of total land use of the area and has important impacts on groundwater (25% of total impacts on groundwater from agriculture). ***CZ***: agricultural use (nitrogen, pesticides/ atrazin) have a relevant impact on groundwater. ***PL***: 9.4% at risk from all pressures; agriculture has an important impact on groundwater, as 50% of total impacts of groundwater by nitrates come from agriculture.
Rhine basin	***Mosel-Saar report***: no information [a)]	***Mosel-Saar report:*** no information [a)] (but pesticides and nitrates are the main risk factors)
Ribeiras do Algarve basin	4.4% at risk from abstraction pressures	4.4% at risk due to diffuse pressures from agriculture
Sado-Mira basin	No information [a)]	No information [a)]
Scheldt basin	***BE-FL***: 18 out of 32 (56%) at risk from quantitative pressures (no sectoral distinction [a)]) ***BE-WL***: 60% at risk (no sectoral distinction[a)])	***BE-FL***: 14 out of 32 (44%) at risk from qualitative pressures (no sectoral distinction [a)]) ***BE-WL***: 48% at risk due to diffuse sources (N)
Segura basin	40% at risk, 24% 'risk under study' from abstraction pressures (no sectoral distinction [a)])	No information [a)]
Tejo-Ribei-ras do oeste basin/ Tajo basin	***PT***: no information [a)] ***ES***: no information [a)]	***PT***: 4.5% at risk due to diffuse pressures from agriculture ***ES***: 4.3% at risk, 74% 'risk under study' from diffuse pressures (no sectoral distinction [a)])
Vouga-Mondego-Lis basin	No information [a)]	5% at risk due to diffuse pressures from agriculture
Wisla basin	No information [a)] (8.6% at risk from all pressures)	No information [a)] (8.6% at risk from all pressures)

Note: a) "None" means that no significant pressure from the agricultural sector was reported in the Article 5 report; "no information" means that the Article 5 report does not specifically refer to agriculture as being the pressure behind the impact; and "no sectoral distinction" means that no distinction between households, industries and agriculture has been made in the Article 5 report.
b) Major pressure but no quantitative information. Deficiencies in livestock waste management and poor siting of on-site wastewater treatment systems such as septic tanks are the main sources for the unacceptable level of contamination of some groundwater bodies.

Source: WRc, 2005a: 20; WRC, 2005d; additional information from WRc; WRc, 2006; [**)] SEPA, 2005; [***)] ICPDR, 2005.

The results from the risk assessment in quantitative terms differs across the EU (see Table 2). In northern Europe, ***abstraction*** puts only a relatively low percentage of GWB at risk in quantitative terms. The exceptions are the RBDs Meuse and Elbe, where about 6% and 8% of GWBs respectively are at risk from over-abstraction, but this is due to successive lowering of the water table as a result of open-cast brown coal mining (WRc, 2005a: 18). However, as for the surface water bodies, this quantitative picture changes when the Mediterranean Countries reports are taken into account. For instance in Greece, agriculture, and especially irrigation, remains one of the major water consuming sectors, accounting for 69% of the total water demand. In the Spanish RDBs Andalucia, Guadalquivir, Guadiana, Júcar, and Segura RBDs, 27% to 40% of GWBs are at risk due to abstraction pressures.

As already mentioned in chapter 2, several Member States reported a low level of confidence in their data and a need to improve data sets and develop better monitoring of GWBs (WRc, 2005a: 18). Furthermore, uncertainties in several reports result mainly from the lack of sectoral distinction presented in the results of the risk assessment. Accordingly, the results of the risk assessment for groundwater bodies will need to be refined in the next implementation phase when the WFD requires the full assessment of the data (establishment of the monitoring systems by end of 2006).

The programmes of measure should be based on the risk assessment (water bodies at risk to fail the WFD environmental objectives), but the individual measures will have to target specific pressures. Therefore, detailed information on driving forces and pressures are needed. As is currently the case, no general picture on the individual pressures from the national synthesis of the Article 5 reports can be drawn, since the data on agricultural pressures are limited in terms of quality and quantity. However, the data reviewed so far show that agriculture significantly contributes to the risk of failing to meet the WFD environmental objectives (for the methodological relationship between pressures and risk assessment, cf. Box 1).

The risk assessed varies between different Member States (and across River Basin Districts). From an agricultural perspective, diffuse pollution with nutrients and hydromorphological modifications seems to be the main driving forces and pressures on water bodies leading to a potentially significant risk of failing to meet the WFD objectives. Pesticides pollution, alterations of hydraulic regimes and soil erosion are further important pressures caused by agriculture. The following chapter gives an overview of the intensity of these pressures and the related impact by summarising data from various sources.

4 Challenges to WFD Objectives specifically from an Agricultural Perspective

As European agriculture is extremely diverse, ranging from large, highly intensive and specialised commercial holdings to subsistence and semi-subsistence farming, using mainly traditional practices, the impacts on the environment vary in scale and intensity and can be either positive or negative.

This chapter analyses the main negative impacts that can be exerted by agricultural activities on water bodies which this background paper identified and has categorised them as follows:

- Pollution (nitrogen, phosphorous, pesticides),
- Alterations of hydrologic regimes (e.g. water abstraction for irrigation),
- Hydromorphological modification, and
- Soil erosion[10].

In order to develop appropriate measures under the Common Agriculture Policy (CAP) and the Water Framework Directive (WFD), it is necessary to understand the main challenges resulting from agriculture as well as the main future developments.

4.1 Pollution

Pollution from different agricultural sources represents one of the key impacts on water bodies. However, the impacts of water pollutants on the environment clearly depend on the quantity of pollutants discharged and on their physiochemical characteristics. A distinction can be made between (i) ***point sources*** of pollution such as such as industrial discharges or spillage of the contents of a farm slurry store into a river, and (ii) ***diffuse (non-point) sources*** including background losses (natural land, e.g. forest), losses from agriculture and from scattered dwelling and atmospheric deposition on water bodies. Pollution from point sources is often easier to treat, while polluting emissions from diffuse sources are difficult to measure and to control. The following box gives an overview of the main diffuse pollutants from agricultural activities.

Box 2: The main diffuse pollutants from agriculture

Fertilisers (mainly nitrate and phosphate, in mineral or organic form) escape from agricultural fields through runoff, drainage, or attachment to eroded soil particles. In many countries, ***nitrate*** pollution is caused mainly by agriculture. Unless fertilisers and manure are absorbed by crops or are removed during harvesting, excess nitrate can be washed into groundwater and surface water bodies. The amounts lost depend on the soil type and organic matter content, the climate, slope of the land and depth to groundwater, as well as on the amount and type of fertiliser in regard to previous yield, the contribution period, and the level of irrigation used.[11] Thus, it is difficult to establish a link between nitrogen supply and water pollution. Nitrates damage the environment, contributing to eutrophication in coastal and marine waters and the pollution of drinking water, especially where groundwater has become contaminated.

Phosphorus as an essential element for plant growth is supplied to agricultural land by broadcasting mineral fertilisers and organic fertilisers (mostly animal manure and, to a lesser extent, compost and sludge). Since phosphorus is not very mobile in the soil solution, most soils contain small quantities that are readily available for plants. Soluble phosphorus can move off-site with run-off water during heavy rainfall, particularly from livestock confinement areas and grazing lands. It can be transported into surface waters together with soil particles and organic matter during erosion processes. Phosphorus is the main cause of eutrophication and of

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[10] Soil erosion is mainly a pressure that results in negative soil quality, but it also has a strong linkage to water resources. Soil erosion contributes to the discharge of both nutrients and sediments into waters.

[11] The use of fertilisers varies between countries, depending on the economic situation and predominant agricultural practices.

water quality deterioration for closed water resources and in a lesser extent for running waters and coastal waters. Even a minimal phosphorus content (some tens of µg/l) can pose environmental and health problems because of eutrophication and micro-algae development respectively.[12]

Pesticides: Agriculture is a major user of pesticides[13]. Pesticides contain one or more biologically active substance with a controlling effect on crop pests, diseases or weeds. Pesticide use by farmers depends on a multitude of factors, such as climatic conditions, the succession and variety of crops, pest and disease pressures, farm incomes, pesticide cost/crop price ratios, pesticide policies and management practices (OECD, 2005: 17). Agricultural pressures due to pesticides are less well-known than nitrate pressures because of insufficient follow-up tools and data on the multiple types of pesticides.[14] Pesticides are often also harmful to non-target organisms, and their presence in food can have a negative influence on both human and animal health. Therefore, in many countries, pesticides have been subjected to strict authorisation procedures for placing on the market, stringent use requirements and severe control measures for a long time already.[15] In addition, training activities for farmers on the application of pesticides to minimise losses are increasingly provided.[16] Nevertheless, pesticides cause surface as well as groundwater quality problems in many European countries.

Organic pollutants and pathogens: There is increasing concern related to the release of microbiological pathogens and organic pollutants from agricultural activities (e.g. from animal manure, residues of veterinary preparations) into waters, as they could pose a serious threat and represent an unknown long-term risk to human health. In many countries (especially in the new Member States, cf. Karaczun et al., 2003), the improper management of liquid manure causes serious risk for human health through the increasing number of *microbiological pathogens* (e.g. Giardia, Cryptosporidium) in soil and water (Karaczun and Indeka, 1999: 221). Furthermore, *organic pollutants* such as endocrine-disrupting compounds (EDCs) found in many pesticides still in use are capable of modulating or disrupting the endocrine system, which can result in adverse effects to growth, development, or reproduction. The exact concentrations of endocrine disrupting compounds in drinking water, and thus the quantities consumed, are currently unknown for all the European countries on the basis of the available information (European Commission, 2004).

Heavy metals: Some heavy metals (cadmium, copper, lead etc.) are essential trace elements for plants and animals. However, high concentrations can be toxic to plants, animals and humans. Agriculture and the related chemistry sector are a source of heavy metals: These (mostly Cd) are generally present in the ores used for P-fertiliser production, animal food (leading to their presence in manure), biocides (for instance for wood protection), and pesticides. Their use increases the concentration of heavy metals in soils. Some minerals move easily from soil complex to underground water, and thus heavy metal pollution can travel over long distances.

Pursuant to Article 5 of the WFD, these pollutants are part of the review of the impact of human activity on the status of surface and groundwaters (cf. chapter 3). In the national synthesis of the submitted Article 5 reports of the EU Member States, nutrient inputs and eutrophication in all categories of surface water are listed as the second most important pressure (WRc, 2005a: 8). The following table gives an overview of the nitrogen, phosphorus and pesticide loads to surface water from agricultural diffuse sources, as indicated by the Member States in their national synthesis of the Article 5 reports. The reports submitted so far include only a few data on pesticide loads (see also section 0), which makes it difficult to have a clear idea on the level of the pesticide pressure. They should be completed by the Member States within the next phase of the WFD implementation process. In addition, the

12 According to the United Nations Economic Commission for Europe (UN-ECE) classification of surface water, water is considered fairly eutrophic as of 25 µg phosphorus per litre (UNEP, 2004: 23).

13 According to the EEA glossary and the US-EPA definition, a pesticide is any substance or mixture of substances intended for preventing, destroying, repelling, or mitigating any pest. Though often misunderstood to refer only to insecticides, the term pesticide also applies to herbicides, fungicides, and various other substances used to control pests (see http://glossary.eea.europa.eu/EEAGlossary/P/pesticide).

14 In Europe around 50 000 to 70 000 products with approximately 800 active ingredients are registered for use (EEA and UNEP, 1999). In terms of active ingredients, the overall amount of pesticides used in agriculture in the EU has decreased since the early 1990s (European Commission, DG Agriculture, n.y.).

15 In the EU, the placing on the market and use of plant protection products is ruled by Council Directive 91/414/EEC. Moreover, the EC Drinking Water Directive (98/83/EC) requires pesticide concentration in drinking water not to exceed 0.1 µg/l for a single pesticide and 0.5 µg/l for total pesticides.

16 See also EU Life project entitled “TOPPS - Train the operators to prevent pollution from point sources” (2005-2008) that aims at identifying and disseminating advice, training and information in Europe with regard to the reduction of losses of plant protection products to water (www.topps-life.org).

new groundwater quality standards that are likely to be introduced by the future daughter directive on the protection of groundwater against pollution will have to be taken into account. The table does not include data on heavy metals, organic pollutants microbiological and pathogens due to the lack of information in the national syntheses of the Article 5 reports.

Table 3: Share of nutrients and pesticide loads in surface water from agriculture

MS level	Share of loads to surface water from agriculture (diffuse)		
	Nitrogen	Phosphate	Pesticides
Austria	No information [a)] (see information on RBD Danube)	No information [a)] (see information on RBD Danube)	No information [a)] (see information on RBD Danube)
Belgium – Flanders	No information [a)] (see information on RBDs Scheldt & Meuse)	No information [a)] (see information on RBDs Scheldt & Meuse)	No information [a)] (see information on RBDs Scheldt & Meuse)
Belgium – Wallonia	No information [a)] (see information on RBDs Scheldt & Meuse, Seine & Rhine)	No information [a)] (see information on RBDs Scheldt & Meuse, Seine & Rhine)	No information [a)] (see information on RBDs Scheldt & Meuse, Seine & Rhine)
Cyprus	5 427 t/a (country land, grassland & cultivated area) 2 500 t/a (livestock)	203 t/a (country land, grassland & cultivated area) 115 t/a (livestock)	No information [a)] (but excessive application of fertilisers and pesticides, which results in increased N and P loads, especially in areas with intensive agriculture)
Czech Republic	No information [a)] (but strong input from agriculture)	No information [a)] (but strong input from agriculture)	No information [a)] (but strong input from agriculture)
Denmark	40 100 t/a (76%)	440 t/a (27%)	No information [a)]
Estonia	44 850 t/a (total diffuse pollution, to be mostly from agriculture)	541 t/a (total diffuse pollution, to be mostly from agriculture)	No information [a)]
Finland	0-43% (across RBDs)	1-57 % (across RBDs)	No information [a)]
France	No information [a)] (but most significant with huge variation across RBDs; 55% from agriculture) (some data are available at the RBD level, see below)	No information [a)] (but significant impact with huge variation across RBDs; 25% from agriculture) (some data are available at the RBD level, see below)	No information [a)] (some data are available at the RBD level, see below)
Germany	80% (mainly agriculture)	70%	No information [a)] (but diffuse sources significant)
Hungary	20 000 t/a (total nitrogen)	3 000 t/a	No information [a)]
Ireland	78 808 t/a (75%)	2 125 t/a (36%)	No information [a)]
Latvia	43 707 t/a (nitrogen load entering Baltic Sea from Latvia) (74% of total nitrogen from diffuse agriculture)	781 t/a (phosphorous load entering Baltic Sea from Latvia) (72% of total phosphorous from diffuse agriculture)	No information [a)]
Lithuania	No information [a)] (across RBD: 1013-8117 t/a)	No information [a)] (across RBD: 36-93 t/a)	No information [a)]
Luxembourg	No information [a)]	No information [a)]	No information [a)]
Malta	Strong nitrate input (no sectoral distinction[a)])	No information [*)]	Strong pesticide input (no sectoral distinction)
Poland	No information [a)] (some data are available at the RBD level, see below)	No information [a)] (some data are available at the RBD level, see below)	None[*)]
Portugal	No information [a)] (some data are available at the RBD level, see below)	No information [a)] (some data are available at the RBD level, see below)	No information [a)]
Slovak Republic	38 589 t/a (total diffuse pollution, to be mostly from agriculture)	2 643 t/a (total diffuse pollution, to be mostly from agriculture)	No information [a)] (but pesticide load from agriculture to water is likely to occur)
Slovenia	No information [a)] (see information on RBDs Donava & Jadran)	No information [a)] (see information on RBDs Donava & Jadran)	No information [a)]
Spain	Information submitted at "RBD basin level" (see below)	Information submitted at "RBD basin level" (see below)	No information [a)]
Sweden	44 870 t/a (nitrogen load from agriculture entering coastal waters) 32% (across RBD: 4-66%)	6 580 t/a (phosphorous load from agriculture entering coastal waters) 30% (across RBD: 5-52%)	No information [a)]
UK	No information [a)]	No information [a)]	No information [a)]

RBD level	Nitrogen	Phosphate	Pesticides
Baleares basin	13.6 t/a (resulting from both fertilisers and contaminant load derived from livestock farming)	3.1 t/a (resulting from both fertilisers and contaminant load derived from livestock farming)	No information [a)]
Cavado-Ave-Leça basin	751 t/a	181 t/a (phosphorus)	No information [a)]
Danube basin[**)]	***Roof report***: 295.6 kt/a (39%); 7.2 kg/(ha*a) (agricultural emissions decrease from upper part of the Danube to the lower part) ***AT***: 35% ***DE***: 65% ***CZ***: 52% ***SK***: 36% ***HU***: 30% ***SI***: 38%	***Roof report***: 21.8 kt/a (32%) (erosion from arable land is the main source of agricultural diffuse pollution) ***AT***: 30% ***DE***: 50% ***CZ***: 47% ***SK***: 40% ***HU***: 20% ***SI***: 20%	***Roof report***: The priority pesticides 2,4-D, Alachlor, Trifluralin, Atrazine and copper compounds are heavily used pesticides in most Danube countries (used in cereals, rapeseed, sunflower, maize, orchards & vineyards). Priority and other pesticides are frequently detected in surface and ground water. ***AT***: local problems
Donava basin	3-70 kg/ha (but for 70-90% of N load, agriculture is main source)	No information [a)] (but due to agricultural activities, local orthophosphate problems)	No information [a)] (but due to agricultural activities, pesticides in whole GWBs, especially atrasine and desetilatrasine)
Douro basin/ Duero basin	***PT***: 48 t/a ***ES***: no information [a)] (but evaluation of pressures from diffuse sources related to nitrogen fertilisation shows significant pressures for 22.6% of GWBs)	***PT***: 36 t/a (phosphorus) ***ES***: no information [a)]	***PT***: no information [a)] ***ES***: no information [a)]
Ebro basin	No information [a)] (but agriculture is cited as main source of diffuse N pollution of groundwater)	No information [a)]	No information [a)]
Guadalquivir basin	No information [a)] (but agriculture is by far the most significant diffuse pressure analysed)	No information [a)]	No information [a)]
Guadeloupe basin	No information [a)]	No information [a)]	More than 50%
Guadiana basin	***PT***: 630 t/a ***ES***: no information [a)]	***PT***: 195 t/a (phosphorus) ***ES***: no information [a)]	***PT***: no information [a)] ***ES***: no information [a)]
Jadran basin	3-25 kg/ha (but for 70-90% of N load, agriculture is main source)	No information [a)]	No information [a)]
Loire basin	No information [*)]	No information [*)]	1-5%
Meuse basin [*)]	***Roof report***: 49 983 t/a (70% RBD Meuse) ***BE-FL***: 2 991 t/a ***BE-WL***: 8 208 t/a	***Roof report***: 2 217 t/a (37% RBD Meuse) (phosphorus) ***BE-FL***: 241 t/a ***BE-WL***: 565 t/a	***Roof report***: no information [a)] ***BE-FL***: 0.34 t/a (total load incl. point & diffuse sources) (only pesticides included in the list of priority substance) ***BE-WL***: no complete and reliable information [a)]
Minho-Lima basin	916 t/a	142 t/a (phosphorus)	No information [a)]
Odra basin	***CZ***: strong input from agriculture ***PL***: 87 223 t/a from diffuse sources	***CZ***: strong input from agriculture ***PL***: 5 645 t/a	***CZ***: strong input from agriculture ***PL***: none [*)]
Rhine basin	***Mosel-Saar report:*** no information [a)] (but important pressures) ***BE-WL***: 368 t/a	***Mosel-Saar report:*** no information [a)] (but important pressures) ***BE-WL***: 38 t/a	***Mosel-Saar report:*** 60% ***BE-WL***: no complete and reliable information [a)]
Ribeiras do Algarv basin	391 t/a	78 t/a (phosphorus)	No information [a)]
Sado-Mira basin	820 t/a	164 t/a (phosphorus)	No information [a)]
Scheldt basin	***BE-FL***: 21 076 t/a ***BE-WL***: 6 412 t/a	***BE-FL***: 1 198 t/a ***BE-WL***: 342 t/a	***BE-FL***: 3.45 t/a (total load incl. point & diffuse sources; no sectoral information) ***BE-WL***: no complete and reliable information [a)]
Segura basin	No information [a)] (but maps of nitrate concentrations n groundwater show a significant influence of agriculture on nitrate levels)	No information [a)]	No information [a)]

RBD level	Nitrogen	Phosphate	Pesticides
Seine basin	***FR***: no information [a)] ***BE-WL***: 56 t/a	***FR***: 23% ***BE-WL***: 5 t/a	***FR***: 70% of pesticides present in water are suspected to be from agriculture ***BE-WL***: no complete and reliable information [a)]
Tejo-Ribeiras do Oeste basin/ Tajo basin	***PT***: 454 t/a ***ES***: no information [a)]	***PT***: 140 t/a (phosphorus) ***ES***: no information [a)]	***PT***: no information [a)] ***ES***: no information [a)]
Vouga-Mondego-Lis basin	2 305 t/a	264 t/a (phosphorus)	No information [a)]
Wisla basin	113 969 t/a from diffuse sources	8 575 t/a	None[*)]

Note: a) "None" means that no significant pressure from the agricultural sector was reported in the Article 5 report; "no information" means that the Article 5 report does not specifically refer to agriculture as being the pressure behind the impact; and "no sectoral distinction" means that no distinction between households, industries and agriculture has been made in the Article 5 report.

Source: WRc, 2005a: 9-11; additional information from the WRc; WRc, 2006; [*)] CIM, 2005; [**)] ICPDR, 2005.

Although the data listed in Table 3 are of different quality, they show that many Member States reported a significantly high share of nutrient loads in surface waters from agriculture. In addition, nitrogen compounds are considered more important than phosphorus compounds in terms of nutrients inputs from agriculture. However, phosphorus can also induce pressures as a result of soil erosion. Indeed, phosphorus is mainly linked to particles of soil and can be transferred to aquatic environments in areas acutely affected by erosion. This phosphorus can accumulate in some stretches and causes eutrophication (cf. section 4.4).

The following sections give a more detailed overview of the current available data of source apportionment of nitrogen, phosphorus and pesticide inputs into water in the EU.

4.1.1 Nitrogen Pollution

Nitrates and ammonia are the most common forms of nitrogen in rivers, with nitrates alone accounting for more than 80 % of total nitrogen (Strosser et al., 1999). This section first provides data on the consumption of mineral nitrogen fertiliser in the EU-15 and the Central and Eastern European (CEE) countries[17], as well as in individual countries. It then analyses the relationship between fertilisers applied and the fraction of nitrogen emitted to the stream. Finally, it describes the nitrogen/nitrate pressures caused by agricultural activities.

Until the 1980s, Central and Eastern Europe broadly followed the same trend as Western Europe by increasing chemical inputs. After the collapse of the communist regimes and a drastic reduction of agricultural subsidies, the use of agro-chemicals dropped sharply by more than 50% (see Figure 1 and Figure 11). In 2001-2002, the EU-15 applied on average 63 kg of nitrogenous fertiliser per hectare of farmland, whereas in the CEE countries the figure was 36 kg per hectare (FoE, 2004: 22).

[17] The CEE-6 countries include Bulgaria, Czech Republic, Hungary, Poland, Romania and Slovakia; from 1992 onwards, data for the CEE-10 are available which cover the current 8 new Member States (Estonia, Latvia, Lithuania, Poland, Czech Republic, Slovakia, Hungary, Slovenia) plus the Accession Countries Bulgaria and Romania.

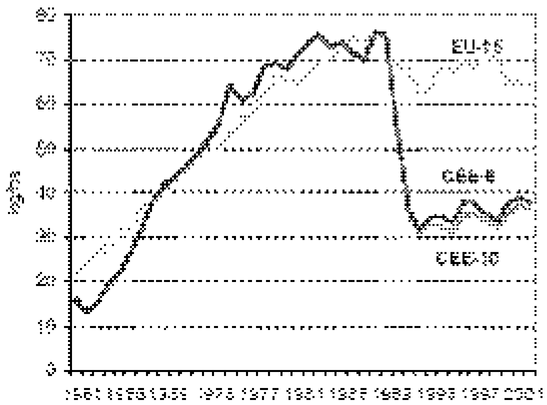


Figure 1: Nitrogenous fertiliser consumption in EU-15 and CEE countries (1961-2001)

Note: The CEE-6 countries include new MS Czech Republic, Hungary, Poland and Slovakia, and Accession Countries Bulgaria and Romania. From 1992 onwards, data for all CEE-10 countries (including also Estonia, Latvia, Lithuania, Slovenia) are available.

Source: FAOSTAT database, 2004, in: FoE, 2004.

In 1980-2001, the trend of ***nitrogenous fertiliser*** consumption decreased in a number of countries such as Hungary, Italy, Poland and the Netherlands (Figure 15 in the Annex illustrates the estimated consumption in OECD member countries). In the EU, the highest amounts of fertilisers are consumed in France, Germany and Spain (OECD, 2005: 17). For example, in France, the consumption of nitrogenous fertilisers is stabilised around 2 300 000 tonnes. However, these data do not allow for any general statement concerning the likely pressure on water resources, since they are not expressed per hectare of land, and above all, since there is no automatic relationship between fertiliser consumption and the leaching of nutrient surpluses (as surpluses also depend on other parameters, such as the nature of the crops cultivated, their yields, the crop rotation system, the timing of fertiliser distribution, the type of mineral fertiliser used, the addition of N compounds from livestock manure, etc.).

Within its activities on linkages between agriculture and water quality (LARA), the EEA presented estimated gross nitrogen balances and N-surpluses for EU Member States, and their potential relationship to water quality (EEA, 2006). A first result of this assessment is that when looking at nutrient surplus and its relation to nutrient pollution, it is relevant to examine the nutrient surpluses at different farm types. For example, the Dutch dairy farms had generally much higher surpluses compared to arable farms, and cattle, pig and mixed farms had significantly higher nutrient surplus than arable farms in Denmark. Although several studies illustrate the relationship between nitrogen concentration and fertiliser application and nitrogen surplus, no universal European relationship between land use variables and nitrogen levels could be established within LARA.

Within the FATE research project[18], the JRC investigated the relation between nitrogen fertilisers applied (mineral and organic fertilisers) and the fraction emitted into streams. The project results show that around 70 % to 97 % of the fertiliser is retained in the soil in the upland phase through crop uptake, soil storage, denitrification etc. Consequently, the predicted fraction of applied nitrogen fertiliser emitted into streams ranges from 3 to more than 30 % (see Figure 2).

[18] Aim of the project is to develop a set of modelling tools puttin g in relation nutrients pressures from various sources (e.g. agriculture, background losses) and water quality.

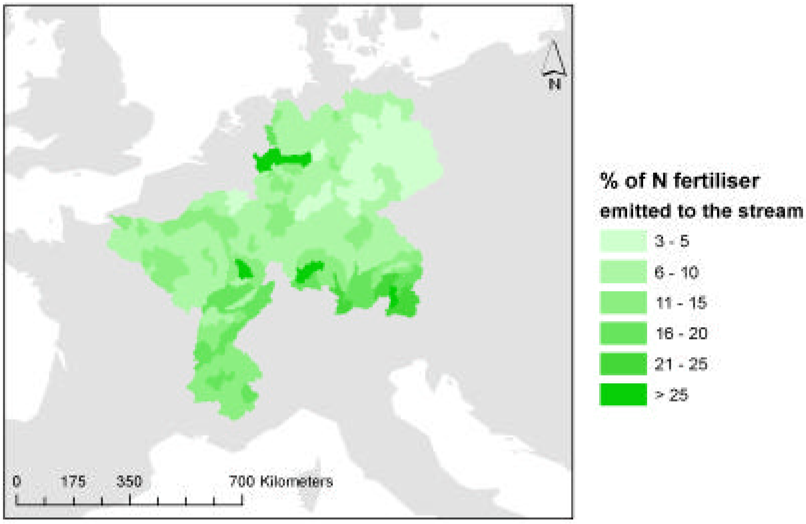


Figure 2: Fraction of applied nitrogenous fertilisers emitted to the stream

Source: JRC, 2006.

Although the nitrogen in water does not only come from agricultural sources, runoff from agricultural land is the main source of ***nitrogen*** pollution in most countries. Typically agriculture is responsible for 50 to 80 % of the total nitrogen load according to the EEA literature study on source apportionment (EEA, 2005a: 5). Nitrogen loading varies between different countries and catchments.[19] The total area-specific loading of nitrogen (kg N per hectare per year), illustrated by the pie charts in Figure 3, generally increases in areas with high agricultural activity. For all countries and catchments examined in the EEA report, the losses from agricultural or diffuse sources (including agriculture and background losses) account for more than 60 % of the total area-specific load of nitrogen (EEA, 2005a: 6).

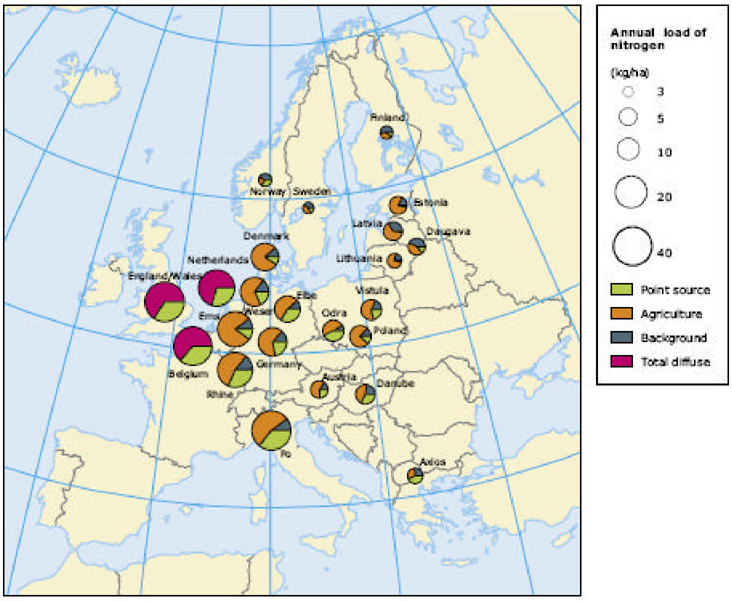


Figure 3: Source apportionment of nitrogen load in selected regions and catchments (2000)

Note: The area of each pie indicates the total area-specific loading (mixed approaches). The exact numbers of the area-specific load can be found in Table 5 presented in the Annex of this document.

Source: EEA, 2005a: 7.

[19] It should be noted here that some data refer to country level, while others give the value for a whole river catchment.

The total area-specific load (kg N per hectare per year) is higher in areas with increasing human activity and, in particular, with more intensive agriculture production. Indeed, the area-specific total nitrogen loads are nearly three times higher for the North Sea than for the Baltic Sea catchment area, as illustrated in Figure 4.

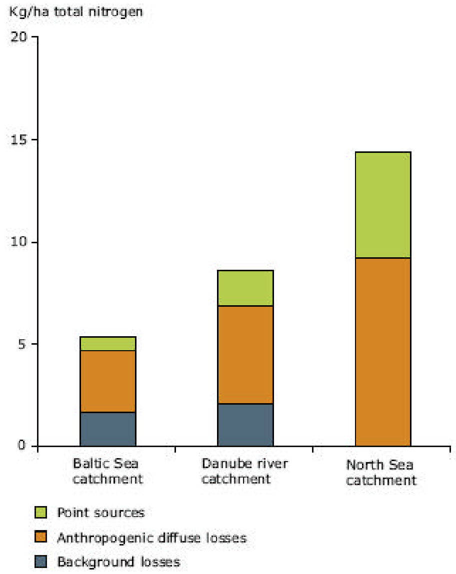


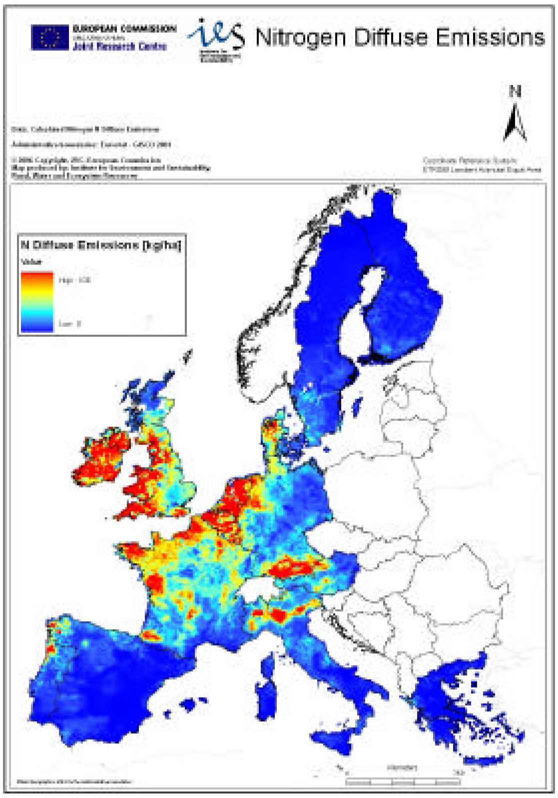
Figure 4: Source apportionment of annual nitrogen load (2000)

Note: The catchments cover the following areas: 1.6 million km^2 (Baltic Sea), 0.8 million km^2 (North Sea), and 0.5 million km^2 (Danube river). No separate information available on background losses for the North Sea.

Source: EEA, 2005a: 5.

The FATE research project calculated the diffuse emissions including the contribution of agriculture, scattered dwellings and atmospheric deposition (Figure 5). The amount of fertiliser applied for the calculation is shown in Figure 6 (Mulligan et al., 2006).

In addition, the JRC carried out source apportionment for various catchments in Europe for the years 1996 until 1999. The results of the project included the estimation that diffuse emissions of ***nitrate*** ranged from less than 4 kg N per hectare to more than 30 kg per hectare, with the lowest emission rates calculated for the Elbe and the highest calculated for the Danube (the German part, which forms 7.5 % of the total watershed area). Concerning source apportionment, it was estimated that agriculture contributes to 70 % of the total nitrate load in the Danube. For France, the agricultural contribution was calculated to be from around 66 % for the Meuse to about 47 % for the Seine (JRC, 2006).



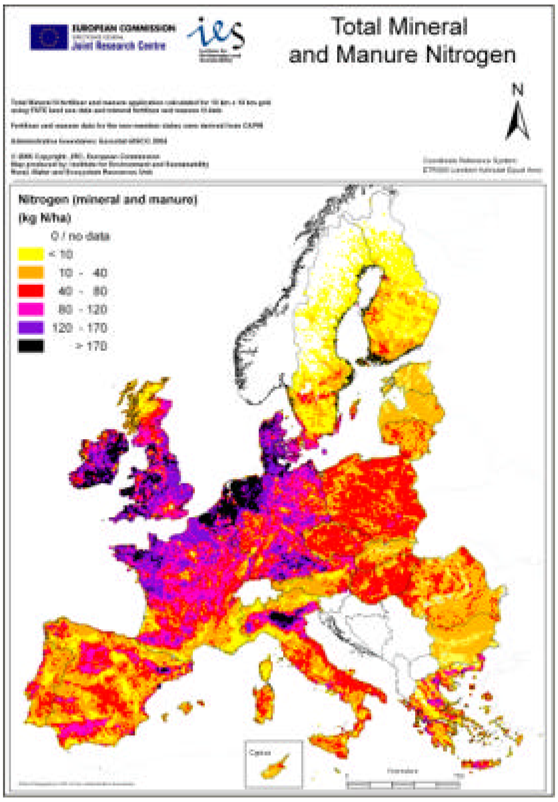


Figure 5: Estimated nitrogen diffuse emissions

Figure 6: Estimated nitrogen fertiliser (mineral + manure)

Source: JRC, 2006.

4.1.2 Phosphorus Pollution

Besides discharges from urban wastewater and industry, agricultural activities also contribute to phosphorus pollution in water bodies. This section summarises the results of an assessment of phosphorous pressures through a phosphorous balance. It then provides data on the application of phosphorus fertiliser and the related fraction emitted into streams. Finally, it describes the phosphorous pressures caused by agricultural activities.

A study on phosphorus related problems in farm practices, commissioned by the Environment Directorate General of the European Commission, assessed phosphorous pressures through a ***phosphorous balance*** (Bomans et al., 2005). This balance considers the land, a farm or an entire region as a system characterised by an inflow (e.g. mineral fertiliser, livestock manure) and outflow of nutrients (crop production, forage production). The surplus in the balance for this nutrient (here: phosphorous) is a measure of the potential loss of this particular nutrient to the environment, or, in the case of a deficit, for the degree of 'nutrient mining'. The results of the assessment include data on the average total phosphorous input per hectare of agricultural land, the ratio between phosphorus input as manure and as mineral fertiliser as well as the resulting phosphorous surplus in the individual Member States of the EU-25 (for more detailed information, see Table 7 in the Annex). The efficiency of P-use and P-uptake seems to be very important. For instance Belgium and Italy have a similar balance surplus, while the average P-load in Belgium is twice as high as in Italy. In other words: P-uptake per hectare is much higher in Belgium than in Italy. This phenomenon can be explained by soil type, climate and level of intensification (Bomans et al., 2005).

The following figure shows the amount of ***phosphorus used*** per hectare in selected European MS in 2003. With the exception of Belgium, the Netherlands, Denmark and the United

Kingdom, all countries consume less than 30 kg phosphorus per hectare of arable land. With regard to the CEE countries, there are different levels of phosphorus applied per hectare of agricultural land: Lithuania and Latvia consume only around 5-10 kg P per hectare, while Poland and the Czech Republic still use about 20 and 15 kg P per hectare respectively (see Figure 7).

It should be noted that, as with statistics on total nitrogen fertiliser consumption, data on phosphate used per hectare of agricultural land do not allow for any general statement concerning the likely pressure on water resources, since there is not necessarily a relationship between fertiliser consumption, the amount of nutrient surpluses (which also depend on other parameters, such as the nature of the crops cultivated, their yields, the crop rotation system, the timing of fertiliser distribution, the addition of nitrogen compounds from livestock manure, etc.) and the final fraction leaching into water (which also depends on the nature of the soil).

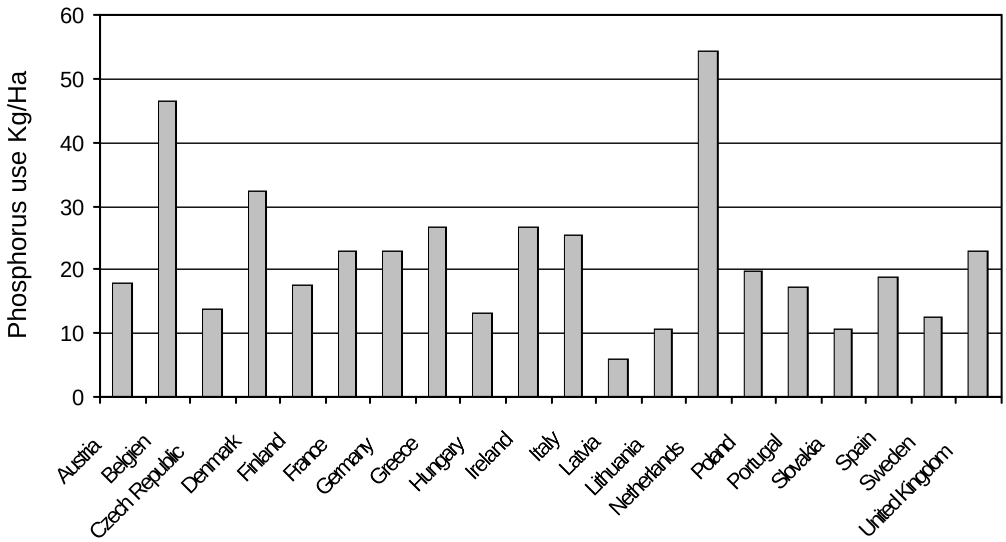


Figure 7: Phosphorus use in selected European countries (2003)

Source: Eurostat, IFA database, in : Soil Service of Belgium, 2005.

Within the FATE research project, the JRC investigated the relationship between phosphorous fertilisers applied and the fraction emitted into streams (JRC, 2005). The predicted fraction of applied ***phosphorus fertiliser emitted into streams*** showed a high variability ranging from 0 to more than 6 % (see **Fehler! Verweisquelle konnte nicht gefunden werden.**) while 94 to 100 % are either stored in the soil in the upland phase or removed through crop uptake. (see P-balance above).

Point sources such as domestic and industrial waste water still tend to be the most significant source of phosphorus. Nevertheless, agriculture is considered to have become in some cases the main source of (diffuse) ***phosphorus pollution***. The reason behind this development is the progressive, marked reduction in phosphorus emissions from other sources during the last 15 years due to increased wastewater treatment and the reduction of industrial discharges.

Similarly to nitrogen, phosphorus loading differs between European countries and catchments.[20] According to the EEA literature study on source apportionment (EEA, 2005a), the total area-specific loading of phosphorus (kg P per hectare per year), illustrated by the pie charts in Figure 8, is highest in countries and catchments with high population density and a high proportion of agricultural land.

However, the reason for high phosphorus loading from agriculture differs from region to region; in highly populated countries and catchments which have installed nutrient removal stages at the majority of their wastewater treatment plants, such as Germany and the Ems and Weser catchments, runoff from agricultural sources generally accounts for more than 50 % of the total loading, resulting from the reduced percentage of phosphorus loading from point sources. In Poland and the Baltic states, however, the high phosphorus loading from agricultural sources (more than 63 % of the total) may be due to excessive contribution in regard to crop needs, especially in intensive farming regions.

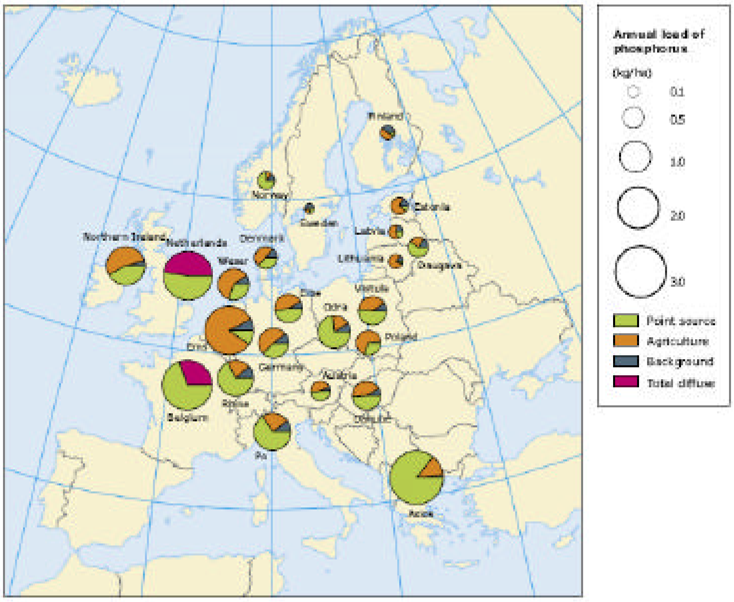


Figure 8: Source apportionment of phosphorus load in selected regions and catchments

Note: The area of each pie indicates the total area-specific loading. The exact numbers of the area-specific load can be found in Table 6.
Source: EEA, 2005a: 8.

In regions with a low population density and with a low percentage of agricultural land such as the Baltic Sea catchment, the phosphorus load amounts to only one third of the area-specific load of regions with a high population density such as the Danube and North Sea catchments (see Figure 9).

[20] It should be noted here that some data refer to country level, while others give the value for a whole river catchment.

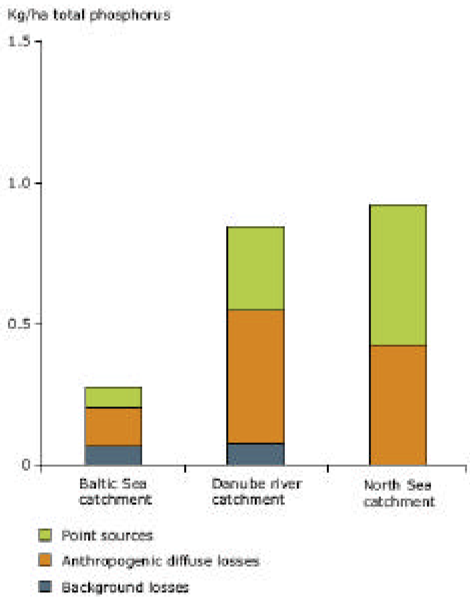


Figure 9: Source apportionment of annual phosphorus load

Note: The catchments cover the following areas: 1.6 million km^2 (Baltic Sea), 0.8 million km^2 (North Sea), and 0.5 million km^2 (Danube river). No separate information available on background losses for the North Sea.

Source: EEA, 2005a: 6.

In addition, the FATE research project performed source apportionment for various catchments in Europe for the years 1996 until 1999. One outcome of the project was the calculation that diffuse emissions from ***phosphorus*** ranged from less than 0.05 kg-P per hectare for the Elbe to close to 1.90 kg-P per hectare for the Rhine (German part).

4.1.3 Pesticide Pollution

Pesticides contribute to agricultural productivity but can be harmful to humans and the environment depending greatly on the toxicity of individual pesticides. The main source of pesticide pollution of water is from agriculture, but pollution also occurs from other sources such as industrial discharges, pollution incidents, sewage treatment works, and urban run-off. Pesticides are present in surface waters and groundwaters at concentrations that, in certain cases, are of potential concern for drinking water and aquatic organisms. This is reflected in the fact that many countries reported pesticides (and metals) as being a problem for their supply of drinking water (EEA, 2003a).

Overall for Europe, there is limited information available on pesticides in both surface water and groundwater. To provide an indicative overview, the following section summarises the data available. The section provides first an overview of the (i) pesticides sold (based on EEA IRENA indicators/ECPA database) and (ii) pesticides used per hectare in the EU-15 and the Central and Eastern European (CEE) countries (based on FoE/FAOSTAT database) as well as in individual countries (OECD assessment). It then addresses the issue of risks of groundwater pollution by pesticides.

According to the IRENA report by EEA (2005b: 34), the total quantity of ***pesticides sold***, expressed in active ingredient (a.i.), increased by 11 % between 1992 and 1999 (from 295.000 to 327.000 tonnes). While sales of herbicides and fungicides grew by 11% and 15%, respectively, sales of insecticides decreased by 16 %. However, the sales figures also cover use outside agriculture. A more detailed picture of the differences between the EU-15 Member States can be derived from Figure 10. The total number of tonnes of plant protection products sold per hectare of agricultural land is highest in the western European countries such as the *Netherlands*, *Belgium*, *France*, the *United Kingdom* and *Germany*.

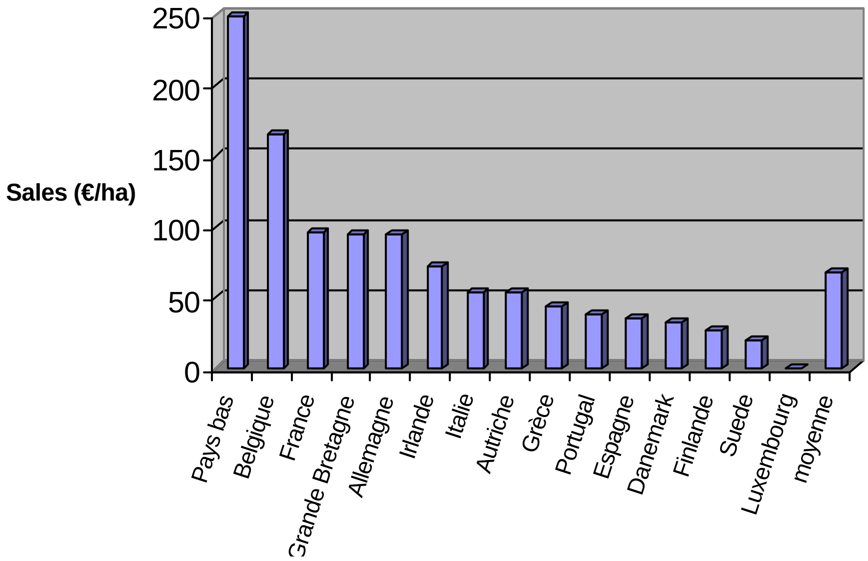


Figure 10: Sales of plant protection products per ha arable land / permanent crop (1999)

Source: EUROSTAT database, in: UIPP, 2002.

Generally, the ***use of pesticides*** is higher in western Europe than in northern or eastern Europe. Between 2001 and 2002, in the EU-15, an average of 2.3 kg of active ingredients of pesticides were applied per hectare of agricultural land, whereas in the Central and Eastern European (CEE) countries[21] the figure was 0.6 kg per hectare (see Figure 11). The average estimated pesticide application rate (kg a.i. per hectare) are higher than the EU-15 average in Italy, Greece, Portugal and France (EEA, 2005b: 34). It is important to note that the total consumption figures are dominated by sulphur and copper products as used in vineyards, orchards and on organic farms (European Commission, 2000).

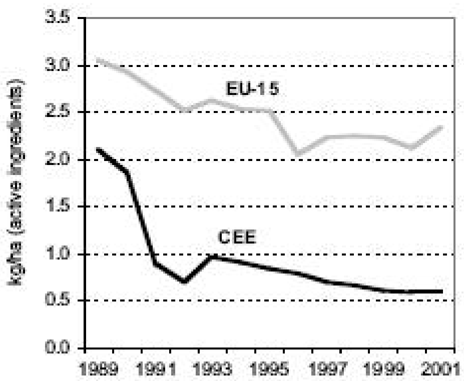


Figure 11: Pesticide consumption in EU-15 and CEE countries (1989-2001)

Note: Due to limited data availability, the figure shows the pesticide use for countries available in a given year per their total farmland. From 1993 onwards, all CEE-10 countries except Bulgaria are included.

Source: FAOSTAT database, 2004, in: FoE, 2004.

Figure 11 shows that, in the CEE countries, pesticide consumption dropped sharply by close to 70 % due to economic restructuring and a drastic reduction in agricultural subsidies after

[21] The CEE-10 countries cover the current 8 new Member States (Estonia, Latvia, Lithuania, Poland, Czech Republic, Slovakia, Hungary, Slovenia) plus the Accession Countries Bulgaria and Romania.

the collapse of the communist regimes. However, some CEE countries have recently seen a slight rise in the use of pesticides, but levels are still much lower than pre-economic transition. For example, in the *Czech Republic*, 4.302 tonnes of pesticide active ingredients were used in 2000, compared to 8.920 tonnes of active ingredients in 1990 (EEA, 2003a: 64).

There are very large differences in the developments in different countries over this period. Figure 16 in the Annex illustrates percentage changes in the total number of tonnes of pesticides used (not weighed per hectare of arable land) in different OECD member countries between 1990-92 and 2000-02. As can be seen, pesticide use in Portugal almost doubled, while the number of tonnes of active ingredients applied was reduced by at least 40 % in *Denmark*, the *Netherlands* and *Hungary*. These differences could reflect differences in the development level of agriculture in terms of productivity (gain of productivity in *Greece*, *Spain*, *Turkey*, *Poland* during this period, difficulties of Hungarian agriculture) and in the use of pesticides, as well as an important policy to reduce the use of pesticides (e.g. *Denmark*).

When evaluating these developments, one should take into consideration that the toxicity of different active ingredients varies greatly, and that a number of low-dose pesticides have come on the market over the last decade. Greater use of low-dose pesticides tends to reduce the number of tonnes of active ingredients, without necessarily reducing the related environmental risks (OECD, 2005: 17). In general, it should be born in mind that statistics concerning the total volume of pesticides sold or used are to be interpreted with caution, to the extent that they say little about the nature of the active substances concerned and, consequently, about the risks of negative impacts associated with their use. Indeed, an increase (or a reduction) in the total volumes of pesticides sold/used is not necessarily equivalent to an increase (or a reduction) in the risks associated with their use (European Commission, 2002: 10).

As regards ***pesticide loads in waters***, the submitted national synthesis of the Article 5 reports of the Member States contained no detailed information other than that diffuse sources are more significant than point sources (WRc, 2005: 8). This makes it difficult to derive a clear idea of the level of pesticide pressure from the national syntheses of the reports. Consequently, Article 5 reports reveal that further investigation is needed in order to harmonise the characterisation methods and better understand agricultural pressures due to pesticides.[22]

In general, there is limited information available and a lack of reliable data on pesticides in *groundwater* overall for Europe. However, the European Environmental Agency (2004) summarises data from national state of the environment (SoE) reports in the indicator fact sheet on pesticides in groundwater. From the data provided in Figure 12, it appears that Member States reported a risk of pesticide pollution in groundwater.[23]

[22] For instance, a first estimation of pesticide pressures in French river basins has been done by coupling crop localisation and frequency of phyto-sanitary treatments on each type of crop per year.

[23] Additional information can be found in the study on "Environmental risks from agriculture in Europe" published by the European Centre for Nature Conservation (ECNC) which provides an overview on aquatic risk caused by pesticide use in arable crops (Delbaere and Serradilla, 2004).

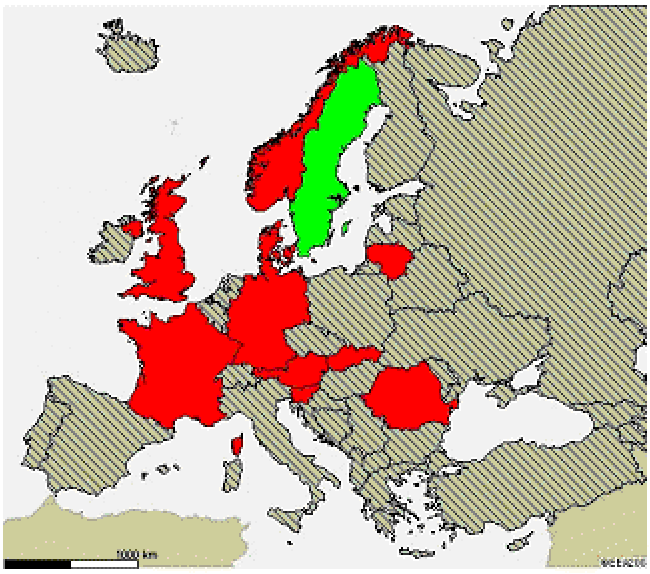


Figure 12: Risk of groundwater pollution by pesticides

Legend: *Red*: danger of pesticide pollution in GW reported by countries; *Green*: no danger of pesticide pollution in GW reported by countries; *Other*: no statements.

Source: WATERBASE data collected through EUROWATERNET, EEA, 2000; in EEA, 2004.

According to the EEA (2004), all countries that reported on the pesticide situation in their SoE reports, except for Sweden, mention a danger of pesticide pollution of groundwater. In *Austria*, between mid 1997 and mid 1999, about 15 % of sampling sites exceed 0.1 µg/l for desethylatrazine and 10 % for atrazine. Atrazine was banned in 1995 and the ban seems to be effective (EEA, 2004). In *France*, in 2002, over half of all monitoring sites (51 %) were classified as good to high quality. Fair or poor quality was detected at 38 % of sites and very poor quality at 8 %. However the available data covers only 75 % of France (IFEN, 2004 in: EEA, 2005b: 60). In *Denmark*, in 2001, pesticides were found to be present in 37 % of the well screens and concentrations of pesticides in 4 % of the screens exceeded the limit value for drinking water of 0.1 µg/l (GEUS, 2004, in: EEA, 2005b: 60). In *England and Wales*, in 2000, about 8-10 % of the freshwater sites failed to meet the 0.1 µg/l threshold for pesticides measured (EA, 2003 in: EEA, 2005b: 60). Even *Sweden*, which stated that pesticides do not cause problems in groundwater, reports sometimes low but not insignificant concentrations of pesticides in groundwater (EEA, 2004).

4.2 Alterations of Hydrologic Regimes

Agricultural activities such as irrigation, drainage and land reclamation can cause the disturbance of the natural water balance. The following box summarises the main alterations of hydrologic regimes caused by agriculture.

Box 3: The main alterations of hydrologic regimes

Irrigation as part of intensive agriculture, including horticulture, has often led to unsustainable use of water in some Member States. The agri-environmental impact of increasing water allocation rates results in a higher demand for water that can lead to declining groundwater levels or the need to build more and larger water reservoirs. In some instances, major water diversion structures are necessary to supply water to irrigation schemes. The diversion or retention of water for irrigation can have serious downstream effects on the environment, especially the drying up of wetland areas. Furthermore, inappropriate irrigation results in an increase of the salinification of agricultural land. Problems arising from irrigation mainly occur in southern MS, and are often linked to specific crops, such as maize, fruit, and vegetables. Nevertheless, irrigation in agriculture also has some positive effects on the environment. Reservoirs created for irrigation can provide fresh water for birds and other fauna; terraces for growing wine can help slow-down run-off and reduce erosion; water-management for agricultural purposes can replenish the water-table and stabilise river levels. Finally, irrigation generally increases competition with other sectors for water resources, which leads to diverse effects. On the one hand, there is a risk that water resources are overused, but on the other hand water becomes an important (and potentially expensive) resource resulting in an improved understanding of the need to protect it.

Agricultural drainage uses surface ditches or underground pipes to remove standing or excess water from poorly drained areas. Thus, agricultural drainage systems generally increase crop yields on poorly drained soils by providing a better environment for plants to grow, especially in wet years. Drainage can have a variety of impacts on hydrology and water quality, depending, among other things, on the techniques used and the type of soil. The drained water can be carried to adjacent streams or rivers. Furthermore, the destruction of wetlands due to drainage can result in the loss of important water retention areas. Drainage can also have direct impacts on biodiversity, as it can cause floodplain disruptions and break the connection between water bodies, thus endangering the survival of, certain fish species etc. Because of the removal of water from drained areas, runoff and high-flow peaks will increase, as will the risk of downstream floods which may lead to river channelisation. The groundwater table and renewal rate will then further decrease in the drained area/catchment (EEA, 1999). However, the actual impact of this phenomenon on water and solute transport has not yet been fully assessed or, especially, quantified. As regards water quality, subsurface drainage can reduce the loss of phosphorus and organic nitrogen but increase the loss of nitrates and other soluble constituents. Surface drainage, however, will usually increase phosphorus loss but reduce nitrate runoff.

Wetlands are also an important habitat for protected species and considered as an important habitat type under the EU Flora Fauna Habitats (FFH) Directive[24] as well as under the international Ramsar Convention. This Convention considers wetlands to be "*a resource of great economic, cultural, scientific, and recreational value, the loss of which would be irreparable*" (preamble). Contracting Parties must endeavour to promote the conservation of wetlands and waterfowl by establishing nature reserves on wetlands (Art. 4). Originally meant to protect wetlands as a habitat for waterbirds, the convention broadened its scope over the years, to include "*the conservation and wise use of all wetlands through local, regional and national actions and international co-operation, as a contribution towards achieving sustainable development throughout the world*" (Ramsar Convention Secretariat, 2004).

The following sections provides more detailed data concerning water abstraction for irrigation and land drainage.

4.2.1 Water Abstraction for Irrigation

Firstly, this section gives an overview of the relative water consumption for agricultural activities, as reported by the Member States in the national syntheses of the Article 5 reports. It then summarises the results from the IRENA project on the water use intensity (irrigable area) and regional water abstraction rates and, based on this, water allocation rates for irrigation.

The following table gives an overview of agricultural activities, the volume of water they use and the percentage of the total extracted water volume this represents, as indicated by the Member States in the national syntheses of the Article 5 reports submitted to the European Commission. However, the representativeness of this overview is limited, as RBDs from the Mediterranean region with a traditional farming based on irrigation are not fully included (Italy and Greece are still missing). In addition, it would be useful to link the relative water consumption for agricultural activities to the availability of the resource (see IRENA assessment prepared by EEA below).

24 Annex I of the FFH Directive lists the "natural habitat types of community interest whose conservation requires the designation of special areas of conservation" and includes such types of wetlands as bogs, sandbanks and salt marshes.

Table 4: Relative water consumption for agricultural activities

MS	List of agricultural activities	Volume of water used [M m^3/a]	Percentage of total volume abstracted
Austria	Small proportion of agriculture land is irrigated (south and south-east, only).	100 M m^3/a	6%
Belgium - Flanders	No differentiation between land drainage and irrigation (see information of Scheldt & Meuse RBDs)	No information [a)] (see information of Scheldt & Meuse RBDs)	No information [a)] (see information of Scheldt & Meuse RBDs)
Belgium - Wallonia	Livestock (Bovines, pigs), crops	6.5 M m^3/a	3.98%
Cyprus	Irrigation, husbandry	182.4 M m^3/a	69%
Czech Republic	No information [a)]	Elbe: 8.66 M m^3/a Danube: 3.85 M m^3/a	No information [a)]
Denmark	Drainage and irrigation (especially in Jutland)	141 M m^3 /a (mainly groundwater)	22%
Estonia	No detailed data available	0.19 M m^3/a	<1%
Finland	No information [a)]	No information [a)]	No information [a)]
France	Irrigation (large variation across RBDs) (some data are available at the RBD level, see below)	No information [a)] (some data are available at the RBD level, see below)	No information [a)] (some data are available at the RBD level, see below)
Germany	No information [a)] (but agriculture is significant water user)	No information [a)]	No information [a)]
Hungary	Irrigation (small proportion (ca. 2%) of agriculture land is irrigated) Aquaculture Animal husbandry and others	No information (11% surface water; 9% groundwater)	27% of water used by agriculture (irrigation) 68% of water used by agriculture (aquaculture) 5% of water used by agriculture (animal husbandry and others)
Ireland	Potatoes, cattle and cattle products, and sheep and sheep products (key water using subsectors for agriculture)	No information [a)]	No information [a)]
Latvia	No information [a)]	No information [a)]	No information [a)]
Lithuania	No information [a)]	7 M m^3/a	2%
Luxem-bourg	Irrigation not significant	No information [a)] (see information of Mosel-Saar & Meuse RBDs)	
Malta	Irrigation Animal husbandry	Limited data exist on abstraction sources and their related abstracted volumes	5% (official data based on billed consumption) 43% (when crop irrigation is taken into account)
Poland	No information [a)]	No information [a)]	No information [a)]
Portugal	No information [a)]	No information [a)] (see information on Vouga-Mondego-Lis, Tejo-Ribeiras do Oeste, Sado-Mira, Guadiana & Ribeiras do Algarve RBDs below)	No information [a)]
Slovak Republic	Irrigation	1 063 M m^3/a	5.3%
Slovenia	Irrigation	606.1 M m^3/a 0.0043 M m^3/a (irrigation from public irrigation system)	No exact data available on total amount of abstracted water
Spain	Mainly irrigation and livestock farming	Information submitted at "RBD basin level" (see below)	Information submitted at "RBD basin level" (see below)
Sweden	Irrigation (low need)	No information [a)]	1-4 % total (0.4-12.3 relative % of total volume extracted)
UK, England & Wales	Irrigation (need varies across RBD)	6-50 M m^3/a (across RBD)	No information [a)]
UK, Scotland	Irrigation (low need) Fish farming (need for high quality water)	56.5 M m^3/a (irrigation) 1 582 M m^3/a (fish farming)	No information [a)]
UK, Northern Ireland	No information [a)]	No information [a)]	No information [a)]

RBD	List of agricultural activities	Volume of water used [M m^3/a]	Percentage of total volume abstracted
Andalucia basin	Irrigation Livestock farming	1 048 M m^3/a (irrigation) 4 M m^3/a (livestock farming)	75% (irrigation) 0.3% (livestock farming)
Baleares basin	Irrigation Livestock farming	105.6 M m^3/a (irrigation) 6.2 M m^3/a (livestock farming)	46% (irrigation) 3% (livestock farming)
Cataluna basin	Irrigation Livestock farming	386.5 M m^3/a (irrigation) 29.7 M m^3/a (livestock farming)	32.6% (irrigation) 2.5% (livestock farming)
Cavado-Ave- Leça basin	No information [a)]	No information [a)]	No information [a)]
Donava basin	Irrigation	551.8 M m^3/a (with 0.0022 M m^3/a irrigation from public irrigation system)	No exact data available on total amount of abstracted water.
Douro basin/ Duero basin	***PT***: no information [a)] ***ES***: irrigation	***PT***: no information [a)] ***ES***: 3 478 M m^3/a	***PT***: no information [a)] ***ES***: 76%
Ebro basin	Irrigation	6 310 M m^3/a	13%
Garonne basin	645 000 ha of land irrigated (especially for maize, 70%)	1 000 M m^3/a	85%
Guadiana basin	No information [a)]	10.2 M m^3/a (surface water) 9.0 M m^3/a (total water abstracted)	13.9%
Jadran basin	Irrigation	54.3 M m^3/a (with 0.0043 M m^3/a irrigation from public irrigation system)	No exact data available on total amount of abstracted water.
Júcar basin	Agriculture	3 657 M m^3/a	76.3%
Loire basin	Irrigation (large variation across RBDs)	473 M m^3/a	No information [a)]
Meuse basin	***BE-FL***: agriculture ***NL***: no information [a)]	***BE-FL***: 7.7 M m^3/a (85% of water used for agriculture is groundwater) ***NL***: no information [a)]	***BE-FL***: 14% ***NL***: no information [a)]
Minho-Lima basin	No information [a)]	No information [a)]	No information [a)]
Rhine basin	***High Rhine part***: no information [a)] ***FR***: irrigation (large variation across RBDs) ***NL***: no information [a)]	***High Rhine part***: 62-100 M m^3/a ***FR***: 100 M m^3/a ***NL***: no information [a)]	***High Rhine part***: 1-3% ***FR***: no information [a)] ***NL***: no information [a)]
Rhône basin	375 000 ha of land irrigated (especially for orchards and maize)	No information [a)]	At least 10% of groundwater abstracted
Ribeiras do Algarve basin	No information [a)]	19.9 M m^3/a (surface water) 115.3 M m^3/a (total water abstracted)	48.3%
Sado-Mira basin	No information [a)]	3.5 M m^3/a (surface water)	17.2%
Sambre basin	No information [a)]	No information [a)]	No information [a)]
Scheldt basin	***Roof report***: no information [a)] ***BE-FL***: agriculture ***FR***: irrigation (large variation across RBDs)	***Roof report***: no information ***BE-FL***: 34 M m^3/a (81% of water used by agriculture is groundwater) ***FR***: no information [a)]	***Roof report***: 4% ***BE-FL***: 5% ***FR***: 4%
Segura basin	Agriculture	1 571 M m^3/a	89%
Seine basin	***FR***: 140 000 ha of land irrigated (large cultivated surface areas, spring crops)	***FR***: at least 95 M m^3/a (mainly from groundwater sources)	***FR***: 0.5%
Tejo-Ribeiras do Oeste basin/ Tajo basin	***PT***: no information [a)] ***ES***: agriculture	***PT***: 2.1 M m^3/a (surface water) 744.3 M m^3/a (total water abstracted) ***ES***: 1 785 M m^3/a	***PT***: 31.9% ***ES***: 37%
Vouga-Mondego-Lis basin	No information [a)]	75.1 M m^3/a (total water abstracted)	No information [a)]

Note: a) "None" means that no significant pressure from the agricultural sector was reported in the Article 5 report; "no information" means that the Article 5 report does not specifically refer to agriculture as being the pressure behind the impact; and "no sectoral distinction" means that no distinction between households, industries and agriculture has been made in the Article 5 report.

Source: WRc, 2005a: 6-7, WRc, 2005d, additional information from the WRc; WRc, 2006.

As already mentioned in chapter 2 on data uncertainties, there are significant gaps regarding the data of water use for agricultural purposes, especially due to the absence of the Article 5 reports from two Mediterranean countries (Italy and Greece are still missing). In addition, with regard to the national syntheses of the Article 5 reports submitted so far, a number of unregulated activities of water abstraction and their impacts are not known but might be significant in certain cases (WRc, 2005: 21).

The main agricultural driving force behind the use of water is the consumption of water for irrigation. With regard to the total area equipped for irrigation (***total irrigable area***) per utilised agricultural area (UAA), some areas may be creating unsustainable trends. The irrigable area in EU-12 increased from 12.3 million hectare to 13.8 million hectare between 1990 and 2000 (increase of 12 %). This is fully accounted for by the southern European countries: France, Greece and Spain, where the irrigable area increased from 5.8. million ha during the same period, representing an increase of 29 % (EEA, 2005b: 34, 47).

An increase in irrigable area may potentially have an impact on water demand, since more farmers are likely to use irrigation methods. However, the adoption of improved irrigation technology from, for example, sprinkler to drip systems, will improve the water use efficiency of irrigation systems, reducing gross water requirements. Last but not least, the role of irrigation differs between countries and regions because of climatic conditions. In southern European countries, it is an essential element of agricultural production and irrigable areas are irrigated throughout the whole growing season each year; in central and northern European countries, irrigation is generally used to improve production in dry summers.

Within the IRENA assessment, the ***regional water abstraction rates*** for agriculture were estimated by weighing national reported water abstraction rates by regional irrigable area (see above). The estimates are based on the assumption that water requirements for irrigation are abstracted from local water supplies, and thus resulting in regional pressures on water resources. In some cases however, large-scale water works include the transfer of water across large distances.[25] Given the estimation method, it is not possible to draw direct conclusions on water use intensity per hectare of land in different regions from these figures, but they show the spatial distribution of potential abstraction pressures across the EU-15 (see Figure 13).

[25] This was for example proposed in the Spanish National Hydrological Plan (SNPH), for further information, see, [http://www.mma.es/rec_hid/plan_hidro/plan_hidro_nacional_boe.pdf].

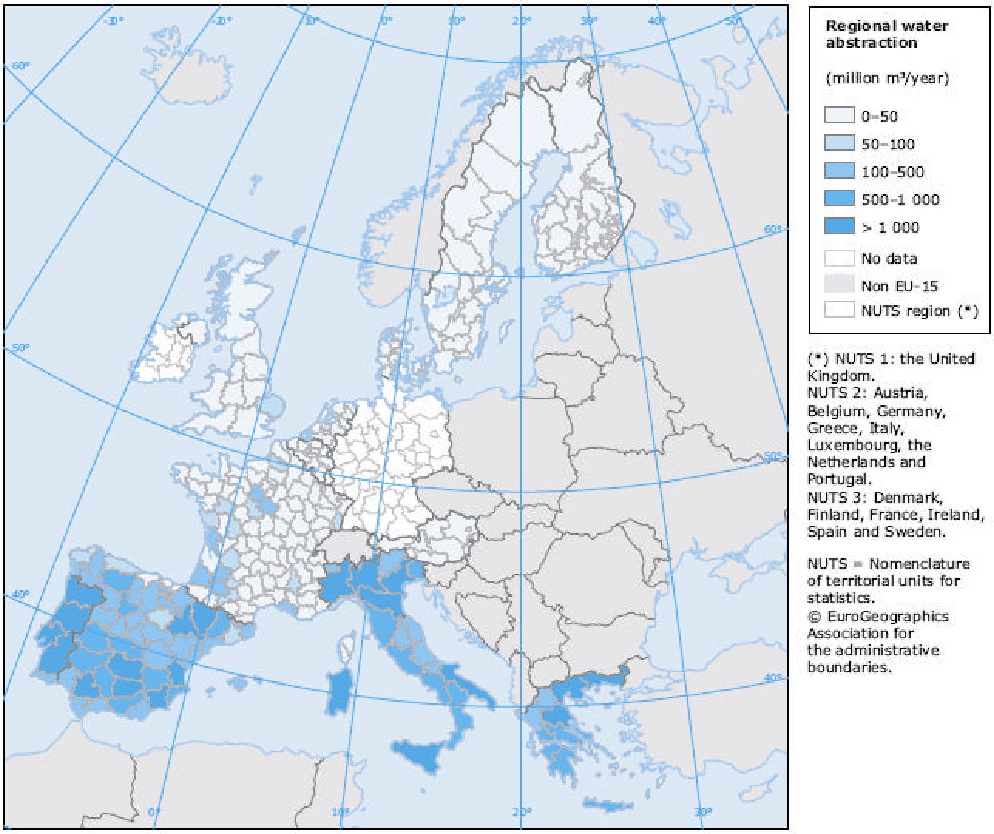


Figure 13: Regional water abstraction rates for agriculture in million m^3/a (2000)

Source: Community Survey on the Structure of Agricultural Holdings (FSS), Eurostat combined with information from OECD/Eurostat questionnaire, in: EEA, 2005b: 47.

Figure 13 provides a good indication of those regions among the 332 analysed for this assessment that have a high abstraction demand. The 41 regions with the highest use of water for agricultural purposes (more than 500 million m^3 per year) are located in southern Europe, 21 of which are estimated to require more than 1 000 million m^3 water per year for agriculture (EEA, 2005b: 48). Conversely, in northern Member States, 90 % of the regions are estimated to have abstraction rates of between 0 and 50 m^3 per year (EEA, 2005c: 4).

However, it should be noted that the water abstraction rate does not refer to water availability and thus no information can be derived in terms of water scarcity and drought issues in the respective region.[26]

Based on abstraction rates and irrigable area, the IRENA assessment prepared by EEA estimated the ***annual water allocation rates for irrigation***. They were grouped into two broader regions, each with different amounts of water allocated for irrigation: northern and southern EU-15 Member States.[27] In southern EU-15 MS, the water allocation rate decreased slightly from 6 578 to 5 500 m^3 per hectare per year between 1990 and 2000. During the same period, the water abstraction rate decreased from 69 103 to 66 424 million m^3 per year, while the irrigable area increased from 10.5 to 12 million hectare (EEA, 2005b: 48). This reduction in water application rates per hectare of land irrigated likely implies an increase in water use efficiency. In the northern EU-15 MS, the water allocation rate was halved from 757 to 349

[26] "Water scarcity" refers to long-term water imbalances, combining arid or semi-arid climate (low water availability) with a level of water demand exceeding the supply capacity of the natural system; for more information, please refer to the outcome of the CIS water scarcity drafting group (Environment Council, 2006).

[27] Northern EU-15 comprises AT, BE, DK, FIN, DE, IE, LUX, NL, SWE and UK; southern EU-15 comprises FR, GR, IT, PT and ES.

m^3 per hectare per year between 1990 and 2000. During this period, both the water abstraction rate and the irrigable area decreased: from 1 622 to 716 million m^3 per year and from 2.1 to 2.0 million hectare, respectively (EEA, 2005b: 48).

4.2.2 Land Drainage

For the European Union, data on land drainage for agricultural purposes are rather limited. According to the EEA (1999), in Austria and Denmark, land drainage, either for flood control or land reclamation, is probably the single most important measure which has adversely affected the landscape (loss of wetlands, small scale structures in the landscape), biodiversity and the hydrological cycle.

Between 1980 and 1990 more than 37 % of wetlands of *Austria* have been destroyed. In *Denmark* it is estimated that about 49 % of agricultural land has been drained, mainly in the 19th century. The main benefits of this intervention are reclaimed land for cultivation, increase agricultural production (economic benefits) and a reduction in the risk of floods (EEA, 1999). Nowadays in Austria, land drainage is no longer supported by government, and programmes to recover drained land and restore rivers, including riparian wetlands, have been initiated to re-establish their natural hydrological features. Land drainage is therefore expected to decrease (EEA, 1999).

4.3 Hydromorphological Modifications

In the past, land drainage (cf. section 4.2.2), intensification of farming practices and inappropriate grazing regimes have contributed to the loss of wetlands and floodplains, resulting in hydromorphological modification of surface waters. Such modifications aggravate major floods, such as the Rhine flood in January/February 1995, the Odra flood in summer 1997, in southern Germany in spring 1999 and on the Elbe and its tributary rivers in August 2002.

Across the EU Member States studied by the WRc, artificial morphological changes lead to significant pressure on surface water bodies (WRc, 2005: 8). In some cases, flood protection measures aimed at gaining and protecting agricultural land (not quantified) are the main cause (WRc, 2005: 11).

In *Spain*, for example, agriculture is a land-use linked to several hydromorphological pressures. This is true for its numerous reservoirs and dams; besides hydropower and water supply, these predominantly serve irrigation needs. In certain areas of Spain, there are also extensive irrigation networks (canals) which contribute to the hydromorphological modification of waters. While in the Baleares RBD, drainage infrastructure for agriculture was reported as an important hydro-morphological pressure, land reclaimed for agriculture and the presence of reservoirs linked to flow regulation were named as an important driver for hydro-morphological alterations in the Júcar RBD.

4.4 Soil Erosion

In the Report of the Working Group on Soil Erosion Task 5 under the EU Soil Thematic Strategy,[28] it is clearly stated that soil erosion by water has implications for the quality of soils and their ability to perform important soil functions, in particular the ability to sustain agricultural and forestry production (European Commission, DG Environment, 2004).

[28] Communication from the Commission to the Council, the European Parliament, the Economic & Social Committee and the Committee of the Regions ‘Towards a Thematic Strategy for Soil Protection’. COM(2002) 179 final, 16.4.2002.

Soil erosion and the delivery of contaminants to water (and air) influence the quality of surface waters, groundwaters (and air), and, in turn, freshwater ecosystems and human health. Inappropriate agricultural practices are only one factor among many: though an important one, contributing to soil erosion by water in Europe. However, the erosion rate at any given site is very sensitive to climate, topography and land use, as well as to soil conservation practices at farm level (EEA; 2005b: 72). In this respect, soil erosion on land and the erosion of river banks have important implications for the ability of Member Countries to implement and comply with the WFD.

Mediterranean regions, especially *Portugal*, *Greece* and *Spain*, are particularly affected by the problem, since they are subject to long dry periods followed by heavy bursts of erosive rain falling on steep slopes with fragile soils. South-western Spain, northern Portugal, southern Greece and central Italy are the largest areas with an erosion risk (i.e. a predicted loss of more than 5 tonnes per hectare per year) by water (EEA; 2005b: 72). This contrasts with northern Europe where bio-climatic conditions, where rain falls mainly on gentle slopes and is evenly distributed throughout the year, are suited to help avoid major soil erosion. Consequently, the area affected by erosion is less extensive than in southern Europe (EEA, 2003b). The removal of protective vegetative cover resulting from cultivation can, however, increase the potential erosion risk. In Belgium for instance, some 10 % of agricultural land area is estimated to be susceptible to water erosion (Montanarella, n.d.).

As Figure 14 shows, two zones of erosion can be distinguished in EU-15: a southern zone characterised by severe water erosion and a northern loess zone with moderate rates of water erosion. The following map shows which regions are mostly at risk from erosion. Within both zones, hot-spots exist where the risk of erosion is more serious.

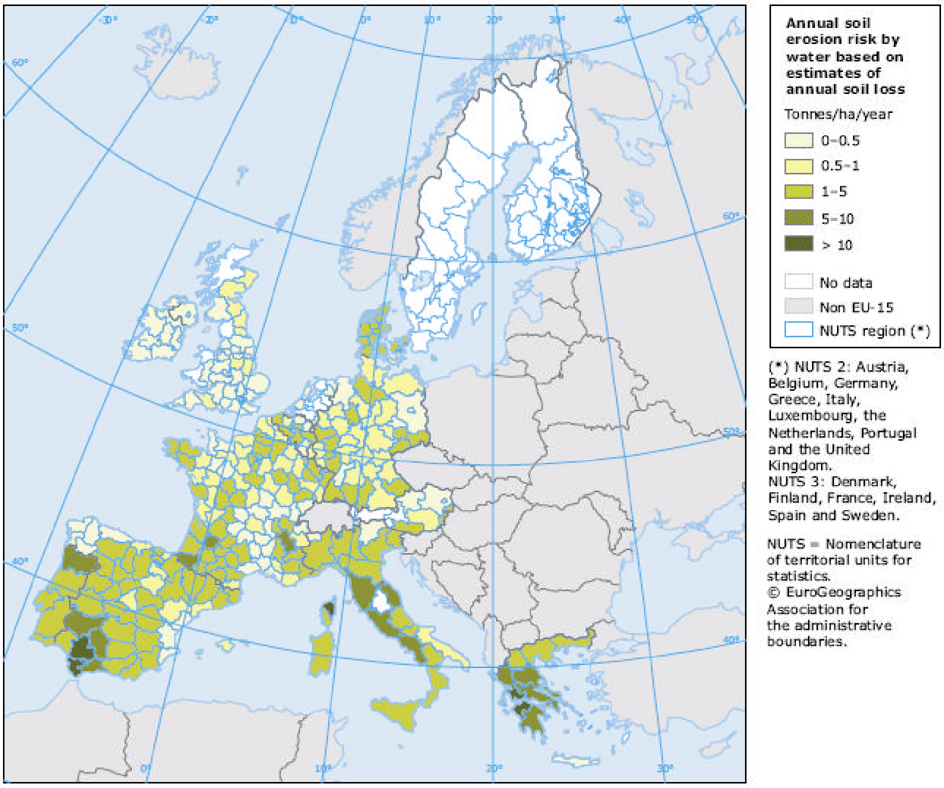


Figure 14: Annual soil erosion risk by water based on estimates of annual soil loss

Note: The Pan-European Soil Erosion Risk Assessment (Pesera) model uses a process-based and spatially distribution model to estimate soil erosion risk by water across Europe. The map shows aggregated results at NUTS 2/3 level.

Source: PESERA project (Gobin and Govers, 2003), in: EEA, 2005b.

With regard to the impact of soil erosion on phosphorus input, the national syntheses of the Article 5 reports submitted by Austria and Denmark provide a telling example. In *Austria*, 52 % of total P inputs are derived through erosion (data for the Danube RBD of Austria, which comprises 96 % of Austria's surface area) (WRc, 2005b). In *Denmark*, erosion of farmland produces significant loads of phosphorus contributing to eutrophication in lakes and coastal waters and leading to depositions of sand and silt in rivers, negatively impacting natural fauna, including spawning possibilities for salmonides (WRc, 2005c: 5).

5 Lessons Learned and Key Messages

The methodology applied by the EU Member States to assess the pressures and impacts on water bodies according to Article 5 of the Water Framework Directive (WFD) is not completely consistent. In general, the methodological approach varies between the different cases studied and linkages between the source and the emitted substances are lacking. Therefore, the summary and conclusions that can be derived from the reports' data regarding agricultural pressures on water bodies are limited in terms of generalisation, as mentioned above in chapter 2 on data uncertainties. However, key messages on a general level of pressures can be identified.

Besides the industrial and household sectors, the agricultural sector generates a significant pressure on both surface waters and groundwaters in terms of quality and quantity. The structure and scope of all these problems vary widely between the different regions in Europe, but they appear in many places. In general, the following pressures on water caused by agriculture are pertinent:

- ***Nutrient load***. Many Member States reported in their WFD Article 5 Reports a significantly high proportion of nutrient loads in surface waters that originated from diffuse sources (mainly from agriculture). In addition, nitrogen compounds are considered more important than phosphorous compounds in terms of nutrient inputs from agriculture. However, phosphorous can also induce pressures from soil erosion. Indeed, phosphorus is mainly linked to soil particles and can be transferred to aquatic environments in areas particularly vulnerable to erosion. For all countries and catchments covered by the EEA study on source apportionment, agricultural or diffuse losses (agriculture plus background) account for more than 60 % of the total nitrogen load. During the past 30 years, the loss from diffuse sources has generally remained at a constant level. For phosphorous, the total load has largely decreased due to the modernisation and extension of sewer systems, leading to a reduced share of point-source discharges. Consequently, the loss from diffuse sources has become relatively more significant.
- ***Pesticides*** are present in surface waters and groundwaters at concentrations that, in certain cases, are of potential concern for drinking water and aquatic organisms. Although the Article 5 reports submitted so far include only a few data on pesticide loads, the EEA data assessment provides additional information. According to this study, the average estimated pesticide application rate is higher than the EU-15 average in Italy, Greece, Portugal and France. Generally speaking, the use of pesticides is higher in western Europe than in northern or eastern Europe. However, these statistics are to be interpreted with caution, to the extent that they say little about the nature of the active substances concerned and, consequently, about the risks of negative impacts associated with their use.
- ***Water abstraction for irrigation***. Extensive abstraction of water for agricultural purposes increases the risk of over-exploiting available water resources. Water demand for irrigation shows a strong regional distribution. All regions with the highest use of water for agricultural purposes (above 500 million m^3 per year) are located in southern EU Member States such as France, Greece, Italy, Portugal and Spain. The overall increase in the annual water allocation for irrigation in this region is due to the fact that, although the water abstraction rates decreased in the period between 1990 and 2000, the irrigable area (as a rough indicator for water use intensity) increased by 29% during the same period.

- ***Hydromorphological changes*** due to agricultural activities pose significant pressures on surface water bodies. This is true for the numerous reservoirs and dams present in some EU Member States. Besides hydropower and water supply, these reservoirs predominantly serve irrigation needs. In certain areas, there are also extensive irrigation networks (canals) which contribute to the hydromorphological modification of waters. In some River Basin Districts (RBDs), drainage infrastructure for agriculture was reported as an important hydromorphological pressure, whereas in other RBDs land reclamation for agriculture and the presence of reservoirs linked to flow regulation were named as important drivers for hydromorphological alterations.

The potential negative impacts of some agricultural practices on water include not only environmental problems but also potential risks for both human health and life (floods, water and food contamination, etc.).

In addition to exerting pressures, agriculture can also play a positive role in respect to water resources and related ecosystems. Moreover, the agricultural sector has an additional strong incentive to reduce pressures on water bodies, since clean water is essential for agricultural production.

Across much of the EU, tackling the pressures on water caused by agriculture constitutes one of the main challenges in achieving the WFD objectives, as shown in the data provided by a wide range of studies. Until now, however, most of the emphasis has been placed on reducing point-source pollution; the review of the national syntheses of the Article 5 Reports, as well as the EEA and JRC investigations, show that implementation measures are needed to address agricultural pressures, in particular for the reduction of diffuse pollution. With regard to quantity aspects, impacts of water abstraction by agriculture on WFD achievement can also be very important regionally.

Furthermore, a more harmonised presentation of data across the EU for the second WFD reporting cycle will provide more useful elements for assessing pressures and impacts from agriculture and, based on this, developing appropriate measures to tackle them. Clear data definition and streamlining of datasets are needed. Developed by DG Environment, JRC, EUROSTAT and EEA, the European-wide data and information management concept, entitled “Water Information System for Europe (WISE)”, could support this harmonisation process.

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Annex

Table 5: Source apportionment of nitrogen in selected regions and catchments

N (kg/ha)	Total diffuse	Background	Agriculture	Point sources	Sum	Source
Austria	–	1.14	4.29	1.72	7	Umweltbundesamt (AT) (2001)
Belgium	21.75	–	–	12.38	34	OSPAR (2003)
Denmark	–	2.05	14.02	1.65	18	Bøgestrand (2004)
England/ Wales	23.74	–	–	12.32	36	WRc (2004)
Estonia	–	1.28	5.76	0.27	7	Helcom (2004)
Finland	–	2.07	1.36	0.53	4	Finlands miljöcentral (2005)
Germany	–	2.61	12.43	4.24	19	Umweltbundesamt (DE) (2004)
Latvia	–	2.84	5.27	0.24	8	Helcom (2004)
Lithuania	–	1.06	3.80	0.18	5	Helcom (2004)
Netherlands	21.75	–	–	9.02	31	OSPAR (2003)
Norway	–	1.68	0.87	1.33	4	Selvik *et al.* (2004)
Poland	–	1.51	8.04	1.33	11	Helcom (2004)
Sweden	–	1.25	1.22	0.54	3	SLU and SMHI
Axios	–	1.50	1.60	2.30	5	Behrendt/EuroCat (2004)
Danube	–	2.00	3.90	2.70	9	Behrendt/EuroCat (2004)
Daugava	–	2.90	3.00	0.90	7	Behrendt/EuroCat (2004)
Elbe	–	1.80	8.50	5.20	16	Behrendt/EuroCat (2004)
Ems	–	3.00	23.10	2.80	29	Behrendt/EuroCat (2004)
Odra	–	0.90	5.10	4.50	11	Behrendt/EuroCat (2004)
Po	–	3.70	19.20	12.70	36	Behrendt/EuroCat (2004)
Rhine	–	4.10	15.60	9.00	29	Behrendt/EuroCat (2004)
Vistula	–	1.80	5.70	2.10	10	Behrendt/EuroCat (2004)
Weser	–	2.90	13.00	3.50	19	Behrendt/EuroCat (2004)

Source: EEA, 2005a: 43.

Table 6: Source apportionment of phosphorus in selected regions and catchments

P (kg/ha)	Total diffuse	Background	Agriculture	Point sources	Sum	Source
Austria	–	0.025	0.161	0.172	0.4	Umweltbundesamt (AT) (2001)
Belgium	0.760	–	–	1.750	2.5	OSPAR (2003)
Denmark	–	0.077	0.252	0.194	0.5	Bøgestrand (2004)
Estonia	–	0.057	0.215	0.031	0.3	Helcom (2004)
Finland	–	0.080	0.098	0.018	0.2	Finlands miljöcentral (2005)
Germany	–	0.101	0.480	0.348	0.9	Umweltbundesamt (DE) (2004)
Latvia	–	0.052	0.131	0.043	0.2	Helcom (2004)
Lithuania	–	0.026	0.152	0.013	0.2	Helcom (2004)
Netherlands	1.130	–	–	1.250	2.4	OSPAR (2003)
Northern Ireland	–	0.062	0.831	0.647	1.5	Smith *et al.* (2004)
Norway	–	0.039	0.026	0.203	0.3	Selvik *et al.* (2004)
Poland	–	0.010	0.380	0.175	0.6	Helcom (2004)
Sweden	–	0.080	0.036	0.034	0.1	SLU and SMHI
Axios	–	0.048	0.373	2.484	2.9	Behrendt/EuroCat (2004)
Danube	–	0.073	0.359	0.412	0.8	Behrendt/EuroCat (2004)
Daugave	–	0.061	0.088	0.221	0.4	Behrendt/EuroCat (2004)
Elbe	–	0.068	0.360	0.381	0.8	Behrendt/EuroCat (2004)
Ems	–	0.177	1.981	0.231	2.4	Behrendt/EuroCat (2004)
Odra	–	0.100	0.189	0.798	1.1	Behrendt/EuroCat (2004)
Po	–	0.144	0.339	0.925	1.4	Behrendt/EuroCat (2004)
Rhine	–	0.143	0.271	0.865	1.3	Behrendt/EuroCat (2004)
Vistula	–	0.071	0.296	0.393	0.8	Behrendt/EuroCat (2004)
Weser	–	0.100	0.633	0.312	1.0	Behrendt/EuroCat (2004)

Source: EEA, 2005a: 43.

Table 7: Average P-use, ratio P-manure/P-fertiliser and balance result (2003)

Member State	Average P-use [kg P/ha]	P-consumption ratio manure/fertiliser	P-balance [kg P/ha]
Austria	18.0	1.89	1.5
Belgium	46.4	2.27	7.5
Czech Republic	13.7	1.31	1.2
Cyprus			
Denmark	32.4	4.70	11.6
Estonia	7.3	4.16	- 1.7
Finland	17.6	0.72	10.9
France	22.9	0.98	2.6
Germany	23.0	1.71	1.5
Greece	26.7	1.04	11.0
Hungary	13.1	0.90	2.4
Ireland	26.7	1.74	7.9
Italy	25.3	0.68	6.6
Latvia	6.0	0.90	- 3.3
Lithuania	10.8	1.55	- 14.3
Luxembourg			
Malta	62.3		
Netherlands	54.4	3.77	13.8
Poland	19.9	1.41	10.1
Portugal	17.4	1.68	0.0
Slovakia	10.6	1.57	1.2
Slovenia	35.2	0.88	19.4
Spain	18.7	0.78	1.1
Sweden	12.7	1.44	0.1
UK	22.8	1.95	- 1.4

Source: Eurostat, IFA, in : Soil Service of Belgium, 2005.

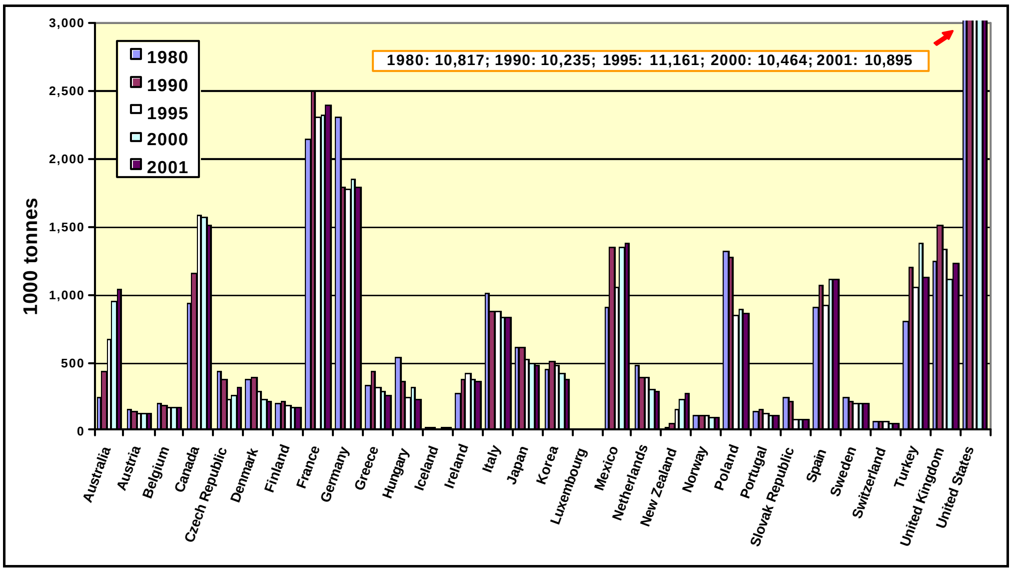

Figure 15: Apparent consumption of nitrogenous fertilisers in OECD member countries

Source: OECD Environmental Data Compendium, 2004. Based on data from FAO, in: OECD 2005: 17.

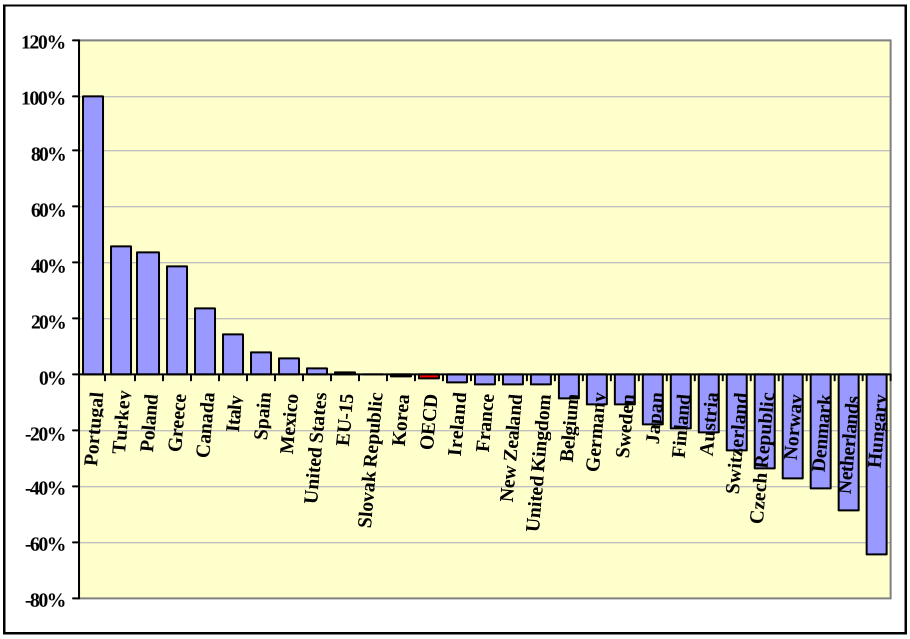

Figure 16: Change in the active ingredients of pesticides used in OECD member countries (1990-92 until 2000-02)

Source: OECD Environmental Data Compendium, 2004; based on data from FAO, in: OECD, 2005: Figure 4.