



COMMISSION OF THE EUROPEAN COMMUNITIES

Brussels, 17.07.2002  
COM(2002) 407 final

**REPORT FROM THE COMMISSION**

**Implementation of Council Directive 91/676/EEC concerning the protection of waters  
against pollution caused by nitrates from agricultural sources**

**Synthesis from year 2000 Member States reports**

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#### Synthesis from year 2000 Member States reports

**The information contained in this report is without prejudice to any further  
Commission assessment in the framework of infringement proceedings**

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## INTRODUCTION

Council Directive 91/676/EEC (hereafter referred to as the Nitrates Directive) concerning the protection of waters against pollution caused by nitrates from agricultural sources was adopted on 12 December 1991. A sister Directive 91/271/EEC (Urban Waste Water Treatment) was adopted on 21 May 1991.

Article 10 of the Nitrates Directive requires that Member States submit a report to the Commission every four years following its notification. This report should include information pertaining to codes of good farm practice, designated nitrate vulnerable zones (NVZs), results of water monitoring and a summary of relevant aspects of actions programmes for vulnerable zones.

This Commission report (required by article 11) is a synthesis of the information transmitted during 2000-2001 by Member States (2<sup>nd</sup> reporting exercise). It is completed by aggregated maps and analysis of pressure from nitrogen from agricultural sources in the EU maps, of present NVZs and by a comparative table on the main content and deficiencies of the first action programmes (1996-1999).

This report was prepared in order to provide an overview of the current situation with regard to the directive together with possible pathways for the future. It illustrates, with some case studies, the positive effects of some farm practices on the quality of water. However, it is emphasised that there is a considerable time lag between improvements at farm and soil level and a response in waterbody quality.

### A. GENERAL CONTEXT

Increasing public concerns about steadily increasing nitrate concentrations in drinking water resources, and disturbance of aquatic ecosystems by eutrophication<sup>1</sup>, ( the best known examples being the south-eastern North Sea, Brittany “Abers” or the Adriatic Sea and Venice lagoons, where algae blooms have been occurring more and more frequently from the 70’s ), were the trigger for action to improve water quality.

*MAP I. Satellite picture of EU seas chlorophyll-a concentrations. Average summer 2000. The red and yellow areas show strong phytoplankton development, one of the most visible symptoms of eutrophication, with potential adverse effects (toxic dinoflagellates, oxygen depletion, changes in bottom flora and fauna, etc).*

N.B.: Interferences of humid and suspended matters near estuaries have to be taken into account

In agriculture, the trend towards greater intensification, and higher productivity during much of the past fifty years, was accompanied by a significant increase in fertiliser use and, as shown by fig. I, particularly inorganic nitrogen use.

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<sup>1</sup> Excessive growth of algae and plants, with potential adverse effects on biodiversity or human uses of water. The precise definition in the Directive (art. 2.i ) is “Enrichment of water by nitrogen compounds, causing an accelerated growth of algae and higher forms of plant life to produce an undesirable disturbance to the balance of organisms present in the water and to the quality of the water concerned”.

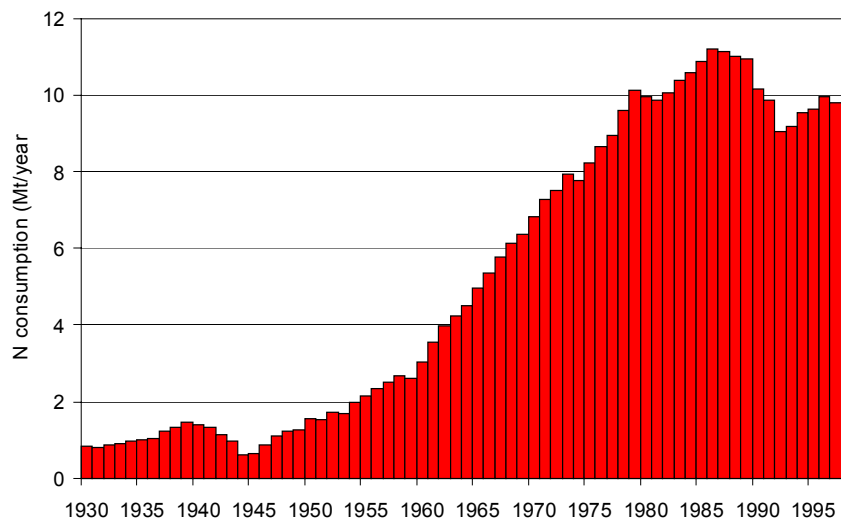


FIG.1 *Mineral N fertilisers consumption – E.U.15 Member States, from 1930 to 1999* Source EFMA (Millions of tons of nitrogen per year).

Inorganic N use reached a peak of 11 millions tons annually in the mid 1980s before falling somewhat to approximately 9-10 Millions tons more recently.

Animal numbers increased during most of this period, contributing to a greater overall N burden through manure. Crop production also increased. Changes in agricultural policy leading to milk quotas in 1984, and suckler cow and ewe premium quotas in 1992, have since stabilised or contributed to a reduction in cattle and sheep numbers, but both the pig and poultry sectors have continued to expand. In addition, animal numbers on individual farms are expanding and over 40% of the E.U.'s dairy herd is held on farms of more than 50 cows while the vast majority of the breeding pig herd contain more than 100 sows.

Globally the nitrogen "pressure" on EU agricultural soils from animal husbandry (mainly cows, pigs, poultry and sheep), also is approximately 8 millions tons annually spread on agricultural soils (MAP III), so the total diffuse nitrogen "pressure" from agriculture reaches almost 18 millions tons (MAP IV).

During this 50 years period, a reduction of permanent grassland and of "buffer" areas (ditches and hedges, wetlands, etc.) which favours erosion, run-off and quicker drainage of nutrients to the aquatic ecosystems and to groundwaters has been a feature of changing farming.

In France, 67% of wetlands have disappeared within the last century. The same phenomena occurred since the 1950s for 84% of peat soils in the United Kingdom, and 57% of German and 60% of Spanish wetlands, due to agricultural drainage, tree planting and landfilling for urban purposes. Such wetlands are able, through natural denitrification and plant assimilation, to remove from water up to 2 kgs Nitrogen/hectare x day (almost 0.8 Ton N/hectare each year)(Fleischer et al, 1997). Their loss, therefore, is detrimental to water quality.

Agricultural policy has responded to some of these trends principally through the introduction of agri-environment measures in 1992 and their expansion in the Agenda 2000 CAP-REFORM.

Finally, greater density of livestock buildings, and manure storage and spreading, has resulted in strong ammonia volatilisation, and atmospheric deposition on neighbouring soils and waters with values up to 50-60 kgs of nitrogen per hectare per year being recorded in regions with intensive livestock activities (EMEP, 1999; RIVM, 2000).

Map II. shows average N inland deposition.

As a marine example, on the North Sea a direct deposition up to 0.3 millions Tons N/year (20% of the aquatic inputs from riverine countries) has been estimated (EMEP, 1999).

The following drawing summarises all the “pathways” of loss of nitrogen to the aquatic environment, including the "soil / air / soil & water" cycle:

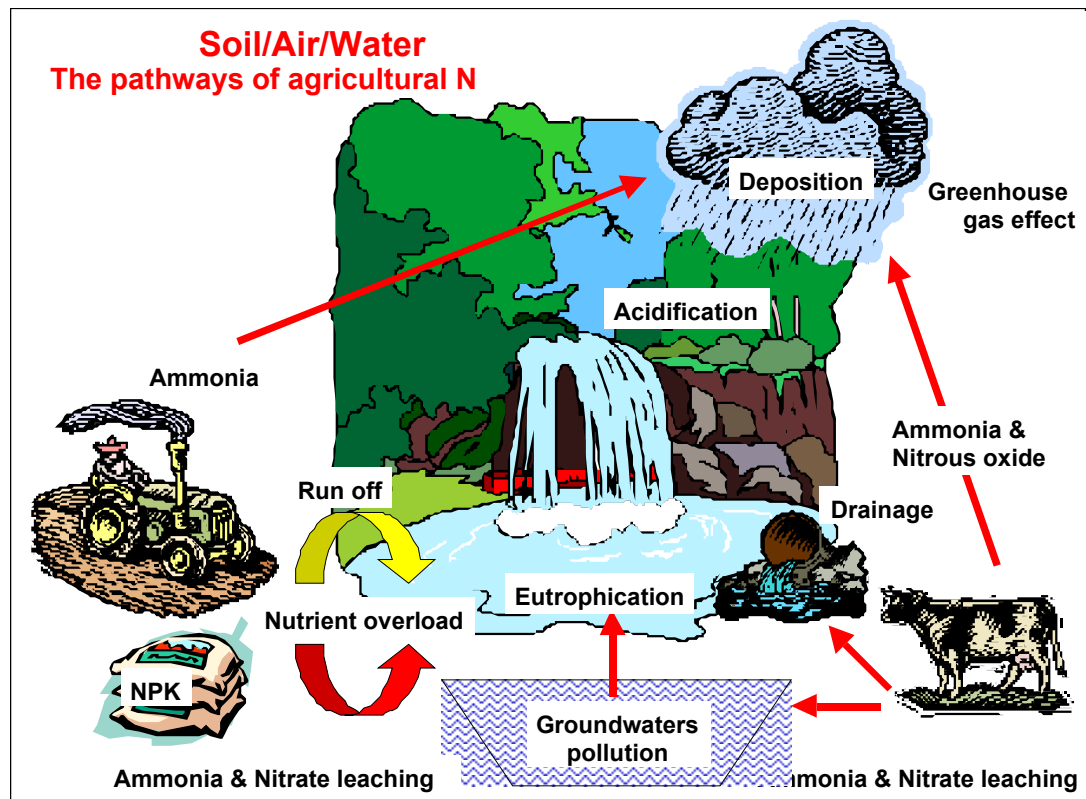


FIG. 2 *The agricultural nitrogen air/soil/water exchanges and possible impacts.*

*POSSIBLE IMPACTS:*

- *A part of this nitrogen loss (50-80%) is recycled to water and soils, causing groundwaters enrichment, eutrophication of surface waters, in synergy with phosphorus, and contributing to “acid rain” damages on terrestrial flora and soils; another part, up to 20-50%, is “denitrified” into inert nitrogen gas (and some N<sub>2</sub>O with a greenhouse gas effect), by soil and sediment bacteria, or by natural chemical reduction in certain types of soils and groundwaters.*
- *Mineral fertilisers directly introduce ammonium and nitrates into groundwaters by leaching, and into surface waters by run-off and subsoil “drainage”. The extent of this depends on ground conditions at time of spreading.*
- *Organic N (in manure) uses the same “pathways”, plus additional losses to the atmosphere in the form of ammonia (volatilisation) and N<sub>2</sub>O (incomplete denitrification). These range from 10 % to 30% of the initial N excreted by animals, and are re-deposited on the soil and waterbodies in rain (wet deposition) or directly (dry atmospheric deposition).*

MAP II. *Average nitrogen atmospheric deposition - (kg N/ha/year).*

MAP III. *Livestock manure nitrogen pressure (per type of animals).*

The total nitrogen “pressure” on agricultural soils of Europe is summarised in MAP IV, which also indicates the origin of the different nitrogen inputs to soil:

MAP IV. *Total nitrogen pressure from agriculture, air deposition and biological fixation.*

In order to limit the losses linked to agricultural activities, the main types of actions that the Nitrates directive promotes (in annexes II-codes of good practice, and III-actions programmes) simultaneously concern:

- Crop rotations, soil winter cover, catch crops, in order to limit leaching during the wet seasons.
- Use of fertilisers and manure, with a balance between crop needs, N inputs and soil supply, frequent manure and soil analysis, mandatory fertilisation plans and general limitations per crop for both mineral and organic N fertilisation.
- Appropriate N spreading calendars and sufficient manure storage, for availability only when the crop needs nutrients, and good spreading practices.
- “Buffer”effect of non-fertilised grass strips and hedges along watercourses and ditches.
- Good management and restrictions of cultivation on steeply sloping soils, and of irrigation.

The nitrogen surplus (difference between inputs and outputs by crops, meat or milk production), can be a good indicator of potential losses to environment, at farm, local or

regional level. A big heterogeneity can be noticed between EU regions, as shown by MAP IV bis (Eurostat, focus N° 8, y. 2000, from 1997 Member States statistics) with surplus ranging from 0 up to 300 kg N/ha, the maximum being reached in areas with an excessive density of livestock breeding. But high N surplus, and associated risks of losses to water, can also be found in regions of intensive fruit and vegetable cropping, or cereals and maize with unbalanced fertilisation and practices favouring N losses (such as bare soils in winter).

## MAP IV bis. NITROGEN SURPLUS FROM AGRICULTURE IN EU REGIONS

### B. STATE OF IMPLEMENTATION OF THE DIRECTIVE

The “Nitrates” Directive “process” consists of 5 steps, following its transposition in each Member State (the latecomers for complete transposition were IT, EL and BE in 1998-99, instead of 1993):

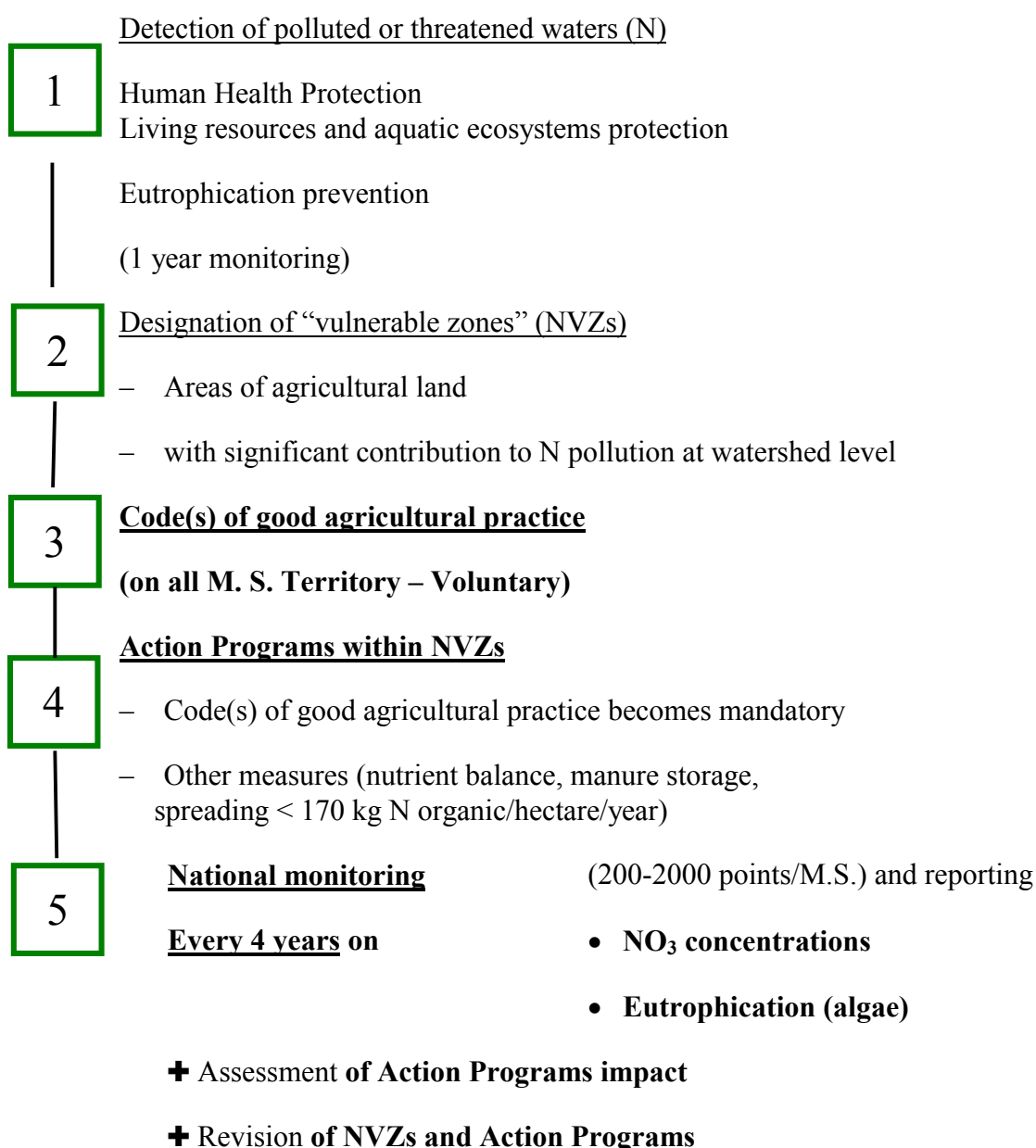
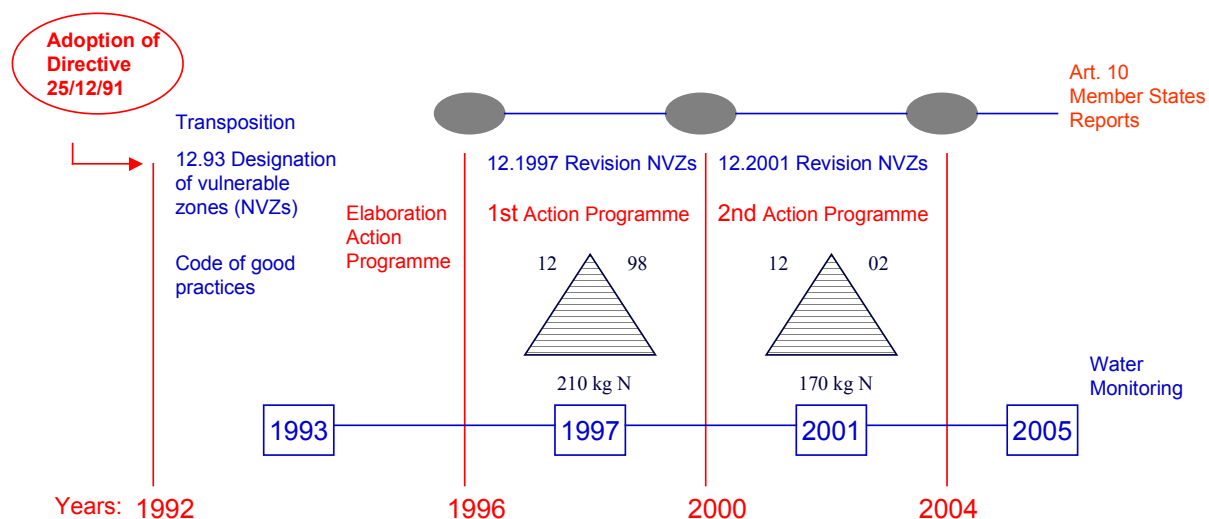


Fig. 3 Associated calendar for implementation:



This calendar shows the cyclic (4 years) process of the Directive, with a first Action Programme between 1996 and 1999, and a second reinforced one for 2000-2003 if the impact of the first one is not sufficient for significant improvement of water quality.

### B.1. Overview of exhaustivity of reports.

The synthesis of year 2000 Member States reports (2<sup>nd</sup> monitoring and end of First Action Programme) shows the following results:

All Member-states, except UK, have transmitted a formal report to the European Commission, between summer 2000 (the legal deadline) and spring 2001. UK had not sent its report 1 year after the deadline.

The following table summarises the compliance of information received with the requirements of annex V of the directive, and the reporting guidelines elaborated in the frame of the “Nitrates” Committee (article 9 of Directive 676/91).



**Table I. Conclusive assessment of quality of the information (= compliance) in the Member States reports for the 2<sup>nd</sup> reporting period on water monitoring, designation of Nitrate Vulnerable Zones (NVZ), water quality forecast, agricultural pressure, and Action Programmes.**

Member State	Report Submitted	Water monitoring data		Reporting on NVZ designation	Forecast On water quality	Agricultural data	Action Programmes <sup>4</sup>
		Ground and surface fresh	Coastal and marine				
Belgium	☺	☺ <sup>2</sup>	☺	☺	☺/☺	☺/☺	☺
Denmark	☺ / ☺	☺	☺	☺ <sup>1</sup>	☺	☺	☺
Germany	☺	☺ / ☺	☺	☺ <sup>1</sup>	☺	☺	☺
Greece	☺	☹ <sup>3</sup>	☹	☺	☹	☹	☺
Spain	☺	☺	☹	☺	☹	☺ / ☹	☺
France	☺	☺ <sup>2</sup>	☹	☺	☺	☺	☺ / ☺
Ireland	☺	☺	☺	In Process	☹	☺	-
Italy	☺ / ☺	☹ <sup>2,3</sup>	☹	☺	☹	☹	☺
Luxembourg	☺	☺	--	☺ <sup>1</sup>	☹	☺ / ☺	☺
Netherlands	☺	☺	☺	☺ <sup>1</sup>	☹	☺	☺
Austria	☺	☺	--	☺ <sup>1</sup>	☺	☹	☺
Portugal	☺	☺ / ☹ <sup>3</sup>	☹	☺	☺	☺ / ☹	☺
Finland	☺	☺	☺	☺ <sup>1</sup>	☹	☺ / ☹	☺
Sweden	☺	☺	☺	☺	☹	☹	☺ / ☺
UK	☹	☹ <sup>3</sup>	☹	In Process	☹	☺ / ☺	☹ / ☺

1. MS applying an action programme on their whole territory ( Article 3.5 of the Directive)

2. Monitoring of deep wells

3. Data provided only in the Nitrate Vulnerable Zones

4. The AP Quality assessment is presented in Table IV

[☺]: good

[☺]: moderate

[☹]: insufficient

**The reports provided by a majority of Member States are generally complete, although some gaps are to be found on water quality results (e.g. eutrophication of coastal waters) or forecast, and on precise agricultural data, such as nitrogen use in vulnerable zones.**

## B.2. Water Quality

### B.2.1 Water monitoring networks

Networks of sampling stations have to cover both all main groundwaters (even if not used for drinking water), rivers; lakes and dams, coastal and marine waters, as required by art. 6 of the Directive. Criteria to monitor are nitrogen (ammonia, total N, nitrates) and eutrophication (chlorophyll, algae blooms, macrophytes development and species shift...). Generally Member States have established networks of hundreds or thousands of sampling stations (~1 for 100-200 km<sup>2</sup> seems reasonable), which give a good overview of water status (1996-98) and trends, by comparison with 1992-94, when the first survey was effectively made.

The network has generally to be completed by an "**operational**" network allowing **assessment of action programmes** (cf. Art. 5.6 of the Directive), dealing with monitoring of N in soil or at rootzone level, in pilot fields, farms or small watersheds, and inside vulnerable zones.

It can be pointed out that:

- No formal report was transmitted by UK before July 2001 (one year after the legal deadline). Only some results for vulnerable areas were available.
- In Germany the network is unbalanced and incomplete, focusing only on areas of polluted groundwaters, and limited to only 10 stations for surface waters.
- In Greece and Portugal the groundwater network is limited to designated vulnerable zones, hampering a periodical evaluation of designation.
- These networks are also geographically unbalanced in Italy, where they don't cover the South and in Luxembourg.
- For groundwaters, drinking water catchments were often over represented (F, EL, IRL, B,...). Deep sampling with natural chemical denitrification (NL, B/Flanders...), or in captive waters (south-west F, B...) sometimes biased results.
- 12 countries succeeded in reporting georeferenced data in a format compatible with EC Geographic Information System (GIS), using harmonised codes and classifications as developed by the "reporting guidelines". So aggregated maps of water quality at EU level can be drawn. Nevertheless the numerous gaps concerning eutrophication criteria (except DK, EL, FIN, IRL, L, PT, SW), and maximum nitrogen levels in surface waters, and all types of data on coastal (except IRL, DK, NL, FIN, SW) and marine waters have hampered drafting any meaningful EU map from reports on these items.

The synthetic water quality maps presented concern:

- Average nitrates content of groundwaters (1996-98) - MAP V
- Average nitrates content of surface waters (1996-98) - MAP VI
- Trends on these 2 parameters between the first (1992-94) and second (1996-98) monitoring periods - MAPS VII (groundwaters) and VIII (surface waters)

N.B.:

- It should be noted that France and Italy included in their reports aggregated results but without precise location, so a different representation system had to be used (pie charts, at "department" level for France) for these Member States. This is a serious drawback to proper comparisons within these Member States.
- 7 Member States (I, IRL, E, B, L, UK, and PT outside vulnerable zones) did not provide data on **trends for groundwaters**. For surface waters 7 Member States (I, E, EL, FIN, SW, UK and PT) did not provide data. Therefore these "trend" aggregated maps are restricted to just 8 Member States.
- Detailed maps for each Member State have been grouped in a digitised atlas (CD-ROM) of about 100 maps (background of rivers, watersheds and land use, location and type of monitoring stations, nitrates in water-eutrophication, extension of vulnerable zones), at the scale of 1/1.000.000, both with agricultural data including Nitrogen surpluses, and a synthetic evaluation of their designation of vulnerable zones and of the content of their action programmes.

### *B.2.2 Results of water quality survey*

#### **Groundwaters**

- Synthetic MAP V shows that globally about 20% of EU monitoring stations suffer nitrates concentrations over 50 mg NO<sub>3</sub>/l, and 40% over 25 mg NO<sub>3</sub>/l in 1996-98. It should be noted that, for complete accuracy in these figures, a better balance of the density of monitoring stations between polluted and unpolluted areas would be necessary.
- The comparison with 1992-94 (MAP VI) shows, as predominant trends:
  - a decrease in Finland, and in the south and east of France
  - stability in Denmark, and western Austria
  - contrasted results ( both decreases and increases) in the Netherlands, Greece (vulnerable zones) and Germany
  - an increase for the north and west of France, north-eastern Austria and south Sweden.

#### **Surface Waters**

- Globally more than 60% of monitoring stations (MAP VII) show average nitrates concentration far under 10 mg/l of nitrates, and this rate reaches 90% in mountainous areas (alpine regions, boreal forests, French "Massif Central, Corsica, etc.).

Luxembourg, Belgium (Wallonia), Ireland (south-west), and specific areas of Spain (north-east) and Austria (north-east) show mainly values between 10 and 25 mg NO<sub>3</sub>/l, indicating already considerable N fluxes to lakes and seas, and important potential eutrophication effects. This is also the situation for Germany (but with only 10 sampling points) and Italy (all monitored points in the north).

Very high values, over 25 and even 40 mg/l are often met in agricultural plains of Denmark, Netherlands, Belgium (Flanders), west of France, Spain and Greece.

- The comparison with the 1992-94 surveys shows (MAP VIII):
  - a slight decrease in eastern Denmark, south-west France, and Belgium (Wallonia). But the part of climatic conditions in this decrease is difficult to appreciate, and the influence of improved wastewater treatment (e.g. for large rivers) has rarely been evaluated.
  - A stability in western Austria and Denmark, and in Germany.
  - Contrasted results in the Netherlands, in Ireland, and in western and north-eastern parts of France.
  - An increase for centre-west part of France and north-eastern Austria.

**Table II general trends in nitrate concentrations in ground water, surface water and coastal/marine waters per Member State, between the first (1992-94) and second (1996-98) monitoring exercises.**

Member State	Trends		
	Ground water	Surface waters	Coastal/marine waters
Belgium	n.d.	⇒	n.d.
Denmark	⇒	⇒ to ↘	↘
Germany	↗ ↘	⇒	↘
Greece	↗ ↘	n.d.	n.d.
Spain	n.d.	n.d.	n.d.
France	↗	↗ to ↗ ↘	n.d.
Ireland	n.d.	↗ ↘	n.d.
Italy	n.d.	n.d.	n.d.
Luxembourg	n.d.	↗	n.a.
Netherlands	↗ ↘	↗ ↘	↘
Austria	⇒	⇒	n.a.
Portugal	⇒	n.d.	n.d.
Finland	⇒ to ↘	n.d.	⇒
Sweden	↗	n.d.	n.d.
UK	n.d.	n.d.	n.d.
Total	⇒ to ↗	⇒ to ↘	⇒ to ↘

⇒= stable; ↗ = increase; ↘ = decrease; ↗ ↘= contrasted.

n.a. = not applicable; n.d. = no data provided in year 2000 report.

### **Conclusions on water quality**

The delays both in nitrates transfer from soil to groundwaters (2-3 years for shallow waters in sandy soils, 10-40 years for deep waters in chalk limestone), inadequate designation of vulnerable zones by the majority of Member States in areas exposed to high nitrogen pressure, and insufficient measures generally applied in the first action programme, have resulted in a high and stagnant level of nitrate concentrations in groundwaters, and about 40% of EU area is of concern on this aspect. Globally, positive (encouraging) signals on shallow groundwaters can be found in Denmark, Portugal (Algarve), Germany (Bade-Württemberg), France (north-east). For surface waters a decreasing trend has been noted in several countries (see synthetic table below), but complementary data would be needed to assess the influence of climatic conditions and urban waste water treatment improvement in this evolution.

### *B.2.3 Forecast of water quality evolution:*

**Only Denmark, Germany, France, Austria, Portugal and Belgium (Wallonia)** provided a forecast of the water quality. France and Austria made some remarks, but no scientific or mathematical basis was given. Sweden reported preliminary results of a specific monitoring programme aiming at assessing the run off of fertiliser-nitrogen into drains and watercourses.

- Belgium (Wallonia) investigated the nutrient transport to and in the aquifer for the Vulnerable Zone of Crétacé de Hesbaye. On the basis of mathematical modelling it will take more than 15 years before the nitrates in the Hesbaye aquifer will stabilise.
- Denmark presented a forecast on the basis of the reduction of N-loads and the general observation that 30-40% of fertiliser-nitrogen runs off to the surface water. A reduction of 90 to 100.000 Tons of N losses to water, compared with 1987 levels is expected around 2003.
- The German forecast is based on very general figures of inflow times in the various river basins, depending on rainfall, soil structure etc. Germany uses the "WEKA" model to predict such inflow times. This model was not presented in the Member State report.
- Portugal applied a "Root Zone Water Quality Model" to simulate the effects of a reduction of the nitrogen dose and the irrigation rate on the leaching of nitrates from soil to waters. The resulting optimisation would allow a reduction of the nitrogen input by 50% for various crops.

It can be concluded that the Member State reports clearly show that they face difficulties in preparing a forecast of the impact of their Action Programmes on the water quality.

In order to better comply with this "forecast" requirement (annex V of the Directive) and with the need for tools for the prediction of the impact of economic or preventive measures, reliable and practical models will be required to correlate the main steps and factors.

Besides the national attempts mentioned above, the Commission is promoting in its research key actions on "sustainable water" and "sustainable agriculture", large scale projects on these items such as "binoculars", "streams", "Eloise" and "Euroharp" (comparative testing of 10 models for assessing diffuse losses of nitrogen, in 18 pilot watersheds of Europe). Exchange on existing models and harmonisation need a strong acceleration, which will be also promoted by the Water Framework Directive (20/2000/EC).

### **B.3. Vulnerable zones designation and revision**

The map n° IX shows the Nitrate Vulnerable Zones which were formally designated (blue) and drafted (pink) by the Member States by Spring 2001, compared with the EC self-assessment (1999-2000) of potential complementary areas (brown), following a review of available information on waters with excessive nitrate concentrations, or threatened with eutrophication. It is stressed that the EC assessment is not exhaustive, due to lack of data on water quality available for some countries (e.g. UK, Irl, It, Pt) in this period.

6 Member States (Austria, Denmark, Finland, Germany, Luxembourg and the Netherlands) apply article 3.5 of the Directive, as their whole territory is covered by an Action Programme.

Table III presents an overview of the area (x 1000 km<sup>2</sup>) of designated vulnerable zones per Member State (2001), the drafted one, and the potential one detected by the EC ( from a review of available information up to end 2000 on N pressure and water quality) , compared with the total Member State area.

Member State	Total area (x 1000 km <sup>2</sup> )	Area NVZ		Additional area NVZ			
			%	Drafted by Member States	%	EC assessment potential Areas**	%
Belgium	31	2.7	9	2.9	9	15.9	51
Denmark	43	43	100*				
Germany	356	356	100*				
Greece	132	13.9	11			9.0	7
Spain	504	32	6			70.6	14
France	539	240.9	48			37.1	7
Ireland	69	0	0			6.5	9
Italy	301	5.8	2			88.7	29
Luxembourg	3	3	100*				
Netherlands	37	37	100*				
Austria	84	84	100*				
Portugal	91	0.9	1			12.2	13
Finland	334	334	100*				
Sweden	448	41	9			43.7	10
UK	244	7.8	3			19.2	8
TOTAL EU-15	3,216	1,202	38	2.9	0.1	303	9

\* countries beneficiating of an Action Programme on their whole territory (art. 3.5 of the Directives)

\*\* not exhaustive, due to severe lack of water quality data available from several countries (e.g.UK, Ireland, Italy, Portugal) at the time of EC assessment (1999-2000)

**The total area of Nitrate Vulnerable Zones (and countries which apply an action programme on their whole territory) covers currently 38% of the EU-15 area (1.2 million km<sup>2</sup> of the total of 3.2 million km<sup>2</sup>). However, based on the EC assessment, this area could increase to at least 46% (1.5 million km<sup>2</sup>) of the total EU-15 area, as illustrated by the following map.**

The total area of the Nitrate Vulnerable Zones in **Belgium** (18%) as proposed by the Member State is far less than the total area of concern (60%) deducted by the EC. from available monitoring data on water quality, mainly in Flanders. Wallonia is currently formalising an important extension (2001). **France** already designated 45% of its area as Nitrate Vulnerable Zone, but this would have to be nearly 50% according to the EC assessment. Also for **Spain, Italy, Portugal and Sweden**, significant potential areas have been detected by the EC, whereas these Member states did not propose any extension at all. For **Greece** the newly designated (2001) vulnerable zones roughly correspond to 70% of the EC assessment. **Ireland, UK and Belgium (Flanders) recently declared (2001) that a very substantial extension of designation would occur in the short term (2002).**

MAP IX: *Overview of the area of designated vulnerable zones in the EU (blue) the drafted one (pink), and the potential one detected by the EC (brown).*

#### **B.4. Action Programmes Assessment**

Nearly 200 various Action Programmes have now been published in Europe. It is not possible to assess precisely each of them in this synthetic report. A selection representative of each Member State has been used for comparison in diverse climatic conditions.



**Table IV gives an overview of the level of compliance of existing Action Programmes (in 1999-2000) concerning the 12 main topics mentioned in annex II and III of the Directive.**

Measure	B-Flan.	B-Wal.	DK	D	EL	ES	F	I	LUX	NL	A	P	FIN	S	UK
Period of prohibition of fertiliser application	☺ / ☺	☺ / ☹	☺ / ☺	☺ / ☹	☺	☹	☺ / ☹	☹	☺	☺	☺ / ☹	☺ / ☹	☺	☺ / ☺	☺
Restrictions for application on steeply sloping ground	☺ / ☺	☺ / ☹	☺ / ☹	☺ / ☹	☹	☹	☺ / ☺	☺	☺ / ☹	☹	☹	☺	☺	☹	☹
Restrictions for application on soaked, frozen or snow-covered soils	☺	☺ / ☹	☺ / ☹	☺	☺ / ☺	☹	☺ / ☺	☺	☺	☺	☺ / ☹	☺ / ☺	☺	☺ / ☺	☺ / ☺
Restrictions for application near water courses (buffer strips)	☺ / ☺	☺	☺ / ☹	☺ / ☹	☹	☺ / ☹	☺ / ☺	☺	☺ / ☹	☺ / ☹	☺ / ☹	☺ / ☺	☺ / ☺	☹	☺
Effluent storage works (safety)	☹	☺	☹	☹	☹	☹	☹	☹	☹	☹	☹	☹	☺	☹	☹
Capacity of manure storage	☺ / ☹	☺ / ☺	☺	☺ / ☹	☺	☺ / ☺	☺ / ☹	☺ / ☺	☺ / ☺	☺ / ☹	☹	☺	☺	☺ / ☺	☺ / ☹
Rational fertilisation (e.g. splitting fertilisation, limitations)	☺	☺ / ☺	☺	☺	☺	☺ / ☺	☺	☹	☺	☺	☺	☺	☺	☺	☺ / ☺
Crop rotation, permanent crop maintenance	☹	☺	☹	☺ / ☹	☹	☹	☹	☹	☹	☹	☹	☹	☹	☹	☺
Vegetation cover in rainy periods, winter	☺	☹	☺	☹	☹	☹	☺ / ☺	☹	☺ / ☹	☺ / ☹	☹	☺	☺	☺	☺
Fertilisation plans, spreading records	☺	☹	☺	☺ / ☺	☹	☺	☺ / ☺	☹	☺ / ☺	☺	☺	☺	☺	☹	☹
Other measures	☺	☺	☺ / ☺	☺ / ☺	☺ / ☺	☺	☺	☺	☺ / ☺	☺	☺	☺	☺	☺	☺
Date for application limits: 210/170 kg N/ha.year	☺	☺	☺	☺ / ☹	☺	☺	☺	☺	☺	☹	☺	☺	☺	☹	☺ / ☺

☺=good ☺=moderate ☹=insufficient

This overview shows that most countries fail to comply with measures on restricted periods for fertiliser application. More particularly the measures are often well in compliance for organic nitrogen (manure), but not for mineral fertilisers.

Another general point of attention is the lack of well defined measures for fertiliser application near water courses and ditches (e.g. buffer strips, sometimes limited to 2 or 3 meters, or with authorised chemical N inputs, while studies (CIPEL, 2001; Gilliam et al, 1996) show that, even under certain conditions of appropriate fertiliser management, at least 5 m of unfertilised grass strips may be necessary for significant N retention); restrictions for application relative to steeply sloping ground are also poorly developed, although it is essential to prevent N losses from erosion, run-off and subsoil drainage.

In some countries the capacity for storage of organic manure is not mandatory or insufficient to cover periods when application is prohibited, or impossible due to climatic conditions: it can vary from 2 to 7 months storage in neighbouring regions with similar climatic conditions. Studies (ERM, 2001) suggest that minima ranging from 4 months (Mediterranean areas) to 9-11 months (boreal areas) should be established.

The essential item (even if optional in annex II of the Dir.) of soil winter green cover is also poorly treated, although winter crops or grass can catch 50 to 80 kgs of N leaching in winter or early spring, so cultivated soils in vulnerable areas could benefit of this protection.

Finally, some Member States have failed so far to establish in the action programmes the limits for organic nitrogen application (normally before 20.12.98 for < 210 kg N/ha, and 20.12.2002 for < 170 kg N/ha).

Nevertheless, based on the information provided by certain Member States, there appears to be a growing awareness amongst farmers of the relevance of measures to prevent water pollution. The new action programmes in preparation appear to develop stronger preventive measures and more frequent controls at farm and field level (N surplus, soil analysis, etc.). Verification of this will only be seen in coming years as these programmes have just been finalised and put into operation.

### **Some examples of positive actions**

A close interaction between research, government and farmers is a promising way of successful implementation of measures that lead to a significant reduction of the input of N in agriculture and in the losses of nitrogen through nitrate leaching, ammonia volatilisation or soil erosion, as shown by the following positive examples.

Based on the information provided by member states, five initiatives are presented below, with evaluations carried out (year 2000):

- a) Denmark : Nitrogen Management Programme
- b) France: the Ferti-Mieux initiative;
- c) Wallonia: Prop'eau-Sable;
- d) Germany: Baden-Wurtemberg ("Schalvo");

e) Greece: Thessaly.

a) *Denmark* : National Nitrogen Management Programme.

Initiated 15 years ago (1987), this programme simultaneously provided precise advice to farmers for accurate and moderate fertilisation (from almost 1000 monitored pilot plots), mandatory soil winter cover, balancing of livestock with available manure storage and spreadable land, a strict State control system including annual N budget and surplus for each farm, and regular controls of practices at field level (several thousands/year).

This programme has resulted in a reduction of 28 % of nitrogen losses from agriculture to Danish waters, and of 50% in the N surplus at farm level. In purely agricultural watersheds, a 20 % reduction of N load has been achieved (delayed effect, due to retention in soils and groundwaters), and eutrophication of coastal waters is beginning to decrease.

b) *France* : *Ferti-Mieux*

The French initiative Ferti-Mieux (improved fertilisation) was launched in 1991 as a programme of advice to farmers for a rational fertilisation. It had its basis in the Nitrates Directive. Complementary to legal measures, Ferti-Mieux aims at encouraging the willingness of farmers to take care of the (aquatic) environment and is therefore based on voluntary measures. At present, it covers 1.3 million ha (22,000 farmers), spread over the country.

Specific elements are:

- commitment to modify existing farming practices;
- a collective approach on the preservation of the water quality in the catchment area;
- scientific support (including advisory services);
- continuous monitoring and evaluation of new practices;
- active communication between farmers and the advisors.

The current results (June 2000) of the monitoring programme in different watersheds indicate:

- a significant reduction of the net use of mineral fertilisers on maize;
- advanced splitting of N inputs on cereals;
- improved use of livestock manure;
- reduction of uncovered soils during winter time;
- joint improvement of fertilisation and irrigation practices.

**Table V summarises important results of three “Ferti-mieux” experiments taken as examples.**

	Location		
	Source de Gorze	Haut Saintois	Seine-et-Marne
• agricultural area concerned by the project (x 1000 ha)	4,0	0,8	120
Number of farmers	56	30	1,200
Catch crops	Yes	Yes	No
Splitting fertilisation	Yes	No	Yes
Soil analysis	No	No	Yes
• Achieved reductions	<u>Total N input</u> - 23 %	<u>Surplus at field level:</u> -86 % ( from 113 kg to 16 kg/ha.y)	<u>Input at field level:</u> -77% (from 130 kg to 30 kg/ha.y)
Impact on water quality (nitrate concentration)	Decrease from 60 to 45 mg/l between 1992 and 1999	Still under survey (2000)	Still under survey (2000)

Extremely low values for the N surplus (Haut Saintois) and N input (Seine-et-Marne) were found. This may be related to high levels of soil N from previous years allowing exceptionally low inputs. Longer term monitoring is required to assess the sustainability (economic, yield) of such low inputs/surplus. In the “Haut Blavet” watershed in Brittany, N pressure from organic and mineral fertilisers was reduced from 232 to 162 kg N/ha.year between 1997 and 1999 as a result of local activities supporting Action Programmes.

#### *c) Belgium-Wallonia Prop’eau-Sable*

“Prop’eau-Sable” is an acronym for a pilot project on the protection of waters on the sandy soils in Wallonia (B). The project started in 1997 with an inquiry on farmers concerning their N fertilisation practices. It appeared that around 50% of the farmers used soil analysis for their fertilisation plans. In the following years, the training and advisory input was intensified to obtain a further improvement of N fertilisation with respect of prevention of N losses to the waters.

On 10 pilot farms, specific measures taken were:

- reasonable fertilisation levels, including soil analysis;
- enhancement of catch crops;
- grassland maintenance;

- manure export from farms with surpluses;
- valorisation of organic manure;
- soil tillage at the end of the summer;
- adapted crop rotation schemes.

An intermediate evaluation report shows that between 1997 and 1998, an average reduction of 41 % of the nitrate-N content (autumn) in the soil profile (0-150 cm), from 68 to 40 kg mineralised N/ha, was achieved. Because this value was still considered an ‘alarm level’, further measures were taken in the years thereafter. The aim is now to realise a 95% soil winter cover and a further reduction of the N surplus in cattle farms (130 kg N/ha. year in 1998/1999).

*d) Germany Baden-Wurtemberg (“Schalvo”)*

This German “Bundesland” covers an area of 36,000 km<sup>2</sup>, with a population density of 293 habitants per km<sup>2</sup>. The agricultural area amounts 1,5 million hectare (around 45% of the total area), with around 1 million hectare of arable land (incl. maize) and 0.6 million hectare of grassland. The stocking density decreased between 1990 and 1999 from 1.04 to 0.92 LU per hectare.

Around 80% of the drinking water in Baden-Wurtemberg originates from ground water. The government aims at an increase of the water protection areas from 21% of the land area to 27% in the next years.

The first initiatives date back to 1976 (Investment programme for slurry storage) and 1988 (Decree to protect catchment areas). Furthermore, improved manure application was enforced by 1995. Recent initiatives aim at an increase in the level of on-farm advice, and soil analysis with up to 100.000 controls per year of N residue in soils in autumn in order to check farmer performance for fertilisation balance. Other mandatory measures are:

- increase of the area with permanent grassland;
- no N fertilisation outside the growing season;
- reduction by 20% of the advised N dosage on crops;
- reduced soil tillage activities in autumn.

To support the activities, 75 advisors are present to guide the farmers, and 55,000 – 80,000 autumn soil samples are taken on various depths (0-30, 30-60 and 60-90 cm) to control the fertilisation practices. The acceptable limit for the amount of nitrate-N (residual N in autumn) in the soil is 45 kg N/ha (with an upper tolerance of 25 kg N/ha for penalty purposes). A farmer is fined when higher values are found; premiums are given for lower residual N.

The entire programme is paid for by a tax system (‘Wasserpfeennig’) on water consumption. Results provided by the authorities show that the nitrate-N content in the soil of the catchment area was reduced by 40-60% between 1988 and 1999, depending on the crop type (e.g. from 60 to 30 kg N/ha under wheat and from 120 to 40 kg N/ha under maize), and that the nitrates concentration in groundwaters is now decreasing or stable in most of the areas.

#### *e) Greece-Thessaly*

Thessaly occupies an area of about 14,000 km<sup>2</sup>, or 11% of the Greek territory. Of this, cultivated land covers 36%. Irrigated land in Thessaly has increased considerably over the last three decades in parallel with mechanisation, introduction of new productive varieties and increased application of fertilisers.

Intensification of agriculture however, in conjunction with the lack of a rational water resources management scheme, led to pronounced over-exploitation of groundwater resulting in alarming water levels. In parallel, nitrogen fertilisers have caused groundwater deterioration and eutrophication in the River Pinios delta. An Action Plan has been adopted, including a reduction of nitrogen fertiliser application.

This reduction can be achieved through a set of measures including:

- better effectiveness of N use;
- the introduction of new irrigation techniques;
- the cultivation of suitable crop varieties.

Results of the pilot nitrogen pollution project in Thessaly, operated within the framework of the National Action Plan, indicate that farmers have started altering their attitude on crop fertilisation towards a rational and more scientific approach. So far, they have experienced that a reduced amount of nitrogen does not necessarily correspond with an equivalent yield loss, especially for cotton. Nitrogen uptake is low during the initial growing stages and nitrate losses can be considerably reduced by lower pre-sowing N fertilisation. Farmers are now convinced that the N fertilisation efficiency is increased and can be achieved by splitting the recommended amount.

In the project, more than 3.200 farmers participated for the period 1996-2000. It was estimated that a reduction of the applied N fertilisers of about 10 kton for the pilot area of Thessaly (e.g. – 30% for cotton, from 140 to 100 kg N/ha, or –25 % for tomatoes, from 270 to 200 kg N/ha) has occurred.

#### **B.5. A preliminary assessment of the economics of Action Programmes**

It is frequently argued that the implementation of Action Programmes is likely to have an impact on a wide range of farm-level and regional economic indicators. Improved practices are likely to have different direct costs, may induce changes in the overall farm management and farm constraints or may lead to changes in crop yields or farm gross output. At the aggregate regional levels, such changes, if taking place simultaneously for a large number of farms, could lead to indirect impacts on economic sectors linked to agriculture (e.g. providers of specific machinery or of input).

Unfortunately, the literature on the economics of practices for complying with Action Programme Measures is very scarce. Also, the information provided in many reports or analyses is rarely complete for a robust economic analysis and sufficiently varying from one report to the other to render any comparison hazardous. Thus, this chapter presents only a series of simple examples illustrating the economic dimensions related to the implementation of Action Programmes.

## Assessing the direct costs of measures

A review of existing EU cost-studies showed that the costs of measures in action programmes can vary widely among Member States and type of measures. However, the review shows that the range 50 to 150 € per hectare per year can be used only as a first rough though very incomplete estimate.

Examples of costs cited in the literature include:

- ***Crop and land management***

Specific cost information is provided for the French projects presented above. Increasing the area of catch crops in winter is an effective measure for reducing nitrate losses as the crop takes up residual soil nitrogen. Total costs of such practices (soil tillage, seeding, seeds) have been estimated at € 125 per hectare per year.

The presence of buffer strips is also a land management measure that will reduce nitrogen losses through runoff and that will prevent direct fertiliser applications into watercourses. Associated costs for a 5 meter wide buffer strip are slightly higher than implementing winter crops (€200 per hectare per year).

- ***Manure storage***

The costs of additional outdoor storage capacity for manure can be significant. Exact investment and operation & maintenance costs vary according to the type of manure, the type of storage and the storage capacity. Clearly, the need for extra storage capacity will depend on the farm type and cropped area. For example, MAFF (1998) reported average additional manure storage of only 200 m<sup>3</sup> for beef farms in vulnerable zones compared with more than 2,000 m<sup>3</sup> for intensive pig farms.

Costs will range from €5 per m<sup>3</sup> for simple storage facilities (e.g. lagoons) to €50 per m<sup>3</sup> for advanced storage (e.g. concrete tanks with cover to prevent precipitation input and odour emission, see MAFF (1998)). However, it is clear that the costs of manure storage rapidly decrease with increasing storage volume and capacity.

- ***Shifting N-input from mineral to organic fertilisers***

In cases where measures aim at replacing the N input from mineral fertilisers by an equivalent amount of N from organic fertilisers, differences in costs reported in the literature result mainly from differences in the manure transportation costs. A study undertaken in the United Kingdom (MAFF, 1988), for example, showed that the annual cost for manure transport ranged from €25 to €200 per hectare per year for dairy and a pig/poultry farms, respectively. The main reason for the low costs for dairy farms was that these farms have more land available.

- *Undertaking soil analysis for optimising N-input to crop needs*

Soil analyses are a promising way of reducing N losses. Fertilisation based on soil analyses is gaining interest in a growing number of Member States

**Table VI illustrates the cost<sup>2</sup> of soil analysis for 3 Member States, France, the Netherlands and Germany. Soil is sampled at three depths (0-30, 30-60, 60-90 cm) in France and Germany and at one depth in the Netherlands (0-10 cm).**

Country	Area considered (in hectare)	Number of soil analysis per year	Frequency of soil analysis	Costs per hectare and per year (in €)	Break even point (in kg per hectare per year) <sup>2</sup>
France	70	18	Every 5 years	10-22 <sup>1</sup>	20-45
The Netherlands	3	1	Every 3 years	8-15	10-20
Germany	5-7	15	Every year	20	40

<sup>1</sup>: Assuming a saving of €0.5 per kg N-input reduced

<sup>2</sup>: With and without fertilisation advice costs, respectively

The table also contains information about the economic break-even point, i.e. the level of saved N-input where the costs of the soil analyses are fully compensated by a reduction in fertilisation costs (providing no yield loss takes place). The table shows that savings of 10 to 45 kgs of N-input per year would fully compensate for the costs of the soil analyses. Experience suggests that an N-input reduction of this magnitude is often feasible.

### **Impact on crop yields**

Situations with N-applications significantly higher (double) than crop requirements are still found in many areas and regions of the European Union. Under such situations, a reduction in the total N-applications is unlikely to lead to any significant yield loss. Indeed, significant yield decreases that would result from N-application reduction are not reported in the literature and reports. In fact, many reports mention reductions in inputs without any yield reduction because of the positive impact of improved practices (e.g. increasing the number of fertiliser applications). The above underlines the need for development of rigorous and coherent recommendations for a **balanced fertilisation**, which take into account the specific conditions of the zone

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<sup>2</sup> The data for France have been obtained from the previously mentioned “RDP project”. The information for the Netherlands has been provided by the Dutch Nutrient Management Institute (NMI). Data for Germany are taken from the Baden-Wurtemberg Bundesland report.



concerned (soil conditions, soil type and slope, climatic conditions), the land use and agricultural practices (including crop rotation systems and irrigation).

This fertilisation should be based on a balance between the foreseeable nitrogen requirements of the crops and the nitrogen supply to the crops from:

- the soil itself (i.e., the amount of nitrogen present in the soil at the moment when the crop starts to use it, and the supply through the net mineralisation of the reserves of organic nitrogen in the soil);
- both organic and chemical fertilisation, plus N atmospheric deposition and biologic fixation.

Moreover, development of training and extension services appears essential for a wide adoption of these recommendations, as well as of codes of good fertilisation practice, by farmers.

It is striking to note that the large range of effective fertiliser applications recorded within the European Union is accompanied by a large range of formal recommendations that can not always be understood by differences in crop variety or yield and climatic, soil, and hydrological conditions. Table VII presents recommended N-input per kg of biomass harvested for Member States from the northern part of the European Union. The sometimes large differences illustrated in this table (e.g. from 1 to 2 at the extreme for sugar beet) underline the need for more rigorous, agronomically and environmentally justified recommendations in each Member-State.

**Table VII Recommended N input levels for major crops relative to the biomass harvested (in kg per ton of product – compiled by EFMA, 2001 from M.S. formal advices)**

Country	Crop type			
	Winter wheat	Rye	Sugar beet	Potatoes
Sweden	22	16	1.7	3.1
Denmark	22	18	2.1	4.1
Germany	23	20	3.6	4.5
The Netherlands	25	18	2.2	5.2
United-Kingdom	28	-	1.7	3.8

## Cost-effectiveness analysis

It is important to ensure public funds are allocated to measures and regions according to their potential in solving nitrate losses and eutrophication problems. It is thus important to compare the costs of different measures or programmes to their impact or effectiveness, in reducing drinking water or eutrophication problems.

Studies assessing the cost-effectiveness of different measures and programmes are extremely rare although their usefulness for policy making and allocation of scarce financial resources is clear.

An example of such analysis is reported (Bel et al - 1999) for the Bièvre-Liers region in France. As illustrated in the table VIII, this report compared two programmes in terms of their impact on N-emissions, N-concentration in groundwater and costs. The table shows that the FARM programme is more cost-effective than the FARM+CIPEN programme, with unitary costs of N-reduction of €1.07 and €1,38 per kg of N, respectively<sup>3</sup>. However, the combined FARM+CIPEN measures are still necessary for achieving reductions in nitrate concentration of groundwater down to the guide value of 25 mg/l. And the overall cost of such combined programme remains reasonable.

**Table VIII Comparison of impacts and cost of two preventive programmes (Belgium/Germany, 1999)**

Variable, Indicator	FARM <sup>1</sup>	FARM + CIPEN <sup>2</sup>
Reduction in N-emission (in kg per hectare)	21	38
Expected N-concentration in groundwater (in mg/l)	44	27
Total cost of the programmes (in € per hectare)	22	53
Cost-effectiveness in € per unit of N-emission reduced	1,07	1,38

<sup>1</sup>: Programme FARM – Expected yields equal to the average of the last 5 years; N-application (including farm manure) optimised according to this average yield (minimum scenario for limiting over-fertilisation).

<sup>2</sup>: Programme FARM + CIPEN – in addition to FARM, systematic integration of catch crops before spring crops and better management of crop residues (which leads to reduction in nitrate losses during inter-cropping).

Such cost-effectiveness analysis made at the local level (i.e. by comparing different practices or programmes) could also be performed at a more global level by

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<sup>3</sup> In the present case study, the reduction in N-losses resulting from catch-crops is limited to approximately 20 kg N/ha. In many situations, however, this reduction could be significantly higher (i.e. between 50 and 80 kg N/ha) thus improving the cost-effectiveness ratio.

assessing, for example, the relative potential and costs of different regions for reducing nitrate losses to a given river or aquifer<sup>4</sup>. Such analysis is key to prioritising investments.

### **Investigating global benefits**

Most economic arguments on Action Programmes concentrate on the costs (often imperfectly estimated) of these measures. The studies and reports investigating environmental benefits arising from the reduction in nitrates leaching and assessing these benefits in monetary terms are rare.

Examples of these benefits can be found in literature dealing with the comparison between different strategies for ensuring an adequate drinking water supply to households. Whenever water is used for human consumption, benefits are high.

As an illustration, Heinz and al (INFU/WRC, Cooperative agreements in agriculture, 2002) investigated for the E.C. cost efficiency of preventive and curative measures for removing the excess of nitrates into groundwater used for drinking purpose. In a German case costs of changing farming practices<sup>5</sup> for reducing the nitrate level in the groundwater to acceptable levels were estimated at 0.06 €/m<sup>3</sup> versus 0.28 €/m<sup>3</sup>, i.e. nearly 5 times more, for the alternative of installing biological denitrification treatment. A Dutch case in the same study showed even a bigger difference, with a cost of preventive measures at field level of 40 € per hectare, instead of 400 € per hectare for estimated water denitrification costs.

Under such situations, farmers, water suppliers and water consumers (who eventually pay the water bill) all have an interest in developing improved farm practices. The number of voluntary agreements that have developed between water suppliers and farmers in many areas of Germany or Austria shows that such *win-win* situations are rather common<sup>6</sup>. Thus, and although improved measures may have significant costs, they remain largely beneficial from a society point of view.

### **Conclusion and issues for follow-up**

Direct costs and yield reductions are often mentioned as key constraints to the uptake of improved N-management practices. However, the available cost information shows that yield reduction may in various cases be marginal and costs reasonable. Furthermore, some farming systems analysis suggest the availability of labour is the key constraint in explaining farmers' reluctance to change practices, (e.g. for splitting N applications or maintaining buffer strips). In such cases, solutions to favour take up need to investigate farm management more globally.

Clearly, significant efforts are required to ensure that:

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<sup>4</sup> The same analysis can be performed for different countries. See for example the article by Markku Ollikainen. 2001. Towards efficient pollution control in the Baltic Sea – An ecological-economic modelling approach, on a cost-effectiveness analysis for reducing nitrate emissions to the Baltic Sea.

<sup>5</sup> By assessing N-balance, shifting from mineral fertilisers to organic manure, installing intercultures, developing organic farming; investing in manure storage, implementing winter soil cover, etc.

<sup>6</sup> In some cases, when high economic interests are at stake such as in areas where water is extracted for bottled mineral water, the financial retribution paid to farmers can sometimes be very high and significantly increase farm income...

- **Indirect costs of eutrophication impacts** on environmental heritage and on other water related economic activities such as fishing, tourism or recreational use of water, are assessed thanks to case-studies in representative watersheds.
- Research and studies are proposed for investigating the socio-economic dimensions of Action Programmes and providing robust socio-economic assessment required for any policy decision and planning.
- Such analyses need to integrate socio-economic and technical issues. For example, a cost-effectiveness analysis needs to combine expertise for assessing the impact of selected measures (in terms of reduction in nitrate use, in the leaching fraction or in the eutrophication level of a given water body) with expertise for assessing the costs of these measures.
- Both a farm-level perspective and a global or society perspective are required in the economic analysis. Indeed, some costs or benefits may arise outside of the farm boundaries and thus need to be considered in promoting and evaluating Action Programmes. As the Water Framework Directive is progressively implemented, cost-effectiveness analysis will be more systematically performed for assessing programmes of measures, including measures for reducing diffuse pollution from agriculture.
- In parallel to analyses and studies, Member States should collect systematically socio-economic information on their Action Programmes. The information should be coherent (e.g. collected via farm surveys such as those developed in France) to ensure comparability and that common lessons of relevance to all Member States can be drawn.

## C. THE ACTIONS OF THE EUROPEAN COMMISSION

These actions have been developed in four directions:

- Knowledge on the pressures and environmental status of EU waters, through regular monitoring and reporting exercises, with improved connections with other Directives (Urban wastewater Dir., Water Framework Dir.), Eurostat/OECD joint questionnaires, and the “Eurowaternet” of the European Environment Agency.
- Exchange of technical information between Member States about good practices in agriculture and their efficiency regarding nutrient losses, and tools for measuring, modelling or forecasting their impact on water quality evolution.
- Legal pressure on Member States which do not implement correctly the different steps of the directive’s process.
- Development of economic tools (eco-compliance, taxation of surpluses, incentives for precautional practices) encouraging a good nutrients management at farm level. This includes linkage of Rural Development Plans funding with progress in implementing the Directive.

As an example of technical information, several studies concerning:

- "Long term reduction of nitrate leaching by cover crops"<sup>7</sup>
- "nitrogen content of animal manure"<sup>8</sup>
- "fertilisation of grassland"<sup>8</sup>
- "good practice in fruit and vegetable cropping"<sup>8</sup>

have been recently finalised by contractors on behalf of the Commission. Reviews on criteria of fresh and marine waters eutrophication have also been published.

The Commission (DG Research) is also promoting and financing international projects concerning:

- inputs and transfers of nutrients in the air ("Anice"), soils and water ("Streames", "Danubs", "Euroharp", "Eloise", "Subgate"),
- their impact on aquatic ecosystems ("Chabade" for Mediterranean, "Comweb" for coastal plankton),
- sampling and modelling methods ("Baseline" and "Fractflow/Famest" for groundwaters, "BMW", "Harmonit/Harmoniqua", these two last studies including socio-economic approach and cost-efficiency scenarios).

Two examples illustrate the direct applicability of this research:

- The recently finalised RANR project, about retention and fluxes of nitrogen from land to sea, has demonstrated the good adequation of a specific model (Soil N/WEKU) for predicting transfers of N from groundwaters to surface waters in Northern Europe, and gives useful elements for calculating time lags and to forecast delayed effects of N transfers in the water cycle.
- The FAWE (Parts 1&2) and NICOLAS projects showed that for the purpose of the reduction of nitrogen inputs into rivers the regular creation of buffer zones confined along the course of rivers may not be the most efficient solution, but that it is often more efficient to maintain and use existing ditches or wetlands, distributed in the landscape between agricultural fields and rivers, which are able to remove up to 80% of diffuse nitrogen loads.

The Joint Research Centre (ISPRA) of the Commission is involved in several of these projects (e.g. "Euroharp", with a central database on the 17 pilot watersheds and the 9 modelling methods tested). Diffuse N pressure assessment and marine eutrophication survey by remote sensing are also developed in its Institute for Environment and Sustainability (IES).

Concerning legal procedures, table IX summarises the present situation (end 2001) for each Member State, regarding each step of the implementation process:

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<sup>7</sup> Concerted action AIR3-CT94-2108.

<sup>8</sup> ERM, 2000-2001.

Member State	B	DK	D	EL	ES	F	IRE	I	L	NL	Ö	P	SF	S	UK
Water monitoring	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Designation of nitrates vulnerable zones	+	+	+	+	+	+	○	+	+	+	+	+	+	+	+
	○	●	●	○					●	●	●		●		○
Codes of good practice	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Action programmes	+	+	+	+	+	+		+	+	+	+	+	+	+	+
Report	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+

+ = Exercise performed but not necessarily approved by the Commission

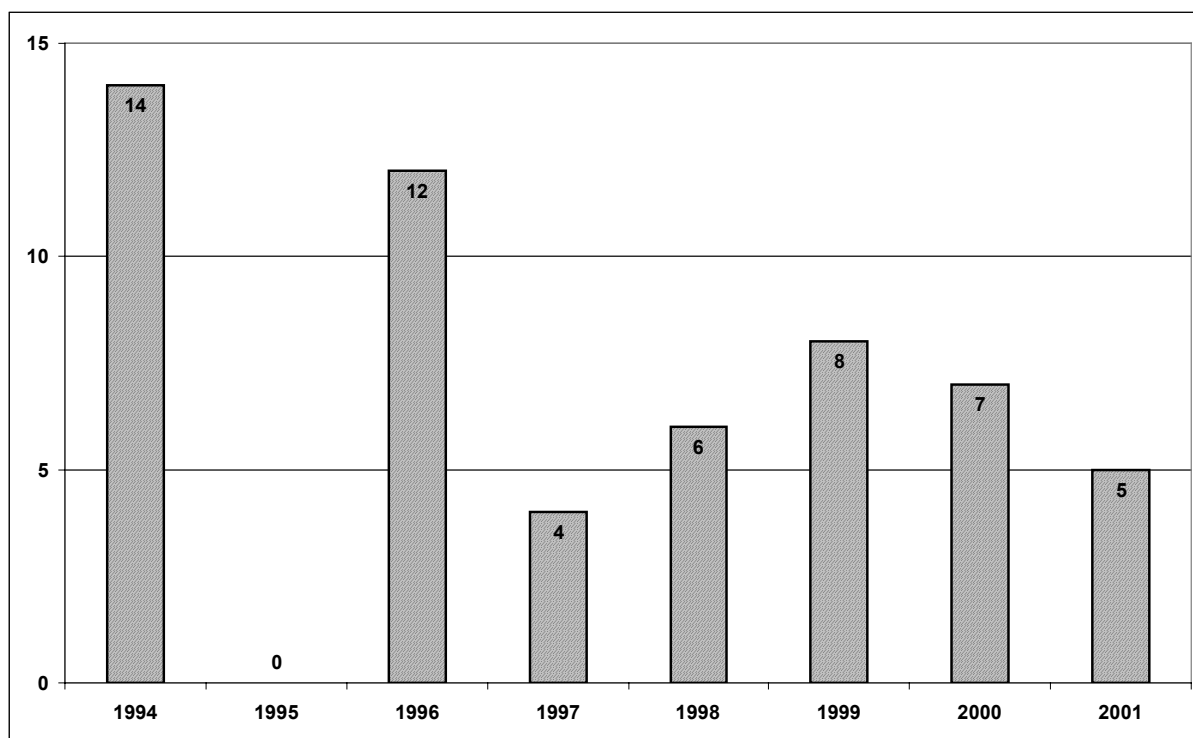
● = Whole territory designated      ○ = important designations expected end 2001 but not achieved

Shaded: Infringement procedure ongoing (For legal reasons, some proceedings at an early stage cannot be mentioned in this table)

From this table it appears that most Member States are concerned by at least one infringement.

Since 1994, the Commission has opened 56 legal cases in which the nitrates directive was involved, alone or with other directives. Half of these cases were closed, due to a quick improvement of implementation by the concerned countries, 7 have resulted in condemnation by the European Court, against Spain (01.10.98 and 13.04.00), Italy (25.02.99 and 08.11.01), United Kingdom (07.12.00) France (08.03. 01) and Luxembourg (08.03.01). Seven cases are still pending in front of the Court, among the 23 cases open today.

Fig 3 shows the repartition of legal actions opened by the Commission in the 1994 –2001 period.



Moreover, in order to assure the coherence of Community policy, considering the linkage between «usual good farming practice», as defined in art .28 of Regulation (EC) No 1750/1999<sup>9</sup> laying down the detailed rules for the application of Council Regulation No 1257/99 on support for rural development<sup>10</sup>, and the Nitrates Directive, Member-states were requested to include in their rural development programming documents, where relevant :

- a commitment to make substantial progress in completing the designation of vulnerable zones as soon as possible.
- a commitment to make sufficient progress in defining and implementing the binding measures of the Nitrates code of good farming practice (GFP) and/or the action programme and adapting and/or completing the general GFP as defined in 1750/99 accordingly.

The dates for the fulfilment of these commitments varied but expired by end 2001 at the latest.

#### D. CONCLUSION

Although incomplete and lacking of coherence, the water monitoring networks set up by Member States show that more than 20% of EU groundwaters are facing excessive nitrates concentrations, with a continuous increasing trend in the most intensive areas of livestock breeding and fertiliser consumption.

At least 30-40% of rivers and lakes show eutrophication symptoms or bring high nitrogen fluxes to coastal waters and seas. **The agricultural origin of these N fluxes accounts for 50**

<sup>9</sup> OJ L214, 13.8.1999, p. 31. This regulation has been recently repealed and replaced by Commission Regulation (EC) No 445/2002 (OJ L74, 15.3.2002, p. 1).

<sup>10</sup> OJ L160, 26.6.1999, p. 80.

**to 80% of total N inputs to EU waters**, depending on Member States, watersheds and annual variations (Be, Dk, D, Fr, Irl reports to the EC, and EEA report n° 4 "nutrients in European ecosystems" - 1999).

Following a delay of 5 years or more by Member States to fulfil their commitments for implementation of the Directive and an effective reduction of N losses from agriculture to water, **a real improvement can be pointed out in the sensibilisation of Member States during recent years**. All M. S. have now transposed the directive, set up a comprehensive monitoring network, established a code of good practice, and designated at least partially their vulnerable zones (except Ireland). Indeed the effects of action programmes, often published only in 1997-1999, will be significant only after some years ("tanker" effect of soil and groundwaters), but **success stories can already be noticed in regions where intense field controls, including soil analysis, have accompanied dissemination of good practice advice** (e.g. in Denmark, some German Länder, East of France, Algarve).

The gradual orientation of the Common Agricultural Policy to take greater account of environmental issues (environmental protection requirements foreseen in Article 3 of Council Regulation No 1259/1999, establishing common rules for direct support schemes under the CAP; expansion of agri-environmental measures; definition of codes of good farming practice foreseen within rural development plans) contributes to the purposes of the Nitrates directive. **A CAP more oriented towards quality rather than quantity, encouraging extensive cropping or breeding, "buffer" natural areas and accurate balanced fertilisation, can further contribute to these purposes.**

However, the failure of a proper application of the "Nitrate" directive in some Member States cannot be rectified only through CAP measures. Controlling nitrate emission is still primarily the task of transposition and implementation of the "Nitrate" Directive. **Cost-efficiency studies on preventive measures should also be encouraged, in order to focus action programmes and practice changes towards the most efficient one.**

Besides financial support for a more environmental-friendly agriculture and dissemination of knowledge, it is necessary that all Member States arrive at a full implementation of the Nitrate Directive, **reinforce surveys and controls** at field level (including checking of fertilisation plans and records, manure storage and handling, soil analysis, natural buffer strips, etc.), **and introduce dissuasive penalties** for the producers who do not ensure **eco-compliance**.

The Nitrates Directive is now 10 years old, and Member States have in the last 2 years shown a real willingness to improve implementation. They realise that costs induced by drinking water treatment for nitrates excess, or by eutrophication damages in dams or coastal waters will still increase, and that the **investments dedicated to urban wastewater treatment will be inefficient regarding nutrients if a parallel effort is not devoted to an effective reduction of agricultural nutrients losses**. For this reason; the "nitrates" Directive maintains its full topicality without any need of short term revision, as pointed out by the European Parliament in its resolution (A5-0386/2000), and recognised by the new Water Framework Directive (WFD), which does not introduce any change to its process or deadlines. Nevertheless a synergy has to be developed in the future work for common implementation of these water directives, on items such as:

- **Harmonisation** of water **sampling points, networks, parameters and frequencies** for water quality monitoring in order to meet, with minimum work at field level, the needs linked with EU Directives, OECD-Eurostat Questionnaires, EEA "Eurowaternet", Marine



and River Conventions, and local/regional needs. This question is crucial for eutrophication effects, which need agreement on harmonised criteria and monitoring methodologies. Common tools and compatible equipment (G.I.S.), for georeferenced information exchange between Member States and the Commission, in electronic format, are under rapid development.

- **assessment of point and diffuse losses of nutrients to waters, and of the breakdown of their origin** (agriculture, urban waters, industry, air deposition...), (analytical differentiation, e.g. isotopic methods, models for calculating pressures, transfers and retentions) in order to compare the efficiency of various measures and set priorities both in nitrates Action Programmes and in management plans of WFD for any polluting parameter at watershed level.
- **models correlating environmental impacts** (e.g. algae blooms) and causative factors (nutrients, natural conditions, etc.), which will allow forecast of impact of various scenarios in the reduction or increase of these factors.
- **cost-efficiency approach** for preventive measures. **Nitrogen and Phosphorus** will certainly appear as priority pollutants in many E.U. watersheds, as promoting cyanophytes (blue algae) problems in lakes and dams, macrophytes and dinoflagellates impairing tourism or aquaculture in coastal waters, etc. Efficiency of investment in preventive measures, on agricultural pressures and practices, or on domestic and industrial discharges, will have to be evaluated and compared. Here also pilot applications and research are urgently needed, as shown by the poor feed back on these “forecast” and “cost-efficiency” items of the Nitrates year 2000 reporting exercise.