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# EUROWATERNET-Emissions A European Inventory of Emissions to Water: Proposed Operational Methodology

## Fourth Draft

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# EUROWATERNET-Emissions
# A European Inventory of Emissions to Water:
# Proposed Operational Methodology

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# Executive Summary

There are a number of legislative requirements for information on pollutant emissions: the implementation of the Fifth Environmental Action Plan of the European Union, various EU directives, especially the Water Framework Directive, for Eurostat and the Marine Conventions. There are strong incentives therefore to develop an inventory and evaluation of pollutant emissions to water which should integrate all possible sources of emissions to supply all the information needs. The Pollution Emission Register (PER) will be used within the limits of legislative requirements. As far as the nomenclature of emission sources (NOSE) proposed by Eurostat is concerned, its application to water emissions requires further tests and refinements. Hence, within the context of developing tools for use in inventorising and evaluating the total emission of pollutants into the environment, the European Topic Centre on Inland Waters (now the ETC on Water) has been developing a European method of inventorising and assessing emissions to water taking into consideration **all possible sources of emission. This is part of the EUROWATERNET process and will support EEA and member countries' activities aimed at streamlining of reporting, especially on emissions.**

The proposed methodology, called the European Emissions Inventory (EEI) is based on the DPSIR approach used by the EEA where Pressures (sources of emission) depend on Driving forces (activities creating the emissions). Those emissions give rise to the State of the environment and observable Impacts. The Responses by society are an important element in policy development.

The EEI combines both the 'register' and 'model' approaches. In both cases, data can originate either from measurements or from estimations based on models. The whole calculation system is based on and remains the responsibility of National Authorities. This is consistent with the overall EUROWATERNET approach which, for rivers, lakes, groundwaters and water quantity is now widely implemented throughout the EEA member countries.

The EEI methodology is based on the following information, called the **Group of Sources**, which comprises different elements. These are:

- **a source category**: seven categories are identified that are Urban, Industrial, Agricultural, Forestry, Transport, Wastes, Natural and Semi-Natural Contributions;
- **a substance**: a list based on the priority lists of directives;
- **a spatial aggregation**: a catchment level of about 5 000 to 10 000 km², at the NUTS level 2 or 3;
- **a temporal aggregation**: the annual load.

The main elements are:

- ***raw pollution*** is the actual pollution emitted by the source category,
- ***global pollution*** is the sum of all the pollution that actually reaches and is discharged to water (e.g. discharge pipe of a WWTP + overflow).

In this context:

- **purified pollution** = (raw pollution - global pollution)

This information is regarded as the minimum information necessary on emissions to water, and this is not yet available at an European scale.

The EEI uses only information available nationally or elsewhere, or required by the different existing Directives, and therefore needs no additional collection efforts by the member countries.

The main difficulties when comparing emissions figures are with: accounting of the sources, characterisation of the identified pathways, and the retention and transformation processes.

Pilot tests in Austria, France and The Netherlands indicate that existing information systems at the national level appear to be sufficiently homogeneous to allow the use of the EEI to build an inventory of emissions at the European level. In some countries, the level of detail will be precise and complete and close to the actual situation, whereas in other countries the level of detail will only reach the above stated minimum level. A proxy approach is used which is based on available monitoring information and this allows both the progressive implementation of the EEI and the accounting of emissions from all sources to water.

Different international (e.g. UNEP, OECD, Eurostat, the Marine Conventions – particularly OSPAR HARP) and national working groups are actively involved in the development of nomenclature for sources of emission or in the framework structure of an emissions register. Co-operation with these working groups is necessary to ensure harmonisation. The EEI does not duplicate existing initiatives, it seeks to harmonise them into a common agreed European system.

To streamline the collection of information it is first of all necessary to have a common base of definitions to ensure uniform classification and reporting. The development of a dictionary of a core set of definitions regarding the different purification processes, the different steps involved from the raw pollution to the discharge to water is an essential step in this process.

This could be done by harmonising the basic information (from definitions and technical coefficients) to the more complex information (models and data improvements). The gathering and synthesis of that information would lead to an emissions coefficient databank, with information on the application field and limits that could be used by any level of administrative organisations for the calculation of emissions to water.

The data collection test highlighted the possibility of assessing emissions in countries with different collection systems that are well implemented, with information available at a disaggregated (or county) level, or national level.

It is now proposed that the EEI methodology be implemented by the ETC on Water from the collection of data to the integrated assessment of emissions to waters, with statistical data collected from all the EEA member countries. National data could be provided in the proposed format using templates where possible, or in their original format where not. The main goals are to test the flexibility of the EEI, its capacity to give accurate results, its consistency with the different European Directives involved (especially the Water Framework Directive) and to supply from one common source the information needs of the member countries, the European Commission, EEA, Eurostat and other international users of emissions data. This would be a significant step forward in streamlining the reporting on emissions to water.

# 1 Reporting emissions to waters

## 1.1 Background and context

The emission of pollutants is the major cause of bad quality of inland waters in Europe. However, information currently available on emissions to water in Europe is not consistent or comparable between countries. Reasons for this are: the lack of common objectives regarding the current data registers; the lack of common nomenclature for the activities leading to emissions of pollutants; and technical difficulties in measuring emissions to water.

There are currently many requirements for the collection and reporting of information on emissions. There is therefore a need for the efficient use of this information in order to avoid duplication of activities. For this reason, the activities on emissions within the ETC/WTR work programme are intended in the long-term to provide a conceptual model for an *Integrated Emission Inventory for Europe (IEI)* restricted to waters, including nomenclatures for sectors and pollutants.

In 1998, the ETC/IW developed the main requirements for implementing a methodology of estimating emissions to water in an integrated framework, which takes into account all sources of emissions and all transfers. The main objective was to develop an operational framework for data on emissions to water, air and from waste, whatever the source or vector and without any minimum threshold i.e. an Integrated Emissions Inventory. This first step (EEA, 1998) revealed multiple methods of approach nationally and the lack of homogeneous data between air, water and waste. It was thus necessary to take a pragmatic approach to the problem on a step-by-step basis. It was proposed that it should focus first on a limited set of the highest priority determinands which can be evaluated by simple means.

During 1999 and 2000 work was done as regards this pragmatic approach: a guidebook for data collection was built, some models and tools for diffuse emissions evaluation were assessed and tests to link the nomenclatures were made. A data collection test was also done with three volunteer countries: France, The Netherlands and Austria. The test was successfully completed in France, showed that the data are available in the Netherlands and that they are not in Austria. This test was based on the premise that emission assessments carried out by different countries need to be based on comparable data. To achieve this, it is important to improve the knowledge of the availability and organisation of the data held by each country, especially those needed for the different legal requirements. This can help each country to improve its own collection of emissions data.

The work was included under a chapter called EUROWATERNET-Emissions with the idea to develop a similar approach for the collection and reporting of emissions information to those used for EUROWATERNET - rivers, lakes, groundwaters and quantity. This means: produce a report on the methodology to be used and the main elements that explain how it works; the results expected; and the underlying theory. This is the purpose of this report. It gives the main elements to the member countries to enable them to develop the methodology based on their own information system. It is completed with the guidebook developed to implement and operationalise it.

## 1.2 EEA Objectives

The development of EUROWATERNET-Emissions is intended to produce data for the production of indicators and reports on the emissions to waters (or pressures upon waters) at the European level.

The general objective of this study is to propose a European method of evaluation of emissions to water that meets the above mentioned needs, whatever the type of source (point or diffuse). This report is intended to describe how it can progressively be put in place. It will result in EUROWATERNET-Emissions (or Pressures) and will be called the European Emission Inventory (EEI) to Waters.

The pathway of a pollutant from its source to its emission to water includes more complicated steps than do emissions to air. There are different pathways (e.g. leaching or runoff) and purification processes within the medium. Furthermore, to restrict the method to a simple inventory of data on emissions to water based only on legal reporting obligations will not be accurate, because these only cover some of the possible sources of emission to water, as they are restricted to certain source or pollutant groups and minimum emission levels. The methodology will, however, focus first on these obligations especially the sources, substances and thresholds listed in them.

The basic methodology must be flexible and simple, yet take into account the complexity of the various steps in a pollutant's pathways. With EUROWATERNET-Emissions we intend to provide emissions data at various geographical levels (local, regional, national, European) and with different source groupings (e.g. urban and domestic/industrial sources).

It should be emphasised that countries are not subject to any mandatory request to apply the emissions inventory method proposed in this report. However, as far as any country is part of the European Community, it has to respect European Directives, and hence to report on emissions when required. The EEI provides a tool for countries to facilitate legal and mandatory emissions reporting and to avoid duplication. At the same time it takes into account developments made by the country in this field. This will help streamlining the collection of the required data without increasing the demands on the data collectors. It could be particularly of help in the implementation of the Water Framework Directive. Countries may choose not to use this method and report on emissions using their own methodologies. Should this be the case, comparisons of data would be less reliable, and the use of results at the European level may be open to question.

In this report and as a first step, the EEI objectives are to:

- take into consideration reporting obligations from European legislation requirements (e.g. IPPC Directive 96/61/EC) and other international initiatives (e.g. OSPARCOM HARP-Haz and HARP-Nut);
- assess emissions regardless of the type of data available in the different countries;
- take into consideration emissions data from individual plants and nationally aggregated data; and individual and group activities;
- provide emissions data at various geographical levels (local, regional, national or European) and with different groupings (e.g. point sources vs. diffuse sources, urban sources/domestic sources (non-sanitary) vs. domestic sources (sanitary) vs. industrial sources). In a first step it will only be limited to the most disaggregated level of the raw data collected;
- provide emissions data at an appropriate temporal resolution (e.g. no more than two years old);

- be consistent with EUROWATERNET requirements to become a part of it as EUROWATERNET-emissions.

In a second phase, but not developed in this report, the EEI should :
- assess whether or not the policies are working and having a positive effect on the water environment;
- cover all significant sources of emission to water, whether point or diffuse sources;
- estimate emissions from sources not subject to legal monitoring.

### 1.3 Definitions

In this section, some terms used within this study have been defined for clarification purposes.

**Diffuse source:** a source of one or more pollutant(s) that cannot be geographically located on a map as a point but originating from a certain area. Diffuse sources can rarely be assessed by monitoring. This is because there is no precise point where water can be sampled. Different quantification methodologies (e.g. mathematical models, lysimetry, small monitored watersheds) can be used and made comparable to obtain a reasonably reliable result.

**Emission:** the direct or indirect release of substances, vibrations, heat or noise from individual or diffuse sources into the air, water or land.[1]
Unless specifically mentioned it will be used in this report for emissions to water.

**Emissions inventory:** the procedure aiming at collecting information on emissions (collection of data resulting either from measurements or modelling), mainly dealing with sources of emissions and amount of pollutant generated. A so-called **European Emissions Inventory (EEI)** will be used here for the inventory of emissions to water. A pollution inventory or register is a database of potentially harmful releases (emissions) to air, water and soil, as well as of wastes transferred off-site for treatment or disposal. Typically, facilities releasing one or more of a list of specified substances must report periodically as to what was released, how much, and to which environmental media. This information is then made available to the public both as raw data and in the form of analyses and reports. The development and implementation of such a system adapted to national needs represents one component towards developing a means for governments, enterprises and the public to track the generation, release, further use and disposal of various hazardous substances from “cradle to grave" (Casey-Lefkowitz, 2000).

**Emissions register:** an emissions inventory, in which the sources are identifiable economic units (for example enterprises, households), which are under a legal obligation to report their emissions.

**Global pollution:** sum of all the pollution that actually reaches and is actually discharged to the natural surface water system (rivers, lakes, marine waters) along the pathway of a pollutant.

[1] modified from EC Council Directive 96/61/EEC of 24 September 1996 concerning integrated pollution prevention and control

**Point source:** a source of one or more pollutant(s) that can be geographically located and represented as a point on a map, for example the point of discharge of a sewer into a river.
Direct sampling is the most common method used to estimate point source discharges from municipal and industrial treatment plants.
A distinction is sometimes made with areal sources that are an aggregation of small point sources apportioned on a territorial basis. The aggregation rule aims at optimising the cost and effort of the collection of data by taking into account the relative quantity of emissions compared with the total quantity emitted by all the sources. For example, in France, 75% of the total load from industry comes from 7% of the number of industries. It is then better to register only the sources, for example greater than 10,000 population-equivalents, and consider industries lower than this threshold as diffuse sources.

**Pollution:** direct or indirect introduction, as a result of human activity of substances or heat into the air, water or land which may be harmful to human health or the quality of aquatic ecosystems or terrestrial ecosystems directly depending on aquatic ecosystems, which result in damage to material property, or which impair or interfere with amenities and other legitimate uses of the environment [2]

**Pollutant:** any substance liable to cause pollution, in particular those listed in Annex VIII of the Water Framework Directive, (2000/60/EC) and which is to be included in an emission inventory or register.

**Source:** the origin of an emission, which may be natural or anthropogenic and a physical entity or process or a set of such entities or processes defined according to some common characteristic (human activities such as industry, agriculture, or metabolic activities), which generates emissions of pollutants. Sources are usually classified into categories, for example urban, industrial, agricultural, forestry, transport, wastes and natural contributions.

**Substance:** any chemical element and its compounds, with the exception of radioactive substances within the meaning of Directive 80/836/Euratom, and genetically modified organisms within the meaning of Directive 90/219/EEC and Directive 90/220/EEC. [3]

## 1.4 The contributions to an emissions inventory (EEI)

There are a number of requirements for information on emissions to water at different European levels. The EU Directives' requirements apply to Member States. The needs of international organisations dedicated to the protection of Rivers and Seas apply at the different convention levels. This part will focus on the main aim of these legal obligations and how they relate to, and can be used for the construction of the EEI.

### *1.4.1 Requirements of Directives*

#### *a) Water Framework Directive (2000/60/EC)*

[2] OJ L 327, 23.10.2000, p. 7.

[3] Council Directive 96/61/EC of 24 September 1996 concerning integrated pollution prevention and control

The aim of the Water Framework Directive (WFD) is to provide '*a transparent, effective and coherent legislative framework within which water policy could be formulated and resources protected*'. In the future, this Directive will replace or subsume some of the Directives described below. The WFD covers all waters, and provides a method for the identification of water bodies, which are likely to be at risk of failing to achieve the Directive's objectives. These water bodies will need to be monitored to assess their actual state, and measures put in place to bring them up to the required standard. All measures to achieve the environmental objectives for the sustainable protection and use of water have to be co-ordinated and their effects be overseen and monitored within river basins, thus ensuring that Community policy is applied in a coherent and rational way. The Directive covers quantity and quality aspects of all surface and groundwaters.

To implement the Directive, the Commission, in conjunction with the Water Directors of the Member States, has set up 10 Working Groups (WG) and 3 Expert Advisory Fora (EAF) as part of the Common Implementation Strategy:
- one of the WGs – Impress, aims to produce guidance on pressures and impacts. The EEI could help the collection of data by providing tools and methods to collect, collate and organise the information.
- the EAF on Reporting, whose objectives are: to streamline the reporting process, develop more targeted data and information collection, avoid duplication and ensure more efficient use of available data and information, and improve access to validated data and information across institutional barriers (national levels, transboundary river basins districts, the Commission and the Eurowaternet). The EEI could particularly contribute to the work in this forum.

Article 5 and Annex II require the identification of significant human pressures (a definition is needed) and form part of the wider analysis of the river basin district. The timetable is challenging: the analysis must be completed within four years of the entry into force of the Directive and reviewed at the latest 13 years after this date. Thus it will be necessary to maximise the use of existing information using a flexible methodology because each Member State will have differing types, sources and amounts of information on pressures. Annex II lists the main types of pressures of which point and diffuse sources are identified but also abstraction and others. The main sources identified are urban, industrial and agricultural. A Working Group is established and began its work with a project called "guidance on the analysis of pressures and impacts" (Environment Agency, 2001).

The need for an emissions inventory is particularly emphasised in the Directive through the requirements for identification of trends in pollutants, on emissions and pressures (the word emission is cited 33 times and the word pressure 26 times). Estimations have to be carried out at the River Basin District level for point and diffuse source pollution, as well as analysis of other anthropogenic influences on the water status, although the methodology to produce the information is not detailed. Potentially much of the information on pressures, state, and impact required by the EEA should be available once the Directive has been implemented.

However, the reporting format for data is not defined in the Directive, (maps, paper copies etc) and the reporting timetable of the Directive is lengthy (six years for the River Basin Management Plans and dangerous substances) Therefore, the EEA proposes to obtain the information it requires using EUROWATERNET and the EEI. In the meantime the EEA and Commission officials are considering how EUROWATERNET could be used to satisfy all information needs in the longer-term.

### *b) Urban Waste Water Treatment Directive (91/271/EEC)*

This Directive sets minimum standards for the collection, treatment and disposal of wastewater depending upon the size of the discharge, and the type and sensitivity of the receiving waters. It covers urban wastewater and industries connected to Urban Waste Water Treatment Plants (UWWTP).
Three types of report are required under this Directive:

- information on the monitoring of treatment plants for agglomerations greater than 10 000 population equivalent (p.e.);
- situation reports, every two years, to provide an overview of the implementation of the Directive;
- reports on the implementation programmes, including planned investments (updated every two years where necessary).

Through those reports the raw pollution and the pollution discharged in waters from all wastewater treatment plants of more than 2 000 p.e. will be available.
A questionnaire was also developed which aims to provide the European Commission with relevant information on monitoring of urban wastewater collecting systems and treatment plants in the large EU agglomerations. For example, the questionnaire asks for information on the nominal load and collected load for each agglomeration, and the daily maximum design load, treatment type and the percentage reduction in COD, $BOD_5$, total nitrogen, total phosphorus and suspended solid loads in each of the involved UWWTPs.
The information collected could also be used for the EEI thus avoiding duplication.

The Directive is broadly based on monitoring and limited to the biggest wastewater treatment plants. The additional monitoring effort for the remaining urban and small and medium enterprises' emissions (for example less than 20% in France) would be too costly relevant to the additional information obtained. However these sources should not be neglected, as they can also have a great impact on the environment and alternatives to monitoring need to be considered.

### *c) Integrated Pollution Prevention and Control Directive - IPPC (96/61/EEC)*

The IPPC Directive aims to prevent and control emissions to air and water and the generation of waste from large industrial point sources (energy industry, production and processing of metals, mining industry, chemical industry, waste management and other activities). The Directive aims to account for 90 % of total industrial emissions in Europe. This Directive sets a European-wide authorisation system by which most medium-sized and large industrial installations across the EU will have to obtain a permit, laying down limit values for emissions. One anticipated benefit of this Directive is to discourage the shifting of pollution between air and water, both having emission limit values.
A European Pollutant Emission Register (EPER) database is then to be developed based on data supplied by Member States and that will be made available to the public through the Web. Its main purpose will be to collect comparable industrial emissions data for a list of 50 pollutants, of which 26 are relevant for water. Every three years, the Commission will publish a report on monitored emissions with annual load, and their sources.

The EEA and ETC/WTR have been involved in the development of the EPER and it could be a very useful input source for the EEI. The guidance document developed for the implementation provides a detailed framework that makes the data comparable over Europe. It also provides details on reporting formats including emission estimation methods and nomenclatures to be used. Moreover, the EEA will be involved in data collection and dissemination and will provide results on the trends of the emissions every three years.

It is however, limited to the discharges from the biggest industries (directly or indirectly) and not necessarily directly to water. For some cases (expected to be widely spread in Europe), the emissions reported will not provide the global release to water and the additional pollution reduction achieved by industrial (off-site) or urban WWTPs.

### *d) Nitrates Directive (91/676/EEC)*

The Nitrates Directive aims to reduce water pollution caused or induced by nitrates from agricultural sources and to prevent further such pollution. Member States have to establish national Codes of Good Agricultural Practice and training programmes for farmers. They shall designate and map nitrate vulnerable zones (NVZ), (areas, which drain into the waters affected by pollution or waters which could be affected by pollution, and which contribute to pollution). Action programmes shall be established in the NVZs and a suitable monitoring programme to assess their effectiveness has to be implemented.

For the EEI, the information collected are not in a suitable form (summary report on application, code of good agricultural practice…) to provide useful figures of diffuse emissions of nitrate. It will only provide proxy indicators potentially not comparable between countries. However, ETC/WTR and Commission officials are prepared to discuss how the information from this Directive could be embraced by the EUROWATERNET process and thus made more comparable and useful for European assessments.

### *e) Standardised Reporting Directive (91/692/EEC)*

The Standardised Reporting Directive was adopted in 1991 to harmonise and improve the reporting requirements included in the existing Directives relating to the environment, and to standardise and rationalise the reports. The aim was to assess the effectiveness of implemented measures and hence compliance with the Directives within Member States and to ensure that information provided to the Commission by Member States was comprehensive, consistent and comparable. It requires Member States to submit information on the implementation of those Directives to the Commission every three years. National reports are to be drawn up on the basis of a questionnaire or outline drafted by the Commission, assisted by a Committee of Member States' representatives. Outline questionnaires for 14 Directives on water were first adopted in Commission Decision 92/446/EEC. The questionnaires were further amended by Commission Decision 95/337/EEC following further consultations with the Committee, and included explanatory notes and agreed fine-tuned tables in order to clarify the reporting obligations imposed on Member States.

For the EEI the answers of the Member States to the questionnaires could be used to give the national or regional emissions for some substances and also to give some qualitative assumptions on the figures provided by the EEI or the possible amount of substance involved. However, an analysis of the first three-year round of reporting by ETC/IW revealed that the quality of responses was highly variable between countries and thus comparability was questionable.

### *f) Dangerous Substances Directive (76/464/EEC)*

The Council Directive concerning pollution caused by certain dangerous substances discharged into the aquatic environment of the Community was adopted in 1976. It establishes two lists of compounds. In view of

dangerousness, persistence and bioaccumulation, pollution by List I substances must be eliminated and pollution by List II substances must be reduced. Member States are required to establish authorisation procedures to limit discharges to surface waters of all effluents liable to contain substances on List I.

What could be useful for EEI is that the Standardised Reporting Directive questionnaire requires Member States to provide the total amount of authorised emissions to surface waters and sewers. Overlap with IPPC Directive should be kept in mind.

However, the first returns allowed very few conclusions due to lack of responses, years quoted and different ways of authorising and measuring loads.

#### *g) Titanium Dioxide Directive (82/883/EEC)*

This Directive lays down the procedures for the surveillance and monitoring of environments concerned by waste from the titanium dioxide industry. Under the Reporting Directive, Member States are required to provide information on authorisations for the dumping of waste at sea or to surface waters, such as the length of the period of the authorisations; the trend in the annual quality of the waste discharged; the type and concentration of the substances contained in the waste; techniques, methods and location of dumping or discharge; and for marine waters; effects on the marine environment.

The Standardised Reporting Directive questionnaire requires Member States to provide figures on types and quantities of substances released to water.This information could be used for EEI, but overlap with IPPC should be taken into account. The revision of the Standardised Reporting Directive is foreseen and the EAF on Reporting of the WFD will, in cooperation with Member States, work on the details of the revision.

### *1.4.2 The International Statistical Offices*

Information on emissions is not only required to comply with Directives, but is also needed by a range of international organisations, the most important being Eurostat and OECD who gather substantial amounts of data through a biennial joint questionnaire.

#### *a) Eurostat*

Eurostat's mission is to provide the European Union with a high-quality statistical information service. Eurostat covers the EU-15 countries, the 3 associated European Free Trade Association (EFTA) countries and the 10 Accession Countries (AC10) from Eastern Europe. Environmental information is requested on point and non-point sources. The nationally aggregated point sources are divided into 8 sectoral activities using ISIC and NACE classifications. The treatment capacity of waste water treatment plants is required in terms of BOD and population equivalents.

This information is obtained in close cooperation with OECD through the dissemination of a joint questionnaire every 2 years. The information is available at a nationally aggregated level and per region.

Much information collected is potentially useful for EEI as default data, especially in the field diffuse emissions from agriculture. Nomenclatures and recent work on technical coefficients are interesting tools to implement the EEI.

The use of Eurostat data is mainly limited by the geographical scale (not all countries respond fully to the questionnaires) and the variable comparability of the data between countries. However, Eurostat are developing regional variations of the joint questionnaire and are working closely with the countries to improve quality. The production of a manual of methodologies and definitions which is scheduled for 2003 will make a significant contribution to the comparability of future data submissions.

#### *b) OECD*

OECD's mission is to provide economic studies, information and support for all the 29 OECD-member countries and also some non-member countries at the country level. It also provides information and tools on environmental themes and emissions and in the early 1990's, developed a methodology called the Pollutant Release and Transfer Registers (PRTR) to inventorise emissions.

OECD strongly recommends to its members to develop a PRTR process and make it publicly available, based on the idea that when a PRTR process is put in place, the results provide comparative quantitative information among reporters and thus provides a powerful incentive for reporters to cut releases and transfers.

PRTRs provide information on releases of a range of pollutants to air, water and land. A guidance manual for governments was produced in which the main elements to consider are listed and detailed: what is a PRTR, what are the benefits, how to create a PRTR. The main elements, for example the objectives of the PRTR or the scope (substances, receiving media…) are the responsibility of each country.

Eight OECD member countries have implemented this methodology, and a further 8 are currently developing it. It is expected that the work of the OECD on PRTR design and development and point and diffuse source release estimation techniques will help address many of the issues of consistency and comparability over time. OECD has established a Task Force on Release Estimation Techniques (TFRET) to manage and oversee the OECD work on PRTR release estimation techniquess, to help the process of establishing a PRTR by the sharing of information about the techniques, the production of manuals and guidance documents and resource compendium (on point sources, diffuse sources and transfers) to help the countries to build their PRTR.

### *1.4.3 The Marine Conventions*

Many different marine conventions apply in different parts of the EEA area with very significant and high level works on emission, that could provide much information, methods and tools for the EEI work.

#### *a) Oslo-Paris Convention for the Protection of the Marine Environment of the north-east Atlantic - OSPAR*

Initiatives to protect the north-east Atlantic were first established in 1969 and the OSPAR Convention signed in 1998 is the most recent tool in this process. It aims to prevent and eliminate pollution and to protect the maritime area (geographically well defined in the Convention) against the adverse effects of human activities. A priority list of substances is established with a 50 % reduction target. The Convention includes the European Economic Commission, Belgium, Denmark, Finland, France, Germany, Iceland, Ireland, The Netherlands, Norway, Portugal, Spain, Sweden, UK, Luxembourg and Switzerland.

Relevant to the needs of the EEI, a wide variety of work is undertaken as regards emissions. Its programmes cover the total loads of contaminants discharged, dumped or deposited to the maritime area via the various pathways. Two main activities can be mentioned :

- The *Riverine Inputs and Direct Discharges* (RID), an annual data collection exercise aiming at collecting geographically referenced annual waterborne load data for a standard set of determinands from coastal countries.
- The *Harmonised Quantification and Reporting Procedure for Nutrients (HARP-Nut) and Hazardous Substances (HARP-Haz)*, guidelines that should enable Contracting Parties to quantify and report on nutrient/hazardous substance discharges and losses to inland and coastal waters.

### *b) Helsinki Commission for the Protection of the Marine Environment of the Baltic Sea Area - HELCOM*

The Convention was first established in 1992 and ratified in 2000. It aims to control and minimise land-based pollution of the marine environment of the Baltic Sea Area (geographically well defined in the Convention). Contracting parties to the convention are European Economic Commission, Denmark, Estonia, Finland, Germany, Latvia, Lithuania, Poland, Russia and Sweden.

The data on riverine load and discharges of industrial and municipal effluents reported by each country could be very useful for the development of the EEI.

### *c) Mediterranean Action Plan and Barcelona Convention*

The Mediterranean Action Plan (MAP) strives to protect the environment and to foster development in the Mediterranean Basin. It was adopted in Barcelona, Spain in 1975 by 16 Mediterranean States and the EC, under the auspices of the United Nations Environment Programme (UNEP). Its legal framework comprises the Barcelona Convention adopted in 1976 and revised in 1995, and six Protocols covering specific aspects of environmental protection including the protection of the marine environment and coastal zones through prevention of pollution and by the reduction and elimination of pollutant inputs, whether chronic or accidental. For the EEI application, one protocol applies to discharges originating from land-based point and diffuse sources and activities of the Contracting Parties that may directly or indirectly affect the Mediterranean Sea Area. A report is required every two years which should include statistical and monitoring data, categories of substances, quantities of pollutants discharged, action plans, programmes and measures implemented. However, no guidelines on how emissions should be quantified and assessed are provided. There are doubts therefore on the comparability and timeliness of the data.

## *1.4.4 The River Conventions*

Many international river conventions exist for different purposes and with different work programmes. They often include emission aspects that could be useful at the appropriate geographical or timescale for the EEI needs.

**Table 1 State of the implementation of emission inventories for seven River Conventions**

| Convention | Implementation of emissions inventory | Status | Diffuse pollution assessment |
|---|---|---|---|
| Rhine | Yes | Implemented | Use of HARP guidelines |
| Meuse | Yes | Results in 2001 | ? |
| Scheldt | Yes | Results in 2001 – 2002 | ? |
| Oder | ? | ? | ? |

| | | | |
|---|---|---|---|
| Elbe | ? | ? | ? |
| Danube | Yes | Implemented | Not specified |
| Protection and Use of Transboundary Rivers and International Lakes | Guidelines | Pilot testing underway | Included in guidelines |

? = No information

***a) International Commission for the Protection of the Rhine against Pollution (ICPR)***

The convention involves Switzerland, France, Luxembourg, Germany and The Netherlands. The scope of action ranges from water quality to flood management, ecology and groundwater quality. A working group is in charge of emissions to water. Threshold values for discharges and with reduction targets (50 % or 70 %) for 45 substances or groups of substances from a priority list were set between 1985 and 1995.

For the EEI needs, inventories of inputs of priority substances are produced (1985, 1992, 1996) using direct measurements or estimates for point sources. Inputs from diffuse sources are measured/estimated using a methodology common to the whole Rhine basin.

***b) International Commission for the Protection of the Danube River (ICPDR)***

The Commission involves Austria, Bulgaria, Croatia, Germany, Hungary, Moldova, Romania, Slovak Republic, Ukraine and other institutions. It supports monitoring, data collection and assessment, emergency response systems, and pre-investment activities on the river and 17 tributary catchments in the basin.

Relevant to the EEI needs, the Commission has an expert group (EMIS/EG) which prepares a pollutant emission inventory on relevant point sources and estimates for non-point sources. This inventory takes into account municipal and industrial emissions per country for approximately 500 cities and 50 million inhabitants, and about 220 industries. It focuses mainly on BOD, COD, N and P and is intended to cover 75 % of the emissions discharged to the river. It includes raw loads and emissions discharged for 8 priority groups of substances and 40 single hazardous substances.

***c) Convention on the Protection and Use of Transboundary Watercourses and International Lakes (UN-ECE)***

This Convention was signed, and/or ratified in August 1999 by 30 European countries and the European Commission.
It is intended to strengthen national measures for the protection and ecologically sound management of transboundary surface and groundwaters and to prevent, control and reduce water pollution from point and non-point sources. Bilateral and multilateral agreements between countries are required whose tasks include the drawing up of inventories.

Several task forces addressing issues such as point and diffuse sources were set up and, presumably, reports addressing these issues will contain guidelines on how emissions data should be collected and reported that could be very useful for EEI development. ETC/WTR has a seat on the Working Group on Monitoring and Assessment so is therefore in a good position to collaborate on guidelines.

### *1.4.5 Aarhus Convention and the UN-ECE-PRTR*

*"Each Party shall take steps to establish progressively, taking into account international processes where appropriate, a coherent, nationwide system of pollution inventories or registers on a structured, computerized and publicly*

*accessible database compiled through standardized reporting. Such a system may include inputs, releases and transfers of a specified range of substances and products, including water, energy and resource use, from a specified range of activities to environmetal media and to on-site and off-site treatment and disposal sites." (Article 5 Paragraph 9 of Aarhus Convention)*

This paragraph establishes a framework of requirements concerning national pollution inventories or registers.The framework is meant to guide the further development of these mechanisms in the signatory countries. Article 5, paragraph 9, sets out general parameters to guide the development of these pollution inventories or registers in signatory countries. In addition, in article 10, paragraph 2 (i), the Parties have undertaken to continue to work on this area by considering the next steps. These next steps could include, for instance, the development of a formal annex or a protocol to the Convention. At their first meeting in April 1999, the Signatories established a dedicated task force to make specific recommendations concerning the implementation of pollution inventories or registers. Several existing international, regional, and domestic programmes will provide guiding principles that help define the potential scope and composition of pollution inventories or registers under the Convention. To help this process the UN-ECE has established a Task Force on Emission Inventories and Projections (TFEIP) that has produced some documents and in particular guidelines for the estimation of and reporting on emissions under the Convention on Long-range Transboundary Air Pollution. A pollution inventory of emissions to air called EMEP was built for the purpose of this Convention.

### *1.4.6 Conclusions on current emissions information*

As previously described, the various programmes (directives, conventions, etc.) require information at different levels of detail and do not necessarily deal with the same pollution sources: urban, industry, agriculture..., nor with the same substances: nitrate, organic matter... The spatial and time scales can also be different. The information available is mainly classified under :

- economic activities,
- polluting process, or
- transferred to the final receiving media.

A comparison of the information requirements of different programmes shows (Table 2) that calculation and information levels are dealt with in very different ways according to the programme.

**Table 2 The requirements of some programmes**

| | Activity | | | | Source size | | | Geographical level | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Industry | Urban | Agriculture | Others | Very large | Medium | Small | Catchment | Country | NUT | Characteristic unit * |
| IPPC | X | | X | | X | | | | X | | X |
| UWWTD | | X | | | X | X | | | X | | X |
| WFD | X | X | X | X | X | X | | X | | X | |
| Eurostat | X | X | X | X | X | X | (X) | | X | (X) | |
| OSPAR | X | X | X | X | X | X | | X | | | |
| ETC/WTR proposal | X | X | X | X | X | X | X | X | X | X | X |

*smallest geographical unit (facility, house …) or technical level (inhabitant, animal…)

In terms of the Directives, the most adequate sources of information are the Urban Waste Water Treatment (UWWT) and the Integrated Pollution Prevention and Control Directives (IPPC) which provide information on nutrient and organic matter emissions and on hazardous substances.

The Water Framework Directive should improve the collection and reporting of information. There are however, no guidelines for the electronic collection and transmission of information. Taking into account all the sources and the substances mentioned in the Directive, and with a progressive implementation, the EEI could be the solution at the European level.

Of the International Conventions, OSPAR would be the most adequate source of information on emissions, if and when the HARP guidelines are implemented by all riparian countries.

However, none of the existing sources of information on emissions to water at the European level completely meet the needs of the EEA to produce indicator-based reports using timely and comparable data, hence the necessity for ETC/WTR to develop an operational methodology, based on the existing programmes, that will meet all needs. This is consistent with the general EUROWATERNET concept.

The EEI will therefore be based on all the existing frameworks. Streamlining the collection of data to meet the requirement of the EEA and EC requires a very rigorous organisation of data and calculations.

Initially, the different demands and the conceivable necessary levels of grouping must be predicted. The methodology to be developed must then be conducted in stages with two objectives in mind

- to produce aggregated information at the appropriate level by source and transfer step, and,
- to validate the results with the available data sources. This means to compare the results obtained through the inventory of emissions and the results given by sampling in waters (rivers, lakes) and the load calculations (flux stations).

# 2 The European Emissions Inventory

In the previous chapter it has been stated that formal demands for emissions data lead to the development of various and complex reporting systems of emissions to waters, to enable each of the separate requirements to be met. Each country therefore has developed and implemented its own systems and these must be taken into account when proposing a new aggregated methodology. The development of a European Emission Inventory should be conducted in stages, from the identification of the problems to the resolution of these problems, and should allow the use of existing national and international systems as the basis.

Once the tool has been implemented, it can be used to report to each of the Directives and the conventions, thus streamlining emissions reporting.

## 2.1 The method

The EEI should provide the raw pollution emitted and the global pollution (see definition above) discharged to water for each source and each substance for defined spatial and temporal aggregation levels.
For EUROWATERNET-Emissions, as a minimum, only the global pollution entering the water is required if the transfers from raw pollution to the final discharge are not known. However, it is recommended to use figures for the raw pollution in the EEI, if they are known, as they are very useful to build a unique, logical and simple system to describe not only the emissions to water but also purification levels prior to emission.

To help the development of this EEI, an information unit needs to be defined. This information unit is called the ***Group of Sources*** because it is the aggregation of several sub-groups into one source category. It consists of the following elements:

- **a source category**: seven categories that are: Urban, Industrial, Agricultural, Forestry, Transport, Wastes, Natural and semi-Natural Contributions;
- **a substance**: a list based on the priority lists of directives;
- **a spatial aggregation**: a catchment level of about 5 000 to 10 000 km², at the NUTS level 2 or 3;
- **a temporal aggregation**: the annual load.

## 2.2 The expected result

With the elements mentioned in the previous section, we want to obtain the following table for each Group of Sources.

**Table 3 Emissions reporting template**

| | Raw pollution | Global pollution | Purified pollution |
|---|---|---|---|
| Source category / Name | | | |

Where:
- Source category is one of the seven categories (See table 4 for more detail)
- Name is the name of the polluting substance
- Raw pollution is the actual pollution emitted by the source category,
- Global pollution is the sum of all the pollution that enters water,

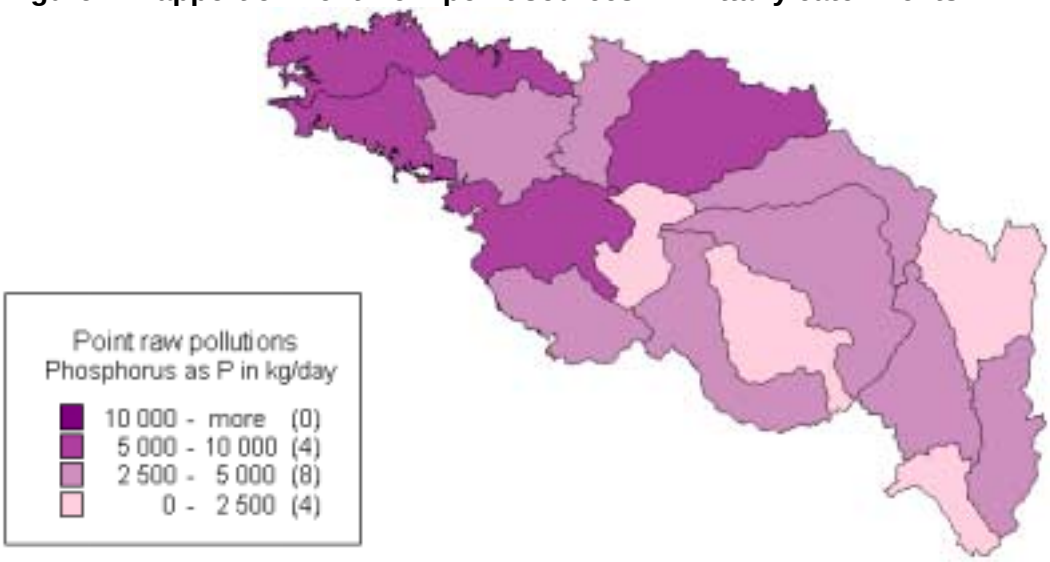
- Purified pollution is pollution that is treated and never enters water (including pollution stored in sludge or in soils),
- and therefore, Raw pollution = Global + purified pollution

This table will provide important information on the source apportionment and the global emission for each polluting substance at different geographical levels and the global purification level for each source. This will assist in the identification of priorities for action.

### 2.3 Possible benefits

The information can be used, for example, to produce maps such as **Figure 1** where the raw pollution emitted daily in each catchment is represented. It is then possible to better define the catchments to deal with or focus on to reduce the raw pollution emitted. As these figures are also apportioned between sources by the methodology, it is also possible to define the sources to focus on.

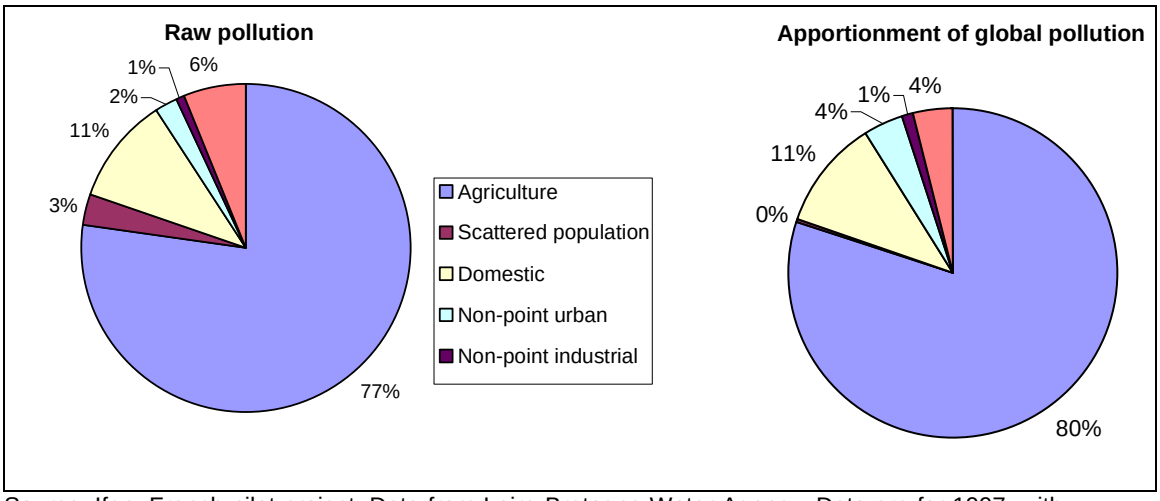
**Figure 1 P-apportionment from point sources in Brittany catchments**




Source: French pilot project. Data provided by Loire-Bretagne water agency. NOPOLU *Système 2* output.

In the following figure (Figure 2) the different removal rates of the retention and/or treatment systems for nitrogen for each economic sector (source categories and sub-categories) are presented. They can be natural (e.g. denitrification in the fields) or artificial (e.g. wastewater treatment plants), and collectively they lead to changes in the global pollution apportionment.

**Figure 2 Apportionment of raw and global pollution for the main nitrogen contributors, in the Loire-Bretagne Water Agency area.**




Source: Ifen, French pilot project. Data from Loire-Bretagne Water Agency. Data are for 1997, with exception of agriculture (1990).

The existing treatment facilities do not have much effect upon the proportion of loads coming from the different sectors of activity in the case of nitrogen discharges with the exception of industry, whose relative contribution drops from 6 % to 4 % through the use of a combination of on-site, private and municipal purification facilities..

## 2.4 The framework

When developing the EEI, some important elements have to be clearly defined. This is especially the case for nomenclatures and the elements of the Group of Sources.

### *2.4.1 Nomenclatures*

A nomenclature is a system of classification of information and a wide variety of these systems exist. The most relevant for emissions are NACE and NOSE-P.
NACE is economically oriented and is the statistical nomenclature whereby economic activities are classified according to their productive output, including products, goods and services (e.g. the production of cars).
NOSE-P is process oriented and is the European nomenclature for all sources of emissions, either to air, water or from waste, linking technological source classifications and economic classifications (e.g. combustion processes).
Some studies have tried to link NACE and NOSE-P, but no simple relationship exists.

### *2.4.2 Source categories*

Potential emission sources, point and diffuse, are aggregated in seven categories which cover all the possible sources of emissions to water. These therefore, are the Driving Forces giving rise to Pressures on and creating the State of water bodies. The three main priority sources are those identified by the Water Framework Directive: urban, industrial and agricultural.

The typology selected for sources is aimed at designing a logical structure, close to the actual situation, for origins and pathways of polluting emissions. It is based on already existing classification structures.
The aim of this apportionment is not to build a new nomenclature and the aggregated level used is similar to that of the High-level NOSE-P. The seven source categories are listed in Table 4 with some sub-groups for each source category. Occasionally, when an activity is wide ranging, it may be listed in more

than one sub-branch, but this is rare. Also, some groups of activities are not included in the list, either because they are unlikely to generate emissions to water, or because they only involve emissions to air.

In the first step of producing the European Emissions Inventory, and based on the pilot study led in France, it is proposed to deal only with the source categories: Urban, Industrial and Agricultural and to consider Agricultural as a whole. Emissions arising from other source categories will be dealt with as a future extension of the source categories list.

In addition to enabling reports of emissions to water as a function of groups and sub-groups of sources, it is possible to consider different levels of aggregation of data, i.e. point, small-point and diffuse sources. This could be a useful future development considering that point and small-point sources are the most easily controlled sources.

**Table 4 EEI classification of emission sources.**

| Source category | Sub-group | Definition |
|---|---|---|
| Urban | Domestic | Activities related to individuals in their home |
| | Metabolic | Liquid waste from WC |
| | Household | Washing machines, dishwashers |
| | Services | Businesses, restaurants, hotels, hospitals, schools, auto repair, construction, zoos, botanical gardens, beaches, etc. |
| | Diffuse urban | Leaching from impermeable surfaces, erosion , run-off, refuse dumps |
| Industrial | Active industrial sites | Any industrial activity that can generate emissions to water (including farm-produce industry, chemical, energy, manufacturing, storage, waste water treatment plants) |
| | Abandoned industrial sites | Contaminated ground, industrial waste, contaminated infrastructures |
| | Extracting industries, mining and quarries | Extraction of naturally occurring minerals , solid, liquid or gas, underground, on the surface or in wells |
| Agricultural | Large-scale farming | Industrial grains and farming |
| | Permanent cultivation | Orchards, vines and tree nurseries |
| | Cultivation in greenhouses or shelters | Fruits, vegetables, flowers and permanent cultivation (e.g. nurseries) cultivated in glass or plastic shelters |
| | Pasture, fallow land and fodder farming (except grains) | Cultivation that needs very little or no fertilisers or pesticides |
| | Animal breeding | All breeding, fish farming and aquaculture |
| | Horticulture | Vegetables, flowers |
| Forestry | Tree farming | Afforestation and re-afforestation, conservation of natural and managed forests |
| | Timber cutting and transportation | Tree felling, cutting and transportation |
| Transport | Urban | Urban movement of passengers, in cars, motorcycles or taxis, light trucks and road maintenance traffic |
| | Road/motorway | Long-distance movement of passengers and goods, in cars, large vehicles, tankers, etc. |
| | Railway | Rail transportation of passengers and freight |
| | Waterway | Transportation of passengers and freight over maritime, coastal and river ways |
| | Harbour loading/unloading | Loading or unloading of merchandise in maritime ports |
| Wastes | Removal and treatment of household waste | Removal of household waste, landfills, incineration |
| | Elimination and treatment of industrial, hospital and agricultural waste | Incineration, transformation |
| | Unauthorised landfill sites | Non authorised burial sites, non authorised waste deposit sites |
| | Treatment and evacuation of sludge from waste water treatment plants | Incineration, spreading of sludge |
| Natural and semi-natural contributions | Soil erosion | Removal of the upper layers of soil by wind and water action |
| | Leaching and dissolving of mineral particles | Deposition of dust on the ground, dissolution of minerals, release of pollutants tied to specific inorganic materials |
| | | Animal and vegetal debris, humus, organic matter attached to atmospheric particles |
| | Decomposition of organic matter | Drainage of wetlands, swamps and marshes, transportation of sediments and debris in waterways, liming of reservoirs, algal blooms |
| | Contributions intrinsic to aquatic systems and liming | |

### *2.4.3 Substances*

The European reporting requirements cover a wide range of determinands depending on the sources involved (e.g. urban or industrial wastewater), or the target chosen (e.g. loads of nutrients to the sea). The selection of substances and determinands to be included in the inventory of emissions to water must take into account:

- the European reporting requirements, including the Dangerous Substances Directive (76/464/EEC), Urban Waste-Water Treatment Directive (91/271/EEC), the IPPC Directive (96/61/EC priority list of 26 pollutants), the Water Framework Directive (2000/60/EC) and marine conventions (e.g. OSPAR);
- decisions to come from the working groups for the Standardised Reporting Directive 91/692/EEC and its related directives, such as the Directive concerning the questionnaires relating to Directives in the water sector (95/337/EC);
- the need to assess progress in environmental policies, such as the setting up of pollutant emission reduction programmes;
- the objectives of European reporting programmes on the state of the environment, including environmental indicator needs;
- national emission inventory and reporting tools already in development;
- the need to provide the public and administrative authorities with information on emissions.

Based on the different requirements of European legislation, international conventions and EEA needs, and on the information already available, a list of determinands for each sub-group of categories is proposed. All the substances previously proposed in Technical Report No. 8 (EEA, 1998) are included, among others. The list of determinands is presented in Appendix 2. It should be noted that this list is based on the already obligatory lists and thus does not imply more than the already existing legal reporting. However, it was observed during data collection tests conducted during 2000 that much of this data is not yet available.

Table **5. Sources of emissions and their determinands**

| Source categories | **Sub-group** | **List of determinands (unit : kg/year)** |
|---|---|---|
| Urban | 1 Domestic and services | 1, 1b, 3 |
| | 2 Domestic | 3 |
| | 3 Services | 3 |
| | 4 Diffuse urban | 3 |
| Industrial | 4 Active industrial sites | 1, 2, 3 |
| | 5 Abandoned industrial sites | 1, 2 |
| | Extraction, mining and quarries | 2 (metals only) |
| Agricultural | 6 all sub-groups | 1b, 3 |
| Forestry | 7 all sub-groups | 3 |
| Solid wastes | 8 household waste | 1, 2 |
| | 9 industrial, hospital and agricultural wastes | 1, 2 |
| | 10 unauthorised landfill sites | 1, 2 |
| | 11 spreading of sludge | 2 (metals only), 3 |

2.4.3.a.1.1 Key:

List 1 Priority list of WFD
List 1b Pesticides of list 1
List 2 Priority list of IPPC
List 3 Eutrophication determinands (N, P and $BOD_5$)

For this first stage in the inventory development, the following determinands are considered:

- $BOD_{5,}$ COD and SS, as general and organic pollution determinands,
- Total phosphorus and total nitrogen as determinands driving eutrophication.

More specific determinands, such as ammonia, arsenic, cadmium, copper, lead, mercury, zinc, PAHs and other compounds could be included later.

### *2.4.4 Spatial aggregation*

The geographic area considered for the aggregation of data may be adapted for the needs of the analysis. Based on a number of pilot studies, it is proposed that the best spatial level of aggregation in the catchment is a river or lake basin between 5 000 and 10 000 km² (or at the administrative level NUTS 2 or 3). As previously defined (EEA, 1998), the river or lake basin is the relevant unit for the assessment of emissions to water in line with the catchment management approach taken more broadly e.g. in the Water Framework Directive. Different sub levels can also be used. For the needs of the EEA, it seems reasonable and appropriate to consider only the topographic surface catchments. The current practice, by which much pressure data is gathered on the basis of administrative units rather than at a catchment level, may cause problems although the proxy pressure data obtained through EUROWATERNET overcomes these. However, there is still value to be gained from the inclusion of administrative levels of aggregation such as NUTS 2 or 3. When comparing results at a catchment level with a NUTS 2 or 3 level, the area of the administrative level should be smaller than the area of the catchment level.

It is important at this point to define what is meant by the 'catchment'. The database of digitised catchments of Europe (GISCO, at a scale of 1:250 000) being prepared by JRC should become the European standard.

### *2.4.5 Temporal aggregation*

Based on a number of pilot studies it is proposed that the calendar year is the most suitable level of aggregation.

For legal reasons and for state of the environment reporting, the preparation of annual reports is appropriate. However, different temporal resolutions may be needed for different purposes. The temporal aggregation in models must be carefully taken into account so as to avoid under- or over-estimations of annual loads. For example, a wastewater treatment plant performs better in summer than in winter; nitrate pollution is more likely in winter than in summer, etc. To meet objectives it may be necessary to calculate emissions on a monthly basis and produce one annual assessment.

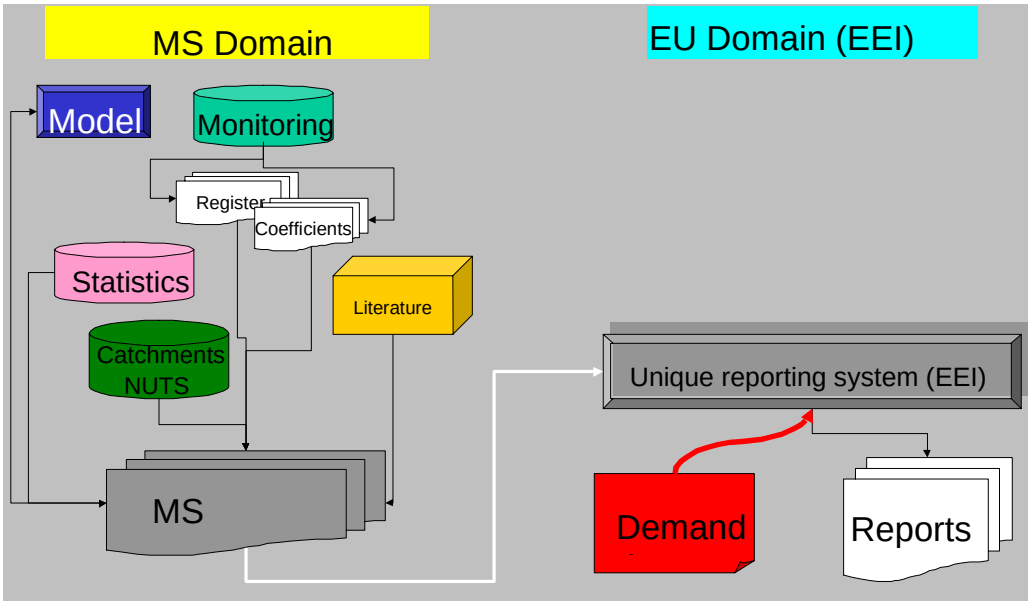
## 2.5 National systems – the basis for EEI

The EEI methodology is intended to provide a flexible, complete and comparable European overview on emissions.I To be consistent with the EUROWATERNET principles it is based on existing national or other reporting systems. Member States (MS) are required to provide data and information to comply with the different European legislation requirements and Conventions (WFD and OSPAR, for example). Data, usually for point source emissions, are provided either from measurements from the monitoring systems or networks, or from calculations

with coefficients derived from statistical treatments or literature. Data are then aggregated according to the national needs or to the availability of the information. For estimation of diffuse sources of emissions, a number of different models already exist in different countries, particularly for the assessment of emissions from agricultural activities. Coefficients, models and calculation methods are the responsibility of each member country, whose information collection system should allow for the calculation of the emissions, regardless of the kind of data available.

The data collection and calculation system is therefore comprised of a number of national parts and an aggregated, European, (EU) part. The whole system of the EEI process, is illustrated as follows:

**Figure 3 The EEI process based on national data collection schemes**




This general method is compatible with the OSPAR/HARP recommendation, which requires direct measurements to evaluate contributions. These measurements can be transformed into emission coefficients.

In this chapter, the main components of the methodology for the EEI have been presented as regards the EEA needs and the existing national and other frameworks. This is a step-by-step process taking into account the already existing tools and methodologies, and the different existing situation of each member country as regards inventories.

It provides a simple and transparent system to support European wide comparability of data on emissions to water. In the following chapter, practical approaches and tools to implement the EEI methodology are described.

# 3 Possible approaches and tools to support the EEI methodology

Based on the elements presented in chapter 2 and in order to facilitate the collection, reporting and use of data, this chapter proposes the main tools and approaches. It will first focus on a methodology to organise the collection of data, then already existing useful tools and models will be presented and the existing nomenclatures.

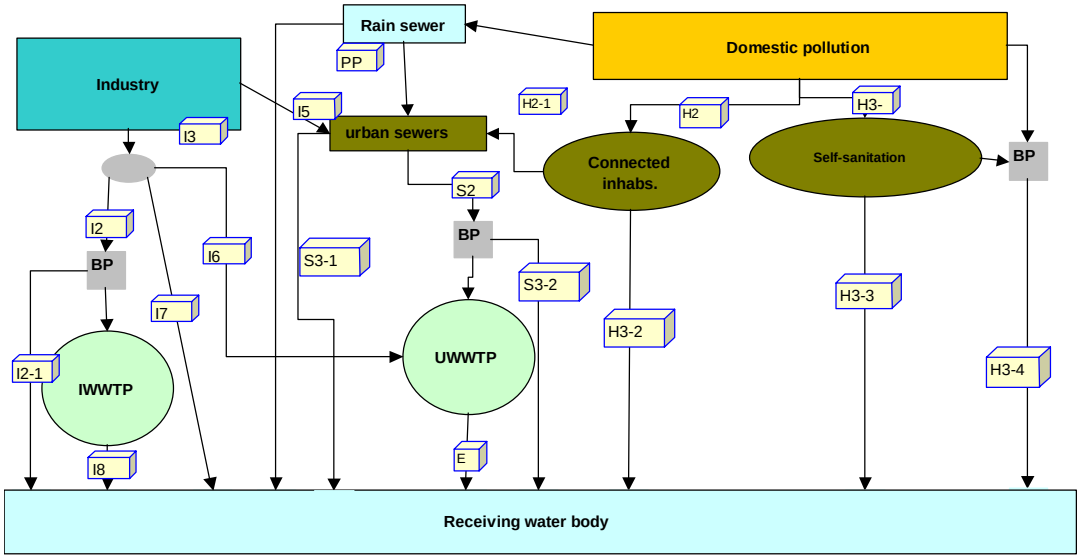
## 3.1 General methodology

In this part, after a first focus on the existing situation, we'll see the calculation system proposed and finally use two examples to illustrate how this can be implemented.

### *3.1.1 A complex Situation*

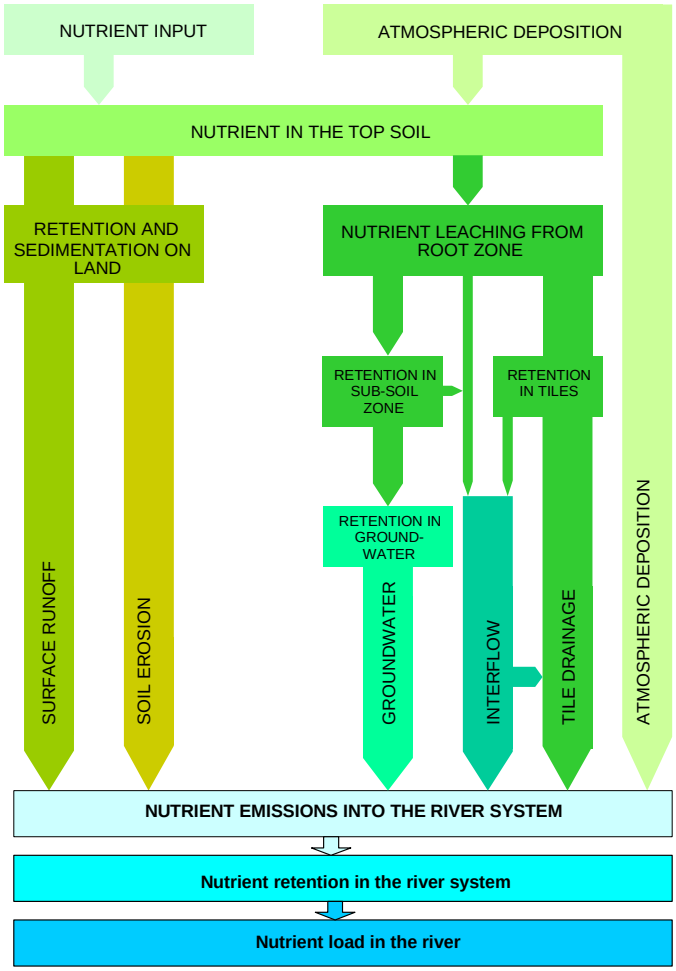
Water pollution is a very complex problem that involves many sources, whether point or diffuse sources, many substances, many pathways and transfer processes from one pathway to the other and many purification processes from the production (emission) of the pollution by the source to the receiving media. This is very well illustrated in the following schemes :

**Figure 4 Scheme of urban point emissions (Derived from EUROSTAT).**




Source: BETURE-CEREC, 1999. Codes refer to the EUROSTAT nomenclature, used in OECD EUROSTAT Joint Questionnaires.

**Figure 5 Interactions between retention processes and transfer of nutrients from diffuse sources to a river system**




Source : de Paepe, 1999 , Adapted from: HARP-NUT group, 1999.

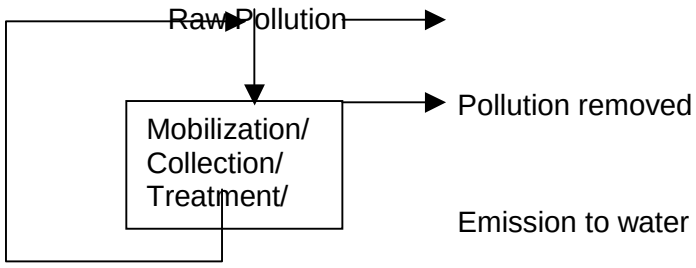
To report on emissions using such an approach lead to the development of a very complex data collection system, not flexible enough to be extended to other sources, other pathways or other transfer processes. This can also lead to oversights in the collection of data and thus to inconsistency.

It's then necessary to analyse the system to see if some redundancy exist, the conceptualisation of which would help to develop a better system.

### *3.1.2 General algorithm to use*

An algorithmic mechanism can be identified and represented as follows :

Figure 6 The pathways of a pollutant




The ***raw pollution*** is the emission of pollution by the source, and the entry of this algorithm.

The pollutant follows a succession of steps that can be

- of ***mobilization*** : that is the processes through which the raw pollution emitted by the source category is led to the collection system (see below the first example),
- of ***collection*** : that is the systems and processes through which the pollution flows (e.g. sewers),
- of ***treatment*** : that is the systems and processes by which the pollution is treated (e.g. WWTP),

The exit of this algorithm is the pollution released to water called ***emission to water*** and the ***pollution removed***, and they can occur in each step.

We call ***global pollution*** to water, as defined in chapter 1, the sum of all the emissions to the natural surface water system (rivers, lakes, marine waters) along the pathway of a pollutant, that is to say all the emissions to water that are released in each cycle of this algorithm.

We call ***purified pollution*** the sum of all the pollution removed in each cycle of this algorithm.

Based on the analysis made, we propose the following template :

Table 5 General emissions calculation template

| Step n° | Type of Step | Entry | Emission to water | Pollution removed | Transfer to next step |
|---|---|---|---|---|---|
| 1 | Mobilization | | | | |
| 2 | Collection | | | | |
| 3 | Treatment | | | | |

Table 5 should be read horizontally from top left to bottom right. The aim is to describe all that happens to a pollutant from its production at source to its final discharge to water (see examples described in the following section). A pollutant follows a pathway with several steps and four types.

These steps are a succession of the three types of steps identified in this table. In general, the pollutant follows successively these three steps but in some cases, only the mobilization step occur (e.g. for diffuse sources), and in other cases the collection and treatment steps can occur more than one time (e.g. industrial

wastewater with a IWWTP and released in the public sewer to a UWTTP : 5 steps of which n°2 and n°4 are collection and n°3 and n°5 are treatment).

For each step we find**:**

- ***entry*** : it is the quantity of pollution that enters this step. ***raw pollution*** is the entry of the first step***,***
- ***emission to water*** is the quantity of pollution that enters the natural water system (rivers, lakes, groundwaters) in this step,
- ***pollution removed*** is the process by which the pollution is treated, purified and/or removed from water,
- ***transfer to next step*** is the quantity of pollution that will be the entry of the next step.

A unique calculation and reporting template is defined which is sufficient to report even the most complex groups encountered. For branches of activities where the process of production is simpler or the information available more aggregated, the same methodology can be used. This methodology also allows the data producers to provide only necessary or available results, therefore respecting the need for confidentiality.

The various levels of calculations have particularly important secondary goals – verification of results and making complementary ratios. For example, the level of raw pollution may be compared to global values available in a state, or to the total quantity of fertiliser sold. Thus, whatever type of data is available, the user may, one way or another, use the methodology while having adapted it to his/her reality.

To better understand how the whole calculation template is organised, two examples based on different sources of emissions are presented.

### *3.1.3 Examples*

#### *a) Example 1 :Domestic urban emission*

The scenario :

- a village of 1000 inhabitants with an average raw emission of N of 4300 kg/y and of P of 1400 kg/y,
- a unique network collecting sewage,
- a waste water treatment plant with secondary biological treatment with by-pass and that discharges in a river,
- 30 % of raw P and 40 % of N remains in sludge, a further 5 % of N disappears in gaseous form in the network.

Further information was collected by the country :
The discharge, immediately before entering the public network called discharge at the source, was evaluated in a pilot study to be 7 % of the volume of the raw pollution : some inhabitants have a part of their waste waters directly discharged in waters. This equates to figures of 300 kg of N and 98 kg of P in the emission to water. No pollution is removed at this level. The real yield of the network is not known, but is 80.38 % nationally, giving 785 kg of N and 255 kg of P in the emission to water with 3000 kg of N and 1047 kg of P being transferred. 9.3 % of the wastewater by-passes this plant, giving 280 kg of N and 97 kg of P emitted to water. After the process the water is discharged to a river giving 1000 kg of N and 530 kg of P emitted to water.

All this information is synthesised in the following tables :

N apportionment in kg/year

| | Entry | Emission to water | Pollution removed | Transfer to next step |
|---|---|---|---|---|
| Mobilization | **4300** | 300 | 0 | 4000 |
| Collection | 4000 | 785 | 215 | 3000 |
| Treatment | 3000 | 280 + 1000 | 1720 | 0 |
| Total | | **2365** | **1935** | |

P apportionment in kg/year

| | Entry | Emission to water | Pollution removed | Transfer to next step |
|---|---|---|---|---|
| Mobilization | **1400** | 98 | 0 | 1302 |
| Collection | 1302 | 255 | 0 | 1047 |
| Treatment | 1047 | 97 + 530 | 420 | 0 |
| Total | | **980** | **420** | |

In these tables the three figures needed for the EEI are stressed :
- 4300kg N and 1400kg P for the ***raw pollution***,
- 2 365 kg of N and 980 kg of P for the ***global pollution*** that reaches water, sum of the emission to water in each step,
- and 1 935 kg of N and 420 kg of P for the ***purified pollution*** sum of pollution removed.

At this stage, we can see that the main discharge comes from the plant (280 + 1000 kg of N and 97 + 530 kg of P), therefore the purification rate of the plant is of more importance than the integrity of the network or the by-pass. This information is very useful at the national level.

However the reporting required for the basic method described in chapter 2 is only on the sum figures. The member country has thus only to provide simplified tables for each substance (in kg/year):

| | Raw pollution | Global pollution | Purified pollution |
|---|---|---|---|
| N | 4300 | 2365 | 1935 |
| P | 1400 | 980 | 420 |

This table will allow users to make many assessments as regards emissions to water. In this example, the global removal rates are 45 % for N and 30 % for P. If the user knows that P is the cause of eutrophication problem in the rivers of this area from this table it can be concluded that improvements in P treatment are possible: wastewater treatments that can remove 90 % of P in waste waters do exist. But it is impossible to say in which part of the collecting and purifying system this should be done.

In this example we can also see that if the detailed information on the pathways is not well known, it is still possible to provide the synthesis table, using neutral coefficients.

***b) Example 2: Agriculture diffuse emission***

The scenario :

- A small administrative region with 1000 ha of wheat and 500 ha of maize,
- The excess of N for wheat is 30 kg/ha, self-purification being at a rate of 20 %,
- The use of atrazine for maize is 1 kg/ha, which leads to 500ha x 1kg = 500kg. The average concentration of atrazine in rivers in this area is 4 µg/l. Rainfall is 1000 mm/m², 30 % of which enters the rivers. Thus the global water quantity

in rivers coming from this area is 4 500 000 $m^3$ and the load of atrazine is 4 $mg/m^3$ x 4 500 000 $m^3$ = 18 kg.

Further information was collected by the country:
Generally, the emission to water from the field through surface runoff in this country is 10 % of the N-surplus, and 10 g/ha of atrazine, and the leakage is 70% of the N-surplus and 200g/ha for atrazine. The only information known about the collection is that this area is all equipped with a drainage network related to a network of ditches in which no pollution is removed. The surface runoff and drainage water flows through these ditches to a marsh alongside the river, where important purification occurs:
47.6 % for N and 87 % for atrazine. The water enters the river after the purification phase in the marsh.

All this information is synthesised in the following tables:

N apportionment in kg

| | Entry | Emission to water | Pollution removed | Transfer to next step |
|---|---|---|---|---|
| Mobilization | **30000** | 3000 | 6000 | 21000 |
| Treatment | 21000 | 11000 | 10000 | 0 |
| Total | | **14000** | **16000** | |

Atrazine apportionment in kg

| | Entry | Emission to water | Pollution removed | Transfer to next step |
|---|---|---|---|---|
| Mobilization | **500** | 5 | 395 | 100 |
| Treatment | 100 | 13 | 87 | 0 |
| Total | | **18** | **482** | |

The sum of the emissions to water in each step gives the global pollution that reaches water (14 000 kg N and 18 kg atrazine) and the sum of pollution removed gives the purified pollution (16 000kg N and 482 kg atrazine).

These tables illustrate the high levels of purification in the marsh and the importance of protecting this marsh to help purifying the water (assuming that there is no adverse impact on the marsh from the pollutants). It also shows that it would be beneficial if the collection phase could also act in the purifying process and bring about a reduction in the emission to water. It finally points out the necessity to better know what happens to atrazine in the field, to better control the pollution.
The tables of this example are also interesting because they show the flexibility of this method. Depending on the level of detail of the available data, it's always possible to add or remove a row or more for the level 2 : collection or level 3 : treatment, without modifying the calculation principle (here the line "collection" was removed because nothing happens at this level).

However the reporting required further to the application of chapter 2 method is only on the main figures. The member country has thus only to provide simplified tables for each substance (in kg/year) :

| | Raw pollution | Global pollution | Purified pollution |
|---|---|---|---|
| N | 30000 | 14000 | 16000 |
| Atrazine | 500 | 18 | 482 |

This table will allow the user to make assessments as regards emissions to water. For example here the global purification rates are 53.3 % for N and 96.4 %

for atrazine. Acting on the raw pollution is the normal way to reduce pollution but in this case the purification processes are not well known and thus difficult to estimate.

In this example we can see the wide variety of information that can be used to implement the system: the information on sources and on loads in rivers is used, as well as general (national) coefficients or more precise (local) ones if they are known.

The methodology provides a flexible framework to assess emissions with already existing data and improve the calculations progressively when more data are available without major modifications.

There are some already existing tools that can be used for developing reporting on emissions to water for the collection of data and these are described in the following sections.

## 3.2 Tools and models

To monitor or measure all the elements necessary to build an inventory is almost impossible. It is thus necessary to develop models and tools that can give reliable estimates of emissions.

### *3.2.1 Tools*

Different approaches have been developed to quantify emissions due to the wide range of sources, substances and pathways. The main categories of approaches developed are the:

- register approach
- model approach
- source approach and
- load approach.

#### *a) The register approach*

The register approach, (or precise recording), is to identify the sources, (e.g. the most polluting industries), and the emissions data above certain levels, (e.g. emissions of more than 1 tonne of organic matter), that are to be reported. This approach thus determines the field for collecting and reporting the data as a function of the source. It is therefore by definition limited as far as emissions evaluation is concerned because of its lack of flexibility.

#### *b) The model approach*

This approach aims to quantify total pollutant flux emitted in a certain geographic area by a certain group of sources and test scenarios about management practices. Models are largely used to predict the transport and alteration processes of pollutants in the environment.

In either case (register or model approaches), since the data used may be the result of estimated quantities, there should be no quantitative difference between the two methods. The difference lies essentially in the areas of data collection, data organisation and the range of reporting.

### *c) The source-oriented approach*

This approach involves quantifying discharges or losses at source. It is generally based on direct sampling, and through it, estimation of loads from the largest point sources. For smaller point sources, estimation is done through low sampling frequency and coefficients. For diffuse sources, statistical and other descriptors are used. The coefficients can be determined from relevant literature, the statistical treatment of measured data or the use of models. Usually, coefficients are multiplied by a characteristic unit (production, livestock) to quantify the discharges/losses. A more detailed methodology can be implemented by the use of specific models, the reliability depending very much on the quality of the input data. One advantage of the source-oriented approach is the possibility to test the effects on emissions of any change in input data.

### *d) The load-oriented approach*

This approach involves quantifying the loads transported by the river at monitoring points downstream and then apportioning it between sources. Source apportionment can be carried out at different levels of detail. Retention and transformation processes have to be taken into account either in soils or in inland waters (sedimentation, chemical reactions) and integrated in the source apportionment quantification. Source apportionment may provide authorities with quantitative information about where in a river basin, and on which sources, they should focus their attention.

However, the load-oriented approach puts detrimental limits on the framework of an EEI. The use of measurements to assess emissions leads to the inability to simulate scenarios, that is to predict emissions according to a modification at source. Within the DPSIR approach, this means there is an inability to link “Driving Forces” with “Pressures”. Moreover, some inadequacies are linked to the measurements themselves. Either empirical or model-based corrective methodologies have been developed (in particular within HARP-Guidelines), but they often require statistical procedures and parameter calibration, which are time consuming. In addition, the proportion of substances released by the water system itself cannot be identified. The load-oriented approach is therefore often seen as a less precise methodology than a source oriented one.

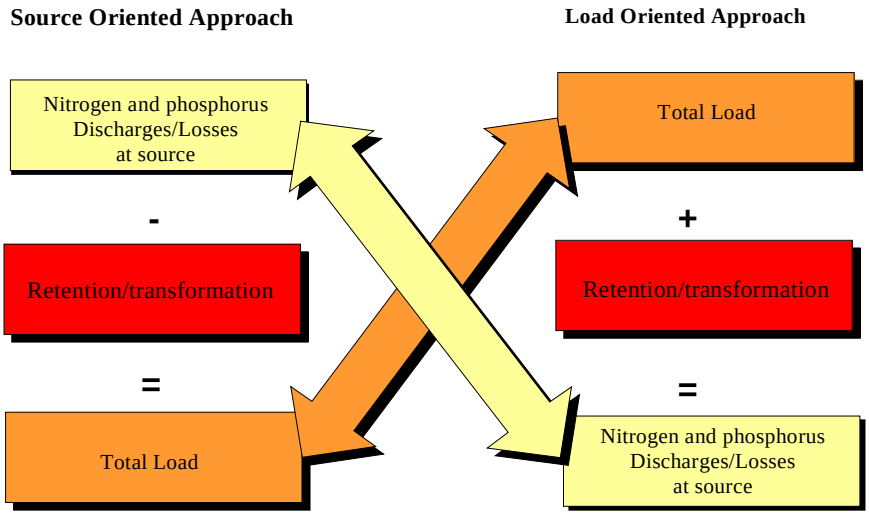
The load-oriented approach can however be useful if combined with the source-oriented approach in a verification procedure of figures and technical coefficients. If significant differences are found, it can be appropriate to re-evaluate the source data and the loads. Retention/transformation represents the connecting link between the two types of approaches, as illustrated in Figure 7.

In addition to these approaches, three other types may be identified:

- A black box approach, in which emissions are not apportioned according to pathways. All pathways are theoretically taken into account and results can therefore be compared with each other. Results may not be particularly reliable since specificity of the transport of each pollutant to receiving water is not taken into account, and that could affect the precision of the results. This approach generally corresponds to the load-oriented approach, although some source-oriented approaches also do not identify pathways.
- A specific approach, which deals with one pathway, and mainly covers runoff or leaching. The load-oriented approach does not allow this specific approach.

- A more global approach, which deals independently with many pathways and, as a final step, gathers emissions arising from the different pathways. This approach corresponds to a combination of several specific approaches.

Figure 7 Link between the source and load oriented approaches




Source : de Paepe, 1999. adapted from HARP-NUT group, 1999.

Current difficulty lies in the fact that few procedures provide global results regarding pollutant emissions, even if restricted to one precise source. Approaches are usually focused on one specific pathway.

Compiling registers of emissions where the data is precisely linked to individual source categories is thus only part of a complete Emissions Inventory. What is required in addition is the systematic use of models to estimate the emissions from sources not within the register.

### *e) Technical coefficients*

So called Technical coefficients are an easy and widely used approach to evaluate the level of emission with a certain confidence. This allows the use of statistical and other available sources of information to assess certain types of emissions that are not, or are only partially, monitored. The general equation used is the following :

| **Emitted load (units $d^{-1}$) = Number of characteristic units x specific coefficient** |
|---|

A well known example is the inhabitant-equivalent or population equivalent. One inhabitant is said to produce 60g of BOD5 per day, then knowing the population in the area, it is possible to calculate the global emission of BOD5.

Due to the various methodologies adopted at each national level, member countries will have to use a wide range of models and technical coefficients to provide the data required. Technical coefficients have been used in the calculation of emissions for several decades. The system used by the French Agences de l'Eau, called TEF (see below section 3.5) enforced by regulations since 1968, used and still uses coefficients for industrial and domestic emission calculations. Since then, the same method has been applied for the assessment of non-point sources, for which direct measurements are quite impossible. The Netherlands' national emissions inventory also uses a wide variety of coefficients to report on approximately 900 substances and 6 main sources.

Each national or regional model uses technical coefficients to assess certain types of emissions that are not, or are only partially, monitored. It is possible to define generally accepted aggregated coefficients or locally specific ones. For example, a country or a region that may not have data collected on certain industrial emissions could use a coefficient calculated from data collected in another country for the same type of industrial activity. The choice of coefficients should take into account the reality encountered. For example, the coefficients used to calculate household emissions will be different depending on whether the national legislation does or does not allow phosphates in washing powder. It would be useful to develop a database of the coefficients being used by member countries. The method itself remains simple yet very powerful and can be progressively implemented, depending on the complexity of each sector.

To define new technical coefficients, modelling or statistical treatment of measured data are used. The choice of the relevant coefficients, and the modelling of new ones, are part of the main activities of working groups involved in national emissions inventory programmes and OSPAR. The development of a "European emission factors database" is of great interest and would require an investigation of the European and national literature, as well as co-operation with the current working groups involved.

### *3.2.2 Models*

Because of constraints on data collection and the necessity to aggregate emissions over different spatial sets (for example river basin or administrative area), the models must be based on a mixed approach, using both registered and calculated data that make it possible to:

- treat sources individually, starting from a threshold determined as the lowest of the thresholds that are applicable to the source;
- use validated data to calculate the modelling coefficients;
- evaluate emissions from sources for which no data exist in the registers. They are calculated from models that can be used to determine the total flux of pollutants over selected geographical areas, and from proxy indicators based on the information available;
- combine all the other sources from the same source category or sub-group (e.g. emissions from agricultural origins).

#### *a) Comparisons of Models*

Several Member States are involved in developing national emission inventory and reporting tools. In order to avoid duplication of effort, the collection and treatment of information then has to be based upon that which is done at a national level.

Table 6 List of procedures analysed and sources of information.

| Country | Methodology | Source of information |
|---|---|---|
| Belgium - Walloon Region | EPIC model | Faculté universitaire des sciences agronomiques de Gembloux |

| | | |
|---|---|---|
| Denmark | Empirical regression model | National Environment Research Institute (NERI) |
| France | Integrated emission assessment: pilot application | Institut Français de l'Environnement (Ifen) |
| France | PEGASE model | Agence de l'Eau Rhin-Meuse - Literature |
| Germany | MONERIS model | Umweltbundesamt |
| Ireland | Loss-coefficient procedure | Literature |
| The Netherlands | Combination of 3 models: WLM-AGRI+DEMGEN+ANIMO | Institute for Inland Water Management and Waste Water Treatment (RIZA) - Literature |
| The Netherlands | Source apportionment in the River Rhine | National Institute of Public Health and the Environment (RIVM) |
| Sweden | HBV-N model | Swedish Environmental Protection Agency |
| United Kingdom | MAGPIE model | Literature |

Table 7 provides a summary of the characteristics of procedures influencing the results of various models used in different Member States to assess nutrient (N and P) emissions. The points which may distort the comparison are in shaded boxes.

It appears that the analysed procedures are relatively homogeneous in their basic principles - the majority are source-oriented. Likewise, total nitrogen is usually assessed. As for input data, the same types are used by virtually every procedure. The main difficulties when comparing results lies in the sources that are taken into account. The ability to identify the contribution of diffuse agricultural sources is of great importance. In particular, PEGASE, the Swedish and River Rhine approaches are relevant in that context. The different characteristics of the accounted pathways and the retention and transformation processes are likely to strongly affect the emissions figures. Other criteria have less impact on the range of results, but they must be kept in mind to interpret any discrepancy between the results, which would not have been explained by the previous points. Despite the fact that national procedures have been independently developed, the broad homogeneity between the principles of the procedures should be emphasised. The main differences are found in the transfer steps considered but this is because they were created in response to varied objectives and their structure is therefore different. As long as these points are kept in mind, it can be stated that results currently provided by the analysed methodologies can be integrated within the first European Emissions Inventory. Monitoring and modelling can lead to the elaboration of maps and a criteria for the presentation of the results, such as the use of a GIS software, which do not affect the figures themselves, but, unified support is required to compare results. If this condition is not met, data treatment would have to be carried out, and this could introduce mistakes or imprecision in the results.

It appears to be of wide interest to carry out both monitoring and modelling in order to compare the results, and sometimes to re-adjust the coefficients used.

Table 7 Comparison summary

| | Denmark | France (Loire-Bret) | France (REGASE) | Germany | Ireland | Netherlands | River Rhine | Sweden | U.K. | Walloon Region |
|---|---|---|---|---|---|---|---|---|---|---|
| Approach | Source oriented | Source oriented | Source oriented | Source oriented | Source oriented | Source oriented | Load oriented | Source oriented | Source oriented | Source oriented |
| Substances | Total N | Total N (+Total P for non agricultural sources) | Total N + Total P | Total N + Total P | Total N + Total P | Total N + Total P | Total N | Total N | Nitrate | Nitrate |
| Sources | Natural background included.<br>Point sources added after model runs. | Natural background excluded.<br>Methodology broken down in several steps to allow aggregation of the results for any emissions source. | Natural background included.<br>Within "soil input", emissions from agricultural sources not indentificable. "Desaggregating" procedure required. | Natural background included.<br>Independent sub-models specific of source or pathway. Studied pathways correspond to diffuse agricultural sources. | Natural background included.<br>Only assessed sources are natural background and agriculture. | Natural background excluded.<br>Only assessed source is agriculture. | Natural background included.<br>Riverine approach: no distinction within diffuse sources. Input-output approach: source distinction depends on input parameters. | Natural background included.<br>"Desaggregating" procedure required. Land-use categories not linked to agricultural ones. | Natural background included.<br>Point sources added after model runs. | Natural background excluded.<br>Only assessed source is agriculture. |
| Pathways | Specific approach.<br>Runoff assessed. | Black box approach. | Black box approach. | Global approach.<br>Many pathways independently assessed, including runoff, erosion, drainage, | Black box approach. | Global approach.<br>Runoff and leaching assessed together. | Black box approach. | Global approach.<br>Runoff and leaching assessed together. | Black box approach. | Specific approach.<br>Leaching to groundwater is assessed. |
| Input data nature | Importance of mean local slope. | Flexibility of input data (integrated within technical coefficients). | Importance of hydrogeology not clear. | No particularity. | No particularity. | No particularity. | Soil characteristics not used.<br>Importance of water sampling. | No particularity. | No particularity. | Importance of mean local slope. |
| Input data source | Use of CORINE Land-cover. | Use of CORINE Land-cover. | Use of CORINE Land-cover. | Use of CORINE Land-cover. | Use of national data only. | Use of national data only. | Use of national data only. | Use of national data only. | Use of national data only. | Use of national data only. |
| Retention / transformation processes | Not taken into account. | Not taken into account for the moment. | Included as final step. | Included as final step. | Indirectly included; not distinguishable. | Not taken into account. | Assessed for each sub-basin. | Included as final step. | Included as final step. | Not distinguishable. Do not include denitrification process in the unsaturated zone adjacent to the root zone. |
| Calculation spatial scale | ? | Administrative unit. | Catchment.<br>Administrative unit for point sources. | Catchment. | Sub-catchment. | Plot. | Sub-catchment. | Sub-catchment. | Plot. | Plot. |
| Results spatial scale | ? | Watershed or administrative unit. | Watershed. | Watershed. | Sub-catchment.<br>Possible aggregation at watershed. | Plot.<br>Possible aggregation at watershed. | Sub-catchment.<br>Possible aggregation at watershed. | Sub-catchment.<br>Possible aggregation at watershed. | Watershed. | Watershed. |
| Results time scale | Annual. | Annual. | Daily.<br>Annual aggregation possible. | Annual. | Annual. | Annual. | Annual. | Daily.<br>Annual aggregation possible. | Annual. | Daily.<br>Annual aggregation possible. |
| Results support | ? | Complete GIS. | Complete GIS. | Complete GIS. | Emissions assessment not included into the GIS. | Complete GIS. | No GIS. | Emissions assessment not included into the GIS. | Complete GIS. | Complete GIS. |
| Current application scale | National. | Basin of the Agence de l'Eau Loire-Bretagne. | Basin of the Agence de l'Eau Rhin-Meuse. | National. | Catchment. | National. | River Rhine basin. | Southern Sweden. | National. | Regional. |

### *b) Ospar : a good example*

As previously mentioned (see chapter 1) a wide variety of international, national or regional organisations have built global approaches as regards emissions, either only to inland waters, to waters as a whole, or to the environment including air, soil and waters.
The Netherlands for example has a well-established (since 1974) inventory of emissions to air, soil and water. Each year a report is published on the contribution of each sector to the emission of almost 100 substances. This approach is compatible with the EEI proposed in chapter 2 and further detailed in this chapter.

France has implemented two systems, one to report on emissions to water coming from the most important industrial facilities and the other to report on emissions coming from most of the waste water treatment plants and industrial sites. Reports are published regularly with maps indicating the most pollutant sources for many substances.

But one very interesting and very well documented methodology to report on emissions is the one developed by OSPAR. The OSPAR Convention (see chapter 1) aims to assess the state and evolution of the marine environment and judge the effectiveness of measures to prevent and reduce pollution. Its programmes therefore cover the total loads of contaminants discharged, dumped or deposited to the maritime area via the various pathways. Reduction targets on many pollutant inputs to the sea were fixed, and a priority list of substances is established with a 50 % reduction target. Regular reporting was asked of the parties to the Convention on these inputs to assess the state and trends and the progress made.

At the beginning of this process, the responsibility for calculation methods and the sources taken into account were entirely left to each country, but this led to large discrepancies in the national reports due to different natural conditions and ways of administrating the environmental issues and related data.

OSPAR thus began an harmonisation process (HARP) in a stepwise approach consisting of an overview of the existing procedures and reporting systems, the development of detailed descriptions of major elements/processes to take into account (retention, natural emission), and of Harmonised Quantification and Reporting Systems and Procedures including different economic sectors.

Nine groups of sources and twelve entry routes to air, soil or surface water are identified.

Two approaches are used to collect the information:
- the Source-Oriented approach uses measurement and estimation data based on emissions factors, activity rates, distribution factors[4] and reported values from literature;
- the Load-Oriented Approach uses load measurements in rivers, measurements of direct discharges at site, measurements and estimations to quantify fluxes (load) from river/harbour sludge and estimations of other direct inputs based on activity rates (for industrial activities), sales/consumer statistics and material flow or distribution factors (e.g. for other diffuse inputs).

This process was developed and is most advanced for nutrients and hazardous substances.

For nutrients the sources are agriculture, industry, treatment of sewage, aquaculture, forests, uncultivated areas and atmospheric deposition on water bodies and 9 guidelines were developed. They are however not split between sources but one gives the approach, some

[4] For instance a 'distribution factor' may estimate a loss of 10 % to water, 50 % to air and 40 % to be accumulated in soil

are source oriented (e.g. one for aquaculture and one for industry), and others are more focused on a technical process (e.g. one on WWTPs.

For hazardous substances the sources are agriculture, transport and infrastructure, building materials, households, small and medium enterprisess, industrial activities, waste, contaminated land and sediments and other direct diffuse sources and 12 guidelines were developed for 12 substances or group of substances.

## 3.3 Nomenclatures

A nomenclature is a classification system of a domain that is used to describe, name and easily retrieve relevant information. The classification of emission sources proposed in chapter 2 can be seen as a new nomenclature. When such a system is developed, it is customary to compare it to, or to establish links with, existing systems to facilitate research and the collection of data.

Several systems for the nomenclature of polluting emissions or activities already exist or are being developed. It is therefore important to assess their capability to satisfy the needs for the EEI.

A rough distinction can be made between economic-based nomenclatures and process-based nomenclatures. The main problem for environmental accounting is to relate processes and economic activities to apportion the emissions, known mainly through processes or source activity groups, to the economic sector involved. In some sectors the link between the economic entity and the pollutant emitter is direct. This is the case for domestic pollution - the inhabitant is the economic unit but also the pollutant emitter unit. In other sectors the link is much more complicated. For example, the farm is the economic unit but the pollutant emitter unit can be the numbers of livestock or the area of arable land.

Currently, there is no European system of nomenclature that specifically targets the inventory of emissions to water. The goal of some systems, like EPIS or NOSE-P, is to propose an approach or a classification that includes all possible emission sources. This part will focus on comparability problems encountered when developing these systems which arise mainly because the original goals for each of the systems are different and sometimes incompatible with the goals of the emission inventory.

### *3.3.1 Nomenclature for economic activities in the European Community –NACE*

NACE is the statistical nomenclature whereby economic activities are classified according to their productive output, including products, goods and services. NACE attempts to combine economic and environmental approaches in a balanced way and is therefore used in the development and implementation of methods for environmental accounts and the development of economic and environmental indices. The determination of inventorised emission data per branch of economic activity needs cross-referencing between NACE tables and other nomenclature tables (such as SNAP or NOSE-P). Matching up NACE and NOSE-P raises certain problems, some of which are due to double accounting when more than one NOSE-P code, or any other source activity code, corresponds to the same NACE code. When developing the French “NAMEA-Eau” matrix (Bouchereau, 2000), other difficulties related to the matching up of NACE tables came to light. The main difficulties were: the modelling of cross-border pollutant flows; accounting for transport (domestic or foreign tourism); consideration of the contents of emissions from imported goods and services and to allot inventory data or calculated emission data (physical data) to a sectoral data structure (economic data). For this last one the problem is in fact to link the process and the economic sector: the same process can be used by different economic sectors.

### *3.3.2 Environmental Pressure Information System – EPIS*

The EPIS system, part of Eurostat's activities, aims to provide an integrated database covering statistical and administrative data. Its goal is to produce a table illustrating the relationships between sectors of economic activity (SNA/NACE) and the pressure exerted by these activities on the environmental issues identified in the EPI (Environmental Pressure Index). These environmental issues are: climate change, reduction of the ozone layer, loss of biodiversity, reduction of resources, waste, air pollution, the dispersion of toxic products, water resources and water pollution, the marine environment and coastal zones, and urban problems.

### *3.3.3 Nomenclature for Sources of Emissions – NOSE-P*

NOSE is the European nomenclature currently being developed by Eurostat for all sources of emissions, either to air, water or from waste, linking technological source classifications (as SNAP used in CORINAIR) and economic classification (NACE). It is intended to be the standard classification system for emission registers and European inventories with a classification of processes known as NOSE-P (NOSE Process List), where activities are divided into 13 sectors.

NOSE-P emission sources are identified as physical means of emission such as direct urban wastewater or industrial processes. This type of classification does not meet the needs of the EEA's reference model, the DPSIR (Driving Forces, Pressures, States, Impacts, and Responses), where Pressures are polluting emissions generated by sets of human or economic activities.

The conceptual approach behind NOSE-P makes it difficult to apply to inventories of emissions to water. Firstly, it groups together all the steps of a pollutant's pathway from its production source through to its place of discharge into one data input. The weakness of that approach was shown in the examples at the beginning of this chapter. Secondly, NOSE's structure does not allow the calculation of emissions from scenarios adapted to geographical or political specificities, nor forecasting calculations to estimate, for example, the consequences of a change in legislation. For water, it is very important to be able to calculate emissions at the catchment level and of course to forecast future changes.

### *3.3.4 Integrated Pollution Prevention and Control – IPPC*

For emissions to water, a report of emissions at the facility level is required. The proposed format would use NACE, Appendix 1 from IPPC and NOSE-P nomenclatures and, to ensure uniform codification, the guidance document will illustrate the relationships between them. The level of detail required for the activity codes is the highest level of detail possible, as in the detailed level of Appendix 1 of IPPC and the 7-digit level in NOSE-P, when these are not more detailed than the IPPC codification. Even though the IPPC emissions inventory only deals with some of the possible sources of emissions to water, these data could, in principle, be used in the current inventory for calculating the technical coefficients related to the inventoried activities. The quantity of data provided this way by the various Member States could be used to develop grids of statistically valid coefficients that are representative of the situation in each country. These coefficients could then be used alone, or combined, to calculate emissions to water.

### *3.3.5 Other national nomenclatures*

In application of French law no. 64-1245, a nomenclature for activities generating emissions to water has been developed to help estimate the fees to be paid by polluting sites. TEF (*Tableau d'Estimation Forfaitaire*, or Water Agencies Nomenclature, WAN), is drawn up to

enable the calculation of the fee applicable for discharged pollution, should no measurements be available, for all sources of water-polluting emissions. The categories of activities are classified in 15 categories and codes are assigned to 375 activities. The basis of assessment for fees due from each of the firm's activities is based on the equation previously mentioned for technical coefficients, which has been used since 1968.

For the needs of an inventory of emissions to water, the way the technical coefficients provided by TEF/WAN are used, focused on a financial aspect, should be adjusted so the list of parameters are in keeping with current analytical methods and European legislation on registers and inventories.

In the work plan of the Inter-agency research programme of IFEN, (the French focal point of the EEA), is the development of an accounting matrix in NAMEA-Eau format to enable economic activities and environmental statistics on waste discharged to water to be related to each other.

# 4 Conclusions and way forward

The main difficulties when comparing emissions figures are with:
- accounting of the sources,
- characterisation of the identified pathways, and
- allowing for the retention and transformation processes.

The step-by-step methodology proposed here is designed to consider all these aspects. It can, without significant changes, be extended to other sources, especially those presently not subject to legal monitoring. The EUROWATER Emissions, or European Emissions Inventory (EEI) methodology is based on the same approach to that currently used in The Netherlands, but modified to be applicable across Europe yet remaining simple to apply.

As regards the initial objectives:

- it uses only information already required under existing Directives and legal instruments and does not require any further data collection efforts by the Member States and can be regarded as a contribution to streamline the overall reporting process.

- the EEI can be used to assess emissions regardless of the type of data available in the different countries with the use of technical coefficients and already existing statistical and geographical data (e.g. Eurostat data and Corine Land Cover tools)

- the data collection pilot test demonstrated the feasibility of assessing emissions in countries with different data collection systems that are well implemented, with information available either at a disaggregated (e.g county) level, or at a national level

- the EEI can provide emissions data at various geographical levels by aggregating the available raw data

- the EEI can provide different source groupings, as each group of sources is precisely defined, and reported separately

- the EEI can provide emissions data at an appropriate temporal resolution (e.g. annually), as the existing information systems at the national level appear to be sufficiently homogeneous

- the basic reporting grid, or template, is simple and this greatly helps the reporting and maintains consistency with EUROWATERNET requirements.

Thus the EEI allows the building of an inventory of emissions at the European level. In some countries, the level of detail will be precise and complete and close to the actual situation, whereas in other countries the level of detail will only reach a minimum level. However, the EEI allows the elaboration of a core set of coefficients that can be used if only the minimum information is available. This proxy approach is based on monitoring information and allows both the progressive implementation of the methodology and the accounting of emissions from all sources to water.

For each source of emission, only the major pollutants are monitored all over the country or at another administrative level. Due to the costs of analysis, other substances, mainly pesticides, organic compounds and metals, are monitored only if a risk of their presence exists. Based on these risk assessments it should be possible to establish emission coefficients.

Different international working groups (e.g. OECD, UNEP) are actively involved in the development of nomenclature for sources of emissions or in emission register framework development. The Marine Conventions also have active working groups in this subject. National working groups such as the Dutch, Finnish, English, German and French are also active in emissions quantification. The development of common tools for the inventory and assessment of emissions at the European level requires co-operation with the different working groups currently involved in order to ensure the harmonisation of their results with the present inventory methodology. An updating of the developments carried out at the national level is, of course, relevant, but the development of a new model specifically for the EEA's needs is not necessary. The EEA could however group all the models already developed or in development to provide a global vision for further implementation of the Emissions Inventory to water. This could be done by harmonising the basic information (from definitions and technical coefficients) to the more complex information (models and data improvements).

To streamline the collection of information it is necessary to have a common base of definitions to ensure common classification and reporting. The development of a dictionary of a core set of definitions regarding the different purification processes, the different steps involved from raw pollution to discharge to water is an essential step in this process.

For the EEI, emission coefficients are necessary to fill the gaps in the existing collection systems. Information on technical coefficients in the published literature is relatively abundant in USA but, for European technical coefficients, most of the information exists as grey literature. The gathering and synthesis of that information would lead to an emissions coefficient databank, with information on the application field and limits that could be used by any level of administrative organisations for the calculation of emissions to water.

This study has shown the need to develop modelling. Although this is a national responsibility, it seems to be appropriate to propose a simple reliable model that can provide the data required by the methodology and the calculation grid. There are two components to this work:

- developing specific models for each pathway involved in emissions. This approach provides precise results, but its application field is usually restricted to one substance and one source.
- Development of a simple procedure which could be adapted to any substance or source. The flexibility of this approach is achieved at the expense of detail.

The EEI provides member countries with a flexible framework which would allow the specifics of the country to be integrated. For this reason, a unique and simple calculation procedure has been developed. However, the responsibility of member countries will lie in the provision of reliable data. It can be progressively implemented, focusing first on the main sectors and substances, where the information is already or easily available. Results can then rapidly be used to give the overall European picture and comparisons between countries or catchments. In the future, the modelling of each emission pathway will undoubtedly increase the precision of results, although it will require additional work.

The French pilot study and the data collection test showed that some of the input data for the inventory are scarce. This is especially true for some sectors including transport, abandoned industrial sites, mining and quarrying, forestry, unauthorised landfills and diffuse sources. This is also true at the substances level, especially for pesticides and organic compounds. From the pilot study on the collection of data, it was learnt that this information is, to some extent, available at a more disaggregated levels. Improvements are needed, either in the gathering of this information or in the measurements themselves.

It is proposed that the EEI methodology be implemented by the ETC Water as part of its programme to develop EUROWATERNET as a tool for the streamlining of national reporting.

This would involve the collection of national (or more disaggregated) data to allow the integrated assessment of emissions to waters, with statistical or geographical data collected from all the EEA countries. National data could be provided in the proposed format using templates where possible, or in their original format where not. The main goals are to test the flexibility of the EEI, its capacity to give accurate results, and, most importantly, its consistency with the different European Directives involved, particularly the Water Framework Directive. The EEI could be a major tool contributing to the work of the EAF on Reporting.

The ultimate goal of course, is to supply the information needs of the member countries, the European Commission, the EEA, Eurostat, and other international users of emissions data from one common, nationally agreed set of data. This would be a significant step forward in streamlining the reporting on emissions to water.

# Acronyms and abbreviations

| | |
|---|---|
| **$BOD_5$** | Biochemical Oxygen Demand in 5 days |
| **CEEC** | Central and Eastern European Countries |
| **CARTHAGE** | Cartographie Thématique des Agences de l'Eau et du Ministère de l'Environnement |
| **CAS** | Chemical Abstract System |
| **COD** | Chemical Oxygen Demand |
| **CORINE** | Co-ordination of Information on the Environment |
| **DG Env.** | Directorate General Environment (European Commission) |
| **DIN** | Dissolved Inorganic Nitrogen |
| **DPSIR** | Driving Forces – Pressures – State – Impacts – Responses |
| **EAP** | Environmental Action Plan |
| **EEA** | European Environment Agency |
| **EEI** | European Emissions Inventory |
| **EIONET** | European Information and Observation Network |
| **EMEP** | Co-operative Programme for monitoring and Evaluation of the Long Range transmission of Air Pollution in Europe |
| **ETC** | European Topic Centre |
| **ETC/AE** | European Topic Centre / Air Emissions |
| **ETC/IW** | European Topic Centre on Inland Waters |
| **ETC/W** | European Topic Centre for Wastes |
| **EU** | European Union |
| **EUROWATERNET** | The generic process by which the EEA obtains national data |
| **GIS** | Geographical Information System |
| **HARP-HAZ** | Harmonised Quantification and Reporting Procedure for Hazardous Substances |
| **HARP-NUT** | Harmonised Quantification and Reporting Procedure for |
| **HELCOM** | Helsinki Commission |
| **Ifen** | Institut français de l'environnement |
| **INRA** | Institut National de la Recherche Agronomique |
| **IOW** | International Office of Water |
| **IPPC** | Integrated Pollution Prevention and Control |
| **IWWTP** | Industrial Waste Water Treatment Plant |
| **LCMGB** | Land Cover Map of Great-Britain |
| **MAFF** | Ministry of Agriculture, Fisheries and Food |
| **MCE** | Main Component Elements |
| **NACE** | Nomenclature for Economic Activities in the Euopean |
| **NERI** | National Environment Research Institute |
| **NEUT group** | Working group on Nutrients and Eutrophication |
| **NFP** | National Focal Point (of the EEA) |
| **NOSE** | Nomenclature Of Sources of Emissions |
| **NRC** | National Reference Centre |
| **OSPAR** | Oslo – Paris convention |
| **PER** | Polluting Emission Register |
| **POP** | Persistent Organic Pollutant |

| | |
|---|---|
| **RNDE** | Réseau National des Données sur l'Eau |
| **RIVM** | National Institute of Public Health and the Environment |
| **RIZA** | Institute for Inland Water Management and Waste Water |
| **SNAP** | Selected Nomenclature for Sources of Air Pollution |
| **TEF** | Tableau d'Estimation Forfaitaire |
| **U.K.** | United Kingdom |
| **UWWTP** | Urban Waste Water Treatment Plant |
| **WRc** | Water Research Centre |

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# Appendix 1 The pilot projects

It is intended that comparable information will be provided from the EEA member countries using the EEI. Different studies were led and three volunteer countries accepted to involve in this process.
It was first necessary to assess the existing information collection systems and demonstrate that results can be obtained through the application of the EEI methodology. Of the three countries, only France led a complete pilot project. The other countries participated in the test process to a smaller extent and the results were the following : the Netherlands study has shown that the data can be provided and Austria study proved the data not to be available.

## 1.1 Objectives

The main aim is to assess the capability of some Member States to provide information for the needs of the EEI, thus showing that through the use of the methodology, comparable results can be expressed at a European level. In order to meet these objectives, it is important to test the organisation and availability of the data for each pollutant and each source category with the method developed. The accuracy of the data organisation was tested in The Netherlands and Austria and a complete test of the method was led in France.

The availability of data is tested by considering the most recently known requirements of the relevant European legislation. The quality of national data provided by the countries was assumed to be accurate and were used in the tests as if they were official figures.

## 1.2 Historical overview

Member States (MS) are currently obliged to report on emissions to water under a number of requirements for Eurostat/OECD and European Directives. Some collections of data (Joint Questionnaire from Eurostat/OECD) were carried out but often gave poor results because of poor returns from the countries. Analysis of the reasons for these poor results led the EEA to elaborate a data collection guidebook, which intends to include all these requirements and to streamline the collection of data in order to obtain a wide range of reliable information. It was then decided to test this guidebook in France, The Netherlands and Austria to assess whether or not it was effective and, if necessary, to develop it further.

In France a National Water Data Network, led by the IOW, collects all the monitoring information for inland waters. A pilot study was carried out on a basin using the EEI methodology. The Netherlands has already implemented an advanced inventory of emissions to water, which is reported annually. The Inspectorate for Environmental Protection manages a central database from which information can be requested. In Austria it is the Federal Environment Agency which manages the national databases of emissions to water.

## 1.3 The French case study

There is no inventory of emissions to water for France. The collection of statistical information is centralised at the national level and a wide range of information on the monitoring of freshwaters is gathered nationally (managed by IOW).

A pilot study was carried out in 1999 to develop an inventory of emissions to water. A simple calculation approach was chosen and is summarised in the following general equation:

| General formula for calculating emissions: |
| --- |
| Emission = emitting unit × emission coefficient |

The whole calculation grid is a succession of equations of this very simple form, that can themselves be subdivided into several sub-equations, or grouped by aggregating the coefficients applicable to the various steps of the calculation, depending on the information available. The “emitting units” and “emission coefficients” used in the equation can be determined from:

- the literature,
- statistical processing of data, notably direct measurements for the largest polluters,
- another model.

Modelling of emissions to water comprises three elements:
1. the general system of equations,
2. the method for defining the set of emission coefficients and particularly taking measurements into account,
3. the architecture of the software package *(and of the associated database).*

The whole territory of France is subdivided in 55 large basins defined in the “Réseau National des données sur l’Eau” (RNDE), each with an average area of 10 000 $km^2$. This study specifically covered the district of the Loire-Bretagne water agency, that is 16 RNDE catchments that cover a total surface of 155 000 $km^2$. A RNDE catchment aggregation was performed, as well as a departmental one, but given that several departments are not completely included in the district of the basin, this latter aggregation simply serves as an example. Moreover, the pilot study was performed only for nutrient emissions.

The availability and disaggregation of data under the classification proposed in chapter 4 is as follows:

## a. Population

For the source category Urban, for the sub-group domestic it's possible to separate it in domestic connected to a sewer and domestic not connected (thus using individual treatment. In France, it is considered less likely that the scattered populations are connected to a municipal sewer system. Scattered population number is estimated by taking the difference between total population and agglomerated population. The total population comes from the most recent population figures available and the agglomerated population number is estimated based on the 1982 census with an adjustment to take into account population growth.

The Water Agency also calculates seasonal population numbers using several sources. The method used aims to represent the potential increase in population during the tourist season.

## b. Municipal WWTP (UWWTP)

Two main sources of data exist: the Water Agency files and the SATESE files.

The data files from the Water Agencies contain the following information:

- Design capacity, expressed in organic matter (OM), For comparison it's easier to use $BOD_5$ and the error is acceptable if considering OM = $BOD_5$.

- Loading rate is calculated as the ratio of the averaged input load to the design capacity.

- Purification rate for OM, total N, total P and suspended solids (SS). These are based on the month of peak activity of each system (UWWTP or IWWTP, etc…).

SATESE files, (*Service d'Assistance Technique aux Exploitants de Stations d'Épuration* - technical assistance service for WWTP operators) are valuable sources of data. They were created in 1973 and were progressively implemented at the département (NUTS 2) level. They contain direct measurements of all the main determinands and purification rates on most UWWTPs, and data from monitoring programmes carried out by the WWTP operators. However, it was only in 1997 that a single format data file (for electronic transfer, to create databases, and to compare the figures) was implemented from existing SATESE. The main parameters monitored are: $BOD_5$, COD, SS, $N_{tot}$, $NH_4$, NKj, $NO_2$, $NO_3$, P, $PO_4$.

## c. Diffuse urban

Currently no measured data are available in France for diffuse urban emissions. Nevertheless, calculations were made for the purpose of the 1999 French pilot study on emissions to water. All the rainwater run-off was considered to by-pass the sewerage system and discharge directly into the river system.

Impervious area was calculated using the CORINE Land Cover database (urban and industrial surfaces). An abatement factor of 50% was applied for urban surfaces and of 20 to 25% for industrial surfaces. Nitrogen loads from rainwater run-off were calculated from the HYDROSOL database([5]) .

## d. Industrial emissions

The core set of industrial emissions data is stored in the RNDE national database (national database for water), held by IOW. The main sources of information are:

- the Water Agencies that have developed the Water Agency's nomenclature (WAN) for polluting activities and transmit measured and calculated emissions data to the RNDE database. The data includes assessments of the pollution loads produced (raw pollution) removed (premium basis) and emitted to the recipient (net emission). The following determinands are calculated and/or measured: SS, OM, N, P and , inhibitive matter (MI).

- the Regional Industry and Environment Public Board (DRIRE : Direction Régionale de l'Industrie, de la Recherche et de l'Environnement), which gathers the measured emissions data collected by the most polluting industrial sites. The parameters analysed are: SS, OM, COD, N, P, F, cyanide, Cd, Hg, Pb, and phenols, all in kg/day except for Hg (kg/year). Under this authority, all industrial installations have to be classified and some require legal authorisation. Furthermore, some installations have a legal obligation to monitor their discharge effluents. Measured data are available for the direct discharges, discharges to a UWWTP and the discharges of sludge spread on fields.

- the Veterinarian Services Board (DSV)

In the case of industrial activities, the final recipient is often an urban sewage network. In these cases, the net emission of an industrial activity is the primary entry to, or the raw

[5] HYDROSOL is the name of the database created by IFEN which combines the intersection of administrative level and hydrographic boundaries, and contains the area of each of the 44 CORINE LC types contained in each intersection. This file is available for France using the municipality (NUTS5, i.e. 36000 units, the zone watershed (i.e. 6000 units and CORINE LC).

pollution of, the urban sewage network. Therefore, the net emission of the connected industries is not an emission to a receiving water.

### e. Agricultural emissions

Agricultural data come from the 1988 national agricultural census or RGA (*Recensement Général de l'Agriculture*) which was designed to meet a wide variety of issues, including crop types, but also equipment of farms, age of farmer, etc. It was carried out at the municipal level (NUTS 5). However, this level has not been used for technical, statistical and economic reasons, rather the *canton* level was used. For convenience, and to allow for comparison with other results, the RGA data were re-coded into the European nomenclature used by EUROSTAT. A pilot study ran an agricultural model which provided the nutrient input to the EEI calculation grid this input being considered as the raw emission. This input is the surplus, which is the difference between the nutrient input and the export by crops (or products). In that step of the calculation, a constant reduction (a kind of purification rate) of 20 % surplus was considered, hence 80 % of the nitrate surplus was assumed to be transferred to receiving water (this includes 75 % of the catchments analysed in Britanny).

### f. Administrative layer data and hydrological codification layer

Since 1968, the French authorities have been developing a geographical information system capable of identifying and localising any point related to surface waters. Following the last ministerial instruction, issued in 1991, the CARTHAGE database (*Cartographie Thématique des Agences de l'Eau et du Ministère de l'Environnement*; - thematic cartography of the Water Agencies and the Ministry of the Environment) was compiled. It comprises three main layers, all designed for use at the 1:100 000 scale (digitised at the 1:50 000 scale). These layers are the administrative layer, that contains all the municipalities (over 36 000 municipalities in France : NUTS 5 level), 6 315 watersheds codified at the lowest scale (organised according to a nested codification) and the layer of the rivers, comprising 525 000 km of codified river stretches.

### g. Solid Waste

In France a number of regulations control the spreading of municipal sewage sludge. Sludge may only be applied to land which is regularly cultivated, and the quantity cannot be greater than the absorption capacity of the soil. A spreading programme must be established and the use must not exceed 3 kg dry solids/m²/10 years. Application is forbidden:

- to soils with metal concentrations above certain fixed limits,
- to soils with pH <5 and, under certain conditions, between pH 5 and 6,
- when weather conditions are not favourable,
- when the slope of the land is too steep.

Limits for concentrations of undesirable substances (including metals, organic compounds, bacteria and parasites) are fixed for individual control and for the 10 year load of each substance per hectare. The spreading systems and distances to surrounding features (settlements, rivers, wells) are also regulated. Soil (every ten years as a minimum) and sludge samples (every year) have to be monitored with a fixed number of control samples depending on the quantity spread.

Leachates from rubbish dumps are usually treated in UWWTPs and are not evaluated separately. Unauthorised landfills and contaminated sites are not all registered in databases and monitored. An estimate of loads of emissions is not possible, because the set of

determinands evaluated depends upon the type of the landfill and monitoring is not always made on a regular basis.

## h. Choice of the geographical unit

Under the 1964 Water Act, the metropolitan French territory was broken down into 6 “Water Agency” areas. The Water Agency is a financial organisation that acts in the field of water : it collects taxes for the use and pollution of water and provides subsidies to build waste water treatment plants and other pollution-prevention systems. The Water Agencies area within jurisdiction was constructed by approximating the watershed of the main surface catchments to the nearest municipal boundaries and then at an administrative level to the nearest canton. French territory is divided into 22 regions (NUTS 2) that comprise about 100 départements (NUTS 3) and those départements are themselves comprised of several cantons that contain 36 000 small or large towns (municipalities),(NUTS 5).

As the Water Agencies all have similar roles and administrative structure, and are all partners of the National Water Data Network, it was assumed that their water data information systems were homogenous. Therefore a single river basin was chosen for the purpose of this exercise: the Loire-Bretagne River Basin, and linked to it, the Loire-Bretagne Water Agency whose territory extends over the Loire-Bretagne river basin, at an administrative level over 10 Regions (NUTS 2) and 31 départements (NUTS 3), both being only partly included in the Water Agency area. The 7 281 municipalities (NUTS 5) are totally included in the aforesaid area; since its boundaries are approximated to the nearest canton.

Twenty towns host more than 50 000 inhabitants and more than 6 000 villages have less than 1 000 inhabitants. The average population density is 75 inh.km$^{-2.}$ However, the settlements are not evenly distributed. The mostly populated areas are St-Etienne and Clermont-Ferrand (in the upstream reaches of the rivers Loire and Allier respectively), the Loire valley (with the urban areas of Orléans, Tours, Angers and Nantes), the Brittany shore area and Rennes. Locally, densely populated areas exist on the river Loire tributaries (Le Mans, Cholet, Limoges, Le Creusot, etc.)

Agriculture is one of the main activities in the Loire-Bretagne Water Agency area. Agricultural activities vary widely between the sub-catchments. Two thirds of French livestock is raised in the Loire-Bretagne area, as well as two thirds of the animal slaughtering and meat processing activities. Half of the national milk production and associated products also come from this area.

## i. Results of the test

The French pilot study showed the potential for the use of charts and GIS maps to obtain results at the catchment or sub-catchment levels and at different administrative levels. The test also showed some limitations; for instance the most disaggregated data used (NUTS 4 or 5) makes the representativity of the results at this scale very bad : results have to be aggregated at a larger scale.
For example, the total loads at the Water Agency area level are disaggregated as follows :

A table is produced that is the synthesis of the tables that could be produced for each source, under the following model :

| Step | Entry | Emission to water | Pollution removed | Transfer to next step |
|---|---|---|---|---|
| Mobilization | | | | |
| Collection | | | | |

| | | | | |
|---|---|---|---|---|
| Treatment | | | | |

In fact for the source category Agriculture, we haven't presently enough data to model the two last levels : collection and treatment. The same apply to the sub-groups scattered population, non-point urban, and non point industrial. Thus for each of these only the first level called "Mobilization" is produced and reported in table A1.1.

For the sub-groups Domestic and active industrial sites, the connected to a sewer network part of these sub-groups gain the same sewer. The coefficients to calculate each step are available only for the sewer and WWTP as a whole, it's thus easier to have one separate row for each sub-group for the "Mobilization" level where separate coefficients are available and then to have one single line for each of the other 2 levels (collection and treatment that are here sewer network and WWTP).

Table A1.1 Total N emissions to water in the Loire-Bretagne Water Agency area (in tonnes N $d^{-1}$)

| Source | Entry | Emission to water | Pollution removed | Transfer to next step | Apportionment |
|---|---|---|---|---|---|
| Agriculture | 903.4 | 581,.7 | 321.7 | 0 | 581.7 |
| Scattered population | 36.6 | 1.8 | 34.7 | 0 | 1.8 |
| Non-point urban | 27.6 | 27.6 | 0 | 0 | 27.6 |
| Non-point industrial | 9.2 | 9.2 | 0 | 0 | 9.2 |
| Domestic | 123.4 | 6.8 | 0 | 116.6 | 79.7 |
| Active industrial sites | 70.7 | 15.1 | 28 | 27.6 | 27.4 |
| Sewer network | 143 | 0.7 | 0 | 142.3 | |
| WWTP | 142.3 | 12.7 + 71.8 | 57.8 | 0 | |
| ***Total*** | ***1170.8*** | ***727.4*** | ***442.2*** | | ***727.4*** |

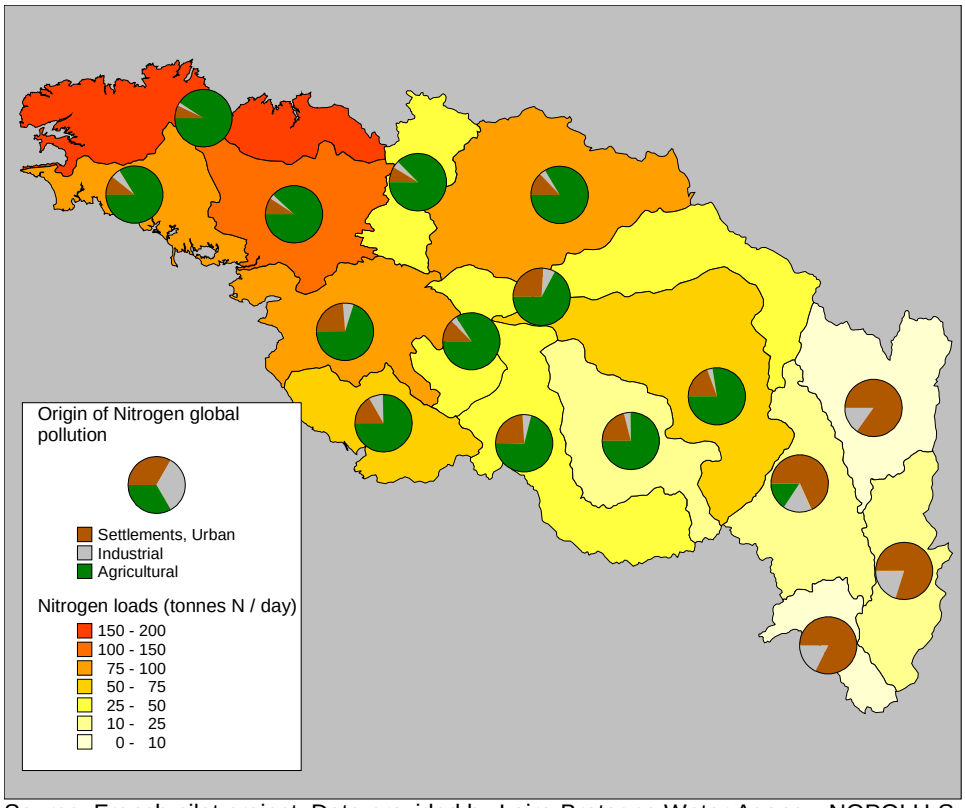
Source: Ifen, French pilot project. Data from Loire-Bretagne Water Agency. Provisional results. Data are for 1997, with exception of agriculture (1990).

In this table, the last line gives the sum for each step (entry, emission to water…) and the last column gives the real pollution that gain water and due to the source (i.e. Agriculture, domestic…) mentioned.

When considering the different contributors to the final load, it appears (Figure A1.1) that agriculture is the main provider of nitrogen, followed by urban discharges.

The existing purification facilities do not have much effect upon the proportion of loads coming from the different sectors of activity in the case of nitrogen discharges. The exception being industry, whose relative contribution drops by 36 %, through the use of a combination of on-site, private and municipal purification facilities.

Figure A 1 Relative origin of the nitrogen global pollution. Loire-Bretagne Water Agency area.

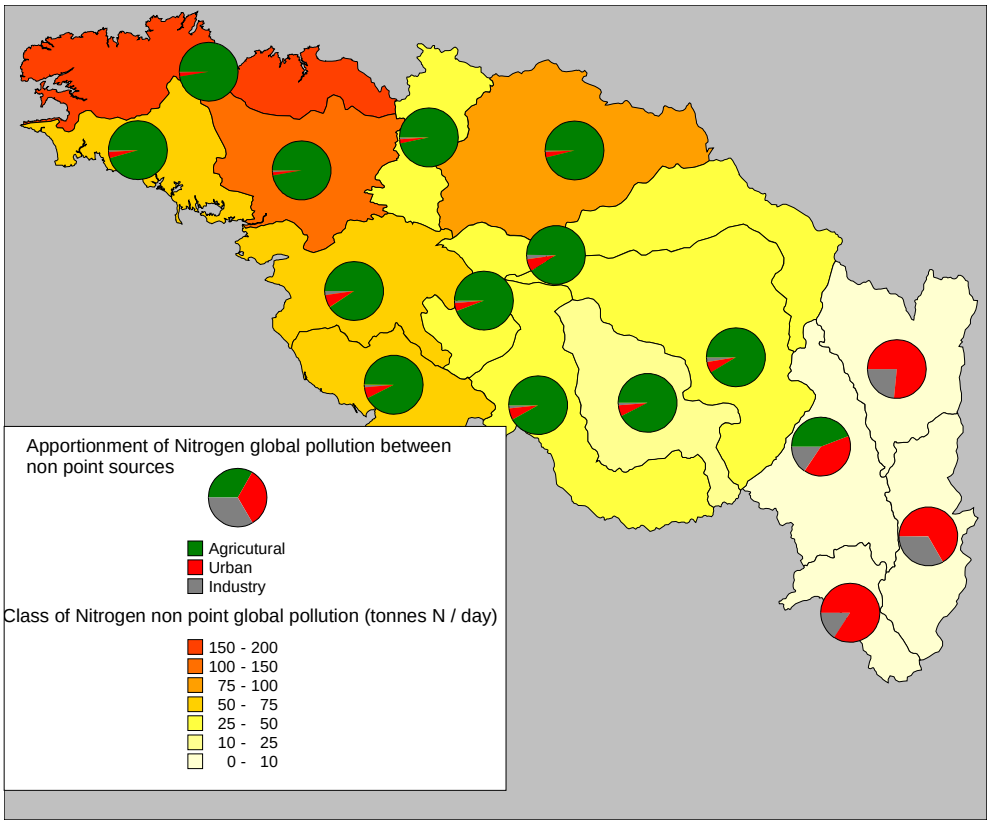



Source: French pilot project. Data provided by Loire-Bretagne Water Agency. NOPOLU *Système 2* output. Provisional data.

The information shown in Figure A1.2 clearly demonstrates a strong regionalisation in both nitrogen loads and in the origin of loads. The urbanised areas of the upstream reaches of the river Loire show negligible contributions from agriculture, but important discharges of urban and industrial origin. Conversely, the western regions suggest a seven fold increase in discharge, three-quarters of which is contributed by agricultural diffuse inputs. In the upstream areas, the modelled surplus is often close to zero, or negative. This is a result of the large proportion of semi-extensive pasture on permanent meadows.

The following figure (Figure A1.3) suggests that urban and industrial non-point sources could contribute, at least to some extent, to this part of the overall load to waters.

Figure A1.3 Apportionment of Nitrogen global pollution between non-point sources related to the total contribution of non-point sources to this global pollution. Loire-Bretagne Water Agency area.




Source: French pilot project. Data provided by Loire-Bretagne Water Agency. NOPOLU *Système 2* output. Provisional data.

The majority of Nitrogen originates from non-point sources. However, point sources are emitting forms of nitrogen that are highly undesirable and could also be mapped. It is especially true for the mapping of the geographic distribution of UWWTP performances.

This powerful system can be used to show the pollution apportionment between sources and to help define policies and reduction targets.

## 1.4 Main findings from the Pilot Projects

The availability of data is quite different from one country to another, with major differences between well described sectors and sectors with unreliable data. This shows that a fully disaggregated method for collecting the information would be of great interest to help evaluate the gaps in the existing national data collection systems.

There is a gap between the present requirements of the EU Directives and the data available for France and Austria. At present, the only information available is that which is necessary for the different Directives and regulations, and even this is not always complete. Most of the information is irregularly available meaning that it is often impossible to calculate total emissions of each substance at a disaggregated level. Only The Netherlands has implemented a complete tool to evaluate total emissions and even this involves a very large number of models and calculation systems.

For the main point sources, the collection of data is well implemented in France and The Netherlands, while in Austria it needs to be developed further. Small and diffuse sources are not monitored, so that most of the information for the evaluation of diffuse pollution has to be calculated from statistical data (e.g. populations, land uses, production etc.) and with the use of emission coefficient applied per characteristic unit (e.g. 60 g of BOD5 x number of people). Hence, although is a very important tool in establishing load-reduction targets, and assessing

the progress made, establishing a complete European emission system appears to be a long-term aim. The experience gained by The Netherlands and France in these pilot studies would be very relevant to this aim.

It is necessary to make the applied methods, and the results, accessible and transparent. This implies the need for a complete Guidebook with definitions, methods, assessment procedures and quality assurance.

It also would be very useful to have a single database for all the information (e.g. EUROWATERNET – Emissions) divided into the different sectors considered for the emissions. This would facilitate information exchange, aggregation and treatment.

The main active point sources are monitored, and enough information is often available for the other active point sources (smaller one not regularly monitored). Therefore, it is already possible to calculate emissions figures at a national level, as demonstrated for Austria.

The guidebook metadata information tables proved very powerful in showing the gaps between the requirements of the main Directives and the data available. The classification of sources can initially be simplified, as the information for the agricultural sector is not available at a disaggregated level. However, a “transport” group can be introduced in order to obtain any available information. The geographic systems seems to cover the temporal coverage and location needs for the information units, It should be stressed that each national collecting system obtains much more information than has been described here. It is very important to build a flexible system; the basis is to be used at a European level allowing for the comparison of all the emissions of the different countries. At a national level, some (or even all) part(s) of it can be developed to use the information available at this level to build a more precise emission system.

# Appendix 2 Lists of substances

**List 1a. List of priority substances in the field of water policy (*)**

| | CAS number[6] | EU number[7] | Name of priority substance | Identified as priority hazardous substance |
|---|---|---|---|---|
| (1) | 15972-60-8 | 240-110-8 | Alachlor | |
| (2) | 120-12-7 | 204-371-1 | Anthracene | (X)*** |
| (3) | 1912-24-9 | 217-617-8 | Atrazine | (X)*** |
| (4) | 71-43-2 | 200-753-7 | Benzene | |
| (5) | n.a. | n.a. | Brominated diphenylethers (**) | X**** |
| (6) | 7440-43-9 | 231-152-8 | Cadmium and its compounds | X |
| (7) | 85535-84-8 | 287-476-5 | $C_{10}$-$_{13}$-chloroalkanes (**) | X |
| (8) | 470-90-6 | 207-432-0 | Chlorfenvinphos | |
| (9) | 2921-88-2 | 220-864-4 | Chlorpyrifos | (X)*** |
| (10) | 107-06-2 | 203-458-1 | 1,2-Dichloroethane | |
| (11) | 75-09-2 | 200-838-9 | Dichloromethane | |
| (12) | 117-81-7 | 204-211-0 | Di(2-ethylhexyl)phthalate (DEHP) | (X)*** |
| (13) | 330-54-1 | 206-354-4 | Diuron | (X)*** |
| (14) | 115-29-7 | 204-079-4 | Endosulfan | (X)*** |
| | 959-98-8 | n.a. | (alpha-endosulfan) | |
| (15) | 206-44-0 | 205-912-4 | Fluoroanthene(*****) | |
| (16) | 118-74-1 | 204-273-9 | Hexachlorobenzene | X |
| (17) | 87-68-3 | 201-765-5 | Hexachlorobutadiene | X |
| (18) | 608-73-1 | 210-158-9 | Hexachlorocyclohexane | X |
| | 58-89-9 | 200-401-2 | (gamma-isomer, Lindane) | |
| (19) | 34123-59-6 | 251-835-4 | Isoproturon | (X)*** |
| (20) | 7439-92-1 | 231-100-4 | Lead and its compounds | (X)*** |
| (21) | 7439-97-6 | 231-106-7 | Mercury and its compounds | X |
| (22) | 91-20-3 | 202-049-5 | Naphthalene | (X)*** |
| (23) | 7440-02-0 | 231-111-4 | Nickel and its compounds | |
| (24) | 25154-52-3 | 246-672-0 | Nonylphenols | X |
| | 104-40-5 | 203-199-4 | (4-(para)-nonylphenol) | |

[6] CAS: Chemical Abstract Services

[7] EU number: European Inventory of Existing Commercial Chemical Substances (EINECS) or European List of Notified Chemical Substances (ELINCS)

n.a. not applicable

| | | | | |
|---|---|---|---|---|
| (25) | 1806-26-4 | 217-302-5 | Octylphenols | (X)*** |
| | 140-66-9 | n.a. | (para-tert-octylphenol) | |
| (26) | 608-93-5 | 210-172-5 | Pentachlorobenzene | X |
| (27) | 87-86-5 | 201-778-6 | Pentachlorophenol | (X)*** |
| (28) | n.a. | n.a. | Polyaromatic hydrocarbons | X |
| | 50-32-8 | 200-028-5 | (Benzo(a)pyrene), | |
| | 205-99-2 | 205-911-9 | (Benzo(b)fluoroanthene), | |
| | 191-24-2 | 205-883-8 | (Benzo(g,h,i)perylene), | |
| | 207-08-9 | 205-916-6 | (Benzo(k)fluoroanthene), | |
| | 193-39-5 | 205-893-2 | (Indeno(1,2,3-cd)pyrene) | |
| (29) | 122-34-9 | 204-535-2 | Simazine | (X)*** |
| (30) | 688-73-3 | 211-704-4 | Tributyltin compounds | X |
| | 36643-28-4 | n.a. | (Tributyltin-cation) | |
| (31) | 12002-48-1 | 234-413-4 | Trichlorobenzenes | (X)*** |
| | 120-82-1 | 204-428-0 | (1,2,4-Trichlorobenzene) | |
| (32) | 67-66-3 | 200-663-8 | Trichloromethane (Chloroform) | |
| (33) | 1582-09-8 | 216-428-8 | Trifluralin | (X)*** |

* Where groups of substances have been selected, typical individual representatives are listed as indicative parameters (in brackets and without number). The establishment of controls will be targeted to these individual substances, without prejudicing the inclusion of other individual representatives, where appropriate.

** These groups of substances normally include a considerable number of individual compounds. Presently, appropriate indicative parameters cannot be given.

*** This priority substance is subject to a review for identification as possible “priority hazardous substance”. The Commission will make a proposal to the European Parliament and Council for its final classification not later than 12 months after adoption of this list. The timetable laid down in Article 16 of Directive 2000/60/EC for the Commission's proposals of controls is not affected by this review..

**** Only Pentabromobiphenylether (CAS number 32534-81-9)

***** Fluoranthene is on the list as an indicator of other, more dangerous Polyaromatic Hydrocarbons

Source: Commission of European Communities, 2001 (see bibliography)

**List 1b. Pesticides of list 1**

| | |
|---|---|
| Alachlore | Herbicide |
| Atrazine | Herbicide |
| chlorfenvinphos | Insecticide, acaricide |
| chlorpyrifos | Insecticide |
| 1,2-Dichloroéthane | Insecticide |
| diuron | Herbicide |
| endosulfan | Insecticide, acaricide |
| Alpha-endosulfan | Insecticide, acaricide |
| hexachlorobenzène | Fungicide |
| Gamma-isomère, Lindane | Insecticide |
| isoproturon | Herbicide |
| simazine | Herbicide |
| pentachlorophénol | Insecticide, fungicide, herbicide |
| trifluraline | Herbicide |

Source: see List 1a

**List 2. List of pollutants to be reported if threshold value is exceeded (3-yearly reporting, starting in 2003)**

**Environmental Themes**

Total - Nitrogen as N
Total - Phosphorus as P

**Metals and compounds**

As and compounds total, as As
Cd and compounds total, as Cd
Cr and compounds total, as Cr
Cu and compounds total, as Cu
Hg and compounds total, as Hg
Ni and compounds total, as Ni
Pb and compounds total, as Pb
Zn and compounds total, as Zn

**Chlorinated organic substances**

Dichloroethane-1,2 (DCE)
Dichloromethane (DCM)
Chloro-alkanes (C10-13)
Hexachlorobenzene (HCB)
Hexachlorobutadiene (HCBD)
Hexachlorocyclohexane(HCH)
Halogenated organic compounds as AOX

**Other organic compounds**

Benzene, toluene, ethylbenzene, xylenes as BTEX
Brominated diphenylether
Organotin – compounds as total Sn
Polycyclic Aromatic Hydrocarbons
Phenols as total C
Total organic carbon (TOC) as total C or COD/3

**Other compounds**

Chlorides as total Cl
Cyanides as total CN
Fluorides as total F

Source: OJ L 192 , 28/07/2000 p. 36. (Commission of European Communities, 2000b see bibliography)

**List 3. Eutrophication parameters**

Total Nitrogen
Total Phosphorus
$BOD_5$

Source: HARP-NUT group, 1999. (see bibliography) and UWWT Directive