European Topic Centre on Inland Waters

GROUNDWATER MONITORING IN EUROPE

By

C Koreimann, J Grath, G Winkler, W Nagy and W R Vogel

October 1996

This report was prepared under the supervision of N. Thyssen, Project Manager,
European Environment Agency

Cover Design: Folkmann Design and Promotion
Printing: XXXXXXXXXXXX

Note

The designations employed and the presentation of material in this publication do not imply the expression of any opinion whatsoever on the part of the European Commission or the European Environment Agency concerning the legal status of any country or territory, and the boundaries shown on maps do not imply official endorsement or acceptance.

Cataloguing data can be found at the end of this publication
ISBN XXXXXXXXXXXX

Printed on recycled and chlorine-free bleached paper

European Environment Agency
Kongens Nytorv 6
DK - 1050 Copenhagen K
Denmark
Tel: +45 33 36 71 00
Fax: +45 33 36 71 99
E-mail: eea@eea.dk
Homepage: http://www.eea.dk

CONTENTS **Page**

EXECUTIVE SUMMARY

The aim of this report by the European Topic Centre on Inland Waters is to give an overview of the current groundwater quality and quantity networks and monitoring procedures within the European Environment Agency (EEA) area. The information for this overview was obtained through questionnaires distributed by the EEA's National Focal Points in 17 of the 18 EEA member countries. (Liechtenstein was not included at this stage). All countries except Belgium and Luxembourg returned the questionnaires. Some countries were also able to include computerised information on monitoring station types in their returns. A detailed inventory of the information obtained has also been created. The following information and topics are included in this overview:

- name of monitoring programmes;
- monitoring objectives (why monitoring is undertaken);
- responsible and collaborating organisations (addresses, contact persons, responsibilities);
- extent of network (geographical coverage, number of regions and sampling sites etc.);
- groundwater regions (area, sampling frequency, etc.) (groundwater quality only);
- monitoring network characteristics;
- observed variables (dimension, frequency, analytical methods, etc.);
- temporal coverage of monitoring;
- data storage and management details;
- data availability (fees, restrictions, reporting organisations, etc.);
- quality control and assurance procedures;
- report of observation (organisation, persons, addresses);
- sampling site details.

From the information obtained it appears that monitoring of groundwater quality has been undertaken in most European countries since the 1970s and '80s. France appears to have the oldest network dating back to 1902. In contrast the monitoring of groundwater quantity has a longer tradition in Europe with the oldest networks being in operation since 1845, and most since the beginning of the 20th century.

Groundwater quality monitoring networks have developed as a result of national demands and the (hydro-)geological situation. As a result monitoring objectives vary a lot from country-to-country, though 'general surveillance' and 'the identification of trends in quality' are widespread goals all over the EEA area. In terms of quantity the respondents gave broadly similar objectives for monitoring activities such as for the collection of basic groundwater data, the management of groundwater resources and

water supply, and in support of (hydro-)geological studies investigating, for example, the reasons for temporal and spatial changes in groundwater levels.

All the quality and quantity networks described in the questionnaires are national in extent with the exception of regional networks in the German Länder and France (quantity only). The majority of sampling sites are distributed evenly within the whole groundwater areas and aquifer types (e.g. porous media, karst, artesian and deep groundwater). However many sampling sites for quality are concentrated around drinking water wells. The total number of sampling sites, the total aquifer area and as a consequence the sampling site density varies a lot. These differences are often a result of differences in national objectives as well as differences in the (hydro-) geological situation and land use. Thus in quality networks sample site density ranges from 0.003 sites/km² to 0.57 sites/km², and in quantity networks 0.004 sites/km² to 7.3 sites/km².

Quantity networks comprise various types of observation points such as bored and dug wells, which are mostly used, but also driven wells and spring wells. The quantity variables observed are broadly the same; groundwater level (all countries), then groundwater temperature (nearly all) and also spring level and spring discharge. The frequency of measurement is, however, variable. For example, in the case of groundwater level nearly all countries have some continuous recording. More typically sampling frequency varies from weekly to two times a year. For groundwater temperature it varies from every 15 minutes to 2 times a month.

The number of measured water quality determinands varies from 15 to 106 between the monitoring networks. 'Basic' programmes often include between 14 and 51 determinands. The selected determinands appear to be adapted to national circumstances and at present cannot be readily compared at a European level. Not every determinand from a single sample is analysed by a single institution. However, the majority of countries have national standardised sampling and analytical methods as well as standardised regulations for precision and accuracy.

The information held in the inventory will be a very useful tool for further co-operation and development in the fields of water protection in the EEA area. For example, the information will be a key component in the implementation of the proposed groundwater monitoring network for the EEA area (as described in project MW3).

In addition to the report, the collected data from the questionnaires has been incorporated into a relational database. Tables are designed for comparing various aspects of data. Technical details of the database and the organisation of the tables are included in this report. An entity relationship diagram shows the relationships between the different tables. A hard copy of the database tables is also available from the ETC/IW. This report is included in the EEA's Catalogue of Data Sources (CDS). The CDS is available to all National Focal Points and forms part of the EIONET. The CDS is also scheduled to be made more widely available (for example, to members of the public) through the World Wide Web during 1997.

1. INTRODUCTION

This report is a summary of the activities undertaken for the 1995 European Topic Centre Project MW2/Task 4 *"Produce an inventory of current and planned water resources monitoring procedures and practices in the EEA member countries and international conventions with particular emphasis on monitoring of groundwater (quality and quantity) and surface water quantity."*
The basic ideas for this task were

- to identify present and planned water resources (quality and quantity, groundwater) monitoring in EU Member States, Norway and Iceland in particular: sampling strategies (frequencies, number of sites, methods of sampling), analytical procedures and the dissemination of results;

- to review national and international quality assurance procedures (and identify the extent to which they are applied in each member state);

- to determine the extent to which the monitoring procedures are applied by the Member States, Norway and Iceland vary

- to judge the extent to which states have instigated measures to harmonise their water resource monitoring strategies and, where possible;

- to identify possible routes to harmonisation and the practical barriers and solutions for greater harmonisation on a European Union level

(from the WRc summary of the technical work programme for the 1994 subvention, p.12/65, 30 January 1995)

As a matter of fact national differences in monitoring systems arise in fields like

- monitoring obligations due to national law
- number of observed parameters
- limits of detection
- number and types of sampling sites
- frequency of data collection
- quality assurance and quality control methods
- data collation and data treatment (statistically)

The detection of these differences within the EEA member countries is absolutely necessary for designing and establishing a European wide monitoring network by the EEA. Only data that are comparable will help to work out possible ways to solve urgent environmental questions of the future. These important topics cannot be treated by every country on its own. International co-operation will be the way, thereupon the demand for comparable data and connected environmental monitoring networks is indispensable.

With the help of a questionnaire the information needed has been collected. The design of the questionnaire was the result of the broad experience of NERI and the contributions of the AWW and IH in February 1995. The questionnaire contains four parts: Part I general description of monitoring activities at the country level; Part II surface water quantity monitoring; Part III groundwater quality; and, Part IV groundwater quantity monitoring. Parts I. III and IV of the questionnaire are given in Annex 3.

The main headings used within Parts I, III and IV are summarised in Table 1.1 below. As Part II dealt with surface water quantity monitoring it is not discussed in this report - further details are given in Rees *et al*., 1996.

Table 1.1 Summary of contents of Parts I, II and IV of the MW2 questionnaire

Monitoring activities at country level	**Groundwater quality**	**Groundwater quantity**
Part I	**Part III**	**Part IV**
groundwater - national extent of porous, karst and other groundwaters. national mapping and characterisation work	name of monitoring programme	name of monitoring programme
water resources - potential, consumption, % of consumption ground and surface waters	monitoring objectives (why monitoring is undertaken)	monitoring objectives (why monitoring is undertaken)
inland surface waters - main characteristics e.g. national hydrological regime, major river basins, lakes, wetlands	responsible and collaborating organisations (addresses, contact persons, responsibilities)	responsible and collaborating organisations (addresses, contact persons, responsibilities)
administrative organisations for groundwater quality and quantity monitoring, and surface quantity monitoring	extent of network (geographical coverage, number of regions and sampling sites etc.)	extent of network (geographical coverage, number of regions and sampling sites etc.)
	groundwater regions (area, sampling frequency, etc.)	
	monitoring network characteristics	monitoring network characteristics
	observed variables (dimension, frequency, analytical methods, etc.)	observed variables
	temporal coverage of monitoring	temporal coverage of monitoring
	data storage and management details	data storage and management details
	data availability (fees, restrictions, reporting organisations, etc.)	data availability (fees, restrictions, reporting organisations, etc.)
	quality control and assurance procedures	quality control and assurance procedures
	report of observation (organisation, persons, addresses)	report of observation (organisation, persons, addresses)
	sampling site details	sampling site details

After the validation of the questionnaire by the ETC/IW consortium and the EEA they were delivered to each National Focal Point (NFP) via selected ETC/IW members within the EEA area. The NFPs were responsible for the distribution of the questionnaires by contacting their national key organisations and key persons and ask

them to answer and provide hard copies as well as ASCII files of monitoring stations. Afterwards the NFPs were asked to return the answered questionnaires to the selected ETC/IW members. These members sent the questionnaires to the ETC/IW members AWW (groundwater quality and quantity) and IH (surface water quantity) who were responsible for collecting and evaluating the questionnaires. Furthermore both organisations were obliged to load the data of the questionnaires onto a database and to produce reports.

The inventory started in February 1995 and was to be completed by the end of April 1995. The national answering procedures turned out to be very difficult due to administrative structures, divided responsibilities for national monitoring or decentralised monitoring systems. Most of the questionnaires were returned with long delays, the last arriving at the AWW by mid of September 1995. To date no information has been received from Belgium and Luxembourg.

A short overview of the responses is given in Table 1.2.

Due to the short deadlines given within this task, the data supplied on the completed questionnaires where loaded into Excel spreadsheets to make the first data handling fast and simple. The design of the spreadsheets was made under the consideration of an easy loading procedure into a relational database (more technical details are given in chapter 3 of this report). Later on this database was constructed as a draft model in MS-Access 7.0. In the future it will converted into a ‘digital VAX-rdb’ database in order to ensure save and fast data access.

The remainder of this report is based on answers given in the questionnaires. It describes the different national status of groundwater quality and quantity monitoring in Europe. For those countries who failed to respond, the relevant sections of the report are simply left blank. In the next chapters the following topics are described:

Chapter 2	National monitoring description (quality and quantity)
Chapter 3	Technical description of database
Chapter 4/5	Tables for comparison
Chapter 6	Discussion
Conclusions	

Supplementary information such as on organisation names and addresses are given in various annexes

Table 1.2 Questionnaires returned:

Country	Questionnaire Part I	Questionnaire Part III	Questionnaire Part IV	Station details	Remarks
Austria	•	•	•	•	
Belgium					to date no inf.
Denmark	•	•	•	•	
Finland	•	•	•	•	
France	•	•	•	•	
Germany	•	•	•		Only four of 16 „Länder“ returned questionnaires, no Part I has been provided
Greece	•				to date only part I received
Iceland	•		•		
Ireland	•	•	•		no quality monitoring in Ireland
Italy	•	•	•	•	questionnaires contain only a national average estimation
Luxembourg					to date no inf.
The Netherlands	•	•	•	•	
Norway	•	•	•	•	
Portugal	•	•	•		
Spain	•	•	•	•	
Sweden	•	•	•		
United Kingdom	•	•	•		No national database of groundwater quality sites exists at present

Notes:
A questionnaire was not sent to Liechtenstein
The Part II questionnaire deals with surface water quantity monitoring and is not included in this report. For more details see Rees *et al.* (1996).

2. SUMMARY DESCRIPTION OF GROUNDWATER (QUALITY AND QUANTITY) MONITORING ACTIVITIES IN EACH COUNTRY

2.1 Austria

2.1.1 Characteristics of Groundwater

The Austrian groundwater areas cover nearly one third of the national territory. Groundwater in karst areas with 15,000 km² extension (18% of national territory) and groundwater in porous media with 10,000 km² (12% of national territory) form the most important groundwater resources of Austria. In addition there is single productive crevice groundwater in the Central Alps, Bohemian Chain and in the borderland of the alpine region and some larger areas with artesian and deep groundwater in Upper and Lower Austria, Burgenland, Styria and in alpine valleys.

Austria offers rich potential water resources that are composed of precipitation (100,000 mio. m³/year) and inflow from neighbouring countries (30,000 mio. m³/year). Yearly evapo-transpiration is about 45,000 mio. m³. Most of the water is consumed by industry (1,700 mio m³/year), by households (700 mio. m³/year) and by agriculture (200 mio. m³/year). Nearly 100 percent of the water consumption is taken from groundwater which is a quite unique position in Europe (only comparable with Denmark with 99%).

2.1.2 Structure of the Administrative Organisations Concerning Groundwater Quality

The Austrian Act on Hydrography (Federal Law Gazette No. 58/1979), later on amended in the Act on Water Law, provides the financial and legal basis for the country wide groundwater quality monitoring system. More details of the monitoring programme are laid down in the Ordinance on Water Quality Monitoring (Wassergüte-Erhebungsverordnung/Federal Law Gazette No. 338/91). Furthermore, monitoring is also done in assessment of compliance with EC legislation - Nitrate Directive 91/676/EEC. The groundwater quality monitoring is run by the Federal Ministry of Agriculture and Forestry in close co-operation with the Federal Environment Agency (both responsible for the standardisation of the whole programme, electronic data storage, evaluation of results, information for decision makers and the general public) and the nine provincial authorities (current realisation of the monitoring programme). The data are evaluated continuously.

The main objectives for the groundwater quality monitoring programme are:

- up to date information on groundwater quality

- quick identification of changes in the water quality
- detection of main areas of water pollution
- supervision of remediation measures
- collection of basic data for legalistic regulations e.g. concerning substances hazardous to water

2.1.3 Monitoring of Groundwater Quality

The national groundwater quality network mainly covers the important aquifers in porous media and karst groundwater. Most sampling sites were selected from wells in perpetual use for industrial, commercial and household purposes. New wells were erected in only a few cases. At this stage there are 1,359 sampling sites for groundwater in porous media and this number will increase to 1,600 within 1996. For karst groundwater 70 sampling sites are being observed at present but the number will also increase to 450 within this year. Consequently the density of the sampling network is at an average of about 10 sites/100 km² in porous media and 2 sites/100 km² in karst areas.

Most of the groundwater samples are taken 4 times a year (river water samples are collected six times a year and sediments as well as biological material are sampled once a year. At some sampling sites water samples are taken 12 times a year because of special bilateral agreements on transboundary water management issues.

The parameters observed can be divided into 3 groups. The first group covers all substances necessary for a general characterisation of hydrochemical properties (e.g. conductivity, pH, dissolved oxygen...) or general pollution situations (nutrients, TOC, DOC). The second group provides an Austrian-wide survey (e.g. heavy metals, hydrocarbons, AOX); substances that do not seem to influence water quality over a certain period of time are not measured routinely and are replaced by others. The third unit covers substances with high ecotoxicological relevance like pesticides, benzene, PAH; their analyses demands sophisticated and expensive analytical techniques. Therefore their selection depends on specific land use and pollution situations. The selection of substances is adapted to regional requirements.

The continuous adaptations of the monitoring programme to specific requirements of water pollution control combined with an appropriate selection of substances guarantee an economical realisation of the monitoring programme.

Sampling and analysing are entirely carried out by private subcontractors who are enlisted by the provincial authorities. The sampling components are laid down in the contract with the laboratories. Each laboratory has to make a standard operation procedure for taking groundwater samples which have to be approved by the employer. An education programme for standardising the sampling procedures is organised by the Federal Ministry of Agriculture and Forestry. The main points of this quality assurance

are as follows: regular laboratory control; an obligatory participation of all contractors in round robin tests; control samples; contractors have to disclose the extent of internal quality assurance they intend to apply within the contract; contractors have to put down all methods used (from bottle washing to data entry) and the contractors are obliged to document all necessary facts and data for a period of 3 (now 10) years.

The groundwater quality networks have collected data since 1991. It has an average record length of 3 years. The data collected is stored and managed in the Federal Environment Agency. The agency's equipment for the hardware and operating system is composed of VMS; UNIX; DOS; Windows and Windows NT. The Federal Environment Agency also developed the software for data treatment by using language; software, query and reporting tools such as C; Pascal; DCL; SQL; SAS; Lotus etc.

The information on groundwater quality data is generally free. For the annual summarising report ("Gewässergütebericht") the printing costs have to be paid for.

2.1.4 Structure of the Administrative Organisations Concerning Groundwater Quantity

In Austria the responsibilities for groundwater monitoring are shared between the federal authorities and the nine provinces. The Central Hydrological Office, founded in 1893, is a division of the Federal Ministry of Agriculture and Forestry in Austria. The legal basis of the division-work is the Federal Act on the Survey of Water Cycle and Water Quality from the year 1979. This act is also called Act on Hydrography. The Act on Hydrography was amended to the 1990 Water Act. On the basis of this act the hydrological divisions in the services of the nine federal provinces are running their own observation networks. Austria is also a signatory to several water treaties with neighbouring countries.

The Hydrological Service in Austria comprises three sections: the Hydrological Central Office, the hydrological divisions in the executive authorities of the nine provincial governments along with several directorates for waterways, finally about 2,500 observers; and has the following general tasks and objectives:

- survey of the water cycle (observation and measurements)
- responsibility for monitoring and reporting
- protection of the environment
- observation of the influence of climatic change
- management of basic and special networks
- contact with collaborating organisations

- regular control of the observer stations and observers, calibration of the equipment, datacheck by comparison with neighbouring stations

The monitoring systems comply national and international standards (e.g. WMO). Data quality control standards assure reliable data.

2.1.5 Monitoring of Groundwater Quantity

The Hydrological Service's observation network has a national coverage of some 83,850 km². The networks comprises 3,100 observation points (i.e. 30 sampling sites/100 km² in porous aquifers and 0.06 sampling sites/100 km² in karst aquifers) spread over 30 karst groundwater regions and 140 groundwater regions in porous media. The majority of observation points, 1,600, are in bored and driven wells. 2,610 observation points observe the water level in a non recording way, 290 in a recording way. In addition water level observation points measure water temperature and the altitude and co-ordinates are indicated.

The network has been in operation since 1930 and each station, on average, has a record length of 25 years. Water level and water temperature are sampled weekly for basic programmes and more often than weekly (water level) or monthly (water temperature) for special ones. At springs water level, discharge, water temperature, conductivity and turbidity are observed continuously (basic programmes) or monthly and fewer (special programmes). The quality of observed data is assured by regular controlling of stations, comparison with neighbouring stations, check of completeness and attention of special hydrological events.

Data are written sequentially to magnetic tape on a Siemens BS2000 computer at the Central Hydrological Office. Software developed in PLI or Cobol is used to manage the data. The data collected can be given free of charge but there are restrictions for data availability. The data are published periodically in: Hydrological Yearbooks (Hydrographisches Jahrbuch von Österreich); volumes of comprehended data on Austrian Hydrology; Information Bulletins of the Hydrological Service.

2.2 Belgium

No information has yet been received from Belgium.

2.3 Denmark

2.3.1 Characteristics of Groundwater

The Danish Groundwater resources are mainly situated in porous media. All regions combined have an area of 43,216 km² i.e. 99.9% of the national Danish territory. The resources in porous media can be divided in Quaternary sand and gravel deposit areas, in Miocene sand and gravel deposit areas and in chalk deposits. The most important potential water resource is precipitation (30,500 mio. m³/year). The evapo-transpiration is about 18,000 mio. m³/year. In Denmark 420 mio. m³/year of water are consumed by households, 225 mio. m³/year by industry and 400 mio. m³/year by agriculture. Denmark is able to gain 99% of the drinking water out of groundwater resources in porous aquifer.

2.3.2 Structure of the Administrative Organisations Concerning Groundwater Quality

Denmark has a nation-wide groundwater quality monitoring network. The head structure for all monitoring activities is the Danish Parliament the „Folketing“ that makes the laws and ordinances and among them groundwater legal obligations. The „Fagdatacentre“, the national Danish data centre, that is composed of different „Institutions“ such as GEUS (DGU changed to GEUS Geological Survey of Denmark and Greenland) and DMU the former NERI. GEUS is the national data centre for groundwater quality and quantity monitoring that is responsible for the scientific content of the groundwater monitoring programme, the organisation of the programme, the evaluation of data and for reporting. The EPA is an administrative unit under the Ministry of Environment and Energy, that is responsible -as an executive body- to co-ordinate the whole groundwater monitoring programme „Aquatic Environment Nationwide Monitoring Programme“ and provide the annual status of the programme. The 14 Danish counties (and 2 municipalities with „county“-status) are responsible for the data collection, data evaluation and the regional reporting. The counties send all data and reports to the Fagdatacentre, groundwater data to GEUS, surface water data to DMU.

The people’s supply of drinking water and therefore the collection of groundwater/drinking quality data differs a bit from the monitoring aforesaid structures. If groundwater is used as drinking water the 14 Danish counties (and 2 municipalities with „county“-status) are obliged to collect groundwater data and send them to GEUS. The 275 municipal units are responsible for the drinking water supply with respect to quality standards. The main objective for the network is to monitor groundwater quality in relation to land use and point sources. In addition the obtained quality data are also used for research and scientific work and for information to the general public.

2.3.3 Monitoring of Groundwater Quality

The Danish Groundwater quality monitoring programme (VAMP) covers the whole country. Quality data are observed by 1,100 sampling sites which were distributed under the consideration of monitoring all geological and hydrological settings in Denmark. Near half of these sampling sites are special wells for observation purpose. The main type (1,090) of the stations is a characterisation station to get the average situation of groundwater in the region.

Parameters observed are sampled between 2-4 times a year. They contain a number of physical descriptive parameters (pH, total hardness, temperature...), as well as major ions (calcium, nitrate, ammonium..), heavy metals (zinc, lead, cadmium..) or pesticides. Hydrochlorinated carbons and pesticides are sampled every other year. The analysing is made by 15 different private laboratories which are obliged to follow the „Danish Standard“ for laboratory work. Scientific inspectors as well as county control are additional measurements for quality control and assurance methods. Raw data in a (digital) RDBMS by using a VAX (VMS) and PCs (Windows/DOS). Language, software, query and reporting tools are SQL, SAS, Datatrieve and Smartstar. Since 1989 computerised data have been available on floppy disks, paper sheets or reports. Data are available without restrictions but not free of charge at the Danish Geological Survey of Denmark and Greenland (GEUS). The GEUS is also responsible for publishing a yearbook about groundwater quality data. The target audience are the Danish Parliament and the general public.

2.3.4 Structure of the Administrative Organisations Concerning Groundwater Quantity

Data about groundwater quantity (pumping rates) are collected by all waterworks, industries with own water supply and municipalities. The data are evaluated and stored by the municipalities and the 14 Danish counties (and 2 municipalities with „county“-status). Summarised data are sent to GEUS. The Counties and GEUS produce the annual report about the groundwater consumption. There are local networks (run by water works), regional networks (run by Counties) and a national network (run by GEUS) for groundwater level monitoring. The Counties also plan the regional use of groundwater in the different sectors such as households, industry or irrigation. The counties give license to larger groundwater abstractions and the municipalities give license to minor groundwater abstractions.

2.3.5 Monitoring of Groundwater Quantity

The Danish groundwater observation network is spread over the whole country. That means that there are 200 observation points distributed in an area of 43,216 km²; thereupon the sampling site density is about 0.5/100 km² in porous media. Most of the observation points are bored wells with indication of altitude and co-ordinates. These sampling sites observe the water level with a monthly frequency. The network has been

in operation since 1950. Data stored refer to water level as well as ground level, co-ordinates and date of record. Data are loaded on to a digital RDBMS or a MS-ACCESS, by using VAX, VMS or Digital. Language, software, query and reporting tools are SAS, DATATRIEVE. The Geological Survey of Denmark and Greenland (GEUS) is responsible for data management. Data can be made available on floppy disks, paper sheets or reports. There are no restrictions but a fee has to be paid.

2.4 Finland

2.4.1 Characteristics of Groundwater

The geologic formation of Finland is a Precambrian crystalline bedrock, which is covered with thin layers of Quaternary deposits. Precambrian bedrock is solid material which allows only low water movements and small water quantity. There is no karst groundwater because of the lack of calcium minerals in the crystalline bedrock. Groundwater in porous media consists of glacifluvial aquifers (eskers and other gravel and sand formations). The other aquifers consists of small till and silt aquifers.

2.4.2 Structure of the Administrative Organisations Concerning Groundwater Quality

There are 50 groundwater quality sampling sites throughout the country. The Finnish Environment Institute is programme co-ordinator, manager of the database and the reporting centre. Regional Environment Centres carry out maintenance renovation, take samples and are partly responsible for the chemical analyses. The network is a national network which is a part of the „Scandinavian Network“. The main responsibilities of the institutions involved are to detect changes in groundwater chemistry and infiltration water due to anthropogenic impact, to collect basic data, to provide data for research and scientific purposes and to identify the trends of water quality.

2.4.3 Monitoring of Groundwater Quality

The 50 groundwater sampling sites are representative for the whole area investigated, meaning that the hydrogeological quantity and quality parameters could be calculated from the balances of water and materials. Sampling sites are mostly situated in springs; the others are in tubes and wells. In porous media aquifers there are 20 sampling sites and In other aquifers there are 30 sampling sites. Stations are background stations in nearly natural state, located in areas where the groundwater quality has not been appreciably affected by local environmental disturbances. The stations are situated in different climatic and soil type regions which are hydrogeologically unified groundwater basins or distinct, defined areas within larger basins. The size of areas investigated varies between 0.2 and 3 km².

About 30 determinants are observed 6 times a year in order to identify the groundwater quality. The laboratory of the Finnish Environmental Agency co-operates with the 13 laboratories of the Regional Environment Centres in sampling and analysing. The Finnish Environment Institute is a kind of supervisor for the Regional Environment Centres and gives guidance to them. These public institutions work due to public regulation. Finnish Standard Procedures (SFS-standard) for analytical methods as well as the regulations of the EN 4500-Standards are the basis for the precision and accuracy of the procedures of the laboratories.

The earliest record of the groundwater quality network was taken in 1974. It has an average record length of 20 years. An SAS-database (with ASCII) is used for raw data storage. The hardware used is VAX-VMS. Software tool is SAS. Computerised data have been available since 1975 and are laid down on floppy disks or published in paper form. Parts of the data can be demanded from public organisations like the Finnish Environment Institute which is responsible for the observation report.

2.4.4 Structure of the Administrative Organisations Concerning Groundwater Quantity

The Finnish groundwater monitoring network is a national network which is also part of the „Scandinavian Network“. The network provides information on changes in the groundwater table of different aquifers and relate observed changes in climatic fluxes. Furthermore it helps to evaluate and predict drought periods. The Finnish Environment Institute is programme co-ordinator, database manager and the centre of reporting. Regional Environment Centres do maintenance renovation.

2.4.5 Monitoring of Groundwater Quantity

The groundwater monitoring consists of 54 groundwater observation stations with 550 observation points throughout the country. These are background stations in nearly natural state, located in areas where the groundwater quality has not been appreciably affected by local environmental disturbances. The stations are situated in different climatic and soil-type regions which are hydrogeologically unified groundwater basins or distinct, defined areas within larger basins. The size of areas investigated varies between 0.2 and 3 km². There are about ten observation tubes and one observation well in every groundwater region.

The sampling sites observe the water level 26 times a year for basic programmes. In addition there is one all-time-recorder for every station. The network has been in operation since 1974 as a whole; the first observations were made in 1968. It has an average record length of 20 years. An INGRES database with FORTRAN programmes is the equipment for data storage and management at the Finnish Environment Institute. SQL is the query language. The groundwater quantity data have been computerised since 1975 and can be made available on floppy disks or on paper sheets. Not all of the data are available, for some information a fee is necessary. The Finnish Environment

Institute publishes parts of the groundwater quantity data in yearbooks. The last of these yearbooks was edited in 1992.

2.5 France

2.5.1 Characteristics of Groundwater

In France one can distinguish between three types of groundwater regions. Due to estimations of experts 30 % of these regions are situated in porous media; <10 % in karst media and about 60% in other media. In 1981 an estimation on potential water resources showed that about 440,000 mio m³/year come from precipitation; 2,000-3,000 mio. m³/year are inflows from neighbouring countries. The rate of evapo-transpiration is about 270,000 mio. m³/year.

Most of the water is consumed for cooling power plants, it takes about 20,000-22,000 mio. m³/year. This amount is followed by water consumption of households with 5,500-6,000 mio. m³/year, then industry with 4,400-5,500 mio. m³/year and finally agriculture with 4,000-5,000 mio. m³/year. Thereupon groundwater resources provide the following percentages of the whole water consumption: porous and karst aquifers together 37-40% (cooling excluded); springs 16-16.5% (cooling included).

2.5.2 Structure of the Administrative Organisations Concerning Groundwater Quality

The French groundwater monitoring programme, the „Observatoire National de la Qualité des Eaux souterraines -ONQES“ is a composition of many different regional, local or basin networks. More details can be found in the „*Catalogue des Sources de Données de l'Environnement*“ released 1994 by IFEN (Institut Français de l'Environnement)/Lavoiser. There is no single administrative structure dealing with groundwater quality monitoring but for a brief overview: the Ministry of Environment/Water Department co-ordinates the programmes for groundwater monitoring activities. The Ministry is supported by the B.R.G.M (Bureau de Recherche Geologique et Minière) an organisation which manages the national database, and the Ministry of Social Affairs and Integration, which is responsible for sampling and analysing procedures.

In fact, the only national network which collects data related to groundwater quality has as legal basis the application of Decree 89-3 (as result on Drinking Water Directive). Natural Water used for drinking water supply is regularly monitored and the results are incorporated in the ONQES database. Other responsible network systems are: the Alsace aquifer network, the Basin Seine Normandie networks (including the AQUAREL special network, devoted to aquifers used by small collectives, unable to afford the analytical obligations of the aforesaid decree), the Basin Loire-Bretagne Triazine/Simazine network (including some surface waters), the specialised network

held by Basin Rhone-Méditerranée-Corse. In the North of France, the Basin Artois-Picardie also manages a patrimonial network, in an area, where most resources are obtained from underground waters. The IFEN is not concerned with the quality of data this is the responsibility of the network owners.

The main purposes for monitoring are to collect information, to survey the water quality, to identify water quality trend and process a system which aims at

- facilitating the reinforcement of water policy
- ensuring the best action from water agencies and
- detecting variations of water characteristics.

The monitoring is undertaken due to legal order.

2.5.3 Monitoring of Groundwater Quality

The French groundwater network covers the whole country. The sampling sites are concentrated around drinking water wells in every kind of groundwater aquifer. The sampling frequency for basic monitoring programmes vary between 0.5-4 times a year. The parameters observed are listed in an ordinance of the French Health Ministry that lays down the detection limit, analytical reference methods and the percentage of precision. More than 200 institutions are involved in sampling and analysing the groundwater quality data. These activities are not standardised and there is also a lack of national quality control and assurance procedures. But of course there are internal obligations for the laboratories to use comparable standardised methods within the whole network as well as ones obliging them to follow standardised regulation for precision and accuracy.

The network has been in operation since 1902. It has an average length of 8 years. The data management is done by the B.R.G.M which loads data on to an ORACLE database using VAX as hardware. Language, software, query, reporting tools are SQL+, ARC/INFO for servers and MS/Windows, MS/ACCESS, MAP/INFO or ARCHVIEW for the clients. The data are evaluated and can be requested due to client's interrogation, or are published e.g. as maps or structured tables with possibilities for statistical computations. The „Comité de Coordination de ONQES" has the authorisation for the data release. No fee has not to be paid for data. Public organisations may provide reports made by the B.R.G.M of groundwater quality information due to authorisation.

2.5.4 Structure of the Administrative Organisations Concerning Groundwater Quantity

With exceptions, groundwater quantity monitoring is not held at national level. But the installation of a basic national network has recently been planned. The Ministry of Environment charged the DIREN (Direction Régionale de l'Environnement) Alsace to make a nation wide inventory of all significant networks. As an result there is to be a

selection of about 1,500 piezometers which will constitute a national basic network in the future. At present the number of piezometers in function is diminishing each year, mainly because of the cost of data collection after recording at the site. For this reason many efforts have been undertaken to solve this problem. There were attempts to automate data collections but they turned out to be not as successful as expected.

Most of the networks are held by the DIREN. They form 22 regional headquarters for environment which are the regional representatives of the Ministry of Environment). Their involvement in groundwater monitoring vary according to the importance of this task in the former organisations of the Ministry of Agriculture, that have been merged into the new DIREN structure. From case to case the DIREN is partly subsided by local authorities in managing the networks.

Due to the strategic importance of the Rhine Aquifer a special network has been established in the Alsace region. The measurement structure has a high degree of political implication. This is also the case in some special areas (such as the Gironde/Bec d'Ambrès system, involved in the Bordeaux city water supply, the aquifers being under the threat of saline, poorly reversible, intrusion).

2.5.5 Monitoring of Groundwater Quantity

The information provided at this stage was taken from the „Catalogue des Sources de Données de l'Environnement", released 1994 by IFEN. Fourteen names of regional organisations have been listed. These organisations co-ordinate the regional network programmes, co-operate partly with other regional agencies together for reporting and are responsible for the database management. All monitor the groundwater level for basic data collection and for a quick indication of changes of the water level. Most of them co-ordinate the water supply. The IFEN pointed out that these data were without warranty. The information given will be updated in future. That is why the majority of the groundwater quantity questionnaires remained unfilled.

2.6 Germany

2.6.1 Characteristics of Groundwater

Not provided at this stage. The first part of the MW2 questionnaire has not been provided in time because of the decentralised structure of the 16 Länder of Germany. The questionnaires were distributed to the „Länderarbeitsgemeinschaft Wasser -(LAWA)" in the 16 German Länder to collect groundwater quality and quantity data. Finally 4 questionnaires were answered and they are recommended to be a representative choice of the whole country .

But a national report on nitrate monitoring programmes in the whole of Germany co-ordinated by the „Länderarbeitsgemeinschaft Wasser -(LAWA)" was sent. In this report

called „Bericht zur Grundwasserbeschaffenheit Nitrat, Stand 1995 (Report on Groundwater Quality -Nitrate-, Status 1995)“ the monitoring activities are described. In relation with the increasing problems of nitrate pollution within groundwater resources caused by agricultural fertilisation all 16 German Länder have special nitrate monitoring programmes. Groundwater data concerning nitrate pollution are gained by using existing groundwater monitoring sites in the current Länder networks. The report also gives a brief overview about current groundwater quality monitoring networks in the 16 Länder.

2.6.2 Structure of the Administrative Organisations Concerning Groundwater Quality

No information is available on this aspect at this stage.

2.6.3 Monitoring of Groundwater Quality

2.6.3.1 Bayern (Bavaria)

The Free-state of Bavaria has a groundwater monitoring network of its own which is called „Meßnetz Grundwasserbeschaffenheit Bayern“. The monitoring activities are partly determined in the national drinking water ordinance. The monitoring network is installed to support the responsible authorities with regular data in selected sampling sites so that they are able to visualise middle and long range changes in groundwater quality.

The groundwater monitoring is run by the „Bayrisches Landesamt für Wasserwirtschaft“, a kind of water management and technical authority. It is responsible for the programme co-ordination, data treatment and storage, chemical analyses as well as quality management for the chemical analyses and finally for publishing reports. The Landesamt co-operates closely with 24 local offices of water management („Wasserwirtschaftsämter“).

In Bavaria there are groundwater resources in porous media, karst media and fractured rock media. The sampling sites are spread evenly in order to get a representative pattern of groundwater quality data with regard to public water supply. The sampling sites are mostly defined as baseline stations. The majority of the sampling sites is situated in observation wells. The area (area in km²/number of sampling sites) investigated is composed of 28,000 km²/118 in porous aquifers; 8,000 km²/40 in karst aquifers and 35,000 km²/121 in fractured rock aquifers. The measuring programmes for the different groundwater parameters are split in 4 types. A broad selection of parameters is observed by the Landesamt. To obtain good quality of analysed data the laboratory work has to be done under the regulations of the German Industry Norm Procedure (DIN) like DIN 38 402 A 13 for taking groundwater samples or DIN 38 402 A 51 for the calibration of analytical methods. The limits of detection are fixed by the Landesamt.

In 1985 the network was installed. The raw data collected are loaded on to a ADABAS database. The used hardware is a VAX/VMS, the used language, software, query and

reporting tool is NATURAL. Thereupon computerised data have been available since 1985, data are for water resource management and administration authorities only. But annual reports of the Landesamt popularise selected information of the groundwater situation.

2.6.3.2 Nordrhein Westfalen (North Rhine Westfalia)

The North Rhine Westfalia State Environment Agency co-ordinates the regional monitoring activities and runs the database for the sampling site data. It is assisted by 12 offices of the Environmental Protection Service/Water Works in reporting the data collected. These 12 offices undertake the local sampling and analysing of groundwater. The greatest groundwater resources can be found in porous media, where 2,256 observation points are distributed evenly in an area of 17,000 km². It is followed by fractured rock area of 16,705 km², which is investigated by means of 310 sampling sites. In karst media 20 sampling sites are locally spread over 300 km². The distribution of the sampling sites should guarantee representative data.

For the basic programme more than 40 determinants are observed 1-2 times a year. Public and private institutions share both sampling and chemical analyses. The German Industry Norm Procedure (DIN) standardises monitoring procedures as well as the analytical methods. Other assurance procedures are laid down in the so called “Good laboratory practice -Gute Laborpraxis“.

The network was established in 1984. The average length of records are 5 years. The State Environment Centre uses a DB2 database for raw data storage. The hardware-operating system therefore is IBM-MVS and the language, software, reporting and query tools used are SQL, SAS and QMF. The data have been electronically stored since 1984 and are available on floppy disks, paper sheets and reports at the North Rhine Westfalia State Environment Agency and the 12 offices of the Environmental Protection Service/Water Works. Reports are published every 5th year. They are free for administrative authorities, universities, experts or the general public.

2.6.3.3 Thüringen

In Thüringen the monitoring network was installed to get data about groundwater quality, to survey the development of the groundwater resources and to assess the influence of agricultural pollution sources as well as acidification. Due to national and European Community legal obligations the monitoring activities have to be reported too. The legal basis are the Water Act (§ 34), the Water Household Act (§ 104) of Thüringen and three regional ordinances concerning nitrate, hazardous substances and general guidelines for groundwater quantity monitoring procedures. The Environment Agency of Thüringen has the full responsibility for the network and the data obtained, for programme co-ordination up to sampling and analysing. The main objectives for groundwater monitoring in Thüringen are for example:

- size of temporal and areal changes in the groundwater quantity/quality due to anthropogenic and geogenic water subject matters

- size temporal and areal changes in the groundwater quantity/quality due to different kind of land use such as agriculture

- surveillance of groundwater aquifers for drinking water supply management

- basic data collection

- water quality trend identification

- quick identification of hazardous substances and other pollution sources to take counter measurements.

The observation points are situated in porous media, karst media and joint aquifers. The criteria for their distribution were to get representative data, to take account of the different hydrogeological units and to seize anthropogenic influences. Consequently 96 observation points are spread over 10,540 km² joint aquifers, about 20 over 4,900 km² of karst aquifers and finally 4 over 900 km² in porous media. The observation points are defined as characterisation stations, mainly situated in drinking water, and observation wells.

The variables observed are taken from 1 up to 6 times a year and analysed in the laboratory of the Environment Agency of Thüringen. To ensure that sampling procedures of groundwater are made correctly and reproducibly they have to be done under the consideration of:

- DIN (German Industry Norm Procedure) 38 402 (Sampling of groundwater aquifers)
- LAWA -Directive for observation and evaluation of Groundwater T3
- DVWK Guidelines for taking groundwater samples and extent of monitoring
- AQS (Analytical quality assurance) - for taking groundwater samples

Data are analysed in the laboratory due to DIN and DEV Norms.

At the Environment Agency the raw data are loaded onto an ORACLE database and a LIM or a LAB database (which is specially designed for laboratory data) or are stored in EXCEL. Further treatment is made with special software; language, reporting, query and software tools are PASCAL; FORTRAN and CLIPPER. The earliest record was taken in 1979, the average record length is 4 years. Data are available on floppy disks, paper sheets or reports. There are restrictions for data availability, data have to be paid for. The Environment Agency publishes monthly and annual reports mostly for local administrative bodies, scientific institutions and environmental organisations.

2.6.3.4 Sachsen-Anhalt

In Sachsen-Anhalt the Act on Hydrography (§§ 149, 54, 55) is the legal basis for the monitoring activities undertaken by the Agency for Environmental Protection („Landesamt für Umweltschutz Sachsen-Anhalt“) and state-offices for environmental

protection („Staatliche Ämter für Umweltschutz“). They co-operate in the fields of programme co-ordination, chemical analyses and database management; reporting is only done by the agency. The monitoring network takes also account of the EC Nitrate Directive 91/676/EEC and the Directives 80/778 EEC (quality of water for human consumption). The network is a programme to fulfil general surveillance purposes and to detect changes in the water quality. The geographical coverage of the network is about 20,444 km²; about 14,000 km² with 82 sampling sites are in porous media and about 6,000 km² with 30 sampling sites in solid rock media. Baseline and characterisation stations are the types used for the monitoring.

The investigation of parameters differs from 1 to 2 times a year for basic programmes. The determinands are analysed in 4 public laboratories of the agency and the offices and are treated due to the German Industry Norm Procedure (DIN) and the AQS (Analytical Quality Assurance). The network started working in 1990 with an average record length of 4 years.
The database at the Agency is an INFORMIX database. The user interface is WINDOWS. ASCII date files are used with Targa Computers . Language, software, query and reporting tools are e.g.: ESQL-C; MSC7,0; SDK 3,1. Data are accessible on floppy disks or paper sheets. More details about reporting can be requested at the responsible agency.

2.6.4 Structure of the Administrative Organisations Concerning Groundwater Quantity

No information is available on this aspect at the present time.

2.6.5 Monitoring of Groundwater Quantity

2.6.5.1 Bayern

The Bavarian groundwater quantity monitoring aims at collecting regularly groundwater hydrological data in order to recognise middle and long range changes within groundwater resources as early as possible. The groundwater monitoring is run by the „Bayrisches Landesamt für Wasserwirtschaft“, a kind of water management and technical authority. It is responsible for the programme co-ordination, data treatment and storage, and finally for publishing reports. The Landesamt co-operates closely with 24 local offices of water management („Wasserwirtschaftsämter“) which take the local samples.

The monitoring network is extended throughout Bavaria and observes groundwater resources in porous, karst and in fractured rock media. There are 1,520 sampling sites operating in porous media area of 28,000 km², 107 sites in 8,000 km² karst area and 559 sites in 35,000 km² fractured rock area. The observation points, mostly bored wells, measure the water level weekly (for basic programmes) or continuously (for special programmes), water temperature is measured weekly in special programmes. No

standardised methods for the monitoring are used but plausibility control helps to obtain high quality data. In 1915 the first record was taken, the average length of the record is 60 years. The Directive on Groundwater for the Landesämter of whole Germany 1/82 determines the storage of variables. The technical equipment consists of ADABAS databases with VAX/VMS, and NATURAL as software tool. Computerised data have been available since 1915 and are accessible on floppy disks or paper sheets without any restrictions at the „Bayrisches Landesamt für Wasserwirtschaft“.

2.6.5.2 Nordrhein Westfalen

The Hydrological Service of North Rhine Westfalia is the regional groundwater monitoring network. Its main objectives are to manage the water supply for consumption and to gain information about the groundwater situation. The North Rhine Westfalia State Environment Agency co-ordinates the regional monitoring activities and runs the database for the sampling site data. It is assisted by 12 offices of the Environmental Protection Service/Water Works in reporting the data collected. These 12 offices undertake the local sampling too. The greatest groundwater resources can be found in porous media where 42,900 observation points are distributed evenly in an area of 17,000 km². It is followed by fractured rock area with 16,705 km² which is investigated by means of 100 sampling sites. In karst media 100 sampling sites are spread locally over 300 km². The main type of observation points are 36,176 bored wells dug followed by 6,625 wells. The sampling frequency differs from case to case, but most sites measure weekly or monthly. The network has been in operation since 1909 and its average length of records is 35 years.

The groundwater data collected is managed with a DB2 database. Computer hardware comes from IBM with MVS as operating system. Software tools are SQL, SAS and QMF. Computerised data have been available since the beginning of the network. Data can be made accessible on floppy disks, paper sheets or reports. These media are free of charge and only partly restricted. The North Rhine Westfalia State Environment Agency delivers the reports to interested audience. Reports are published every 5th year. They are free for administrative authorities, universities, experts and the general public.

2.6.5.3 Thüringen

The Network in Thüringen covers the whole area and has been installed in order to get basic information on the status of the groundwater resources. One of the most important purposes for the monitoring procedures is the obligatory report. Actual data are necessary for the following reports

- Hydrological Report of Thüringen (monthly)
- State of Groundwater Reports (quality and quantity)
- Environmental Reports
- IHP Yearbook (UNESCO)
- German Hydrological Yearbooks for Rivers Elbe 1, Rhine/Main, Weser/Ems
- Reports for the European Communities

The Environment Agency of Thüringen is responsible for the network and the data obtained, for programme co-ordination, database management and reporting. In addition 4 governmental environment agencies („Staatliche Umweltämter“) co-operate with the agency in the fields of database management and reporting.
Typical regional aspects for this network are to get information about:

- the communication between groundwater and surface water
- the communication between the different groundwater aquifers
- the status quo of groundwater and the hydrogeological units
- the borders of groundwater aquifers
- the groundwater relations in urbanising areas

Groundwater resources in porous, karst and joint aquifers are observed by 1,225 sampling sites. The majority of the sampling sites is represented with bored wells, 116 are situated at springs. The area investigated is composed of 900 km² in porous media, 4,900 km² in karst media and 10,540 km² in joint media. Variables observed are water level and discharge. Measurements are made 4 times a month for both variables in basic programmes; a special programme measures the water level 4 times a day. Ordinances for groundwater monitoring determine the procedures. Plausibility control ensures the quality of analysed data. The network has been in operation since 1915 and has an average record length of 25 years. The Agency manages the data with the help of an ORACLE database or by using EXCEL. Further treatment is made with special software, reporting and software tools are PASCAL; FORTRAN and CLIPPER. The Thüringer Agency publishes monthly and yearly reports, the data can be made available without restrictions and are free.

2.6.5.4 Sachsen-Anhalt

In Sachsen-Anhalt monitoring activities are undertaken and co-ordinated by the Agency for Environmental Protection of Sachsen-Anhalt („Landesamt für Umweltschutz Sachsen-Anhalt“) as well as three state-offices for environmental protection („Staatliche Ämter für Umweltschutz“). They co-operate in the fields of programme co-ordination and reporting, the database management is made by the state-offices only. The monitoring network is in operation both for managing groundwater resources and collecting basic data. The whole monitoring system covers 12,000 km² with 1200 sampling sites in porous media and 8,000 km² with 650 sampling sites in solid rock areas. About 1,200 sampling sites are bored wells for observation purpose only. There water level is recorded 2-4 times a month in basic and special programmes. The network is in operation since 1907 and has an average length of record of 20-70 years. Information on data treatment has not been provided. But computerised data have been available since 1907, and can be made accessible on floppy disks, paper sheets and reports. Target audience for reports are administrative bodies and citizens.

2.7 Greece

2.7.1 Characteristics of Groundwater

The groundwater potential in Greece is around 10.3 x 10^9 m^3/year, whilst 7.4 x 10^9 m^3/year is karst groundwater. Spring water is considered as surface water and it is, therefore, not included in the groundwater potential.

2.7.2 Structure of the Administrative Organisations Concerning Groundwater Quality

Due to the decentralised structure it was impossible for the Greeks to provide answered questionnaires in time. They tried to give a first common overview in a letter attached and in the first part of the MW2 questionnaires. The organisations involved in groundwater quality monitoring are many different ones such as the Greek Ministry of Agriculture, the Institute of Geological and Mining Research, the Public Service for Sewerage and Domestic Water Consumption. Even some universities carry out groundwater quality monitoring within the framework of research programmes. The monitoring helps to survey and control the exploitation of groundwater for consumption in households, industry and agriculture (mostly irrigation purposes).

For the future a national network is planned within the second EC Structural Fund under the responsibility of the Ministry of Environment, Physical Planning and Public Works with high priority. The network will comprise 186 monitoring sites and laboratory analyses will be carried out to determine NO_2, NO_3 and NH_4 concentrations in accordance with the EC Directive 80/778 EEC (quality of water for human consumption). In addition pH, temperature, conductivity, total hardness and solid residue will be determined together with ion concentrations (Cl, SO_4, Ca, Na). Samplings will be carried out on a six monthly basis (wet and dry season).

2.7.3 Monitoring of Groundwater Quality

Due to the decentralised structure it was impossible for the Greeks to provide answered questionnaires in time. In a letter attached as well as in the first part of the MW2 questionnaires they tried to give a first common overview.

The Ministry of Agriculture carries out groundwater quality monitoring programmes comprising 275 sampling sites distributed all over Greece. The sampling frequency is 3 times a year and the aim of the monitoring is for the exploitation of groundwater for irrigation purposes.

2.7.4 Structure of the Administrative Organisations Concerning Groundwater Quantity

The responsible organisation is the Institute of Geological and Mining Research. The Institute caries out monitoring programmes on groundwater quantity within the framework of certain projects (hydrogeological studies) in specific areas and for given period of time. A database is now under development.

2.7.5 Monitoring of Groundwater Quantity

Monitoring of groundwater quantity is carried out by the Institute of Geological and Mining Research (see section 2.7.4). At the present time a database is under development using GIS and the Institute could not provide an answer in line with the structure of the circulated questionnaire.

2.8 Iceland

2.8.1 Characteristics of Groundwater

In Iceland groundwater resources are situated in two main areas. In late Quaternary hyaloclastites and basaltic lavas there are 40,000 km² high permeable and deep aquifers, an area that represents 35 % of the national area. The other aquifers are more superficial and low permeable and lie in Tertiary and early Quaternary basaltic lavas. The extent of them are about 60,000 km² about 45% of the national area.

The potential water resources come from precipitation with 200,000 mio m³/year and groundwater resources of 30,000 mio m³/year. The evapo-transpiration rate is 25,000 mio m³/year. The majority of the water resources is consumed in households (80 mio m³/year), for agricultural activities (70 mio m³/year) and finally for industrial procedures (10 mio m³/year). Only for domestic consumption it is possible to determine the percentages of the consumed water. About 62 % are taken from the Quaternary aquifers and 32 % from springs.

2.8.2 Structure of the Administrative Organisations Concerning Groundwater Quality

The Drinking Water Announcement is the legal basis for the monitoring of groundwater in order to supply people with good drinking water. Local municipal health bodies are responsible for the implementation of the Drinking Water Announcement and for the quality monitoring. Their activities are done under the supervision of the Environment and Food Agency. The monitoring network is an instrument that helps to ensure the quality standards of water taken for human consumption.

2.8.3 Monitoring of Groundwater Quality

No information is available on this aspect at the present time.

2.8.4 Structure of the Administrative Organisations Concerning Groundwater Quantity

In Iceland groundwater quantity monitoring is done without having a special national monitoring programme, consequently the national coverage of the networks is incomplete. The NEA (National Environment Authority), a governmental organisation is mainly responsible for groundwater monitoring and energy matters. The NEA's Hydrological Service supervises the monitoring measurements. The countrywide water gauging networks of different National Power Companies (NPCs) or Public Water Works are connected with the Hydrological Service. The NPCs are semi-governmental co-operations which produce electricity for Iceland. Most of the electric energy is taken from hydropower plants. The exploitation of groundwater is assessed by local public water works with a wide spectrum of methods (from rough estimates to exact gauging). The main tasks of the monitoring activities are basic data collection, research work, the management of water supply for power plants.

2.8.5 Monitoring of Groundwater Quantity

Groundwater quantity monitoring is split in many local and regional networks, mostly co-ordinated by energy co-operations. At this stage no detailed information about total number of sampling sites could be given. Most of them are situated in drinking water wells, collecting data of groundwater level, temperature and conductivity for special programmes. Spring observation points measure discharge, water temperature and conductivity. The data collected are stored in ORACLE database using GIS.

2.9 Republic of Ireland

2.9.1 Characteristics of Groundwater

The total area of the Republic of Ireland is around 70,000 km². The geological structure of Ireland consists of Precambrian schists and quartzites, Devonian sandstone, Carboniferous limestone and some more smaller formations. The only widespread aquifers with inter-granular permeability are in the Quaternary deposits. Irish aquifers are relatively shallow and often small in their lateral extent. In the western parts of the country there are karst aquifers. In Ireland the total aquifer is estimated to be of the order of 18,870 km². Is has not been possible to give a detailed breakdown by type. The potential water resources of Ireland are composed as follows: Precipitation provides 80,882 mio m³/year, inflow from neighbour countries about 3 mio m³/year, the evaporation rate is minus 31,620 m³/year. The water is mostly consumed in households

(431.5 mio m³/year), followed by industry (249.7 mio m³/year) and finally agriculture (129.6 mio. m³/year). A quarter of all water consumed is taken from groundwater, the other 3 quarters come from surface water. Public water supply may be a problem in rural areas where the density of population is low. This fact leads to regional provisions of piped supplies, which is expensive. The more isolated farmhouses are responsible for their own supply with boreholes and springs.

2.9.2 Structure of the Administrative Organisations Concerning Groundwater Quality

At present an Irish programme for groundwater quality monitoring is planned. The EPA (Environmental Protection Agency) has prepared a draft national groundwater quality monitoring programme which is expected to be finalised in late 1996. The public water supply is managed by local authorities.

In older Irish legislation groundwater has already been mentioned. The legal basis is considered to be the Common Law, but more in the field of water abstraction than water protection. The Protection of Water, including groundwater was determined with the enactment of the Water Protection Act of 1977. This act was amended by the Local Government (Water Pollution) (Amendment) Act of 1990. Its pollution control provisions are fully applicable to groundwater. Part IV of the regulations makes further provisions for the control of discharges of harmful substances to groundwater. The EC (Waste) Regulations of 1979 and the EC (Toxic and Dangerous Waste) Regulations, both Irish transpositions of the European Toxic and Dangerous Waste Directive 78/319/EEC and the EC Waste Directive 75/442/EEC oblige local authorities in planning, organisation, authorisation, supervision and disposal of waste within their areas. Other regulations are the EC (Environmental Impact Assessment) Regulations of 1989 and Local Government (Planning and Development) Regulations of 1990 which follow the Council Directive 85/337/EEC. Additionally the EC Nitrates Directive and EC (Quality of Water Intended for Human Consumption) Regulations of 1988 have implications for water quality monitoring programmes and also for water quality control in aquifers. Finally the EPA is obliged due to the Environmental Protection Agency Act of 1992 to organise the national monitoring programmes and water resources.

2.9.3 Monitoring of Groundwater Quality

At this stage only a general description of the planned quality network can be given. More details are given in the report „Groundwater in Ireland“ prepared by EPA for *EurAqua.*

Groundwater quality monitoring is carried out on a national basis by the EPA in collaboration with local authorities. They act in relation to the Irish and European laws. Data on groundwater quality are also collected by the Geological Survey of Ireland (GSI) or universities related to specific projects. Three different types of monitoring are in operation,

1) the representative or basic network that studies the state of groundwater, detects trends and assesses causes of any changes. Sampling sites are distributed in relation to hydrogeological conditions. 293 groundwater abstraction points are spread countrywide, parameters are measured twice a year. Responsible organisation will be the EPA in collaboration with local authorities;

2) the user related monitoring has the purpose to monitor water resources used for drinking water supply in relation to Drinking Water Regulations. It is undertaken by local authorities that send the raw data to EPA for analyses and publication;

3) the pollutant related monitoring helps to detect possible pollutant emissions from landfill sites, septic tank clusters, industrial sites etc. These monitoring activities are carried out by the owners and operators of possible pollution causes.

An information database will be established at EPA which will provide data for research, development and planning activities or environmental protection measurements. The main responsibility of data collection have local authorities on a county basis. The extent of the network is related to the types and number of aquifers, the location of potential pollution sources and water abstraction procedures.

2.9.4 Structure of the Administrative Organisations Concerning Groundwater Quantity

The Geological Survey of Ireland is a national body concerned with all aspects of the geology of Ireland. The Groundwater Section of the Geological Survey undertakes a groundwater level survey in five of the 26 Counties for basic data collection and scientific research purposes. This is the only national network for groundwater monitoring and it is carried out in selected locations at 22 sites in 6 groundwater regions.

2.9.5 Monitoring of Groundwater Quantity

The „Groundwater Level Monitoring Network“ of the Geological Survey (GSI) of Ireland collects basic data and provides information for scientific research. The geographical extent is within the counties of Cork, Laois, Kilkenny and Roscommon. In porous aquifers there are 2 selected locations for groundwater sampling, in karst aquifers there are 17, in fractured rock aquifers there are 3 of them. The sampling sites are characterised as bored wells, dug wells and springs. They measure the groundwater level monthly (wells) and continuously (springs). No standardised procedures for the whole monitoring network have been fixed up to now. The earliest record was in 1974, the median record in 1976 and the average length of records is 16 years. The data collected are written in EXCEL-spreadsheets. Data are not free of charge. Data are accessible without restrictions at the Geological Survey of Ireland.

2.10 Italy

2.10.1 Characteristics of Groundwater

Due to the divided responsibilities for monitoring activities (see structures of monitoring) the information given is only a kind of an average estimation. More than 50 % of groundwater resources are in porous media with a territorial extension of 157,244.86 km² Groundwater aquifers in karst media are extended over 50,615.11 km² (i.e. 16.76 %) and finally there are smaller groundwater resources in volcanic rock media with an area of 13,488.78 (i.e. 4.46 %). In Italy the precipitation is about 2,960 mio m³/year the evapo-transpiration rate is about 1,290 mio m³/year.

2.10.2 Structure of the Administrative Organisations Concerning Groundwater Quality

The Italian Ministry of Health and the Ministry of Environment survey the monitoring activities undertaken. Monitoring networks of the 19 Italian regions and 2 of 103 autonomous provinces are run by Local Health Units and Local Water Supply Services. Consequently many hundred different organisations have their own monitoring system. A national network has not been installed. Data are collected in so many different ways that a comparison does not seem really useful. The legal basis for water monitoring can be found in the Decree of the President of the Republic No. 236, 24 May 1988 concerning quality requirements, monitoring and water for human consumption.

2.10.3 Monitoring of Groundwater Quality

Although there exists no national monitoring there are two main purposes for network activities concerning groundwater quality. One group of network systems are operating due to the Decree No. 236 of 24 May 1988. This law regulates monitoring procedures for groundwater quality monitoring in order to supply people with good drinking water. The Decree 236 implements the EC Directive 80/778 EEC (quality of water for human consumption) too. Organisations in the 103 provinces are responsible for sampling and chemical analysing. Sampling sites are situated in springs, wells, aqueducts, purifying plants and water supply networks. They were distributed with regard to the Decree No. 236 of 24 May 1988 and they collect data of water taken for human consumption and for food industry. There are obligations to use comparable standardised methods for analyses. The networks have been in operation since 1988. Data are stored in many different ways, from province to province other technical facilities are used.

The other group of networks for groundwater quality monitoring can be summarised as a „national informative environmental network“. But at this stage this network has not been fully installed, it is still in a kind of testing status. The Ministry of Environment with the National Environment Information System co-ordinates the programme, manages the data collected and publishes them. The Ministry is supported by

collaborating organisations in the 19 regions and the 2 autonomous provinces. These organisations are also responsible for local sampling and chemical analysing within their own networks. Sampling sites in drinking water wells and springs measure the parameters. The most important criteria for their distribution were to seize the whole extension of the aquifers, to take account of the population density, land cover and to get representative data of water quality and water balance. Regulations lead to comparable monitoring procedures and analytical methods. The organisations responsible for sampling are also obliged to follow quality control procedures. Data are mainly stored in ORACLE databases using UNIX or CICS. Software tool is SQL. Computerised data have been available since 1966 and are accessible on floppy disks, internet and paper sheets.

2.10.4 Structure of the Administrative Organisations Concerning Groundwater Quantity

The legal reasons and duties for monitoring are fixed in the Decree of the President of the Republic No. 319, 10 May 1976 concerning: protection of water from pollution, regulations for disposal, use, purification and monitoring. In the 19 Italian regions and 2 autonomous provinces the monitoring systems are run by Local Health Units or Provincial Bodies. Seven regions have recently established the Regional Environment Agencies to co-ordinate the activities of the Local Health Units.

2.10.5 Monitoring of Groundwater Quantity

The information given was just a attempt of an average estimation. Groundwater quantity monitoring is run by regional water supply bodies. They have to follow the Decree No. 319 of 10 May 1976. The main objective is to collect basic data like groundwater level.

2.11 The Netherlands

2.11.1 Characteristics of Groundwater

The Netherlands is a densely populated country covering an area of 38,000 km². It is heavily industrialised whereas the agricultural use of soils is one of the most intense in the world. Because of the wide use of fertiliser (average use of e.g. nitrogen fertiliser 260 kg/ha/year) there are great problems of groundwater pollution in wide areas, especially sandy regions, about 42 % of the whole country. Consequently the nitrate concentration is often higher than the drinking water standard of 50 mg/l. In urbanised regions hundreds of thousands local pollution sources can be found, thereupon the groundwater quality is often endangered.

In more than 90% the country groundwater level is less than 4 m below the surface level. Only in the central glacial formed hills a deeper level can be measured. Several national environmental institutions gather national environmental data such as groundwater data. These networks -with exception of the surface monitoring one- are managed by the National Institute of Public Health and Environmental Protection. In addition smaller network units at regional and local level exist. The general goals of the networks are:

- description and diagnosis of the environmental quality for the benefit of environmental policy
- evaluation of the effects of corrective actions
- increase of environmental knowledge
- observation of changes in the quality of the environment
- enforcement of regulations
- facilitation of responses to emergency situations

Potential water resources can be divided in 30,000 mio m^3/year precipitation, 80,000 mio.m^3/year inflow from neighbouring countries minus 20,000 mio. m^3/year evapo-transpiration. Most of the water, 4,000 mio m^3/year is needed for the industrial sector, 600 mio. m^3 for households. No detailed information is available for the agricultural sector.

2.11.2 Structure of the Administrative Organisations Concerning Groundwater Quality

The Netherlands are divided in 12 provinces. Although the national network provides sufficient national groundwater quality data there was also a need for the establishment networks of a provincial level (PMG-networks). Since 1993 the provincial monitoring networks has provided information needed for the special aspects of political measurements at provincial and regional levels. All these networks were designed in close co-operation with the National Institute for Public Health and Environmental Protection (RIVM). The RIVM co-ordinates the national groundwater quality monitoring activities (LMG-network) as well as sampling and analysing activities. The RIVM manages the groundwater database on both national and provincial level. The central government is the national authority which makes the laws and ordinances that are the legal basis for the networks. Sub regional and/or local level municipalities and water boards are the main responsible authorities for the water management.

2.11.3 Monitoring of Groundwater Quality

The Dutch groundwater network was established in the early 1980s. The objectives of the network are:

- inventory and diagnosis of groundwater quality in relation to soil use, soil type and hydrogeological conditions

- indication of human influence on groundwater quality
- identification of long-term changes in groundwater quality
- provision of data for groundwater quality control and groundwater management

The structure and operation modus of the network takes account of the objectives listed above. At present the network consists of approximately 380 monitoring wells i.e. an average density of 1 well/100 km². The majority of wells are spread in areas with fresh groundwater that can be used for drinking water. The monitoring sites are each closely associated with the soil type and the land use in their operation area. The wells used as sampling sites were drilled specially for the network. Taking into account the very low groundwater velocity in the Netherlands the sampling frequency is once per year. All samples are collected under standardised operating procedures. With the help of special instruments samples are collected under nitrogen gas directly before filtration. Quality assurance procedures (ISO 9000, EN 4500) are provided for all important steps in the course of monitoring from drilling of wells up to data presentation. There are two main programmes in the Netherlands, the „basic“ and the „ad-hoc“ programmes. The ad hoc programme is a kind of special monitoring programme in selected wells due to type and use of pollutants such as heavy metals, industrial organic pollutants or several groups of pesticides. The earliest record was taken in 1979, the average record length is 10 years.

The data are loaded onto a special database developed in 1991. In this INGRES database data of different networks in the Netherlands are included, thus simplifying mutative use of data. The hardware is HPUX and the software tools are INGRES/SHELL SCRIPT. The presentation of data occurs at different levels firstly individual data presentation, secondly annual data presentation on a provincial level and finally annual description and diagnosis of groundwater quality in the Netherlands through statistical characterisation and mapping of groundwater quality. In addition, all data are also collected in MONITOR, a user friendly GIS system developed by order of the RIVM. MONITOR is a tool for researchers and policy makers and can be easily installed at PCs. Data are free of charge but there are restrictions for the availability.

In the 12 Dutch provinces networks on a provincial level are in operation. They have quite the same goals as the national network e.g.:

- description of present quality situation
- identification of temporal trends
- source of basic data for research and management
- evaluation of policy measures
- signalling of quality developments in vulnerable areas (early warning).

Most attention is paid to the quality assurance procedures and standardised regulations for the whole monitoring procedures to make data comparable between provincial and national networks. The provincial authorities run the networks and are responsible for sampling and analysing. All data gathered are stored in the database of RIVM and are there accessible for the provincial authorities.

Other Dutch groundwater networks are:

1. Drinking water networks. Water supply companies abstract groundwater at about 240 pumping stations. Before and after the treatment groundwater is sampled and analysed.
2. Monitoring networks near local pollution sources like waste disposal sites (for every new site a network is obligatory), baseline stations, sites with polluted soil/groundwater.
3. Forest monitoring programme: In 150 forest sites the effects of soil acidification in forests and heathland sites are focused. The programme is related to shallow groundwater in the Dutch sand regions.
4. Eutrophication monitoring of groundwater in agricultural areas. The programme is related to the use of fertiliser and manure in agriculture as well as policy measurements to reduce environmental impacts of nutrient losses.

2.11.4 Structure of the Administrative Organisations Concerning Groundwater Quantity

As the Netherlands are a low-lying country, piezometric heads of groundwater are found at shallow depths. Slight changes of groundwater level can highly influence the situations for households, industry and agriculture. With regard to this vulnerable status the level monitoring is very important. There are approximately 30,000 groundwater observation wells. Monitoring networks can be divided in 3 groups: networks for water management, networks for exploration and exploitation of groundwater and networks for scientific research. The networks for water management can be found at three different levels:

- on a national level; on behalf of the Ministry of Transport Public Works and Water Management
- on a regional level; on behalf of the provincial authorities
- on the local level; on behalf of water boards, municipalities and nature conservancies.

The national monitoring network is maintained by the TNO Institute of Applied Geo-science and provincial authorities. The other networks are maintained by their owners and the TNO Institute of Applied Geo-science. All data are stored in a national database maintained by the TNO Institute of Applied Geo-science. To ensure the quality of data a quality control programme has been developed which is also co-ordinated by the TNO Institute of Applied Geo-science. The most important legal basis for the monitoring activities is the Water Management Act. This act requires the water manager to design and implement water management plans, in which the water manager indicate how the water in a certain area will be used and protected.

2.11.5 Monitoring of Groundwater Quantity

The „Dutch Primary Monitoring Network for Groundwater Levels“ was established in the 1980s. The number of observation wells expanded considerably as a result of an increase in groundwater investigations related to agricultural and public water supply. The main purposes for groundwater quantity monitoring are:

- identify potential uses
- design target scenarios
- design management measures
- evaluate water management

The responsible organisation for the co-ordination of the networks is the Ministry for Transports, Public Works and Water Management. It is supported by the RIZA, the Institute for Inland Water Management and Waste Water Treatment. The local sampling is carried out by provincial authorities. The TNO Institute of Applied Geo-science co-operates closely with all of them. It manages the database and is responsible for the design and the optimisation of the monitoring network, in some regions for the maintenance of the network and research on monitoring topics. In an area of 36,000 km² of porous media 4,000 sampling sites are distributed. They are bored wells measuring water level (2 times a month/basic programme and daily/special programmes); water temperature (every 15 minute/basic programme) and density -EC, TDS or Cl- (once a year/basic programmes). There are no standardised procedures with respect to the measurement methods and maintenance of observation wells. The quality assurance procedures for the groundwater level can be schematised in three phases, phase I - automatic plausibility check, phase II - detection of extremes in one time series and phase III - detection of spatial extremes. There are standardised methods for data handling. The earliest record was taken in 1870, the average length of record is 20 years.

The following data are stored in a DBMS:ORACLE and/or a GIS : ARC/INFO and SMALLWORLD database using UNIX hardware:

Point data	***Spatial data***
groundwater heads	dimension and properties of layers
chemical analyses	surface water system
well logs	infiltration/seepage areas
geophysical measurements	surface level
geo-electrical soundings	fresh/saline interfaces
pumping tests	groundwater head contours
groundwater abstractions	polluted areas

Data are available on floppy disks, paper sheets and hard disks of central-on-line-database. Data have to be paid for and are not accessible to everyone. Reporting is not a regular activity but it is carried out on an ad hoc basis normally (but not always) by the TNO Institute of Applied Geo-science.

2.12 Norway

2.12.1 Characteristics of Groundwater

In Norway there are two main types of aquifers: bedrock without primary porosity but with secondary passages such as joints and other fractured or Quaternary superficial deposits with primary porosity. Bedrock aquifers: with exception of the upper Permian aeolian sandstone in Brumunddal and some Permian volcanic rocks, all Norwegian bedrock types lack primary porosity and are non permeable on small scale. The presence of groundwater is restricted to joints formed by tectonic fracturing and to a less extent to open fractures and voids formed by dissolution of limestone and vein and void minerals, usually calcite. The abundance of water bearing fractures and the frequency of open joints (fissures) are strongly controlled by rock type (competency), thickness and type and orientation of paleo stress and recent stress. These factors also control the actual fracture pattern and strongly influence topography.

About 80,000 wells have been drilled in bedrock for groundwater supply, and about 4,000 new wells are drilled annually. The wells are mostly used as water supply for single house farm, small concentrations of houses and local waterworks in areas with sparse population. Information on depth and water yield from about 20,000 of the total 80,000 wells drilled in Norwegian bedrock is stored in the hydrogeological Data base for Geological Survey of Norway in Trondheim.

Water quantities usually obtained out of drilled wells in bedrock range from zero to 10,000 l/hour, although the latter figure must be regarded as a very good yield. Most wells have capacities between 300 l/h and 2,000 l/h. The potential of wells drilled in bedrock for household water supply with bigger concentrations is probably somewhat underestimated. With a water consumption of 350 l/person/day only a well that yields about 1 l/s (3,600 l/h) can be sufficient to cover the demand of about 250 people.

Quaternary aquifers: The Quaternary deposits represent a very good aquifer in ice-margin deltas and in glacio-fluvial valley fills. Wells can produce water quantities in the order of ten to a hundred times higher than bedrock wells. Several cities, towns and other rural sites, as well as industrial enterprises use good water from aquifers in Quaternary deposits, The groundwater in fluvial aquifers in the valleys is infiltrated from rivers and is of good quality with groundwater characteristics and stable temperature. The deposits can be regarded as large natural filters. The yield of wells in such aquifers may sometimes give about 100 l/s.

The Norwegian water management terms to these aquifers are regarded as groundwater supplies. Therefore these types of aquifers have not been characterised as bank filtered water.

2.12.2 Structure of the Administrative Organisations Concerning Groundwater Quality

In 1977 The Geological Survey of Norway (NGU) and the Norwegian Water Resources and Energy Administration (NVE) initiated a nation wide groundwater monitoring network named „Landsomfattende Grunnvannsnet“, LGN) to co-ordinate the groundwater data collection in Norway. This network was extended in 1980 by including four stations within or close to „calibrated“ catchments, in order for the Norwegian Institute for Water Research (NIVA) to carry out (in co-operation with NGU) its responsibility for groundwater monitoring within the context of the Norwegian Monitoring Programme for Long-Range Transported Air Pollutants. This programme is a major, collaborative initiative co-ordinated by the state Pollution Control Authority (SFT) to describe and follow trends in precipitation chemistry, soil and water acidification. Within the LGN the NGU is responsible for the monitoring and reporting; apart complies from the four stations where NIVA is responsible. The extent of the monitoring is national. It complies with international and national standards with respects to analyses and international procedures for sampling. The quality of data is hereby assured.

2.12.3 Monitoring of Groundwater Quality

The „Landsomfattende grunnvannsnet, LGN is a national groundwater monitoring network in Norway. Until 1991 NIVA was the responsible organisation for database management and chemical analyses. At present the Geological Survey of Norway (NGU) fulfils these tasks. It co-operates with the Norwegian Water Resources and Energy Administration (NVE) that does the local sampling. The LGN consists of 38 monitoring stations distributed all over the country, groundwater level is measured 2-4 times a month at each station, groundwater temperature is monitored 2-4 times a month at 31 stations and groundwater chemistry is determined 1-2 times a year at 17 stations and monthly at 4 stations. Standardised procedures are used for monitoring, e.g. wells are pumped for sampling. Sampling is taken 15 minutes after the water seems clear. All water determinants are analysed in the laboratories of the NGU using the Norwegian Norm Procedures NS-EN 45001 for precision and accuracy. The earliest record was taken in 1978, the average length of records is 15 years.

Data are stored by NGU in an EXCEL-database using PC with Windows software. Computerised data have been available since 1978. Whether data are passed on free of charge or not, depends on the data amount and degree of processing. The NGU publishes annual reports for consultants, research institutes or environmental organisations.

Another Norwegian groundwater monitoring network is called Norwegian Monitoring Programme for Long-Range Transported Air Pollutants. This programme is a major, collaborative initiative co-ordinated by the State Pollution Control Authority (SFT) to describe and follow trends in precipitation chemistry, soil and water acidification. Within this project NIVA is obliged to take samples, store data on to their database and

produce reports. The NGU co-operates with NIVA by measuring water level. The observation points are 4 wells, situated in each groundwater region in porous media. Norwegian standards are used for sampling methodology. The chemical analyses are carried out by one private laboratory. Quality assurance procedures for the laboratory are determined. The laboratory has to use the EN 4500-Standard, data are checked for outliers and ionic balance control is conducted. This network has been in operation since 1980 and the average length of record is 15 years. Data are stored in a „RESA"-database, an application oriented data archive system, developed by „Egil Stoeren Programutvikling". Hardware used is based on a UNIX system running on IBM/PCs. Software tools are C or UNIX. Since 1980 computerised data have been available. The are laid down in floppy disks, paper sheets and reports. NIVA publishes data yearly, the data are for national and local environmental authorities only.

2.12.4 Structure of the Administrative Organisations Concerning Groundwater Quantity

In 1977 The Geological Survey of Norway (NGU) and the Norwegian Water Resources and Energy Administration (NVE) initiated a nation wide groundwater monitoring network named „Landsomfattende grunnvannsnet, LGN) to co-ordinate the groundwater data collection in Norway. This network was extended in 1980 by including four stations within or close to „calibrated" catchments, in order for the Norwegian Institute for Water Research (NIVA) to carry out (in co-operation with NGU) its responsibility for groundwater monitoring within the context of the Norwegian Monitoring Programme for Long-Range Transported Air Pollutants. This programme is a major, collaborative initiative co-ordinated by the State Pollution Control Authority (SFT) to describe and follow trends in precipitation chemistry, soil and water acidification. Within the LGN the NGU is responsible for the monitoring and reporting; apart from the four stations where NIVA is responsible. The extent of the monitoring is national. The reason for monitoring is basic data collection for use as reference data and for use in research, trend identification and public information. The Geological Survey of Norway (NGU) and the Norwegian Water Resources and Energy Administration (NVE) are both responsible for the monitoring and reporting. The monitoring does not comply with any international standards. However, internal procedures and database quality assurance routines maintain the demand of quality standard.

2.12.5 Monitoring of Groundwater Quantity

The „Landsomfattende Grunnvannsnet", LGN is a national groundwater monitoring network in Norway. The network has the goal to support basic groundwater quantity data for the management of water supply and research. Data collected should improve the knowledge on regional and periodical variations in the quality and quantity of the groundwater and whether these changes may be attributed to geological, topographical and climatic conditions. The programme is co-ordinated by the NGU. The NGU is also the reporting and chemical analysing organisation. It is assisted in its task by the NVE that is responsible for sampling, database management and co-reporting. In porous

media 36 sampling sites, mostly driven wells, are distributed. They measure water level and water temperature 2-4 times a month. An internal manual for water level and temperature provide standardised methods of observation for the NVE-observateurs. The earliest record was taken in 1967, the average length of record is 15 years. Groundwater quantity data are stored in a SYBASE-database using SiliconGraphics, IRIX, and MS WINDOWS as operating system running on PCs. Software tools are C, C++, FORTRAN, Usoft Developer and Report Smith. Data are available on floppy disks. Internet, paper sheets and reports. The data are only available via NVE. A handling fee is charged dependent on the data amount and the degree of processing.

2.13 Portugal

2.13.1 Characteristics of Groundwater

In Portugal the main aquifer systems are in porous media and karst. The area of porous media has an extension of 26,000 km² (i.e. 29.4 % of national territory), karst groundwater comprises an area of 5,500 km² (i.e. 6.2 %). The aquifers systems are located in meridianal and occidental Mesocenozoic border and tiercearies basins of Tejo and Sado. The average productivity is between 10 and 30 l/s per well. Almost 40 % of these aquifers have a productivity of more than 30 l/s. In general the unconfined aquifers have a higher or moderate vulnerability. Some other aquifers are located in residual soils of ancient rocks, e.g. igneous or metamorphic formations, which are important local resources. The productivity of these aquifers is less than 3 l/s and is related to the periodicity of wet and dry periods. As the groundwater quality is mainly good about 70 % of the water supply is supported by groundwater resources. The potential water resources are composed of 81,890 mio. m³/year precipitation and 35,100 mio. m³/year inflow from neighbouring countries. The yearly evapo-transpiration rate is 44,560 mio. m³ high. Most of the water is used in the agricultural sector (293 mio. m³/year), followed by households (276 mio. m³/year) and finally industry (145 mio.m³/year).

2.13.2 Structure of the Administrative Organisations Concerning Groundwater Quality

Head of all groundwater monitoring activities is the Portuguese Ministry for the Environment. On behalf of the Ministry INAG (Instituto da Agua) co-operates with several DRARNs (Direccoes Regionais do Ambiente e Recursos Naturais) in fields of groundwater monitoring. In some cases quality monitoring is also done by so called ARS's (Administracao Regional de Saude). At present groundwater is only monitored in the Miopliocenic systems of Tejo and Sado. These regional networks are done by the DRARN of Lisbon and Tejo Valley. It was established in 1977 with 28 observation points which control the seawater intrusion at the estuary border. In 1985 these networks were increased; 46 new observation points were installed to get an average situation of the groundwater region.

Since 1983 in the Algarve region within karst and porous media regional networks have been operating in order to get information on seawater intrusion points and agricultural nitrate pollution areas. At the beginning there were 25 bored wells and 3 dug ones. Samples were taken 2 times a year. From 1992 to 1993 an implementation of nitrate monitoring with 60 sampling sites was made there. At present the DRARN Algarve implements a quality network with 30 sampling sites located in areas for water supply.

INAG and some institutions are developing a protocol to do several projects in order to optimise the current quality networks, to implement others to support the water resource management and to comply the national and international laws.

2.13.3 Monitoring of Groundwater Quality

The „Rede de Control da Qualidade“ is a regional groundwater monitoring network in the Tejo and Sado Miopliocenic aquifer systems that informs about seawater intrusion and nitrates contamination and provides data about the present groundwater status. The Instituto da Agua-INAG co-ordinates the network activities and runs the database. The DRARNs take the local samples and co-operate with INAG in report writing and database management. The 74 sampling sites are located evenly in the whole area as well as concentrated around specific sites such as impact areas or drinking water wells. Samples are taken from 1 to 4 times a year. The analyses are done in a public laboratory. Sampling procedures are standardised. Analyses have to be carried out with regard to laboratory quality assurance standards but detailed information was not available at this stage of report. The earliest record was taken in 1977, it has an average length of 18 years. Raw data are stored in an ACCESS, ORACLE-RDBMS database, the operating systems are DOS, OSF1, using ALPHA DIGITAL and PCs as hardware. Software tools are SQL, ACCESS BASIC, C, SQL+ Forms and Reportwriter. The data are available on floppy disks and reports. Reports are published by INAG. To date there are no periodical Portuguese reports concerning groundwater quality observations, because the monitoring network is only just starting in some regions.

2.13.4 Structure of the Administrative Organisations Concerning Groundwater Quantity

Groundwater quantity monitoring is undertaken in all relevant aquifers of the occidental and meridianal Mesocenozoic borders, in the Tejo and Sado system aquifers and in the karst of Palaeozoic formations. INAG co-operates with several DRARNs (Direccoes Regionais do Ambiente e Recursos Naturais) in fields of quantity monitoring activities. The operation of local networks is done by water supply systems. INAG and DRARNs act on behalf of the Ministry of Environment. INAG and some institutions are developing a protocol to do several projects in order to optimise the current quality networks, to implement others to support the water resources management and to comply the national and international laws.

2.13.5 Monitoring of Groundwater Quantity

Groundwater quantity monitoring has several purposes; it helps to characterise the groundwater, it is the basis for analysing the space/time development of the piezometric level in terms of natural recharge, soil occupation and water uses and it is necessary for the groundwater management. The responsible organisations are INAG and the DRARNs. INAG co-ordinates the whole programme and with the help of the DRARNS it manages the data and reports on groundwater quantity. In return the DRARNs are involved in local sampling. The network operates on national level, the main aquifers in Portugal are covered. About 477 sampling sites observe groundwater in porous media and 143 sampling sites do the same in karst media. 430 are bored wells, 168 dug wells and 31 spring wells which provide water level and discharge data. The sampling frequency varies from 12 to 2/3 times a year. The piezometric level is measured by electric sound of contact. If a registered value does not seem realistic it will be confirmed at the field. If a critical situation occurs an alert (of decisiveness) will be activated. The network has been in operation since 1970. The average length of a record is 15 years. Data are stored in an ACCESS, ORACLE-RDBMS database, the operating systems are DOS, OSF1, using ALPHA DIGITAl and PCs as hardware. Software tools are SQL, ACCESS BASIC, C, SQL+, Forms and Reportwriter. The data are available on floppy disks and reports at INAG. Monthly hydrological bulletins are published by INAG. In the reports the development of groundwater piezometric level is laid down. Some other reports have been done by the Universities and by the national Laboratory of Civil Engineering.

2.14 Spain

2.14.1 Characteristics of Groundwater

More than one third of the Spanish national areas contains groundwater aquifers. Groundwater in porous media contains an area of 79,258 km² (16 % of whole country), karst groundwater is spread in an area of 54,628 km² (11 % of the whole country) and other groundwater resources can be found in an area of 38,644 km² (8 % of the whole country). The potential water resources are 340,000 mio. m³/year precipitation minus 277,000 mio. m³/year evapo-transpiration. In households about 43,000 mio. m³/year water is consumed, in industry about 19,000 mio. m³/year. The highest demand for water has the agricultural sector which is about 24,200 mio. m³/year. Nearly a quarter of the water consumed can be gained from groundwater resources.

2.14.2 Structure of the Administrative Organisations Concerning Groundwater Quality

The Spanish monitoring network is called „Red general de la calidad y red the intrusion“. There are two main organisations involved. Firstly the „General Directorate of water quality -Direccion general de calidad de las aguas“ which is a department of the

Ministry for Public Works, Transport and Environment. It is working in the fields of monitoring and monitoring-administration activities. Secondly, the „Institute of Geomining Technology of Spain -ITGE“ which depends on the Ministry of Industry and Energy. It carries out network design, data collection, chemical analyses, storage and management of database and the reporting.

The Spanish monitoring is an instrument that helps to collect basic data for the „National Groundwater Research Plan“. Reports on the data are worked out by the ITGE and delivered to public authorities. The extent of this network is national. Additionally, there are two other networks in Spain. A network called „General groundwater quality network“ for general purposes and the „Sea Water Intrusion Quality Network“ for the study of pollution problems in coastal areas. Data collected have a quality control. Quality assurance procedures are carried out such as general supervision from project managers, syntax checking and depuration from database managers and checking analyses.

2.14.3 Monitoring of Groundwater Quality

The Spanish groundwater quality network PNGC (Plan Nacional de gestion y conservation de aquiferos) was established to study the general groundwater quality and sea water intrusion within the research programme of the groundwater general studies plan named „Groundwater Investigation National Plan“ (basic network for general purpose). Responsibilities within this network are shared between the „General Directorate of water quality -Direccion General de Calidad de las Aguas“ and the „Institute of Geomining Technology of Spain -ITGE“. The general directorate co-ordinates the programme and reports with the assistance of the ITGE, which is also busy in the fields of local sampling, database management and chemical analyses. The observation points are distributed evenly in the groundwater regions. In porous media 1,147 sampling sites are in operation, in karst media 408 and in isolated groundwater regions 1,377. In every region sampling sites are mostly baseline stations and control stations for sea water intrusion. Data collected are analysed by the ITGE. Within the whole network there are obligations to use comparable standardised methods for analytical methods. The ITGE laboratory has its own standardised regulation for precision and accuracy.

The network has been in operation since 1967 and has an average record length of 10 years. The database is managed by the ITGE. This database includes complete information about different groundwater parameters at control points. Computerised data have been available since 1971. Data are available on floppy disks, paper sheets and reports. Data are not free of charge, but accessible without restrictions. The reports worked out by ITGE vary as to their frequency.

2.14.4 Structure of the Administrative Organisations Concerning Groundwater Quantity

The national groundwater monitoring network is called „Red de Control Piezometrico y Red de Hidrometria“. The administrative responsibilities for the monitoring are carried out by the „General Directorate of Hydraulic Works - Direccion General de Obras Hidraulicas“ of the Ministry of Public Works, Transport and Environment. The ITGE - Institute for Geomining Technology of Spain, which depends on the Ministry of Industry and Energy, works in the fields of data collection, database management, data storage and reporting. Monitoring activities have the main purpose to gain data for the National Groundwater Research Plan. Reports on groundwater data are written by the ITGE and distributed to public authorities.

Other networks for groundwater quantity data collection are the „General Groundwater Waterlevel Network“ for general purposes and the „Groundwater Hydrometry Network“ for pollution problems in coastal areas. Guaranteed procedures for data collected have been carried out : e.g. general supervision from project managers, syntax checking and depuration from database managers, different filters and comparisons such as temporal evolution and spatial distribution of water levels. The database is an ORACLE database, the hardware is Hewlett Packard 9000 and 700 series. Operating systems used is UNIX. The network used is Ethernet with protocol TCP/IP. Language and software, reporting tools used: SQL, SQL forms, SQL-RW; ORACLE DATABROWSER; specific tools are: net software: LAN MANAGER-and APRA SERVICES. Computerised data have been available since 1971. Data are laid down on floppy disks, paper sheets and reports. Data are available without restriction, but a fee has to be paid. ITGE publishes reports with variable frequency for the general public.

2.14.5 Monitoring of Groundwater Quantity

The PNGC (Plan Nacional de Gestion y Conservacion de Acuiferos) is the Spanish national groundwater quantity network. The monitoring aims at obtaining and studying the general movement of groundwater and the aquifer response to pumping, as part of the National Groundwater Research Plan (basic network for general purpose). The general directorate and the ITGE are both responsible for programme co-ordination and reporting, whereas the ITGE is the only responsible for local sampling, chemical analyses and database management. The sampling sites are distributed evenly within the groundwater regions, 2,726 sites in porous media, 1,411 in karst area and 2,439 sites in isolated control points. The main type are bored wells (3,564) followed by dug wells (1,901) other wells (1,089) and 385 spring wells. They mainly record water level and discharge. Special programmes have different sampling frequencies (between 1-5, all series and basic programmes from 2-6 times a year). Observation is standardised: At the beginning of the programme 4-6 times per year at each control point, currently 2-6 times per year using electrical sounding.

The earliest record was taken in 1967; it has an average length of 10 years. The database managed by the ITGE includes a complete information about water observation points. Static information and variable information include water levels.

2.15 Sweden

2.15.1 Characteristics of Groundwater

The main aquifers are found in glacifluvial sand and gravel deposits. They cover only a few parts of Swedish territory, although more than three quarter of the Swedish population is supplied with drinking water from these resources. Till, another porous aquifer, covers 75 % of the country. Occasionally good yields can be achieved from these deposits, but wells in this area are mainly for single household supply. Aquifers in porous sedimentary rock are found in south-west of Sweden. They are very small regions as compared to the whole Swedish area. Karst groundwater is rare in Sweden. Aquifers in Archaean bedrock area have the largest extent of all aquifers. They can be found all over the country. Wells drilled in these rock types seldom yield more than 1l/s and are mainly for private water supply for single households.

2.15.2 Structure of the Administrative Organisations Concerning Groundwater Quality

The Ministry for Industry finances the Geological Survey of Sweden which is responsible for groundwater monitoring networks on a national level. Additionally the SGU is also responsible for environmental groundwater monitoring and produces reports and manuals on that topic that are delivered to the Environmental Protection Agency (EPA). The EPA is an organisation under the Ministry for Environment, which finances this kind of monitoring network. Databases on groundwater chemistry of both network systems are run and managed by the SGU. The 24 Swedish county authorities collect regional and local monitoring data -in co-operation with municipalities- and send them to the SGU. The SGU provides a handbook for sampling methodology, reports and data from the national database for them.

The main purposes for monitoring are:

- the description of environmental status and the detection of changes caused by anthropogenic load (acidification, Eutrophication, heavy metals)

- the assessment of the threat by anthropogenic load on groundwater quality as a basis for the formulation of environmental goals and on decisions on measurements (national and international) to achieve the goals.

The monitoring complies with national standards as the outline of the monitoring. Chemical analyses are made according to Swedish standards which usually agree with

international standards. Integrated monitoring is carried out according to international standards. Quality assurance is determined by sampling methods according to manuals. Analyses are made by authorised laboratories. A complete set of variables allows ion balance control.

2.15.3 Monitoring of Groundwater Quality

The „Country Wide Environmental Monitoring of Groundwater in Forest Ecosystems“ undertakes monitoring activities in order to describe the environmental status and to reveal changes caused by anthropogenic load such as acidification, Eutrophication, heavy metals. The observation of water quality is a basis for the formulation of environmental goals and helps to decide measurements on both national and international level to achieve these goals. The Geological Survey of Sweden co-ordinates the whole monitoring programme and manages the network database and carries out reports. The SGU is supported by the Swedish counties that organise the local sampling of data with their regional programmes. Sampling sites are distributed taking account of the heterogeneity of the geology of Sweden. Two sampling sites are operating in each of the 27 different geological regions of Sweden.

Groundwater data are analysed by 2 public laboratories. The sampling methodology is standardised, as follows: 1) the material of observation tubes is polythene. 2) the sampling equipment is of inert material, 3) turnover of water before sampling, 4) polythene bottles for heavy metals are washed in strong acids, 5) filtering of samples before acid preservation -acid washed 0.45 µ membrane filter and finally 6) transport of samples in cool boxes. In the laboratories the quality control and assurance procedures are ion balance control, control of individual variables and internal laboratory control. Data are stored in a RDBMS database (MIMER) using PCs, main frame computers and SUN workstations. Reporting, software tools are SAS and SQL. Computerised data have been available since 1979. Data can be made available on floppy disks, paper sheets and reports. Data have to be paid for, but are not restricted. The SGU publishes the annual reports for e.g. county authorities or environmental agencies.

2.15.4 Structure of the Administrative Organisations Concerning Groundwater Quantity

The Swedish Ministry for Industry provides the financial basis for the Swedish Geological Survey (SGU). This is the responsible organisation for the database management within the groundwater quantity networks. The network is a national reference network. Local networks are connected with municipal water works. There is no connection between them and the national network, but the national one serves as a reference to the local ones. Quality assurance is done by manual checking of time series.

The objectives for the groundwater network are:

- Study of regional and temporal variations of groundwater quality and quantity in relation to geology, topography and climate for groundwater resource estimation, reference purposes, forecasting and environment monitoring.

The SGU co-ordinates the monitoring activities and publishes the reports. Mass media agencies and subscribers of the information are monthly supplied with the reports.

2.15.5 Monitoring of Groundwater Quantity

The Swedish National Groundwater Network aims at studying temporal variations of groundwater quantity and quality in relation to geology, topography and climate. This should be a basis for groundwater resource estimation, reference purposes, forecasting and environmental monitoring. The responsible organisation is the Swedish Geological Survey (SGU) which co-ordinates the programme. In porous media 357 sampling sites are distributed in order to collect water level and temperature data. The majority of them are driven wells. The methodology of observation is standardised. Local observers manually measure the depth of the groundwater level twice a month and e-mail the result to SGU. Approximately 50 observers telephone the result of mid-month observations to a telephone recorder at the SGU on the day of observation. Quality control and assurance procedures are undertaken by intermittent manual control

The network has been in operation since 1955, the average length of record is approximately 20 years. Data are stored in a RDBMS database (MIMER) using PCs, main frame computers and SUN workstations. Reporting, software tools are SAS and SQL. Computerised data have been available since 1979. Data can be made available on floppy disks, internet, paper sheets and reports. The extraction of data is not free of charge whereas the data itself is not restricted. The SGU publishes reports about groundwater quantity monitoring.

2.16 United Kingdom

2.16.1 Characteristics of Groundwater

2.16.1.1 England and Wales

The three most important aquifers are the Chalk, the Sherwood Sandstone and the Jurassic Limestones which are consolidated, indurated sedimentary formations with dual porosity. The smaller aquifers have similar characteristics. They are formations in which groundwater flow has varying combinations of matrix and fractured flow components producing complex aquifers. These characteristics make representative sampling difficult. Another aspect is that smaller but important groundwater bodies are situated in consolidated sedimentary aquifers which are often heavily exploited.

2.16.2 Structure of the Administrative Organisations Concerning Groundwater Quality

2.16.2.1 England and Wales

The National Rivers Authority (NRA) is the responsible organisation that assesses and manages groundwater quality monitoring required by European and UK legislation. Section 84 of the Water Resources Act 1991 obliges to „*monitor the extent of pollution in controlled waters*“ , including groundwater. Sampling frequencies or determinands are not nearer specified by present legislation, with the exception of the EC Nitrate Directive. Moreover, in a European context, there is an increasing need for all EC member states to be able to provide a comprehensive national picture of the national status of water resources. Due to European and UK legislation other organisations are obliged to monitor water quality too.

- Waster Regulatory Authorities (WRAs) act on the Environmental Protection Act 1991 to ensure the property of local monitoring activities in the fields of the performance and security of landfill sites and the detection of pollution of groundwater from such sources.

- Drinking Water Inspectorates (DWIs) survey the potability within public water supply systems. They evaluate compliance with the EC Drinking Water Directive

- District Council Environmental Health Inspectors act in accordance with their duties under the Private Water Supply Regulations 1991

Samples taken from the organisations are not exceptionally raw water samples and consequently not representative for the groundwater in the referring aquifer.

The primary objectives for the national groundwater quality assessment for the NRA are:

- trend identification of groundwater quality changes caused by natural events or the impact of diffuse pollution sources and changes in the hydraulic regime.

- collect baseline information on groundwater quality in order to detect future impacts

- provide a picture of the three-dimensional distribution of groundwater quality within aquifers

- set up of an early warning system in recharge areas on aquifer outcrops of the impacts of diffuse sources of pollution

- provide information to meet the requirements of the EC Nitrate Directive to identify Nitrate Vulnerable Zones

Furthermore, information on industrial and urban impacts are to be gained; groundwater protection facilities are to be evaluated; contaminated land impact, landfill impact and saline intrusion are to be assessed; groundwater and surface water interaction are to be described, incident impacts are to be assessed and models used for prediction of groundwater quality are to be validated.

2.16.2.2 Scotland

In Scotland the Secretary of State for Scotland has overall responsibility for national water policy in Scotland. The Scottish Environmental Protection Agency(SEPA) has the duty to promote the quality of all controlled waters. SEPA undertakes the monitoring of groundwater (and other) resources used for public supply. The Unitary Authorities are responsible for monitoring of private water supplies. .....[1] One of the principal functions of SEPA is to grant consents for discharges to water resources (including groundwater),subject to out relevant to the particular resource, detailed hydrometric surveys and water quality monitoring.

2.16.2.3 Northern Ireland

The groundwater monitoring in Northern Ireland is shared between many institutions. The Environmental Service (ES; Department of Environment/NI) is responsible for the organisation, co-ordination and collation of the data. The original survey work is carried out by the British Geological Survey (BGS) which is a component of the Natural Environment Research Council (NERC). They deliver the data to Water Quality Inspectors, members of Local Councils, that collect and deliver the data to laboratories. Samples are analysed for nitrate in the IRTU, the Industrial Research and Technological Unit (Department of ED/NI). Currently groundwater samples from 5 sites are collected monthly by the Water Quality Inspectors (WQI) and delivered to the Industrial Research and Technological Unit which carries out the nitrate analyses. The results are reported monthly to the Environment Service.

In April 1992 the ES contracted the BGS to undertake a baseline study of the groundwater in Northern Ireland and thereupon a Hydrogeological and a Groundwater Vulnerability Map have been produced. Initially a total of 759 groundwater sources were measured for diameter, depth and statistic water level. At a total 351 sites with either pumped or naturally flowing water: pH, Eh, DO, SEC, temperature, alkalinity and major ions were measured. 109 sites were revisited at 3 monthly intervals until July 1994. These were reduced to 78 target sites and a monitoring contract will be arranged later this year. A BGS report detailing the above information will be available in the near future. In 1992/93 ES contracted ISC (????)[2] to sample and analyse nitrates in 95 groundwaters monthly for 12 month. This monitoring was reduced to 5 sites in October 1993 and sampling will continue until the aforesaid contract is commenced.

[1] …… means that answer provided was handwritten and not readable

[2] The full name was not given

2.16.3 Monitoring of Groundwater Quality

2.16.3.1 England and Wales

In the UK the „National Groundwater Quality Monitoring Programme“ is a network that provides information for the National Rivers Authority (NRA) which helps to manage the subsurface component of the water resources of England and Wales in a sustainable way, without deterioration in quality. Due to the „Water Resources Act 1991“ the NRA has the general duty to monitor „controlled waters“. Another legal obligation for water monitoring activities are given in the EC Nitrate Directive and the EC Groundwater Directive. A special interest is given to Nitrate monitoring. The NRA is responsible for programme co-ordination, database management, local sampling, chemical analyses and reporting. It is supported by the Water Service Association which assists in the fields of local sampling and chemical analyses.

In porous media 346 sampling sites are distributed, 270 sites in karst and 1,920 in other groundwater media. Regional current monitoring networks run by NRA have two main types of sampling points, one group for quality monitoring over a wide area and the other for a specific pollution source monitoring covering relatively small areas. These site specific monitoring activities are principally directed at landfills area. Sampling sites greatly vary in their regional distribution. An intended target of the UK`s National Groundwater Monitoring network is to have an average density of 1 site/25 km². The gaps of existing distribution can be filled by using private domestic supply boreholes. Samples are taken from 0.5-4 up to 1-4 times a year. Sample handling procedures depend on the determinants observed. The British Standard provides recommendations for appropriate storage and preservation methods (BS 6068, section 6.3, 1986). Data of regional monitoring activities mostly come from public water supply bodies or are obtained from private or industrial abstraction sources. Springs not used for supply are not seized. The NRA gets the data from the public supply sources due to several regional arrangements made by NRA and the operating companies. The operator mostly takes the local samples and analyses the water and provides the data for the NRA database. Sample analysing procedures have to conform to National Quality Control Standards. At present there is a lack of national uniform quality control and quality assurance procedures. But they will be developed soon.

Data collected are managed by 8 regional databases, which have no common format, plus a unified nitrate database. Over the next 1-2 years the data will migrate to 8 regional databases all using common format and software (WAMS - Water Archive Management System). Data are available on floppy disks, paper sheets and reports at regional NRA offices. Data have to be paid for but they are available without restrictions (except confidential data). The NRA is the reporting organisation, that intends to carry out National Annual Reports in the near future. The target audience is wide, from general public to professionals or governmental organisations.

At present the different regions are busy in improving their network systems to reach the goals of the National Groundwater Monitoring Network in the UK. Its implementation will be approached in a three steps’ development. The monitoring programme should

comprise Reference Networks, National Networks and Local Networks. The NRA is mainly responsible for Reference and National Network. Local Networks are run by NRA with other regional or local organisations. The current networks, which often vary in sampling methods, achieving groundwater quality data or have no quality control and assurance procedures, will be improved. The most important improvement concerns the lacks of interpretation and reporting of information on groundwater quality.

A summary of the features of the present and planed monitoring system in the UK is given by the Table S.1 of Technical Report WD/94/40C „Groundwater Quality Assessment: A National Strategy for the NRA, Final Report, November 1994 P J Chilton and C J Milne (British Geological Survey BGS):

Present Monitoring system Strategy	**Interim Strategy**	**National**
	Implementation in 3 years	Implementation in further 4 years
Widely regional variation in all	*All regions have reached common approach and level*	*All regions have moved aspects forward together*
widely different relationships with water undertakings	relationship with water undertakings for sampling and data transfer agreed nationally	Reference Network of 150-250 sampling points at a mean density of 1/250 to 1/400 km² established using new boreholes
historically evolved network of 2547 sampling points, primarily public and private abstraction sources	National Network of about 3000 sampling points at a mean density of 1/25 km² established mainly using existing unconfined sources	National Network of 3000 sampling points at a mean density of 1/25 km² established
mean network density varies from about 1/10 to 1/60 km² between regions	framework of determinand suites agreed nationally	framework of determinand suits established for both networks
different regional approaches to same aquifer	modified sampling regime implemented, each aquifer treated consistently	sampling regimes established for both networks
range of sampling frequencies and determinants suites	sampling protocols written and tested	QA/QC procedures
no written sampling protocols	QA/QC procedures written and tested	sampling protocols established
no sampling QA/QC	data handling standardised nationally using WAMS	presentational methods and reporting approaches in use
wide range of data archiving and handling approaches	presentational methods and reporting approaches defined	regular reports prepared to address NRA's objectives
too little effort devoted to interpretation and reporting		

More details on the future NRA's National Groundwater Quality Monitoring Network are described in the report *„Framework agreement for sampling, analyses and data transfer for the NRA's National Groundwater Quality Monitoring Programme"*, from 31 March 1995 developed by a working group consisting of the NRA, WSA (Water Service Association) and WCA (Water Company Association).

2.16.3.2 Scotland

No information is available on this aspect at the present time.

2.16.3.3 Northern Ireland

No information is available on this aspect at the present time.

2.16.4 Structure of the Administrative Organisations Concerning Groundwater Quantity

2.16.4.1 England and Wales

The National Rivers Authority with its National Groundwater Centre co-ordinates the groundwater quantity monitoring activities. Several water supply companies in some regions collaborate with the NRA.

2.16.4.2 Scotland

In Scotland the Secretary of State for Scotland has overall responsibility for national water policy in Scotland. The Scottish Environmental Protection Agency (SEPA) has the duty to promote the quality of all controlled waters. SEPA undertakes the monitoring of groundwater (and other) resources used for public supply. The Unitary Authorities are responsible for monitoring of private water supplies. .....[3].. One of the principal functions of SEPA is to grant consents for discharges to water resources (including groundwater), subject to out relevant to the particular resource, detailed hydrometric surveys and water quality monitoring. There is no general licensing of water abstractions in Scotland, however, the Water Authorities may acquire water rights for public supply by obtaining water orders from the Secretary of State..... In certain areas where SEPA considers that restrictions on abstractions are required, Control Orders may be made by the Secretary of State to limit the abstraction of water for irrigation.....

2.16.5 Monitoring of Groundwater Quantity

2.16.5.1 England and Wales

[3] ….. means that answer provided was handwritten and not readable

The National Groundwater Levels Monitoring Programme is a national network for basic data collection about groundwater to manage the water supply. It is in operation due to the „Water Resource Act 1991“ that demands as general duty to manage and conserve water resources. The National Rivers Authority with its National Groundwater Centre co-ordinates the monitoring activities, manages the database, takes samples and carries out reports. Several Water Supply Companies in some regions collaborate with the NRA. 735 sampling sites are situated in porous media, 598 in karst and 4,085 in other groundwater regions. The distribution aims at covering the regions evenly, but minor concentrations exist around groundwater river support schemes and productive aquifer outcrop areas. Most of the sampling sites are bored wells. Sampling frequency for groundwater level monitoring varies between 2-12 times/year in basic programmes and there is variable frequency in special programmes. Wherever continuous measurement of water level is available from data loggers and recorders, data are typically sampled on a weekly basis. A standard national specification for groundwater level monitoring has been developed, but has not yet been set into use in all regions.

For the fieldwork there exists no national quality control methodology in several regions. Wherever levels monitoring is contracted out, a quality control audit specified of 2-3% of the sampling undertaken by the contractor. Data quality control is made by visual examination of graphical data presentation. Where hydrodata is in use, some quality control is carried out on incoming data. In the future WAMS data validation rules will enhance data quality control. The network has been in operation since 1845, it has an average length of 20 years. At present there are 8 regional databases; 40-50 % of the data are on hydrodat/hydrolog. In future data should be loaded onto a WAMS (Water Archive Management System). ORACLE database using WAMS:UNIX as hardware. Software, reporting tools will be WAMS:SQL and PV-Wave. Data are accessible on floppy disks, paper sheets and reports without restriction at regional NRA offices. The reporting organisation is the NRA. At present data are passed on to IH that produces the IH Yearbook. In future the NRA plans to produce a National Annual Groundwater Report for professionals, governmental organisations and the general public.

2.16.5.2 Scotland

No information is available on this aspect at the present time.

2.16.5.3 Northern Ireland

No information is available on this aspect at the present time.

3. THE EEA GROUNDWATER QUALITY AND QUANTITY MONITORING DATABASE

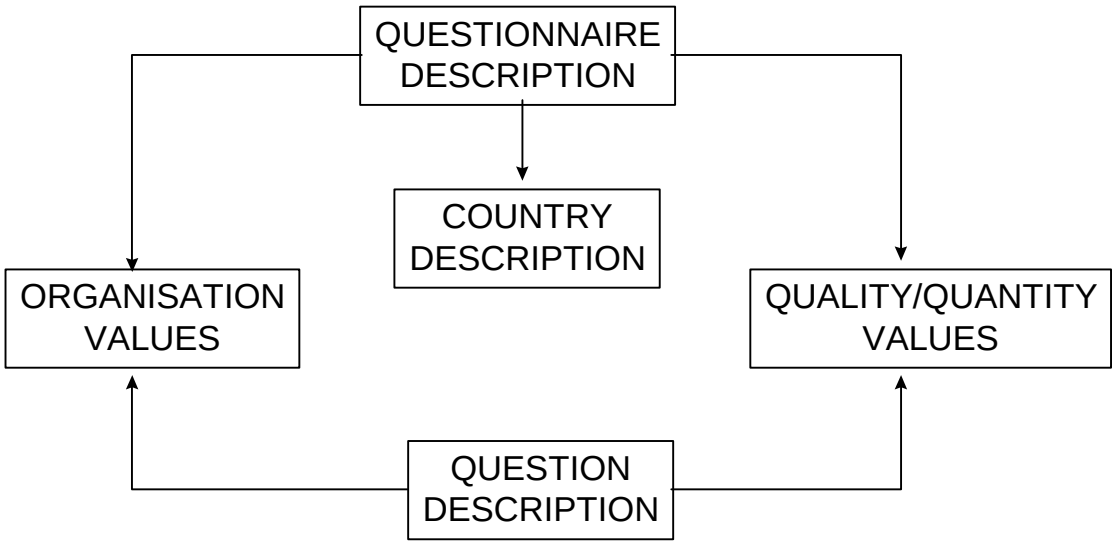
3.1 Database description

The objective of Task 4 of activity MW2-1 was to "collect and collate, into a database, information on groundwater quality and quantity" using data and information provided within the MW2 questionnaires.

The Database was designed using MS-Access for rapid application development (prototyping). The final version of the database will be a Digital Vax/VMS rdb database for save and fast data access.

The blue print of the database is a shown below in a entity relationship diagram.

Figure 1 Simplified entity relationship diagram



Questionnaire description
Information about the headings of the questionnaires, e.g. country-code, state of work or date of receipt.

Country description
Translation between country-code (abbreviated country name) and long version of the country name.

Question description
Every question of each questionnaire is coded with a hierarchical unique number.

Quality and Quantity Values
Information about the contents of the questionnaires (part iii quality and part iv quantity)

Organisation Values
Information about organisations involved within the different monitoring systems.

A lot of work-tables are created for quick handling of reports.

3.2 Data Entry

3.2.1 Questionnaire data

The data of the questionnaires where entered manually into MS-Excel spreadsheets to make reports available as soon as possible for the MW3 tasks (network design) of the ETC/IW 1995. The preparation of the spreadsheets facilitated the later on loading procedures onto a relational database. Textual answers caused great problems to convert these data into structured form. As a consequence it may be useful to for the further questionnaire design to provided more coded answer fields (e.g. multiple choice) in state of textual description fields.

3.3 Data Export

The data export will be available in CSV format. This format allows a data transfer via internet without any converting and an easy import in standard PC-application (e.g. Excel).

4. DATA SUMMARY

In this chapter tables are presented which summarise the data provided in the questionnaire which is currently stored in the EEA groundwater Quality and Quantity Monitoring Database:

A) Groundwater quality

Table 4.1	Summary of monitoring programmes
Table 4.2.1	Summary of organisation types and responsibilities
Table 4.2.2	Summary of collaborating organisation types and responsibilities
Table 4.3	Objectives of monitoring
Table 4.4.1	The geographical extent of monitoring networks and the distribution of observation points
Table 4.4.2	Total number of groundwater sampling sites and regions and total area of regions,
Table 4.4.3	Total area of groundwater regions, total number and density of sampling sites
Table 4.5	Temporal extent of monitoring networks
Table 4.6.1	Monitoring networks characteristics (porous media)
Table 4.6.2	Monitoring networks characteristics (karst)
Table 4.6.3	Monitoring networks characteristics (others)
Table 4.7	Observed variables and sampling frequency
Table 4.8	Details of sampling, chemical analyses and institutions involved
Table 4.9	Data storage and management
Table 4.10	Availability of data
Table 4.11	Sampling site details held at source

B) Groundwater Quantity

Table 5.1	Summary of monitoring programmes
Table 5.2.1	Summary of organisation types and responsibilities
Table 5.2.2	Summary of collaborating organisation types and responsibilities
Table 5.3	Objectives of monitoring
Table 5.4.1	The extent of monitoring networks (geographical, the total number of sampling sites and regions) and density of sampling sites
Table 5.4.2	The distribution of observation points
Table 5.5	Temporal extent of monitoring networks
Table 5.6.1	Number of different types of observation points and their total number
Table 5.6.2	Number and percent of observation points equipped with (non) recording water level/discharge indicators
Table 5.7.1	Number and percent of observation points with indication of altitude
Table 5.7.2	Number and percent of observation points with indication of co-ordinates
Table 5.8.1	Frequency of observed variables (basic and special programmes)
Table 5.8.2	Observation methodology and quality assurance procedures
Table 5.9	Data storage and management
Table 5.10	Availability of data
Table 5.11	Sampling site details held at source

Table 4.1

Summary of monitoring programme

Austria

1. Monitoring programme	Groundwater quality monitoring in Austria (Erhebung der Wasserguete in Oesterreich)
2. Abbreviation	WGEV
organisation name	Bundesmisterium für Land- und Forstwirtschaft, Abt. IV A1 Wasserwirtschaftskataster (Federal Ministery of Agriculture and Forestry, Dep. IV A1, Federal Water Management Register)
collaborating organisation	Amt der Vorarlberger Landesregierung, Abt. VIId/Landeswasserbauamt
collaborating organisation	Amt der Burgenlaendischen Landesregierung Abt.yIII/3 Gewaesseraufsicht
collaborating organisation	Umweltbundesamt (Federal Environment Agency)
collaborating organisation	Amt der Wiener Landesregierung, Magistratsabteilung 45
collaborating organisation	Amt der Tiroler Landesregierung Abt. VI h / Wasserwirtschaftliche Planung
collaborating organisation	Amt der Steiermaerkischen Landesregierung Fachabt. Ia
collaborating organisation	Amt der Salzburger Landesregierung Ref.13/04-Gewaesseraufsicht
collaborating organisation	Amt der Oberoesterreichischen Landesregierung Abt. Umweltschutz Unterabteilung Gewaesserschutz
collaborating organisation	Amt der Niederoesterreichischen Landesregierung Abt. B 9
collaborating organisation	Amt der Kaerntner Landesregierung Abt. 15 U-Umweltschutz
Reporting organisation	Bundesministerium fuer Land- und Forstwirtschaft, Abt. IVA1, Wasserwirtschaftskataster

Denmark

1. Monitoring programme	Nationalwide monitoring programme
2. Abbreviation	VAMP
organisation name	Miljotyrelsen= Danish Environmental Protection Agency
collaborating organisation	DGU Geographical Survey of Denmark
Reporting organisation	DGU

Finland

1. Monitoring programme	Geoydrological monitoring
2. Abbreviation	Groundwater quality of soil aquifers
organisation name	Finnish Environment Institute
collaborating organisation	North Ostrobothnia Regional Environment Centre
collaborating organisation	West Finland Regional Environment Centre

Summary of monitoring programme

collaborating organisation	Uusimaa Regional Environment Centre
collaborating organisation	Southwest Finland Regional Environment Centre
collaborating organisation	Southeast Finland Regional Environment Centre
collaborating organisation	South Savo Regional Environment Centre
collaborating organisation	North Savo Regional Environment Centre
collaborating organisation	Lapland Regional Environment Centre
collaborating organisation	Central Finland Regional Environment Centre
collaborating organisation	Haeme Regional Environment Centre
collaborating organisation	Kainuu Regional Environment Centre
collaborating organisation	Central Ostrobothnia Regional Environment Centre
collaborating organisation	North Karelia Regional Environment Centre
Reporting organisation	Finnish Environment Institute

France

1. Monitoring programme	Observatoire National de la Qualite des Eaux Souterraines
2. Abbreviation	ONQES
organisation name	Ministere de l'Environement - Direction de l'Eau
collaborating organisation	B.R.G.M
collaborating organisation	Ministere des Affaires Sociales et de l'Integration Sous direction de l'organisation et de l'informatique
Reporting organisation	B.R.G.M

Germany

1. Monitoring programme	Groundwater quality monitoring programme of Sachsen-Anhalt
1. Monitoring programme	Monitoring Network Groundwater Quality Bavaria
1. Monitoring programme	Grundwasserueberwachung (Groundwater quality monitoring)
1. Monitoring programme	Landesmessnetze zur Ueberwachung der Grundwasserbeschaffenheit - groundwater quality monitoring -
2. Abbreviation	GWUE
organisation name	Bayrisches Landesamt fuer Wasserwirtschaft LfW
organisation name	State Environement Agency North-Rhine-Westfalia
organisation name	Thueringer Landesanstalt fuer Umwelt
organisation name	Landesamt für Umweltschutz Sachsen-Anhalt
collaborating organisation	Staatliches Umweltamt Duisburg
collaborating organisation	Saatliches Amt fuer Umweltschutz Halle
collaborating organisation	Saatliches Amt fuer Umweltschutz Dessau-Wittenberg
collaborating organisation	Staatliches Umweltamt Siegen

Summary of monitoring programme

collaborating organisation	Staatliches Umweltamt Muenster
collaborating organisation	Staatliches Umweltamt Minden
collaborating organisation	Staatliches Umweltamt Lippstadt
collaborating organisation	Staatliches Umweltamt Krefeld
collaborating organisation	Saatliches Amt fuer Umweltschutz Magdeburg
collaborating organisation	Staatliches Umweltamt Hagen
collaborating organisation	24 local offices of water management
collaborating organisation	Staatliches Umweltamt Duesseldorf
collaborating organisation	Staatliches Umweltamt Aachen
collaborating organisation	Staatliches Umweltamt Bielefeld
collaborating organisation	Staatliche Umweltamt Herfen
collaborating organisation	Aussenstelle Soest
collaborating organisation	Aussenstelle Bonn
collaborating organisation	Staatliches Umweltamt Koeln
Reporting organisation	State Environement Agency North-Rhine-Westfalia
Reporting organisation	Bayrisches Landesamt fuer Wasserwirtschaft
Reporting organisation	Thueringer Landesanstalt fuer Umwelt

Italy

1. Monitoring programme	National Network of National Informative Environmental System. Groundwater Quality National Monitoring Network (is still being tested now)
1. Monitoring programme	Quality requirements, monitoring, water for human consumption (Degree of the President of the Republic no.236 of the 24.05.1988
organisation name	Regione Lazio
organisation name	Regione Veneto
organisation name	Regione Toscana
organisation name	Regione Sicilia
organisation name	Regione Umbria
organisation name	Regione Sardegna
organisation name	Regione Puglia
organisation name	Regione Piemonte
organisation name	Regione Molise - Ass. Ambiente
organisation name	Regione Marche
organisation name	Regione Liguria
organisation name	Regione Friuli Venezia Giulia
organisation name	Regione Emilia Romana

Summary of monitoring programme

organisation name	Regione Valle D'Aosta
organisation name	Regione Calabria
organisation name	Regione Basilicata
organisation name	Regione Abbruzzo
organisation name	Ministery of Environment - Servizio Valutazione Impatto Ambientale
organisation name	Provincia autonoma di Bolzano
organisation name	Regione Campania
organisation name	Provincia autonoma di Trento
organisation name	Regione Lombardia
collaborating organisation	Regione Lazio
collaborating organisation	Regione Liguria
collaborating organisation	Regione Valle D'Aosta
collaborating organisation	Regione Umbria
collaborating organisation	Regione Marche
collaborating organisation	Regione Piemonte
collaborating organisation	Regione Puglia
collaborating organisation	Regione Sardegna
collaborating organisation	Regione Sicilia
collaborating organisation	Regione Friuli Venezia Giulia
collaborating organisation	Regione Lombardia
collaborating organisation	Regione Toscana
collaborating organisation	Provincia autonoma di Trento
collaborating organisation	Regione Emilia Romana
collaborating organisation	Provincia autonoma di Bolzano
collaborating organisation	Local Health Units
collaborating organisation	Regione Abbruzzo
collaborating organisation	Regione Basilicata
collaborating organisation	Regione Molise - Ass. Ambiente
collaborating organisation	Regione Calabria
collaborating organisation	Regione Campania
collaborating organisation	Regione Veneto

Norway

1. Monitoring programme	Landsomfattende grunnvannsnett (LGN) (in norwegian) Norwegian groundwater monitoring network

Summary of monitoring programme

1. Monitoring programme	Norwegian Monitoring Programme for Long Range Transported Air Pollutants
2. Abbreviation	LGN
organisation name	Norwegian Institute for Water Research
organisation name	Geological Survey of Norway
collaborating organisation	Norwegian Water Resources and Enegry Administration (NVE)
collaborating organisation	Norwegian Institute for Water Research (NIVA)
collaborating organisation	Norwegian Geological Survey
Reporting organisation	Geological Survey of Norway
Reporting organisation	NIVA

Portugal

1. Monitoring programme	Rede de control da Qualidade
organisation name	Direccao Regional do Ambiente e Recursos Naturais do Alentejo (DRARNAlentejo)
organisation name	Direccao Regional do Ambiente e Recursos Naturais do Algarve (DRARNAlgarve)
organisation name	Direccao Regional do Ambiente e Recursos Naturais do Centro (DRARN Centro)
organisation name	Direccao Regional do Ambiente e Recursos Naturais do Norte (DRARN Norte) E135
organisation name	Instituto da Agua
organisation name	Direccao Regional do Ambiente e Recursos Naturais de Lisboa e Vale do Tejo (DRARNLVT)

Spain

1. Monitoring programme	Plan Nacional de Gestion y Conservacion de Acuiferos
2. Abbreviation	PNGC
organisation name	Direccion general de Calidad del Agua
collaborating organisation	Instituto Tecnologico Geominero de Espana
Reporting organisation	Instituto tecnologico geominero de Espana

Sweden

1. Monitoring programme	Country wide environmental monitoring of groundwater in forest ecosystem
2. Abbreviation	MOGWIFE (not official abbrevation)
organisation name	Geological Survey of Sweden
collaborating organisation	The Counties of Sweden
Reporting organisation	Geological Survey of Sweden

Summary of monitoring programme

The Netherlands

1. Monitoring programme	National Groundwater Quality Network
2. Abbreviation	LGM
organisation name	RIVM
collaborating organisation	8 out of 12 provinces
Reporting organisation	RIVM

UK

1. Monitoring programme	National Groundwater Quality Monitoring Program
organisation name	National Rivers Authority, National Groundwater Centre
collaborating organisation	Water Service Association
Reporting organisation	National Rivers Authority, National Groundwater Centre

Table 4-2-1 Summary of organisation types and responsibilities

code	*organisation*	*national*	*regional*	*local*	*regulatory body*	*water supply company*	*private contract.*	*program-coord.*	*local sampling*	*database managem.*	*chemical analysis*	*reporting*	*others*
AUT01	Bundesmisterium für Land- und Forstwirtschaft, Abt. IV A1 Wasserwirtschaftskataster (Federal Ministery of Agriculture and Forestry, Dep. IV A1, Federal Water Management Register)	y						y				y	*
DEN01	Miliotyrelsen= Danish Environmental Protection Agency	y			y			y				y	
ESP01	Direccion general de Calidad del Agua	y						y				y	
FIN01	Finnish Environment Institute	y						y	y	y	y	y	
FRA01	Ministere de l'Environement - Direction de l'Eau	y						y					
GBR01	National Rivers Authority, National Groundwater Centre	y			y			y	y	y	y	y	
GER01	Bayrisches Landesamt fuer Wasserwirtschaft LfW		y					y	y		y	y	y
GER02	State Environement Agency North-Rhine-Westfalia		y					y	y			y	
GER03	Thueringer Landesanstalt fuer Umwelt		y	y				y	y	y	y	y	
GER04	Landesamt für Umweltschutz Sachsen-Anhalt		y		y			y	y		y	y	
ITA01	Regione Campania		y	y									
ITA02	Ministery of Environment - Servizio Valutazione Impatto Ambientale	y						y	y			y	
NED01	RIVM	y						y	y	y	y	y	

*) Standardisation of the whole programme, quality assurance

code	organisation	national	regional	local	regulatory body	water supply company	private contract.	program-coord.	local sampling	database managem.	chemical analysis	reporting	others
NOR01	Geological Survey of Norway	y						y	y	y	y	y	
NOR02	Norwegian Institute for Water Research	y							y	y	y	y	
POR01	Direccao Regional do Ambiente e Recursos Naturais do Norte (DRARN Norte) E135	y	y					y	y	y		y	
SWE0	Geological Survey of Sweden	y						y	y			y	

*) Standardisation of the whole programme, quality assurance

Table 4-2-2 Summary of collaborating organisation types and responsibilities

code	*organisation*	*national*	*regional*	*local*	*regulatory body*	*water supply company*	*private contract.*	*program-coord.*	*local sampling*	*database managem.*	*chemical analysis*	*reporting*	*others*
AUT01	Amt der Wiener Landesregierung, Magistratsabteilung 45	y	y					y	y	y		y	
DEN01	DGU Geographical Survey of Denmark	y						y	y			y	
ESP01	Instituto Tecnologico Geominero de Espana	y						y	y	y	y	y	
FIN01	Lapland Regional Environment Centre		y							y	y		
FRA01	Ministere des Affaires Sociales et de l'Integration Sous direction de l'organisation et de l'informatique	y							y	y			
GBR01	Water Service Association	y				y				y	y		
GER01	24 local offices of water management			y						y	y		-
GER02	Staatliches Umweltamt Siegen			y						y	y	y	
GER04	Saatliches Amt fuer Umweltschutz Magdeburg			y					y		y		
ITA01	Local Health Units			y						y	y		
ITA02	Regione Campania		y	y									
NED01	8 out of 12 provinces		y		y			y	y	y	y	y	
NOR01	Norwegian Institute for Water Research (NIVA)	y							y	y	y		
NOR02	Norwegian Geological Survey	y											W
SWE0	The Counties of Sweden		y							y			T

*) Standardisation of the whole programme, quality assurance

Table 4-3 Objectives of monitoring

code	*general surveillance purpose*	*water quality trend identification*	*research and scientific*	*national legislation*	*EC legislation*	*internat. obligations*	*identif. of areas *)*	*control impact of point sources*	*baseline station for background identif.*	*Data for legal regulation of hazardous substances*	*information for general public*	*others*
AUT01	y	y		y	y		y			y	y	
DEN01	y	y	y	y	y		y	y		y	y	
ESP01	y	y	y								y	
FIN01	y	y	y						y		y	
FRA01	y	y		y								y
GBR01	y	y		y	y		y	y	y		y	
GER01	y	y		y	y		y		y			y
GER02	y	y	y					y	y			
GER03	y	y		y	y		y	y	y		y	
GER04	y	y		y	y	y			y	y	y	
ITA01				y	y							
ITA02	y	y		y								
NED01	y	y	y		y		y		y		y	
NOR01	y	y	y						y		y	
NOR02	y	y	y									
POR01	y	y	y									
SWE01	y	y	y			y	y				y	

**) where reductions of pollution may be necessary*

Table 4-4-1 The geographical extent of monitoring networks and the distribution of observation points

code	*administrative extent*	*geographical extent*	*PM evenly*	*PM concentrated around drink. water wells*	*PM concentrated around impact areas*	*PM others*	*KA evenly*	*KA concentrated around drink. water wells*	*KA concentrated around impact areas*	*KA others*	*OS evenly*	*OS concentrated around drink. water wells*	*OS concentrated around impact areas*	*OS others*
AUT01	National	The network covers mainly the important aquifers in porous media and karst groundwater (see attached map - groundwater regions, sampling sites for karst groundwater)	y							y				
DEN01	National	Denmark	y	y		y								
ESP01	National	Spain	y				y				y			y
FIN01	National	Finland	y								y			
FRA01	National	France		y				y				y		
GBR01	National	England, Wales	y	y			y	y			y	y		
GER01	Freestate of Bavaria	Bavaria	y		y		y				y			
GER02	regional and local	North-Rhine-Westfalia	y	y	y					y				y
GER03	national, regional	Thueringen	y				y				y			
GER04	Land Sachsen-Anhalt	Sachsen Anhalt	y		y						y		y	
ITA01	regional	whole regional area		y		y		y		y		y		y
ITA02	National	Italy		y		y		y		y		y		y

PM: porous media; KA: karst; OS: others

code	administrative extent	geographical extent	PM evenly	PM concentrated around drink. water wells	PM concentrated around impact areas	PM others	KA evenly	KA concentrated around drink. water wells	KA concentrated around impact areas	KA others	OS evenly	OS concentrated around drink. water wells	OS concentrated around impact areas	OS others
NED01	National	all major (relevant) combinations of land use and soil type	y								y			
NOR01	National	Norway												
NOR02	National	Southern Norway				y								
POR01	regional	Tejo and sado mioplitocenic aquifer system	y	y	y									
SWE0	National	Sweden				y								

PM: porous media; KA: karst; OS: others

Table 4-4-2 Total number of gw sampling sites and regions, total area of regions

code	*total no. .sampling sites PM*	*total no. of sampling sites KA*	*total no. of sampling sites OS*	*total no. of gw regions PM*	*total no. of gw regions KA*	*total no. of gw regions OS*	*total area of gw regions PM*	*total area of gw regions KA*	*total area of gw regions OS*
AUT01	1359 (1996: 1600)	70 (1996: 450)		106			17000		
DEN01	1100			3			43216		
ESP01	1147	408	1377	101	156	200	79258	54628	38644
FIN01	20		30	20		30	35		30
FRA01	16112	2490	20480	342	69	201			
GBR01	346	270	1920				13534	11004	75219
GER01	118	40	121	3	1	7	28000	8000	35000
GER02	2256	20	310	150	25	79	17000	300	16705
GER03	4	20	96				900	4900	10540
GER04	82		30				14000		6000
ITA01									
ITA02									
NED01	375		5				35000		
NOR01	17								
NOR02	4			4					
POR01	74			1			12450		
SWE01									

Table 4-4-3 Total no. of gw sampling sites, total area and sampling site density

code	*PM sampl. sites, total no.*	*KA sampl. sites, total no.*	*OS sampl. sites, total no.*	*PM total area*	*KA total area*	*OS total area*	*PM sampl. sites density*	*KA sampl. sites density*	*OS sampl. sites density*
AUT01	1359 (1996: 1600)	70 (1996: 450)		17000			0,080		
DEN01	1100			43216			0,025		
ESP01	1147	408	1377	79258	54628	38644	0,014	0,007	0,036
FIN01	20		30	35		30	0,571		1,000
FRA01	16112	2490	20480						
GBR01	346	270	1920	13534	11004	75219	0,026	0,025	0,026
GER01	118	40	121	28000	8000	35000	0,004	0,005	0,003
GER02	2256	20	310	17000	300	16705	0,133	0,067	0,019
GER03	4	20	96	900	4900	10540	0,004	0,004	0,009
GER04				14000		6000			
ITA01									
ITA02									
NED01	375		5	35000			0,011		
NOR01	17								
NOR02	4								
POR01	74			12450			0,006		
SWE01									

Table 4-5 Temporal extent of monitoring networks

code	*earliest record (year)*	*median record (year)*	*average record length (years)*
AUT01	1991		3
DEN01	1989		
ESP01	1967	1980	10
FIN01	1974	1985	20
FRA01	1902	1988	8
GBR01	1978		17
GER01	1985		
GER02	1984	1990	5
GER03	1979	1988	4
GER04	1990		4
ITA01	1988		
ITA02			
NED01	1979		10
NOR01	1978		15
NOR02	1980		15
POR01	1977	1988	18
SWE01	1968	1976	15

**) where reductions of pollution may be necessary*

Table 4-6-1 Monitoring network characteristics for groundwater in porous media

code	*no. drinking water wells for 1-1,000 people*	*% drinking water wells for 1-1,000 people*	*no. drinking water wells for 1,000 -10,000 people*	*% drinking water wells for 1,000 -10,000 people*	*no. drinking water wells for over 10,000 people*	*% drinking water wells for over 10,000 people*	*no. of well not only for observat. purpose*	*% of well not only for observat. purpose*	*total no. of wells*	*no. of baseline stations to get back-ground values*	*% of baseline stations to get back-ground values*	*no. of charact. station to get average situation in gw region*	*% of charact. station to get average situation in gw region*	*no. of inpact station to control potential emission*	*% of inpact station to control potential emission*
AUT0	660	48,6	0		0		392	28,8	1052			1359	100		
DEN0	0		0		0		575		575	10		1090			
ESP0	0		0		0		1147	39	1147	783	27				
FIN01	0		0		0		1	5	1	20	100				
FRA0	0		0		0		0		0						
GBR	65	26	40	16	134	53	14	5	253						
GER	0		0		0		52	18,6	52	118	42,3				
GER	0		0		0		0		0						
GER	0		0		0		0		0	4		4			
GER	0		0		0		0		0						
ITA01	0		0		0		0		0						
ITA02	0		0		0		0		0						
NED0	0		0		0		375	98,8	375						
NOR	0		0		0		17	100	17	17	100				
NOR	0		0		0		4	100	4			4	100	4	100

code	no. drinking water wells for 1-1,000 people	% drinking water wells for 1-1,000 people	no. drinking water wells for 1,000 -10,000 people	% drinking water wells for 1,000 -10,000 people	no. drinking water wells for over 10,000 people	% drinking water wells for over 10,000 people	no. of well not only for observat. purpose	% of well not only for observat. purpose	total no. of wells	no. of baseline stations to get back-ground values	% of baseline stations to get back-ground values	no. of charact. station to get average situation in gw region	% of charact. station to get average situation in gw region	no. of impact station to control potential emission	% of impact station to control potential emission
POR	0		0		0		0		0			46	63	76	37
SWE	0		0		0		0		0	78	59	54	41		

Table 4-6-2 Monitoring network characteristics for karst groundwater

code	no. drinking water wells for 1-1,000 people	% drinking water wells for 1-1,000 people	no. drinking water wells for 1,000 -10,000 people	% drinking water wells for 1,000 -10,000 people	no. drinking water wells for over 10,000 people	% drinking water wells for over 10,000 people	no. of well not only for observat. purpose	% of well not only for observat. purpose	total no. of wells	no. of baseline stations to get back-ground values	% of baseline stations to get back-ground values	no. of charact. station to get average situation in gw region	% of charact. station to get average situation in gw region	no. of impact station to control potential emission	% of impact station to control potential emission
AUT0	48	69	0		0		22	31	70			70	100		
DEN0	0		0		0		0		0						
ESP0	0		0		0		408	14	408	376	13				
FIN01	0		0		0		0		0						
FRA0	0		0		0		0		0						
GBR	68	25	37	14	123	46	40	15	268						
GER	0		0		0		17	6,1	17	40	14,3				
GER	0		0		0		0		0						
GER	0		3		0		10		13	4		13			
GER	0		0		0		0		0						
ITA01	0		0		0		0		0						
ITA02	0		0		0		0		0						
NED0	0		0		0		0		0						
NOR	0		0		0		0		0						
NOR	0		0		0		0		0						

code	no. drinking water wells for 1-1,000 people	% drinking water wells for 1-1,000 people	no. drinking water wells for 1,000 -10,000 people	% drinking water wells for 1,000 -10,000 people	no. drinking water wells for over 10,000 people	% drinking water wells for over 10,000 people	no. of well not only for observat. purpose	% of well not only for observat. purpose	total no. of wells	no. of baseline stations to get back-ground values	% of baseline stations to get back-ground values	no. of charact. station to get average situation in gw region	% of charact. station to get average situation in gw region	no. of impact station to control potential emission	% of impact station to control potential emission
POR	0		0		0		0		0						
SWE	0		0		0		0		0						

Table 4-6-3 Monitoring network characteristics for groundwater in other media

code	*no. drinking water wells for 1-1,000 people*	*% drinking water wells for 1-1,000 people*	*no. drinking water wells for 1,000 -10,000 people*	*% drinking water wells for 1,000 -10,000 people*	*no. drinking water wells for over 10,000 people*	*% drinking water wells for over 10,000 people*	*no. of well not only for observat. purpose*	*% of well not only for observat. purpose*	*total no. of wells*	*no. of baseline stations to get back-ground values*	*% of baseline stations to get back-ground values*	*no. of charact. station to get average situation in gw region*	*% of charact. station to get average situation in gw region*	*no. of impact station to control potential emission*	*% of impact station to control potential emission*
AUT0	0		0		0		0		0						
DEN0	0		0		0		0		0						
ESP0	0		0		0		1377	47	1377	1019	35				
FIN01	0		0		0		18	60	18	30	100				
FRA0	0		0		0		0		0						
GBR	510	26	275	14	978	51	172	9	1935						
GER	0		0		0		46	16,5	46	121	43,4				
GER	0		0		0		0		0						
GER	0		17		0		79		96	68		96			
GER	0		0		0		0		0						
ITA01	0		0		0		0		0						
ITA02	0		0		0		0		0						
NED0	0		0		0		5	1,2	5						
NOR	0		0		0		0		0						
NOR	0		0		0		0		0						

code	no. drinking water wells for 1-1,000 people	% drinking water wells for 1-1,000 people	no. drinking water wells for 1,000 -10,000 people	% drinking water wells for 1,000 -10,000 people	no. drinking water wells for over 10,000 people	% drinking water wells for over 10,000 people	no. of well not only for observat. purpose	% of well not only for observat. purpose	total no. of wells	no. of baseline stations to get back-ground values	% of baseline stations to get back-ground values	no. of charact. station to get average situation in gw region	% of charact. station to get average situation in gw region	no. of impact station to control potential emission	% of impact station to control potential emission
POR	0		0		0		0		0						
SWE	0		0		0		0		0	78	59	40	41		

Table 4-7 Observed parameter details

Country	Total number of measured parameters	Number of parameters basic progr.	descriptive parameters	major ions	add. parameter	heavy metals	chlorinated hydrocarbons	number of pesticides	Frequency of basic programme per year	remarks
AUT	106	34	Y	Y	Y	Y	Y	47	4	
DEN	55	51	Y	Y	Y	Y	Y		2-4, 0,5, 0,33,	B and S meas. together
ESP	30	14	Y	Y	Y	Y			1-2	
FIN	28	28	Y	Y	Y	Y			6	
FRA	?? 59(+1 as group or +47)??	no further information available						?? 1(or 47) ??		Pesticides only mentioned as a substance group
GBR	55	14	Y	Y	Y	Y	Y	24	1-4, 0,5-4	in some cases B and S meas. together
GER01	115	27	Y	Y	Y	Y		64		
GER02	44	29	Y	Y	Y	Y	Y		1-2	
GER03	45	43	Y	Y	Y	Y	Y	1	1, 1-6,2-6, 4	
GER04	68	24	Y	Y	Y	Y	Y	22	1, 2	
GRE										no gw. qual. up to now
IRL										no gw qual. monitor. programme
ITA	59	26	Y		Y	Y		2	F1,F2	pesticides only mentioned as two substance groups! no details, F1= Champions number/year changes between 6 to 360 depending on the served poulation, F2 the same but number changes between 6 to 20
NED	23		Y	Y		Y				
NOR	18	18	Y	Y	Y				1-2	
NOR	15	14	Y	Y					1, 12	
POR	15	15	Y	Y					1	
SWE	25	24	Y	Y	Y	Y			2-6	

Table 4-8 Details of sampling, chemical analyses and institutions involved

code	*institutions involved in sampl. and analysing*	*all sampl. and analys. carried out by same institutions*	*all variables of a single sample carried out by the same institution*	*public laboratory*	*private laboratory*	*standardized procedure for monitoring system*	*obligations to use comparable standardized anal. methods within the whole monit. network*	*have limits of detection been fixed for every variable to be respected within the whole network*	*standardized regulation for precision and accuracy*
AUT01	15	n	n	y	y	y	y	y	y
DEN01	15	n	n	y	y	y	y	y	y
ESP01	1	y	y	y		y	y	y	y
FIN01	14	y	n	y		y	y	y	y
FRA01	more than 200	n	n	y	y	n	y	y	y
GBR01	>10	n	y	y	y	y			
GER01	2	n	n	y		y	y	y	y
GER02	12	n	y	y	y	y	y	n	y
GER03	1	n	y	y	y	y	y	y	y
GER04	4	n		y		y	y	y	y
ITA01		y	y	y	y	n	y	y	n
ITA02		y	y	y	y	n	y	y	y
NED01	1	y	y	y		y	y	y	y
NOR01	2/1	n	y	y		y	y	y	y
NOR02	1	y	y		y	y	y	y	y

code	*institutions involved in sampl. and analysing*	*all sampl. and analys. carried out by same institutions*	*all variables of a single sample carried out by the same institution*	*public laboratory*	*private laboratory*	*standardized procedure for monitoring system*	*obligations to use comparable standardized anal. methods within the whole monit. network*	*have limits of detection been fixed for every variable to be respected within the whole network*	*standardized regulation for precision and accuracy*
POR01	2	n	y	y		y	y	y	y
SWE01	2	n	y	y		y	y	y	y

Table 4-9 Data storage and management

code	*database*	*operating system*	*hardware*	*software and language*	*all raw data stored*	*aggregated data stored*
AUT01	VAX/Rdb, Informix, Foxpro (x-base)	VMS, UNIX, Windows NT, DOS, Windows		C, Pascal, DCL, SQL, TPU, AWK, Smartstar, MGE, SAS, Lotus	y	
DEN01	RDBMS (DIGITAL Rdb)	VMS, Windows, DOS	VAX, PC	SQL, DATA TRIEVE, SMARTSTAR, SAS	y	n
ESP01	ORACLE	UNIX	Hewlett Packard 9000 and 700 Ethernet net. Protocol TCP/IP	SQL, SQL-Forms, SQL-RW, ORACLE DATABROWSER, SPECIFIC TOOLS: NET SOFTWARE: LAN MANAGER-APRA SERVICES	y	n
FIN01	SAS-database, ASCII-file	VMS	VAX	SAS	y	
FRA01	ORACLE	VMS	VAX	Server: SQL+,ARC/INFO,ARC VIEW Client: MS/Windows, MS/ACCESS, MAP/INFO, ARCVIEW	y	n
GBR01	present: various WAMS:ORACLE	present: various WAMS:UNIX		present: various WAMS:SQL and custom software	y	y
GER01	ADABAS		VAX, VMS	Natural	y	
GER02	DBS	MVS	IBM	SQL, SAS, QMF	y	
GER03	ORACLE, EXCEL			PASCAL, CLIPPER, FORTRAN	y	

code	*database*	*operating system*	*hardware*	*software and language*	*all raw data stored*	*aggregated data stored*
GER04	ASCII, Windows		Targa Computer, Infomix Database	ESQL-C, MSC 7.0, SDK 3.1	y	n
ITA01					y	
ITA02	RDBMS, ORACLE	CISC,UNIX		SQL	y	
NED01	INGRES		HPUX	INGRES/SHELL SCRIPT	y	n
NOR01	Excel	Windows	PC		y	n
NOR02	RESA- application oriented data archive system developed by "Egil Storen Programmtvikling"	Based on UNIX system V operating system	IBM PC/AT or compatible machines using the Microport implementation of UNIX	C	y	n
POR01	RDBMS,ORACLE,ACCESS	DOS,OSFI	PC,ALPHA DIGITAL	SQL,ACCESS BASIC,C,SQL FORMS,REPORTWRITER	c	
SWE01	RDBMS, present MIMER, from 1996 INGRES	PRIMOS, UNIX	PC, Main frame computer, SUN-computers	SAS, SQL	y	

Table 4-10 Availability of data

code	*computerized data avail. since*	*floppy disk*	*internet*	*paper sheets*	*reports*	*data avail. without fee*	*data avail. without restriction*	*at public organisations*	*reporting organisations*
AUT01	y			y	y	y	n	y	Info is generally free,an annual summar. report is available with fee (covering cost of printing). For authorities and scientific research work data are restricted available on floppy disks. Address: D.I.K. Schwaiger, addr. see responsible organisation
DEN01	y	y		y	y	n	y	y	DGU
ESP01	y	y		y	y	n	y	y	
FIN01	y	y		y		n	n	n	Finnish Environment Institute
FRA01						y	n	y	Ministere de l'Environement Direction de l'Eau, 100 Avenue de Suffren - 75015 Paris, Mme Oliveros-Toro. Phone 1 42 19 12 21, fax 1 42 19 12 06
GBR01		y		y	y	n	y	y	NRA Regional Offices: see attached reports
GER01	y								computerized data only available to "water resources management administration" , reports based on this data are published.
GER02	y	y		y	y	y		y	
GER03	y	y		y	y	n	n	y	Thueringer Landesanstalt fuer Umwelt, Pruesingstr. 25, 07745 Jena
GER04	y	y		y					Landesamt fuer Umweltschutz Sachsen-Anhalt, Ms Wenzel, phone 0345 57 04 334
ITA01									Ministerio Sanita. Dott. Giuseppe Filipetti - Via Sierra Nevada 60 - 00100 Roma, phone. +39 6 59944253 fax. +39 6 59944256
ITA02	y	y	y	y					Ministery of Environment Servizio Valutatione Impatto Ambientale. Via Ferratella in Laterano 33, Rome, ITALY, Enrico Satta Phone:+39 6 7036 2312, Fax +39 6 70257005
NED01	y	y		y	y	y	n	y	
NOR01	y	y					n	n	Data available on request. Geol. Survey of Sweden, Lars Kirkhusmo, P.O.Box Lade 3006, N-7002 Trondheim
NOR02	y	y		y	y	n	n	n	Brit Lisa Skjelkvale. Norw. Inst. for Water Research, PO Box 173, Kjelsas, N 0411 Oslo, Phone: 47 22 18 52 09, Fax: 47 22 18 52 00, e-mail: Brit.skjelkvaale@niva.no

code	*computerized data avail. since*	*floppy disk*	*internet*	*paper sheets*	*reports*	*data avail. without fee*	*data avail. without restriction*	*at public organisations*	*reporting organisations*
POR01	y	y			y				INAG: Direccao de Servicos de Recursos Hidricos, Av. Almirante Gago Coutinho 30-12,1000 Lisboa, phone: 874 00 80
SWE01	y	y	y	y	y	n	y	y	Geolog. Survey of Sweden Bo Thunholm, S-75128 Uppsala, phone: 46 18 17 90 00, fax: 461817 92 10, e-mail: BoThun@SGU.SE

Table 4-11 Sampling site details held at source

code	*local number*	*name of gw region*	*code of gw region*	*station name*	*location*	*measuring authority*	*altitude of station (m)*	*period of record*	*measured variables*	*(hydro-)geol. information*	*possible impacts*	*techn. inform.*	*diameter of the well*	*depth of well*	*use of water*
AUT01	y	y	y	y	y	y	y	y	y	y	y	y	y	y	y
DEN01	y	n	n	n	y	y	y	y	y	y	n	y	y	y	y
ESP01	y	y	y	n	y	y	y	y	y	y	n		y	y	y
FIN01	y	y	y	y	y	y	y		y	y	y	y	n	y	y
FRA01	y	y	y	n	y	n	y	n	n	n	n	n	n	y	y
GBR01	y	y	y	y	y	n	y	y	y	y	n	y	y	y	n
GER01	y	y	y	y	y	y	y	y	y	y	y	y	y	y	y
GER02	y	y	y	y	y	y	y	y	y	y	y	y	y	y	y
GER03	y	y	y	y	y	y	y	y	y	y	y	y	y	y	y
GER04	y	y	y	y	y	y	y	y	y	y	y		y	y	y
ITA01	y			y		y		y	y						
ITA02	y	y	y	y	y	y		y	y	y					
NED01	y	n	n	y	y	n	y	y	y	y	y	y	y	y	n
NOR01	y			y	y	y	y	y	y	y			y	y	
NOR02	y	n	n	y	y	y	y	y	y	y	y	n	y	y	y
POR01	y	y	y	y	y	y	y	y	y	y	n	y	y	y	y
SWE0	y			y	y		y	y	y	y	n	y	y	y	n

Table 5.1

Summary of monitoring programme

Austria

1. Monitoring programme	Hydrological Service
2. Abbreviation	HS
responsible organisation	Hydrographisches Zentralbuero (Hydrological Central Office)
collaborating organisation	Magistrat der Stadt Wien, Magistratsabteilung 45, Hydrographischer Dienst
collaborating organisation	Wasserstrassendirektion -Abt. Hydrographie
collaborating organisation	Amt der Vorarlberger Landesregierung, Landeswasserbauamt, Hydrographischer Dienst
collaborating organisation	Amt der Tiroler Landesregierung, Hydrographischer Dienst
collaborating organisation	Amt der Steiermaerkischen Landesregierung, Hydrograph.Landesabteilung
collaborating organisation	Amt der Oberoesterreichischen Landesregierung, Hydrographischer Dienst
collaborating organisation	Amt der Niederoesterreichischen Landesregierung, Hydrographischer Dienst
collaborating organisation	Amt der Kaerntner Landesregierung, Hydrographischer Dienst
collaborating organisation	Amt der Burgenlaendischen Landesregierung, Hydrographischer Dienst
collaborating organisation	Amt der Salzburger Landesregierung, Hydrographischer Landesdienst
Reporting organisation	Central Hydrological Office

Denmark

1. Monitoring programme	The Danish groundwater observation network
responsible organisation	Geological Survey of Denmark
Reporting organisation	DGU

Finland

1. Monitoring programme	Geohydrological Monitoring
2. Abbreviation	Groundwater table
responsible organisation	Finnish Environment Agency
collaborating organisation	North Ostrobothnia Regional Environment Centre
collaborating organisation	Southeast Finland Regional Environment Centre
collaborating organisation	West Finland Regional Environment Centre
collaborating organisation	Southwest Finland Regional Environment Centre
collaborating organisation	South Savo Regional Environment Centre
collaborating organisation	North Savo Regional Environment Centre

Summary of monitoring programme

collaborating organisation	Lapland Regional Environment Centre
collaborating organisation	Kainuu Regional Environment Centre
collaborating organisation	Haeme Regional Environment Centre
collaborating organisation	Central Ostrobothnia Regional Environment Centre
collaborating organisation	Central Finland Regional Environment Centre
collaborating organisation	Uusimaa Regional Environment Centre
collaborating organisation	North Karelia Regional Environment Centre
Reporting organisation	Finish Environement Agency

France

1. Monitoring programme	Reseau piezometrique du DIREN centre (progr. # 2052)
1. Monitoring programme	Suivi piezometrique SNEA de l'Aquifere profond Nord-Pyreneen (progr: #2130)
1. Monitoring programme	Reseau eaux Souterraines-Languedoc-Roussillon (progr: #2090)
1. Monitoring programme	Suivi piezometrique de quelques aquiferes en Languedoc-Roussillion (progr: # 2132)
1. Monitoring programme	Reseau Telenappe (progr: # 2058)
1. Monitoring programme	Reseau piezometrique d'Alsace (Progr. # 2056)
1. Monitoring programme	Reseau de Surveillance Regional du Niveau des nappes souterraines dans la region Nord Pas de Calais (progr: # 2133)
1. Monitoring programme	Suivi piezometrique des nappes du socle en pays de la Loire (progr: #2131)
1. Monitoring programme	Reseaux Piezometriques du Basin Rhone-Mediterrane-Corse (progr:# 2054)
1. Monitoring programme	Reseau piezometrique de Lorraine (progr. #2057)
1. Monitoring programme	Reseau piezometrique de Haute-Normandie. Departement de l'Eure (progr: # 2134)
1. Monitoring programme	Reseau piezometrique du bassin Seine-Normandie (progr. #2051)
1. Monitoring programme	Reseau piezometrique du bassin Loire Bretagne (programme #2050)
1. Monitoring programme	Reseau piezometrique de Haute-Normandie departement de la Seine-Maritime (progr: # 2135)
responsible organisation	network owner
responsible organisation	network owner
responsible organisation	network owner
responsible organisation	network owner
responsible organisation	Network owner
responsible organisation	Network owner
responsible organisation	Not stated
responsible organisation	not stated, assumed to be the conseil Regional d'Alsace

Summary of monitoring programme

responsible organisation	Direction Regionale de l'Environement
responsible organisation	Direction regionale de l'Environement Centre
responsible organisation	Ministere de l'Industrie ou Agence de l'Eau Seine-Normandie ou DIREN
responsible organisation	Départements ou regions (Centre, Poitou-Charentes, Vendee, Sarthe, Maine-et-loire)
responsible organisation	network owner
responsible organisation	Agence et DIREN
collaborating organisation	Direction Regionale pour l'Environement
collaborating organisation	Bureau des Recherches Geologiques et Mineres-Agence regionale
collaborating organisation	BRGM, for the programme manager
collaborating organisation	Bureau des Recherches Geologiques et Mineres-Agence regionale Aquitaine
collaborating organisation	Conseil regional d'Alsace, Direction regionale de l'Environement Alsace
collaborating organisation	for the programme manager: BRGM
collaborating organisation	Direction regionale de l'Environement Centre
collaborating organisation	for programme manager: DIREN, DDAF ou conseil general selon le cas
collaborating organisation	Direction regionale de l'Environement Lorraine
Reporting organisation	Reseau Piezo de l'Haute Normandie Annuaire 1990 Depart. de l'Eure (DRIRE Haute-Normandie, Ministere Industrie, BRGM, Conseil gegeral), Bassin Seine-Normandie Reseau Piezo Annuaire 1990 (BRGM Il-de-France, Mission Deleguee de Bassin SN, Ministere Industr
Reporting organisation	Sluvi Piezometriques des nappes du socle. Region Pays-de-la-Loire. Resultats des mesures 1990-91 (BRGM Pays da la Loire)
Reporting organisation	Annuaire piezometriques de quelques aquifers en Languedoc Roussillion (BRGM Languedoc Roussillion)

Germany

1. Monitoring programme	Landesmessnetz Grundwasserstand
1. Monitoring programme	Grundwasserdatenbank
1. Monitoring programme	Landesmeßnetz zur Ueberwachung von Grundwasserstand/Quellschuettung (regional monitoring Network for measurement of gw-level and spring discharge)
2. Abbreviation	LGD (Landesgrundwasserdienst)
responsible organisation	Landesamt fuer Umweltschutz Sachsen-Anhalt (LAU)
responsible organisation	Thueringer Landesanstalt fuer Umwelt
responsible organisation	Bayrisches Landesamt fuer Wasserwirtschaft LfW
responsible organisation	Landesumweltamt
collaborating organisation	Saatliches Amt fuer Umweltschutz Dessau-Wittenberg

Summary of monitoring programme

collaborating organisation	Staatliches Umweltamt Duisburg
collaborating organisation	Saatliches Amt fuer Umweltschutz Magdeburg
collaborating organisation	Saatliches Amt fuer Umweltschutz Halle
collaborating organisation	Aussenstelle Bonn
collaborating organisation	Staatliches Umweltamt Suhl
collaborating organisation	Staatliches Umweltamt Sondershausen
collaborating organisation	Staatliches Umweltamt Gera
collaborating organisation	Staatliches Umweltamt Erfurt
collaborating organisation	Aussenstelle Soest
collaborating organisation	24 local offices of water management
collaborating organisation	Staatliches Umweltamt Bielefeld
collaborating organisation	Staatliches Umweltamt Krefeld
collaborating organisation	Staatliches Umweltamt Koeln
collaborating organisation	Staatliches Umweltamt Lippstadt
collaborating organisation	Staatliches Umweltamt Aachen
collaborating organisation	Staatliches Umweltamt Minden
collaborating organisation	Staatliches Umweltamt Muenster
collaborating organisation	Staatliches Umweltamt Hagen
collaborating organisation	Staatliches Umweltamt Duesseldorf
collaborating organisation	Staatliches Umweltamt Siegen
collaborating organisation	Staatliche Umweltamt Herfen
Reporting organisation	Landesumweltamt
Reporting organisation	Bayrisches Landesamt fuer Wasserwirtschaft LfW Lazarettstr. 67, D-80636 Munich, Germany
Reporting organisation	Landesamt fuer Umwltschutz Sachsen-Anhalt (LAU), Reideburgersrt. 47-49, 061166 Halle/Saale
Reporting organisation	Thueringer Landesanstalt fuer Umwelt, 07745 Jena, Pruesingstr. 25

Ireland

1. Monitoring programme	Geological Survey of Ireland, Groundwater Level Monitoring
Reporting organisation	Geological Survey of Ireland

Italy

1. Monitoring programme	In only a few regiones there are groundwater quantity monitoring programmes according to law Nr. 319 of the 10/5/1976
responsible organisation	Regions /Water Supply bodies

Norway

Summary of monitoring programme

1. Monitoring programme	Norwegian Groundwater monitoring network (in Norwegian) Landsomfattende grunnvannsnett (LGN)
2. Abbreviation	LGN
responsible organisation	Geological Survey of Norway (NGU)
collaborating organisation	Norwegian Water Resources and Energy Administration (NVE)
Reporting organisation	NGU/yearly

Portugal

1. Monitoring programme	Rede piezometrica
responsible organisation	Instituto Nacional de Agua e Direccoes Regionais do Ambiente e Recursos Naturais
collaborating organisation	Direccao Regional do Ambiente e Recursos Naturais do Norte
collaborating organisation	Direccao Regional do Ambiente e Recursos Naturais da Lisboa e Vale de Tejo
collaborating organisation	Direccao Regional do Ambiente e Recursos Naturais do Alentejo
collaborating organisation	Direccao Regional do Ambiente e Recursos Naturais do Centro
collaborating organisation	Direccao Regional do Ambiente e Recursos Naturais do Algarve
Reporting organisation	INAG

Spain

1. Monitoring programme	Plan Nacional de Gestion y Conservacion de Acuiferos
2. Abbreviation	PNGC
responsible organisation	Direccion General de Obras Hidraulicas
collaborating organisation	Instituto Tecnologico Geominero de Espana
Reporting organisation	Instituto Tecnologico Geominero de Espana

Sweden

2. Abbreviation	GWNET
responsible organisation	Geological Survey of Sweden
Reporting organisation	SGU

The Netherlands

1. Monitoring programme	The National Swedish Groundwater Network
1. Monitoring programme	Dutch Primary Monitoring Network for GroundwaterLevels
responsible organisation	Dienst Water en Milieu, Dep. Waterstaatszaken
responsible organisation	Dienst Milieu en Water, Dep. Water
responsible organisation	Dienst Water en Milieu, Dep. Water en Waterkering
responsible organisation	Ministery for Transport, Public Works and Water Management together with RIZA Institute for Inland Water Management and Waste Water Treatment

Summary of monitoring programme

responsible organisation	Dienst Water en Milieuhygiene, Dep. Water
responsible organisation	Dienst Waterstaat, Milieu en Vervoer, Dep. Water en Landinrichting
responsible organisation	Diensten Milieu Beheer en Milieuplanvorming
responsible organisation	Directie Milieu en Waterstaat, Dep. Waterbeheer
responsible organisation	Hoofdgroep Milieu en Waterstaat, Dep. Water
responsible organisation	Hoofdgroep Ruimte en Milieu, Dep. Waterhuishouding
responsible organisation	Hoofdgroep Verkeer, Waterstaat en Milieu, Dep Water en ontgrondingen
responsible organisation	Dienst Water en Milieu Dep Waterstaat
collaborating organisation	TNO Institute Of Applied Geoscience
Reporting organisation	TNO Institute of Applied Geoscience

UK

1. Monitoring programme	National Groundwater levels monitoring programme
responsible organisation	National Rivers Authority, National Groundwater Centre
collaborating organisation	Water Supply Companies in some regiones
Reporting organisation	National Rivers Authority: National Groundwater Centre

Table 5-2-1 Summary of organisation types and responsibilities

code	*organisation*	*national*	*regional*	*regulatory body*	*water supply company*	*program-coord.*	*database managem.*	*local sampling*	*chemical analysis*	*reporting*	*others*
SWE02	Geological Survey of Sweden	y				y	y	y		y	
NED02	Ministery for Transport, Public Works and Water Management together with RIZA Institute for Inland Water Management and Waste Water Treatment	y				y					
FRA02	Departements ou regions (Centre, Poitou-Charentes, Vendee, Sarthe, Maine-et-loire)		y			y					
FRA03	Ministere de l'Industrie ou Agence de l'Eau Seine-Normandie ou DIREN	y	y	y		y					
FRA04	Direction regionale de l'Environement Centre		y	y		y					
FRA05	Direction Regionale de l'Environement		y	y		y					
FRA06	not stated, assumed to be the consell Regional d'Alsace					y					
FRA07	Agence et DIREN		y	y		y					
FRA08	Not stated	y				y					
FRA11	network owner					y					
FRA12	network owner					y					
AUT02	Hydrographisches Zentralbuero (Hydrological Central Office)	y				y	y			y	
ESP02	Direccion General de Obras Hidraulicas	y				y				y	
FIN02	Finnish Environment Agency	y				y	y			y	
GBR02	National Rivers Authority, National Groundwater Centre	y				y	y	y		y	
GER05	Bayrisches Landesamt fuer Wasserwirtschaft LfW		y			y	y			y	

code	organisation	national	regional	regulatory body	water supply company	program-coord.	database managem.	local sampling	chemical analysis	reporting	others
GER06	Landesumweltamt		y			y	y			y	
GER07	Thueringer Landesanstalt fuer Umwelt	y	y			y	y			y	
GER08	Landesamt fuer Umweltschutz Sachsen-Anhalt (LAU)		y			y				y	
NED02	Ministery for Transport, Public Works and Water Management together with RIZA Institute for inland Water Management and Waste Water Treatment	y				y					
NOR03	Geological Survey of Norway (NGU)	y				y			y	y	
POR02	Instituto Nacional de Agua e Direccoes Regionais do Ambiente e Recursos Naturais	y				y	y			y	

Table 5-2-2 Summary of collaborating organisation types and responsibilities

code	*organisation*	*national*	*regional*	*regulatory body*	*water supply company*	*program-coord.*	*local sampling*	*database managem.*	*chemical analysis*	*reporting*	*others*
AUT02	Magistrat dar Stadt Wien, Magistratsabteilung 45, Hydrographischer Dienst		y			y					
ESP02	Instituto Tecnologico Geominero de Espana	y				y	y	y	y		
FIN02	Lapland Regional Environment Centre		y					y			
FRA02	for programme manager: DIREN, DDAF ou conseil general selon le cas		y	y		y	y				
FRA03	for the programme manager: BRGM	y				y	y				
FRA04	Direction regionale de l'Environement Centre		y	y		y	y				
FRA05	Direction Regionale pour l'Environement		y	y		y					
FRA06	Conseil regional d'Alsace, Direction regionale de l'Environement Alsace		y	y		y	y				
FRA07	Direction regionale de l'Environement Lorraine					y	y				
FRA08	BRGM, for the programme manager	y				y	y				
FRA11	Bureau des Recherches Geologiques et Mineres-Agence regionale					y					
FRA12	Bureau des Recherches Geologiques et Mineres-Agence regionale Aquitaine					y					
GBR02	Water Supply Companies in some regiones										
GER05	24 local offices of water management							y			
GER06	Staatliches Umweltamt Siegen							y			
GER07	Staatliches Umweltamt Gera	y	y				y				
GER08	Saatliches Amt fuer Umweltschutz Magdeburg		y			y	y				

code	organisation	national	regional	regulatory body	water supply company	program-coord.	local sampling	database managem.	chemical analysis	reporting	others
NED02	TNO Institute Of Applied Geoscience						y				
NOR03	Norwegian Water Resources and Energy Administration (NVE)	y					y	y			
POR02	Direccao Regional do Ambiente e Recursos Naturais do Norte		y				y	y			
SWE02	Geological Survey of Sweden	y				y					

Table 5-3 Objectives of monitoring

code	*basic data collection*	*managem. of GW resources*	*research and scientific*	*national legislation*	*EC legislation*	*internat. obligations*
AUT02	y	y	y	y		y
DEN02	y		y			
ESP02	y	y	y			
FIN02	y		y			
FRA02	y	y				
FRA03	y		y			
FRA04						
FRA05						
FRA06	y	y	y			
FRA07	y					
FRA08	y					
FRA09		y				
FRA10	y	y		y		
FRA11	y	y	y			
FRA12	y	y				
FRA13	y	y				
FRA14	y					
FRA15	y					
GBR02	y	y		y		
GER05	y	y				
GER06	y	y	y	y		
GER07	y	y		y		y
GER08	y	y		y		

**) where reductions of pollution may be necessary*

code	*basic data collection*	*managem. of GW resources*	*research and scientific*	*national legislation*	*EC legislation*	*internat. obligations*
IRL01	y		y			
ITA03	y			y		
NED02	y	y		y		
NOR03	y	y	y			
POR02	y	y	y	y	y	
SWE02	y		y			

**) where reductions of pollution may be necessary*

Table 5-4-1 Geographical extent of monitoring networks, total no. of sampling sites, gw regions, total area and sampling site density/km²

code	*administrative extent*	*geographical extent*	*PM, total no.of sampl. sites*	*PM, total no. of gw regions*	*KA, total no.of sampl. sites*	*KA, total no. of gw regions*	*OS, total no.of sampl. sites*	*OS, total no. of gw regions*	*PM, total area*	*KA, total area*	*OS, total area*	*PM, density*	*KA, density*	*OS, density*
AUT02	National	Austria	3000	140	10	30	0	0	10000	15000	0	0,3000	0,0007	
DEN02	National	Denmark	200	3	0	0	0	0	43216	0	0	0,0046		
ESP02	National	Spain	2726	101	1411	156	2439	200	79258	54628	38644	0,0344	0,0258	0,0631
FIN02	National	Finland	270	22	0	0	360	32	37	0	35	7,2973		10,2857
FRA02		Bassins Loire-Bretagne	0	0	0	0	0	0	0	0	0			
FRA03		Bassin Seine-Normandie	0	0	0	0	0	0	0	0	0			
FRA04		Region Centre	0	0	0	0	0	0	0	0	0			
FRA05			0	0	0	0	0	0	0	0	0			
FRA06		Plaine d'Alsace	0	0	0	0	0	0	0	0	0			
FRA07		Groundwater of Lorraine	0	0	0	0	0	0	0	0	0			
FRA08			0	0	0	0	0	0	0	0	0			

code	*administrative extent*	*geographical extent*	*PM, total no.of sampl. sites*	*PM, total no. of gw regions*	*KA, total no.of sampl. sites*	*KA, total no. of gw regions*	*OS, total no.of sampl. sites*	*OS, total no. of gw regions*	*PM, total area*	*KA, total area*	*OS, total area*	*PM, density*	*KA, density*	*OS, density*
FRA09		Region Languedoc-Roussillon: departements de l'Herault (nappe de l'Astien) et departement du Gard+F143 (nappe de la Vistrenque)	0	0	0	0	0	0	0	0	0			
FRA10			0	0	0	0	0	0	0	0	0			
FRA11			0	0	0	0	0	0	0	0	0			
FRA12			0	0	0	0	0	0	0	0	0			
FRA13			0	0	0	0	0	0	0	0	0			
FRA14			0	0	0	0	0	0	0	0	0			
FRA15			0	0	0	0	0	0	0	0	0			
GBR02	National	England, Wales	735	0	598	0	4085	0	13584	11004	75219	0,0541	0,0543	0,0543
GER05	Free State of Bavaria	Bavaria	1520	3	107	1	559	7	28000	8000	35000	0,0543	0,0134	0,0160
GER06	regional	North Rhine Westfalia	42900	150	100	25	100	79	17000	300	16700	2,5235	0,3333	0,0060
GER07	national, regional	freestate of Thueringen	0	0	0	0	0	0	900	4900	10540	0,0000	0,0000	0,0000
GER08	Sachsen-Anhalt	Sachsen-Anhalt	1200	9	0	0	650	19	12000	0	8000	0,1000		0,0813
IRL01	National	Counties Cork, Laois,Kilkenny,Roscommon	2	2	17	3	3	1	0	0	0			

code	*administrative extent*	*geographical extent*	*PM, total no.of sampl. sites*	*PM, total no. of gw regions*	*KA, total no.of sampl. sites*	*KA, total no. of gw regions*	*OS, total no.of sampl. sites*	*OS, total no. of gw regions*	*PM, total area*	*KA, total area*	*OS, total area*	*PM, density*	*KA, density*	*OS, density*
ITA03			0	0	0	0	0	0	0	0	0			
NED02	National	The Netherlands	4000	100	0	0	0	0	36000	0	0	0,1111		
NOR03	National	Norway	36	0	0	0	2	0	0	0	0			
POR02	National	regional	477	4	143	4	0	0	26000	5500	0	0,0183	0,0260	
SWE02	National	Sweden	357	70	0	0	0	0	0	0	0			

Table 5-4-2 Distribution of groundwater observation points

code	*PM, evenly within the whole gw area*	*PM, concentr. around drinking water wells*	*PM, concentr. around impact areas*	*Pm, others*	*KA, evenly within the whole gw area*	*KA, concentr. around drinking water wells*	*KA, concentr. around impact areas*	*KA,, others*	*OS, evenly within the whole gw area*	*OS, concentr. around drinking water wells*	*OS, concentr. around impact areas*	*OS,, others*
AUT02	y							y				
DEN02	y											
ESP02	y				y							y
FIN02	y								y			
FRA02												
FRA03												
FRA04												
FRA05												
FRA06												
FRA07												
FRA08												
FRA09												
FRA10												

code	PM, evenly within the whole gw area	PM, concentr. around drinking water wells	PM, concentr. around impact areas	Pm, others	KA, evenly within the whole gw area	KA, concentr. around drinking water wells	KA, concentr. around impact areas	KA,, others	OS, evenly within the whole gw area	OS, concentr. around drinking water wells	OS, concentr. around impact areas	OS,, others
FRA11												
FRA12												
FRA13												
FRA14												
FRA15												
GBR02	y			y	y			y	y			y
GER05	y				y				y			
GER06	y	y	y		y							y
GER07	y				y				y			
GER08	y								y			
IRL01				y				y				y
ITA03												
NED02	y											
NOR03												
POR02	y	y		s	y	y						

code	PM_1, evenly within the whole gw area	PM_2 concentr. around drinking water wells	PM_2 concentr. around impact areas	Pm_3 others	KA_1 evenly within the whole gw area	KA_2 concentr. around drinking water wells	KA_2 concentr. around impact areas	KA_{3} others	OS_1 evenly within the whole gw area	OS_2 concentr. around drinking water wells	OS_2 concentr. around impact areas	OS_{3} others
SWE02	y											

Table 5-5 Temporal extent of monitoring networks

code	*earliest record (year)*	*median record (year)*	*average record length (years)*
AUT02	1930	1955	25
DEN02	1950		
ESP02	1967	1980	10
FIN02	1968	1985	20
FRA02	1993		
FRA03			
FRA04			
FRA05			
FRA06			
FRA07			
FRA08			
FRA09			
FRA10			
FRA11			
FRA12			
FRA13			
FRA14			
FRA15			
GBR02	1845	1977	20
GER05	1915		60
GER06	1909	1960	35
GER07	1915	1950	25

code	*earliest record (year)*	*median record (year)*	*average record length (years)*
GER08	1907		20-70
IRL01	1974	1977	16
ITA03			
NED02	1870	1975	20
NOR03	1967	1980	15
POR02	1970	1983	15
SWE02	1955	1971	20

Table 5-6-1 Numbers of different types of observation points and their total numbe

code	*number spring wells*	*number bored wells*	*number driven wells*	*number digged wells*	*total number*
AUT02	10	1600	1600	1300	4510
DEN02	0	156	0	0	156
ESP02	385	3564	0	1901	5850
FIN02	0	576	0	54	630
FRA02	0	0	0	0	0
FRA03	0	0	0	0	0
FRA04	0	0	0	0	0
FRA05	0	0	0	0	0
FRA06	0	0	0	0	0
FRA07	0	0	0	0	0
FRA08	0	0	0	0	0
FRA09	0	0	0	0	0
FRA10	0	0	0	0	0
FRA11	0	0	0	0	0
FRA12	0	0	0	0	0
FRA13	0	0	0	0	0
FRA14	0	0	0	0	0
FRA15	0	0	0	0	0
GBR02	0	5100	50	268	5418
GER05	43	1334	400	397	2174

code	*number spring wells*	*number bored wells*	*number driven wells*	*number digged wells*	*total number*
GER06	209	36176	90	6625	43100
GER07	91	1172	0	0	1263
GER08	10	1200	650	0	1860
IRL01	1	17	0	4	22
ITA03	0	0	0	0	0
NED02	0	4000	0	0	4000
NOR03	4	4	82	6	96
POR02	31	430	0	168	629
SWE02	0	25	332	0	357

Table 5-6-2 Number and percent of observation points with (non) recording water level/discharge indicators

code	*no. of non rec. water level*	*% of non rec. water level*	*no. of rec. water level*	*% of rec. water level*	*no. of non rec. discharge level*	*% of non rec. discharge level*	*no. of rec. discharge level*	*% of rec. discharge level*
AUT02	2610	90	290	10				
DEN02			200	100				
ESP02			6144	100			791	100
FIN02	576	91	54	9				
FRA02								
FRA03								
FRA04								
FRA05								
FRA06								
FRA07								
FRA08								
FRA09								
FRA10								
FRA11								
FRA12								

code	no. of non rec. water level	% of non rec. water level	no. of rec. water level	% of rec. water level	no. of non rec. discharge level	% of non rec. discharge level	no. of rec. discharge level	% of rec. discharge level
FRA13								
FRA14								
FRA15								
GBR02	4878	90	542	10				
GER05			2186	100				
GER06	17806	40	24876	60			209	100
GER07	500	30	1172	70	70	43	91	57
GER08								
IRL01	6	27	16	73				
ITA03								
NED02			4000					
NOR03	96	100						
POR02	572	91	26	4	31	5		
SWE02	354	99	3	1				

Table 5-7-1 Number and percent of observation points with indication of altitude

code	*spring wells (no)*	*spring wells (%)*	*bored wells (no)*	*bored wells (%)*	*driven wells (no)*	*driven wells (%)*	*digged wells (no)*	*digged wells (%)*
AUT02		100		100		100		100
DEN02			200	100				
ESP02	385	100	3564	100			1901	100
FIN02								
FRA02								
FRA03								
FRA04								
FRA05								
FRA06								
FRA07								
FRA08								
FRA09								
FRA10								
FRA11								
FRA12								
FRA13								
FRA14								

code	spring wells (no)	spring wells (%)	bored wells (no)	bored wells (%)	driven wells (no)	driven wells (%)	digged wells (no)	digged wells (%)
FRA15								
GBR02			4590	90	45	90	243	90
GER05		100		100		100		100
GER06		100		100		100		100
GER07	91		1172					
GER08								
IRL01	1	100	17	100			4	100
ITA03								
NED02			3900	97,5				
NOR03	4	100	4	100	82	100	6	100
POR02	25	4	300	48			74	12
SWE02			25	100	330	100		

Table 5-7-2 Number and percent of observation points with indication of coordinates

code	*spring wells (no)*	*spring wells (%)*	*bored well (no)*	*bored wells (%)*	*driven wells (no)*	*driven wells (%)*	*digged wells (no)*	*digged wells (%)*
AUT02		100		100		100		100
DEN02			200	100				
ESP02	385	100	3564	100			1901	100
FIN02								
FRA02								
FRA03								
FRA04								
FRA05								
FRA06								
FRA07								
FRA08								
FRA09								
FRA10								
FRA11								
FRA12								
FRA13								
FRA14								

code	spring wells (no)	spring wells (%)	bored well (no)	bored wells (%)	driven wells (no)	driven wells (%)	digged wells (no)	digged wells (%)
FRA15								
GBR02			5049	99	50	99	256	99
GER05		100		100		100		100
GER06		100		100		100		100
GER07	91		1172					
GER08								
IRL01	1	100	17	100			4	100
ITA03								
NED02			5000	100				
NOR03	4	100	4	100	82	100	6	100
POR02	31	5	430	68			130	21
SWE02			25	100	330	100		

Table 5-8-1 Frequency of observed variables in basic (B) and special (S) progr.

code	*gw level (B)*	*gw level (S)*	*gw temperature (B)*	*gw temperature (S)*	*gw others (B)*	*gw others (S)*	*spring water level (B)*	*spring water level (S)*	*spring water discharge (B)*	*spring water discharge (S)*	*Observation methodology standardized procedures for monit. system*
AUT02											y
DEN02	12/year										y
ESP02	2-6/year	1-5 all serie									y
FIN02	2/month										y
FRA02											y
FRA03											y
FRA04											y
FRA05											y
FRA06											y
FRA07											y
FRA08											y
FRA09											y
FRA10											y
FRA11											y
FRA12											y
FRA13											y

code	gw level (B)	gw level (S)	gw temperature (B)	gw temperature (S)	gw others (B)	gw others (S)	spring water level (B)	spring water level (S)	spring water discharge (B)	spring water discharge (S)	Observation methodology standardized procedures for monit. system
FRA14											y
FRA15											y
GBR02	2-12/year				y	y					y
GER05	weekly	continously		weekly			weekly				n
GER06											y
GER07	4/month	4/day							4/month		y
GER08	4/month	4-2/month									y
IRL01											n
ITA03											n
NED02	24/year	365/year	every 15 minute		1/year						y
NOR03	2-4/month		2-4/month								y
POR02	12/year	2 or 3/year					12/year	2 or 3/year	12/year	2 or 3/year	y
SWE02											y

Table 5-8-2 Details of standardized observation methodology procedures and and quality assurance

code	*observation methodology, standardized procedures, details*	*quality assurance procedures*
AUT02		regular controlling of stations (2-4 times /year), comparison with neighbour stationes, check of completeness, attention of special hydrological events
DEN02		Written Instructions, Data control, Scientific Inspection and evaluation
ESP02	At the beginning of the program 4-6 times per year at each control point. Currently 2-6 times per year using electrical sounding	General supervision from project managers
FIN02	Local observators are using measuring tape	Using manual quality control
FRA02	Network with 400 observation points (has been set up) which connects the regions, departments, the DIREN and l' Agence de l'Eau Loire-Bretagne. Frequency of observation: hourly or daily, depends on the case	
FRA03	260 piezom. In the basin which are administrated and run by differ. organisation. Frequenc. of observ: mensuelles obtained by the piezometer equipm. of MADO which are observed every 6th month by "micro-ordinateurs". the other piezom. monthly	
FRA04	10 piezometers run by DIREN Centre	
FRA05	In every region, BRGM et DIREN run one network. In Rhone-Alpes, they are unified for running a network financed by the region. Others: EDF, University, Reseau Dep.de la (cont.)	
FRA06	140 points and their financing is assured by the contract of the Nappe. Frequency of observation: weekly by one observator, measures not continously	
FRA07	23 points retenus lors d'une reunion de concertation DIREN, Agence, BRGM et DDA Meuse. Frequence d'observation: Hebdomadaire	
FRA08	Demonstration network const. of 40 observ. points, later this National Piezometric Network Project should contain 400 points. The 40 points chosen are prexisting piezometer of the BRGM. The points are situated in non influenced areas.	

code	observation methodology, standardized procedures, details	quality assurance procedures
FRA09	Network of 1000 piezometers over two groundwater areas	
FRA10	Surveillance around gas stocks (well drilling for exploitation, piezos, well drilling for pressure control in the stocks) except the stocks themselves, this network comprises 4 piezometers and 19 wells for water exploitation	
FRA11	17 piezometers observe:groundwater resources, physio-chemical characteristics. Piezometers observe certain parts with 8 regions	
FRA12	65 points incorporated in the yearbook (3 established before 1974 and some are set up for long periods) and using private observ. points constructed from the origin for serving the piezometres	
FRA13	501 measuring points BRGM with regular measurements informed by 63 observation points were data are collected only. Observations cover 3 captive gw rasources 4 free groundwater resources.	
FRA14	The observations are made with piezometers (observations are taken manually or limnographicaly monthly) or sources in periods with low levels. Rx piezo situated within karst (?) aquifers to enshure the alimentation with drinking water from gw resources	
FRA15	The observations are made with piezometers (observations are taken manually or limnographicaly monthly) or sources in periods with low levels. Rx piezo situated within karst (?) aquifers to enshure the alimentation with drinking water from gw resources	
GBR02	A standard national specification for groundwater levels monitoring has been developed. This will not yet be in current use in all regions	Fieldwork: No formal national QC Methodology in use in most regions. Where levels monitoring is contracted out, a QC audit is specified of 2-3% of the sampling undertaken by the contractor. Data: Currently QC is by visual examination (cont.)
GER05		
GER06		
GER07	Guidelines for observation and interpretation LAWA 1.Part: Groundwaterlevel 1982, 4.Part Springs (Quellen - Gelbdruck 1984)	Plausibility control/ Verdichtungen Staatliche Umweltaemter, trendanalyses at Thueringer Landesamt
GER08		
IRL01		
ITA03		

code	*observation methodology, standardized procedures, details*	*quality assurance procedures*
NED02	Only standardised methods for data handlings, see attached annexes A, C, E	automatic plausibility checks, detection of extremes in one time series, detection of spatial extremes, more details see Annex E.
NOR03	Internal manual for water level and temperature for NVE - observateurs	Syntax,Bounds check.,Visual control. Homogenity check. (double mass analysis/time series analysis (appiles only for daily values). Interpol. over short gaps. Scaling data from nearby station (use of models). All infilled data are marked (cont.)-
POR02	The piezometric level are done by electric sound	The piezometric level is periodically measured by electronic sound of contact. if some outlier data is been registered, that value is been confirmed at the field. The decisiveness will being alerted when some critical situations occurs
SWE02	Local observers measure manualy the depth to the groundwater level twice a month and send the result by post to SGU. Approximatelly 50 observers telephone the result of the mid-month observation to the telephone-recorder at SGU the day of observation	Intermittent mannual control

Table 5-9 Data storage and management

code	*database*	*hardware*	*operating system*	*software and language*	*variables stored*
AUT02	data collection, magnetic tape, (sequential)	Siemens BS 2000	PLI, Cobol, Fortran		groundwater level and temperature
DEN02	Digital Trieve, RDBMS	VAX		Digital Data Trieve, SAS	DGUNV (ID), UTM-coordinates, ground level data, water level
ESP02	ORACLE (RDBMS)	HewlettPackard 9000-845 and 700 Series Ethernet, TCP/IP Protocol	UNIX	SQL, SQL-Forms, SQL-RW, ORACLE DATABROWSER SPECIFIC TOOLS NET SOFTWARE: LAN-MANAGER-APRA SERVICES	General Data Base including a completely information about water plants. Static information and variable information including water levels. Water levels, water yeld.
FIN02	Ingres database		INGRES	SQL, Fortran	In our own INGRES database with fortran programs
FRA02					data base detailed construction not available
FRA03	Databank of the Donnes du Sous-Sol (BBS), written under ORACLE (Version 6)		VAX-Stations de travail micros, run under VMS		
FRA04	Piezologie DIREN Centre				
FRA05					
FRA06	Databank de l'Eau du Rhine-Meuse, written under IDS 2	Bull DPS 7000			
FRA07	Banque de l'Eau Rhin-Meuse, written under IDS 2	Bull DPS 7000			
FRA08					
FRA09					

code	database	hardware	operating system	software and language	variables stored
FRA10					
FRA11					
FRA12	unknow or not existing, written under ONDINE				
FRA13					
FRA14					
FRA15					
GBR02	Present: various regional systems, 40-50% of data on hydrodat/hydrolog. Future: WAMS, UNIX		WAMS, UNIX for Future, Present: Various regional systems	WAMS, SQL, PV-Wave for future, Present: Various regional systems	groundwater level
GER05	ADABAS	VAX/VMS	VAX/VMS	Natural	due to LAWA Grundwasser Richtlinie 1/82
GER06	DB2	MVS		SQL, SAS, QMF	
GER07	ORACLE, EXCEL			PASCAL, FORTRAN, CLIPPER	
GER08					
IRL01	spreadsheet-excel				
ITA03					
NED02	DBMS:ORACLE, GIS: ARC/INF and SMALL WORLD			Dutch and see type of database for software	Point data: groundwater heads, chemical analysis, well logs, geophysical measurements, geo-electrical soundings, pumping tests, gw abstraction. Spatial data: dimension and properties of layers, surface water syst., infiltration seepage area, (cont)
NOR03	SYBASE	PC,	IRIX, Silicon Graphics, MS-Windows	C,C++, Fortran, Usoft Developer, Report Smith	Ground water level, ground water temperature

code	*database*	*hardware*	*operating system*	*software and language*	*variables stored*
POR02	RDBMS, ORACLE, ACCESS	PC, ALPHA DIGITAL	DOS, OSF1	SQL, ACCESS BASIC, C, SQL FORMS, REPORTWRITER	Piezometric level
SWE02	RDBMS, INGRES	SUN-computer	UNIX	SGL, SAS	groundwater level, groundwater temperature

Table 5-10 Availability of data

code	*floppy disk*	*magnetic tape*	*internet*	*paper sheets*	*reports*	*data available without restriction*	*data available without fee*	*available at public organisations*	*reporting organisation details*
AUT02	y	y		y	y	y	n	y	
DEN02	y	y		y	y	n	y	y	Danish Geographical Society DGU
ESP02	y	y		y	y	n	y	y	Juana Baeza Rodriguez-Caro, Margarita Gomez Sanchez, ITGE Rios Rosas 23, 28003 Madrid Fax: 341 44 26 216, Phone: 341 34 95 846
FIN02	y	y		y	y	y	y	y	Finnish Environment Institute, Jouko Soveri, P.O.Box 140, SF-00251, Helsinki, Finnland
FRA02				y					
FRA03				y					
FRA04							n		Direction Regionale de l'Environement Centre
FRA05									
FRA06	y	y					n		Agency de l'Eau Rhin-Meuse
FRA07							n		
FRA08									BRGM
FRA09									
FRA10									
FRA11									
FRA12									

code	*floppy disk*	*magnetic tape*	*internet*	*paper sheets*	*reports*	*data available without restriction*	*data available without fee*	*available at public organisations*	*reporting organisation details*
FRA13									
FRA14									
FRA15									
GBR02	y	y		y	y		y		From regional NRA offices
GER05	y	y		y	y		y		
GER06	y	y		y	y	y		y	
GER07	y	y		y	y	y	y	y	Thueringer Landesanstalt fuer Umwelt, 07745 Jena, Pruessingstr. 25
GER08	y	y		y	y				
IRL01						n	y	y	Geological Survey of Ireland, Beggars Bush, Haddington Road, Dublin 4, Ireland. Contact person: G.R.Wrigth, phone: +353 1 67 07 444, fax: +353 1 668 1782.
ITA03									
NED02	y	y		y		n	n	y	TNO Institute of Applied Geoscience. Person: M.J. van Bracht, P.O.Box 6012, 2600 JA Delft. phone'+31 15 69 71 56, fax: '+31 15 56 48 00, e-mail: VBRACHT@IAG. TNO.NL
NOR03	y	y	y	y	y	n	n	n	Available through NVE. A handling fee is charged dependent on the data amount and degree of processing
POR02	y	y			y				INAG, Direccao de Servicos de Recursos Hidricos, Ave. Gago Coutinho, 30-12, 1000 Lisboa, phone: 847 00 80
SWE02	y	y	y	y	y	n	y	n	

Table 5-11 Observation station details

code	*local number*	*name of gw region*	*code of gw region*	*station name*	*location*	*measuring authority*	*altitude of station (m)*	*period of record*	*measured variables*	*observation frequency*
AUT02	y	y	y	y	y	y	y	y	y	y
DEN02	y	n	n	n	y	n	y	n	n	n
ESP02	y	y	y	n	y	y	y	y	y	y
FIN02	y	n	n	y	y	y	y	y	y	y
FRA02	y	y	y	y	y	y	y	y	y	y
FRA03	y	y	y	y	y	y	y	y	y	y
FRA04	y	y	y	y	y	y	y	y	y	y
FRA05	y	y	y	y	y	y	y	y	y	y
FRA06	y	y	y	y	y	y	y	y	y	y
FRA07	y	y	y	y	y	y	y	y	y	y
FRA08	y	y	y	y	y	y	y	y	y	y
FRA09	y	y	y	y	y	y	y	y	y	y
FRA10	y	y	y	y	y	y	y	y	y	y
FRA11	y	y	y	y	y	y	y	y	y	y
FRA12	y	y	y	y	y	y	y	y	y	y
FRA13	y	y	y	y	y	y	y	y	y	y
FRA14	y	y	y	y	y	y	y	y	y	y
FRA15	y	y	y	y	y	y	y	y	y	y

code	*local number*	*name of gw region*	*code of gw region*	*station name*	*location*	*measuring authority*	*altitude of station (m)*	*period of record*	*measured variables*	*observation frequency*
GBR02	y	n	n	y	y	n	y	y	y	y
GER05	y	y	y	y	y	y	y	y	y	y
GER06	y	y	y	y	y	y	y	y	y	y
GER07	y	n	n	y	y	y	y	y	y	y
GER08	y	y	y	y	y	y	y	y	y	y
IRL01	y	n	n	y	y	y	y	y	y	y
ITA03										
NED02	y	y	y	y	y	y	y	y	y	y
NOR03	y			y	y	y	y	y	y	y
POR02	y	y	y	y	y	y	y	y	y	y
SWE02	y	y	y		y	y	y	y	y	y

5. DISCUSSION

5.1 Groundwater quality

The discussion deals with data out of the MW2 questionnaires which are presented in this report. It is important to bear in mind that not all of the 17 countries returned the questionnaire or answered it completely (e.g. no questionnaires returned from Belgium and Luxembourg) and that the answers were differently detailed.

The monitoring of groundwater quality has been undertaken in most European countries since the seventies and eighties. Only France has installed a groundwater quality monitoring system since 1902. The majority of monitoring programmes are co-ordinated by a single national institution which mostly collaborates with regional or provincial organisations. The number of collaborating organisations varies from 1 (e.g. Denmark) to 103 (Italy) and often corresponds with the number of provinces (e.g. Austria) or counties (e.g. Sweden). The responsible organisations work in the fields of programme co-ordination and reporting and, with few exceptions, local sampling and database management. Collaborating organisations have their main tasks in the fields of programme co-ordination, local sampling, chemical analyses and database management.

Six countries undertake their monitoring networks in assessment of compliance with national legislation and/or EC legislation (e.g. Nitrate Directive 91/676/EEC, Drinking Water Directive 80/778/EEC).

Groundwater quality monitoring networks are developed as a result due to national demands and (hydro-)geological situation. Evidently the monitoring objectives, which fit for each country, vary a lot from country to country. Although „general surveillance purpose“ and „water quality trend identification“ are widespread goals in all over the EEA area. There are many more national differences comparing the other purposes. The Netherlands e.g. have great problems with agricultural soil overuse that endangers their shallow groundwater aquifers with e.g. fertilisers. Consequently their national network takes care to this special situation. Whereas in the north of Denmark e.g. a special monitoring network (with only four sampling sites) was installed to control the impacts of airborne pollutants due to the serious acidification there. In other countries like Portugal, Spain or UK seawater intrusion in coastal areas is also investigated within their monitoring networks. It can be stated, that the knowledge of the different national monitoring objectives and consequently of the criteria for the sampling site distribution is essential for any further evaluation and comparison of the network data.

All networks described in the questionnaires have national extent with the exception of the networks of the German Länder which are regional. Within the different types of groundwater resources (in porous media, in karst, in others like till, silt, volcanic aquifers...) the majority of sampling sites are distributed evenly within the whole groundwater area. Furthermore many are concentrated around drinking water wells. Only in Germany and Portugal sampling sites also investigate impact areas. As a matter

of fact records from the first sampling site group cannot be compared with records from the ones in impact areas. The national networks comprise distinct areas and distinct number of sampling sites and as a consequence a broad heterogeneity of sampling site density can be found. The following examples for groundwater in porous media may underline this with fact:

The greatest area investigated is in Spain and comprises 79,258 km², the smallest area with 30 km² in Finland. A comparison of their sampling site density per square kilometres shows that in Finland the density is about 0.57 and in Spain about 0.014 sites/km². Density ranges within all networks from 0.003 up to 0.57 sites/km²; or the number of sampling sites varies from 1,162 (France) to 4 (Norway; special programme). The situation in karst and other groundwater resources is also very heterogeneous. The differences arise from the differing national objectives and (hydro-)geological situations and land use.

Investigated determinands vary between the monitoring systems. They are adapted to the national circumstances but cannot really be compared on a European level at this stage of time. The total number of investigated parameters varies from 15 to 106, even the number of parameters measured for basic programmes ranges between 14 and 51. The parameters observed can be divided into 5 groups, the descriptive parameters (e.g. pH, conductivity, temperature,...) and the major ions (e.g. Ca, Mg, Na, K, NO_3, NO_2, NH_4, Cl, SO_4, HCO_3,...), which are the most investigated parameter groups, then followed by heavy metals (Pb, Cd, Ni, Hg,...), pesticides (herbicides, insecticides) and chlorinated solvents (trichlorethene,...). The variety among the countries concerning pesticides and chlorinated solvents are surprisingly high, e.g. 1-64 pesticides are observed. Sampling frequency also differs a lot, e.g. from 0.5 to 12 times/year for basic programme parameters.

Sampling and analysing procedures are key elements of every monitoring programme, evidently it is necessary that regulations for sampling and analysing procedures provide a standard to make the data obtained comparable. This fact become more important if an EEA network will be installed. Sampling and analysing is carried out from 1 up to more than 200 institutions which are mostly public ones. Not every variable of a single sample is analysed by a single institution. The majority of countries have standardised sampling and analytical methods as well as standardised regulations for precision and accuracy, but on their national level.

Data are stored and managed in various national databases. The databases used are e.g. ORACLE, VAX/Rdb, INGRES and INFORMIX. Frequent used operating systems are for example VMS, UNIX, WINDOWS, DOS and MVS on hardware such as Digital, HP, IBM, SUN, etc. The languages mostly used are e.g. FORTRAN, PASCAL, C and COBOL. Data are available on paper sheets, floppy disks and reports and internet (e.g. Austria). Most countries release data free of charge and without restrictions. To make data more and exchangeable it will be a need to design an interface for data exchange and provide codification guidelines. With this measures a EEA wide database can be installed.

Sampling site details held at source were available from nearly all of the countries. All countries have information about the local number of sampling sites, nearly all provide information about location, altitude of station, period of record, measured variables and (hydro-)geological information. Only few information about use of water or possible impacts is available.

5.2 Groundwater Quantity

This report contains data provided via the MW2 questionnaires. Under the consideration that not all of the countries returned answered questionnaires and that the answers given were differently detailed, this discussion is restricted to the information supplied.

The monitoring of groundwater quantity has a long tradition in Europe. The eldest groundwater monitoring network have been in operation since 1845, most of them have been installed at the beginning of the 20 century. The average length of records lies between 20-35 years. The majority of monitoring networks is managed by one single national institution, except the networks of France and the German Länder, which have a regional scale. The national organisations work all in the fields of programme co-ordination, furthermore many of them are responsible for local sampling, database management and reporting. Often they are supported in these tasks by collaborating organisations like water supply companies (UK) or water management offices (Germany). The number of collaborating organisations often depends on the number of provinces or the regional administrative borders in a country.

The respondents gave broadly similar objectives for groundwater monitoring activities such as the collection of basic groundwater data, the management of groundwater resources and the water supply, the support for (hydro-)geological science like the reasons for temporal and spatial changes of the groundwater level. The monitoring objectives often correspond to special national requests. For example: In the Netherlands there are shallow groundwater resources, if their level sinks, households, agriculture and industry can be endangered. Consequently good supervision of monitoring levels is necessary. In Portugal and UK the groundwater is endangered by seawater intrusion, thereupon the groundwater quantity monitoring network is also adapted to this special problem.

The connection between monitoring activities and legal obligations is surprisingly low. Only seven countries monitor groundwater in assessment of national legislation and only Portugal monitor due to EC legislation. In opposite to groundwater quality problems there is no current EC Directive which mentions specific requirements for groundwater quantity monitoring. This may be an important aspect for the future installation of the EEA wide groundwater monitoring network.

In most cases the extent of monitoring networks is national, with exception of the German Länder and French Regions. The majority of groundwater observation points is distributed evenly within the different types of groundwater resources such as porous media, karst, artesian and deep groundwater, etc. The total number of sampling sites, the

total area and as a consequence the sampling site density per km² varies a lot. These differences are often a result of heterogeneous national as well as (hydro-)geological situation. To give some examples; for porous media: The largest area investigated is in Spain with 79,258 km², the smallest is in Thüringen/Germany with 900 km². The highest number of sampling sites can be found in North-Rhine-Westfalia/Germany with 42,900 sites, the lowest in Ireland with two selected sites. Density of sampling sites varies from 0.004 in Norway up to 7.3 sites in Finland. The comparison of the other types of groundwater resources shows equal results.

The networks comprise various types of observation points such as bored and dug wells, which are mainly used and then driven wells and spring wells. The variables observed are broadly the same; groundwater level (all countries), then groundwater temperature (nearly all) and furthermore spring level and spring discharge. Quite all countries have observation sites which observe water level in a recording way. The frequency of other observation points is distinct, for example: for groundwater level it varies between weekly to 2 times a year, for groundwater temperature it differs from every 15 minutes to 2 times a month. A solution for a better correspondence of sampling frequency should be found before the EEA wide network starts to operate. It is encouraging that nearly all stations indicate altitude and co-ordinates. The quality of observation and sampling methodology is determined by various national standardised procedures. Quality assurance procedures are key elements within every monitoring network, they help to make data obtained more reliable and comparable. It is made e.g. by regular controlling of stations (e.g. Austria), plausibility checks (e.g. Netherlands, Germany), visual examination or general supervision of project managers (e.g. Spain). A harmonisation of these procedures will also be necessary for the EEA wide network.

Data management and storage is made via distinct national databases. Widespread databases are e.g. ORACLE, INGRES, RDBMS, etc. The most frequent operating system used are for example UNIX, VAX/VMS, DOS, Fortran, etc. Hardware equipment comprises e.g. HP, Digital, Bull, Sun, etc. and languages as well as software tools often installed are Fortran, Pascal, Cobol, C++, Windows, SQL, SAS, etc. To facilitate data access and data transfer it will be a need to design an interface and to provide codification guidelines. In most cases data are no subject of restriction and they are accessible without paying a fee. They can be made available on paper sheets, reports and floppy disks. Two countries, Norway and Sweden also make their groundwater data available via internet.

Observation site details held at source contain many information throughout all member countries. Information about location, name, altitude and number of station, name of groundwater region, period of record, frequency etc. are given.

6. CONCLUSIONS

This report provides an overview about groundwater quality and quantity monitoring activities in Europe. The report only contains data that were available via the MW2 questionnaires and the answers given. Consequently the report is limited to the information. This data collection had to be realised within a very strict timetable. As a consequence it was quite laborious for countries with centralised structure to succeed in answering in time. But due to the time available for this task it was not really possible for decentralised countries to deliver information within the deadline. Thereupon some of them could only give „average estimations“ on their monitoring systems due to the fact that their monitoring networks are differently structured. This experience may be a helpful instrument for further project planning. Also the data obtained from all member countries were variously detailed. Thereupon the evaluation procedures were not that easy.

Although database systems within the EEA member states are also often as different as the national monitoring objectives it is possible to adopt them for the data transfer into an EEA core database or for data transfers between countries and researchers. As pointed out in the discussion an EEA wide interface installation or a common use of the EIONET system can facilitate data transfer in future, even further inventories can be made faster and easier. Cost effectiveness is guaranteed as present systems can be widely used. This EEA groundwater database which contains surface and groundwater monitoring data -as described in the report- will assist these processes by providing

- a first overview of data available and responsible organisations for groundwater monitoring activities in each country

- the state of monitoring activities, sampling site details, geographical and temporal extent of networks, measured variables and frequencies, sampling and analysing procedures, database infrastructures, reporting and organisations involved at country level

- demonstrations of quality assurance procedures in each country which may be a key information for data comparison

- comparisons of monitoring practices adopted in each of the member states, with each aspect of the monitoring procedure examined in turn

- information about ways of harmonisation within the groundwater monitoring strategies of the member countries, with normally one central organisation co-ordinating the programme and having responsibility for maintaining the national database.

All data collected via the inventory can be a very helpful tool for further co-operation and development in the fields of water protection in the EEA area. For example the work for the MW3 project „Network Design“ already showed that the MW2 monitoring

inventory and data collection was a very good basis for the MW3 task reports. Thereupon this database is an important basis for the further harmonisation of the different national monitoring activities as well as the data management and storage. The need for these procedures were highlighted in the MW3 tasks reports (1995) too. These efforts can lead to a better co-ordination and handling for the solution of environmental problems. The solution of water problems is one of the main task for the further environmental policy of the European Community. Nowadays as good drinking water quality as well as the water resources themselves are more and more endangered by human activities. The water problem can destabilise all our living conditions. Careful management of water resources and protection by good water monitoring systems will help to handle these topics. A first step is initialised with the design for the EEA database.

REFERENCES

Austria:
Federal Ministry of Forestry and Agriculture at al 1995: „Wassergüte in Österreich - Jahresbericht in Österreich 1994/Report on the Status of Water Quality in Austria, Annual Report 1994“. Available at: Federal Ministry of Forestry and Agriculture, Marxergasse 2, 1030 Wien

Hydrological Service of Austria 1994: „Verzeichnis der Veröffentlichungen /Inventory on Publications 1983-1994“. Available at: Hydrological Service of Austria, Marxergasse 2, 1030 Wien

Germany:
Länderarbeitsgemeinschaft Wasser (LAWA) 1995 „Bericht zur Grundwasserbeschaffenheit Nitrat/ Report on Groundwater Quality Nitrate“
Available at: Senatsverwaltung für Stadtentwicklung und Umweltschutz, Berlin, Salvador-Alliende-Str. 78-80e, 12559 Berlin Köpenick, Germany

Further detailed information on groundwater monitoring activities in German Länder can be found in:

Landesanstalt für Umweltschutz in Baden-Württemberg 91-95:
„Grundwasserüberwachungsprogramm/ Groundwater monitoring programme Reports“
a) „Project Report“, November 1991
b)“ Grundwasserstände der Trockenperioden 1989-1992/Groundwater Level During Arid Periods between 1989-1992“, November 1992
c) „Ergebnisse der Beprobung/Results of monitoring" Mai 1995
d) „Rahmenkonzept Grundwassermeßnetz Entwurf/Framework Groundwater Monitoring network Draft“, 16 August 1994
Available at: Landesanstalt für Umweltschutz Baden-Württemberg, Abteilung 4 - Wasser, Griesbachstr. 3, PO Box 210 752, 76157 Karlsruhe, Germany

Niedersächsisches Landesamt für Ökologie, 1992: Gewässerüberwachungssystem Niedersachsen GÜN/Water Monitoring Network Niedersachsen“
Available at: Niedersächsisches Landesamt für Ökologie, An der Scharlake 39, 31139 Hildesheim, Germany

Landesamt für Wasser und Abfall Nordrhein-Westfalen, 1994: Grundwasserbericht 1993/Groundwater Report 1993“
Available at: Landesamt für Wasser und Abfall Nordrhein-Westfalen, Auf dem Draap 25, 40221 Düsseldorf, Germany

Ireland:
Environmental Protection Agency: Republic of Ireland - Groundwater -Country Paper = Groundwater In Ireland Report for *EuAqua*.
Available at EPA Headquarter, Ardcavan Wexford, Ireland

The Netherlands:

Bracht, 1989: An organisation scheme for the operation and management of the groundwater water level monitoring network in the Netherlands, KNGMG Symposium „Coastal Lowlands, Geology and Geotechnology“ 1987: 261-266

Bracht, year?: Demand for information as the basis for groundwater monitoring strategies

TNO Institute for Applied Geoscience, year?: REGIS -Regional Geohydrological Information System

TNO Institute for Applied Geoscience, May 1992: Reportnr. OS 92-59-B: Quality check,
all available at TNO Institute for Applied Geoscience, TNO, PO Box 285, 2600 JA Delft, the
Netherlands

Norway:

Norges Geologiske Undersokelse NGU, 1994: NGU Rapport 94.079 Landsomfattende Grunnvannsnett Arsrapport 1993“
Available at: Norges Geologiske Undersokelse NGU, Leiv Eirikssons vei 39, Po Box 3006, Lade, 7002 Trondheim

Statens Forurensningstilsyn, 1994: „Rapport 583/94 Overvaking av langtransportert forurenset luft og nedbør Arsrapport 1993“
Available at: Statens Forurensningstilsyn, PO Box 8100, 0032 Oslo

UK:

Rees, Gustard, Cole,1996: Inventory of Water Resources Monitoring Networks - Surface Water Quantity Monitoring - WRc Ref:PO5/95/-4e/Draft Report
available at Institute of Hydrology, Crowmarsh Gifford, Wallingford, OXON, OX10 8BB, UK

Nixon S C, 1995: European Environment Agency’s requirements for an inland waters monitoring network, draft for discussion,
Report available at: WRc, Medmenham, Marlow, Bucks SL7 2HD, UK

NRA/WSA/WCA, 31 March 1995: Framework agreement for sampling, analyses and data transfer for the NRA’s National Groundwater Quality Monitoring Programme

Chilton, Milne; November 1994: Groundwater quality assessment: A national strategy for the NRA, Final Report
available at: British Geological Survey, Maclean Building, Crowmarsh Gifford, Wallingford, Oxfordshire OX10 8BB, UK.

ANNEX 1: RESPONSIBLE ORGANISATION DETAILS

Groundwater Quality

Groundwater Quantity

ANNEX 2: DETAILED PARAMETERS

ANNEX 3: MW2 QUESTIONNAIRES

PARTS I, III AND IV