Czech National Groundwater Quality Monitoring Project and Harmonization with the Approaches in the EU Countries

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Czech Republic applies for a membership in the EU with horizons of entry in 2004. This political intention is joined with great numbers of legislative and organizational requirements that must be fulfilled. That is why the National program of the arrangements for a membership in the EU in the field of environment – the special area of the water quality was worked out. A remedy in the area of the water protection is a priority of the national environmental policy and the expenses in this field are high. In spite of it all the achievement of the full compatibility with the EU needs a great effort and further expanses even after the entry of the Czech Republic into the EU.

Czech Hydrometeorological Institute is a national institution that monitors abiotic and biotic components of the water environment on the territory of the Czech Republic. One of the main fields of its activity is an evaluation of surface and ground water quality. Nowadays CHMI monitors surface water quality in 263 sampling sites on rivers and groundwater quality on 480 objects nationwide.

The observation network for groundwater quality

The observation network for groundwater quality is a subset of the national groundwater observation network. Quality monitoring was gradually introduced since 1984, when 138 springs were monitored. Since 1986 another 121 shallow boreholes have been monitored, since 1991 additional 192 deep boreholes were monitored.

The observation network was located in the geological bodies, important for water management. In the fact are 7 types of groundwater bodies observed (created by joining of hydrogeologically similar hydrogeological regions):

- Bodies in quaternary fluvial and glacial sediments
- Bodies in terciary sediments
- Bodies in paleogenic and cretaceous (flysch) sediments of Carpathians
- Bodies in sediments of the Czech cretaceous sediments
- Bodies in limnic permian and carboniferous sediments
- Bodies in karst paleogenic sediments
- Bodies in proterozoic, paleozoic and igneous rocks

The groundwater monitoring program

- All springs and wells are sampled two times per year (spring – autumn cycle).
- Sampling is done by specialised company, which is selected in public competition called by CHMI.
- The samples are analysed in accredited laboratories, which are also selected in similar competition, repeated in 3-year cycles.
- As the number of elements in the monitoring network, also the number of measured properties gradually changed over the time.

- *Analysed matters:*

- Spring: basic and additional physico-chemical analysis, alfa activity, tensides, cyanides, heavy metals, fenols, nonpolar extractible matters, signal indicators of fluoranthen and AOX. In case, that indication limits are exceeded, specific analysis is introduced.
- Autumn: analysis consists of basic physico-chemical analysis, alfa activity, nonpolar extractible matters.

- Groundwater is sampled in accordance with normative ISO 5667-2, ISO 5667-3, ISO 5667-11, ISO 5667-6 (ČSN 75 7051) and related.

Over the CR territory vulnerable and endangered groundwater sources are gradually determined following the preparation to EU accession and implementation of EC directives and normative. These areas will be monitored by special programmes and with higher measurement frequency. This concerns mainly the Nitrates Directive 91/676/EEC and the Dangerous Substances Directive 76/464/EEC and daughter directives. The National accession plan expects, that regular monitoring will be extended by monitoring of old loads influence on groundwater quality (e.g. uranium mines, chemical, metallurgical and textile industry etc.). Sampling programmes and types of analyses should in the coming years be modified to fulfil requirements listed here, with the aim of maintaining and increasing the predicative ability of CHMI groundwater quality database.

Information system

Integrated in the water quality monitoring are data collection, primary check and data storage. CHMI established a hydro-ecologic information system (HEIS) for this purpose, where are all historical hydrological data are stored since beginning of CHMI operation. This system has three levels: first cover data collection, control and saving to the databases, second level concern maintenance of historical data, management of monitoring devices, management of monitored characteristics and third level consists of database outputs (primary data, characteristic values and interconnection to GIS).

A special data format was defined for transmitting of data from external laboratories to CHMI. This format is uniform for surface water and groundwater analysis and has a wide variability, so any combination of element type, sample type, date/time, sampling technique, analysed characteristics, laboratories, analytical procedure, detection levels, measurement errors and other issues and events may be covered by using this data format.

The measured data are collected at regional branches of the Institute and transferred from manual to digital shape. From automated registration devices data are transferred directly. Special purpose-oriented software is used for primary data processing, primary control, editing and corrections. Data is transferred to a central database (Oracle). Time series of primarily measured values are regularly produced as well as time series "cleaned" from known time-defined anthropogeneous influences and with filled observation gaps. These time series are created for statistical purposes.

Time series of regime observation are used as a basis for yearly hydrologic balance of groundwater quantity, which forms a basis for complete hydrologic balance. Separation of baseflow and dynamic part of the time series form basis for other computations. Changes of groundwater regime are regularly processed; forecasting methods are under development in present time. Data about groundwater regime is used as a basis for expertises and also as a basis for comparative studies on local groundwater regime influence.

Current observation network and plan for its improvement

Current observation network is concentrated prevailingly around rivers, but other areas are covered insufficiently. This fact is documented by the number of observed points. Hydrogeologic bodies important for water management, situated far from river zones cover area about 18 000 km^2, collecting approximately 50% of usable groundwater sources, are monitored by 243 observation points. Zones close to rivers, which have about one half of this water amount, with an area of around 8 000km^2, are monitored by 980 observation points. These areas are comparable in size, whereas the rest of the area (52 000km^2) providing the remaining 25% of groundwater sources are monitored by 443 observation points. Hydropedological profiles (HP, 475 observing objects), which are purpose-specific and outside of regular observatory network, are not included in this list. If we include this subsystem (concentrated in zones along rivers and surrounding quaternary layers), ratio of both groups will result even in worse number.

From the listed number of observing objects it is apparent, that configuration of the observation network is very non-uniform from the point of view of area as well as amount of usable groundwater sources. If we include also vulnerability of groundwater in relation to exploitable sources, the ratio will be even worse.

Plan for improvement of monitoring network

Analysis shows, that current observing network does not fulfil requirements coming chiefly from the Water Framework directive. We assume that primary task is to obtain basis for determination of groundwater conditions from the point of view of quantity in particular hydro-geological balance bodies following Annex 5 in the mentioned Directive.

Basic idea of the solution is to create two- component model of observation network. First component of the network allows uniform description of the groundwater regime over CR territory. Expected density is about 1 site / 75 km^2. Second, an additional component of the network in areas with important groundwater resources (considering menaced amount and quality of water) will be needed to fulfil the requirements of the Framework Directive. The density of the network in important areas will be about 1 observation point / 30 km^2. Springs are included to the observational network in cases, where observation of spring-discharge gives representative description of groundwater regime.

A new arrangement of the observation network is consistently based on article No. 4 of the Framework Directive for water and from requirements listed in Annex V, point 2. According to the geographic position of Czech Republic territory, no important rivers enter the territory and all discharge is formed from the precipitation and (in rainless periods) from groundwater resources. For this reason the formation of the groundwater sources has crucial importance not only as a drinking water source, but it also maintains the necessary surface outflow.

In accordance with current calculations, groundwater gives over 40% of total outflow from Czech Republic territory. That is why it is necessary to emphasize also the quantitative part of the groundwater regime and integration of groundwater to the whole hydrologic balance. In case it is not possible maintain good conditions of groundwater, environmental aims (specified in article 4 for surface water) cannot be met. Consequently, small and average discharges will be significantly influenced, up to periodical drying state. Replenishment of the observation network aims to fulfil requirements listed in Annex, paragraph 2.2.

Crucial importance is given to the methods for measured data evaluation. Density and configuration of the observation network should correspond with current methods of hydraulic and hydrologic balance modelling. These methods we assume as basic tools for groundwater ecologic status determination from the point of view of water quality. Considering that flow direction determines also contaminants propagation, they are highly important also from the point of view of water quality.

Dangerous matters in the hydrosphere of Czech Republic

Together with common groundwater quality monitoring programme a new project *"Occurrence and transport of dangerous matters in the hydrosphere of CR"* was launched by MoE and it is executed by CHMI since January 2000. The importance of water quality monitoring has increased in connection with the accession process. New requirements for monitoring for different purposes has arisen; consequently demands increased on currently performed activities. Close cooperation among responsible authorities of each project concerning the monitoring (ensured by monitoring networks and monitoring body in water quality area on national level) is necessary to assure mutual interlacing and cost-effectiveness. The question of occurrence and transport of dangerous matters in hydrosphere (in the meaning of Directives concerning dangerous matters) is one of most important issues in EC within water management. Above-mentioned project was close to routine activity of CHMI and project outputs will influence future activities of CHMI.

Aim of the project and its goals

- The main goal of the project is an inventory of dangerous substances in each part of hydrosphere as they are defined in the 76/464/EEC directive and daughter directives, 80/68/EEC directive, IPPC directive 96/91 EEC and in the Water Framework Directive.

- A definition of dangerous substances relevant for the Czech republic and definition of imission limits for surface and ground waters for those substances

- Inspectional monitoring will be carried out for identification of presence of dangerous substances in following parts of hydrosphere: surface and ground water, suspended sediments, sediments, biota.

- An identification, inventory and categorization of pollution sources and an assessment of their possible impact on hydrosphere. Identification of impacted water bodies based on already published studies will be a part of it too.

- In words of Framework directive the result will be "Overview of antropogeneous impacts to surface water conditions and to the groundwater". This result will be used as a basis for action programmes setting, with purposes to achieve good status of surface water and to achieve good ecological status and chemical status of surface water and to achieve good status of groundwater in all groundwater bodies on Czech Republic territory.

The selection of substances relevant for the hydrosphere of the Czech republic

CHMI proposed to divide substances into three classes:

Class A
Criteria of a class A:
Harmful substances to aquatic environment or adversely affecting aquatic life
Presence in the hydrosphere is proven
Substances are listed in EU and Czech directives as parameters of water quality with need of long term and regular monitoring
There are commonly used analytical methods

CHMI proposed 54 substances to be included in the class A, from that 29 are relevant for groundwater, surface water and sediments. 23 substances are relevant just for water and 2 are relevant for sediments only.

Class B
Criteria of class B:
Harmful substances or adversely affecting aquatic life.
The presence of substances in the hydrosphere is either possible (there are potentional sources) or partly proven
Substances are listed in different Czech and European legislation and documents (directives, monitoring programs, environmental objectives, regulations, recommendations) dealing with water quality assessment and evaluation with need of investigative monitoring.
Analytical methods are either commonly used or introducing.

CHMI have included 150 substances into the class B. The relevancy for hydroshere of Czech republic shall be a part of the results from an investigative monitoring.

Class C:
Substances in the class C are not present in the classes A and B. Substances were mentioned in studied documents just marginally, there is no information on their presence and their potentional source available.

Dangerous substances in ground and surface water Class A

anhtracene	arsenic
atrazine	benzene
benzo(a)pyrene	benzo(b)fluoranthene
benzo(g,h,i)perylene	benzo(k)fluoranthene
1,2 - dichlorobenzene	1,4 - dichlorobenzene
1,2 - dichloroethane	1,2 - dichloroethylene (isomers cis- and trans-)
2,4 - dichlorophenol	ethylbenzene
phenol	fluoranthene
fluorides	hexachlorobenzene
gama-hexachlorocyklohexane(gama-HCH, Lindane)	aluminium
chlorobenzene	chromium
indeno(1,2,3-cd)pyrene	cadmium
cobalt	cyanides
mangan	copper
molybdenium	2 - monochlorpphenol
naphtalene	nickel
lead	PCB 28
PCB 52	PCB 101
PCB 138	PCB 153
PCB 180	pentachlorobenzene
pentachlorophenol	mercury
selenium	tetrachloroethylene (perchloroethylene)
tetrachloromethane	toluene
1,2,4 - trichlorobenzene	trichloroethylene
2,4,6 - trichlorophenol	Trichloromethane (chloroform)
xylene	zinc

These dangerous substances (group A) were included to routine monitoring program this year. In surface waters we have choose 44 sampling sites including water, suspended sediments, sediments and biota.

Also in groundwater national monitoring network were this year in the spring round of sampling also sampled and analyzed samples for group A in all object of groundwater quality monitoring network (deep wells, shallow wells, springs).

As a part of this project is also preparation and application of COMMPS procedure (combined monitoring-based and modeling-based priority setting scheme) of dangerous substances in surface water and groundwater in the Czech republic. The result of project will be a list of dangerous substances relevant for Czech republic with order of importance.

Results of the project will be applied directly in the body, which solved the project tasks and also software products used for solution of this project will be further used in ordinary activities of CHMI for state administration support. Results will be also used for creation files with common information about current state and development of water quality in CR, with interactive access, which will be available on CD or accessible via Internet for wide public use.