# XXXVIII IAH Congress

## Groundwater Quality Sustainability
## Krakow, 12–17 September 2010

# Extended Abstracts

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**University of Silesia Press 2010**

abstract id: **545**

topic: **0**
**Keynote lectures**

title: **Polish Hydrogeological Survey — challenges and achievements**

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keywords: hydrogeological survey, Water Framework Directive, groundwater management, drainage basin action plans

Poland joined the European Union in May 2004. Intensive preparations had been underway since 2000, i.e. since the EU Framework Water Directive came into force. Taking into account the necessity to introduce considerable changes in water management, water resources protection, water status reporting and actions undertaken in connection with this, an idea was put forward to organise Polish hydrogeology within a national service institution.

The Polish Hydrogeological Survey (PHS) has been operating for 9 years and was established based on the Water Law Act of 2001. As far as I know, it is the first national hydrogeological survey in Europe and possibly in the world. The fact that the duties of the state as regards groundwaters are delegated to a unit established specifically for this purpose shows on one hand that hydrogeology is highly ranked in the field of Earth sciences, and on the other it reveals the significance of groundwater resources for society, the economy and the protection of groundwater-dependent terrestrial ecosystems. After 9 years of the PHS being in operation we are entitled to draw conclusions regarding the scope of responsibilities and the method of their implementation in practice, and to assess the effectiveness of the largest hydrogeological organisation in the country.

At this point it ought to be mentioned that the term 'hydrogeology' meaning the branch of science devoted to groundwaters has been in use in Polish for 120 years. For 60 years Polish academic institutions have been promoting graduates in the field of hydrogeology. Approximately 2000 people currently work in design and consulting offices, in administration and in academic centres in the specialised branch that is hydrogeology and engineering geology. This branch has solved a series of problems connected with detailed cartography of the country, mining excavation dewatering, construction excavation dewatering, intake construction and the provision of water to cities and districts.

## CHALLENGES FOR POLISH HYDROGEOLOGY

In the last two decades, Poland has undergone system and economic transformations, has become a member of the European Union and is currently implementing the Union's policy as regards protection of groundwater resources, along with neighbouring countries. Once Poland became a member of the EU in May 2004, the necessity arose to change the legal regulations by harmonising them with EU directives and to adapt activities that could make it possible to determine GWBs, evaluate their status and design and undertake actions to improve it. These activities are being successfully implemented, mainly due to structural and organisational changes, such as the establishment of the Polish Hydrogeological Survey at the Polish Geological Institute – the National Research Institute.

The 21st century brought new challenges to hydrogeology, especially:

- Increased demand for groundwater as drinking water. Currently some 68% of drinking water in Poland comes from groundwaters, with an annual increase trend of 1-2% in favour of groundwaters;
- During droughts excessive exploitation of groundwater resources can be observed, while in periods of prolonged downpours there is an excess of water. In the last 15 years we have experienced 3 enormous floods, including those in May and June this year;
- Construction of reservoirs is hindered by pro-ecological organisations. However, it is possible to retain the excess of water in aquifers during floods and to store the resources re-

tained in case of a drought. The retained groundwater resources can be of particular significance during emergency situations in the country. During the nuclear power plant disaster in Chernobyl, Poland supplied drinking water from groundwater intakes only, where no radionuclide contamination was detected;

- Plans and projects of storing $CO_2$ in rock masses pertain also to the area of Poland. However, there are possible problems with $CO_2$ injection to aquifers of the greatest hydraulic conductivity – the reaction of gas with rock matrix and the effectiveness of the levels that isolate and prevent gas from escaping to the atmosphere;
- Increased use of rock mass for underground storage of toxic and radioactive substances can be expected. In this case there are also some not entirely solved problems involving migration of contaminants, effectiveness of isolation and methods of securing aquifers against contamination across centuries;
- In the last decade problems of the temporal and the spatial scale have become increasingly evident. Groundwater flow modelling results at a regional scale give approximate outcomes, most often for steady-state conditions. Data for the models come from on-the-spot studies of hydrogeological conditions carried out in wells or from laboratory tests of small soils samples. This leads to errors arising from extrapolation. Errors can also be caused by assuming the boundary conditions that are known at the moment of measurement and they usually do not exceed the horizon of human life;
- another challenge for groundwater resources protection is the increasingly frequent use of renewable energy sources (RES). The largest geothermal water resources in Poland occur in Mesozoic aquifers. Geothermal waters have been observed in sandy forms of the Lower Cretaceous and Lower Jurassic periods. Geothermal power plants draw thermal waters from a depth of over 1500 m and their testing projects and hydrogeological documentations must be confirmed. These procedures do not apply to heat pumps, of which there are already thousands of installations. The obligation of filing environmental impact assessment reports does not apply to them either.

## THE TASKS OF THE POLISH HYDROGEOLOGICAL SURVEY UNDER THE WATER LAW ACT

The basic objective of the Polish Hydrogeological Survey is to perform the tasks of the state for the purposes of studying, balancing and protecting groundwaters so that they can be rationally used by society and the economy. The tasks specified in the Water Law Act, which implements the provisions of the Water Framework Directive, are the fixed responsibilities of the Polish Hydrogeological Survey and are performed based on long-term agreements ordered by the Ministry of Environment and financed by the National Fund for Environmental Protection and Water Management. These tasks can be grouped in several sections:

### Groundwater measurements and observations

The Polish Hydrogeological Survey organises and modernises the groundwater monitoring network and makes it possible to maintain it in a condition that permits constant measurements, observations and research. The network has over 800 points (primary and secondary stations) and will ultimately comprise around 1200 monitoring points. Automated measurement and data transmission equipment is installed in some stations. Depending on the needs,

the network's monitoring points observe the chemical (diagnostic, operational monitoring) and quantitative condition.

Groundwater condition measurement results are a basis for assessing groundwater status (chemical and quantitative) in the territory of the country. Changes in groundwater conditions can be caused by human activity, such as excessive exploitation of resources in areas of large municipal and industrial groundwater intake, water intake for agricultural purposes, mining drainage and construction dewatering. Changes in groundwater conditions can be also caused by natural factors, which include mostly weather anomalies or, so far poorly proven, climatic changes (greenhouse effect). The Polish Hydrogeological Survey prepares annual reports (assessments) and forecasts of groundwater conditions and hazards. This is possible due to long-term observations collected in GIS databases and processed according to standard procedures (in conformity with the INSPIRE guidelines).

The groundwater monitoring network's measurement and observation data kept in the database is made available by PHS to state administration and municipal governments, state institutions and upon the consent of the data owners (State Treasury) – to commercial companies and private persons.

In addition to managing the basic groundwater monitoring network, the Polish Hydrogeological Survey also manages measurements and observations within dedicated monitoring. For this purpose PHS carries out measurements in the monitoring network along the country borders (border monitoring), around facilities that strongly affect underground waters (local monitoring) and protected areas. PHS is also entitled to enter private premises in order to measure the water condition and to collect samples for analytic tests. Representatives of the Polish Hydrogeological Survey actively participate in the work of the border water committees in collaboration with all the neighbouring countries.

**Hydrogeological data collection, verification and processing**

The Polish Hydrogeological Survey is responsible for updating and verifying information resources of hydrogeological databases nationwide, as well as making them available. The data collection and processing system managed by PHS is the largest hydrogeological database in the GIS system, constantly updated and processed and made available based on proper legal regulations.

Data on the parameters of aquifer masses, specific resources, potential discharge of intakes, quality and systems of groundwater circulation are obtained in the country during construction work of new intakes, searches for natural resources or specialist field studies. The results of these studies are very costly and cannot be conducted for one-time purposes due to financial reasons, e.g. for the purpose of assessing the condition of groundwater resources in regions or in the area of the country. It is therefore necessary to accumulate and verify the data in the Central Hydrogeological Data Bank (the HYDRO Bank), which has been under constant development for 40 years in the Polish Geological Institute – the National Research Institute. According to data as at 2010, the HYDRO Bank contains information on around 135,000 hydrogeological features.

Information on the groundwater monitoring network and results of measurements and observations carried out since 1974 is stored in the *Groundwater Monitoring* database (over 900 measurement results for the groundwater table level are annually entered in the database).

Another important database is a digital Hydrogeological Map of Poland, at a scale of 1:50,000, made as a digital serial map comprised of 1069 sheets, covering the whole area of Poland. The integrated, spatially continuous GIS database makes it possible to select informational layers according to freely defined boundaries (voivodeship, river basin, catchment area etc.) and to analyse spatial information accumulated in the database. Starting in 2004, the GIS Hydrogeological Map of Poland is being constantly enriched with new thematic layers connected with identification and characteristics of the first aquifer level.

The *Groundwater Resources* and *Intakes* databases contain periodically updated information to be used in regular assessments and forecasts of changes in groundwater resources, prepared for people who make strategic decisions regarding the country's economy and population. The condition of the resources and the possibility of their use are also very important issues in the case of emergencies. Moreover, for the purpose of reports for the EU, changes in the quantity of groundwater reserves in the country and in particular water management regions or river catchments are annually assessed. Reports containing groundwater resource balances are part of water management balances of regions, catchments and the area of the whole country. Collaboration with the Polish National Hydrological and Meteorological Service in terms of uniform water balances for catchments and regions in order to prepare annual reports on water resources in the country is mandatory.

**Warnings against hazardous phenomena in groundwater recharge or intake zones**

High groundwater levels entail a risk of flooding. They commonly accompany high levels of surface waters in river valleys or in topographic lows beneath escarpments and rock steps. Also endangered by floods are mining areas after the discharge systems of mining plants are disconnected. These processes change slowly; in the case of mine dewatering they last for ten plus years up to several decades. PHS develops forecasts of the scope, scale and duration of these hazards.

High groundwater levels during precipitations and considerable soil humidity cause additional flow-off pressure in escarpments and high embankments, which is usually the cause of landslides and soil creeping (surface mass movements). PHS is responsible for assessing the risk and studying an endangered area. A map of areas endangered by flood in the valleys of Poland's main rivers was successfully and thoroughly verified during this year's flood.

In the case of failure of the water supply network, danger of warfare, terrorist attacks or as a result of chemical contamination of surface waters, groundwater resources are the only reserve of drinking water for people. Strategic groundwater reservoirs and their protection are supervised by PHS.

**Publications, training, personnel qualifications and national standards as regards groundwater resources protection and use**

Development of reports, announcements, balances and groundwater monitoring systems requires uniform procedures and techniques as regards measurements and field work, sample collection, data collection and processing. PHS takes care of the development of procedures and standard techniques for the country through publications, training and scientific workshops. For educational purposes and reports, assessments and forecasts, graphic representation of

groundwater database results is necessary. This is developed in Poland by means of standard GIS systems, computer cartography and result visualisation methods for the decision-makers.

PHS disseminates and popularises knowledge on groundwaters, their protection and use. Within the ecological education of society, the Survey approaches water resources as an element of the environment that is necessary for ecosystems to function.

**SUMMARY**

Polish hydrogeology has had some considerable achievements in the last decade. 2004 marked the completion of a serial edition of the Hydrogeological Map of Poland, scale 1:50,000, comprised of 1069 sheets. Currently, new informational layers are being added to the database.

In 2007 *Regional Hydrogeology of Poland* was compiled – a two-volume monograph prepared by a team of over 30 authors from all the hydrogeological centres in Poland. It is also available in a digital version on the website of the Ministry of Environment and the official PHS website: www.psh.gov.pl. These pages systematically present results for groundwater measurements and tests for groundwater chemical composition – hydrogeological annual reports and quarterly informational bulletins on groundwaters, available also in print ready versions. Printed and placed on internet sites are also PHS informational brochures on provision of water to the largest agglomerations in Poland, announcements and forecasts of groundwater status.

Along with numerous scientific institutions and geological companies, the Polish Hydrogeological Survey documents the Major Groundwater Reservoirs (MGR). The studies help determine the most perspective resources and protect drinking waters in Poland which are also an alternative for current water supply sources and apply to future generation of citizens.

In response to the current demand of society for drinking water, between 2007 and 2008 PHS determined alternative sources of drinking groundwater for cities of over 50,000 inhabitants which currently use mainly surface water intakes in circumstances of emergency hazards.

The Polish Hydrogeological Survey works also on flood hazards caused by surface mass movements – landslides and flooding during floods. Prepared between 2003 and 2006, *The Map of Areas in Danger of Being Flooded in Poland* is an important tool assisting flood risk management in the country, confirmed during this year's flood in Poland.

In the last decade, a series of engineering geology atlases at a scale of 1:10,000 were prepared for those large cities that show the greatest development dynamic. They can be used for the purposes of planning, preparing an initial evaluation of construction conditions, assessing the intensity of surface processes, such as mass movements and the depth to groundwaters, as well as creating land maps.

EU regulations require that information on the environment, and in the case of non-living nature – geoinformation, be made available to the public. This is in conformity with the INSPIRE directive in force. Therefore, geological, hydrogeological and geoenvironmental study data is presented via web browsers with the number of visits reaching hundreds of thousands a year.

To summarise, it ought to be stated that the experience accumulated over the 9 years of the Polish Hydrogeological Survey in Poland permits forming the conclusion that this is a good solution for every country that aims to limit the degradation of groundwaters intended mainly

for consumption and to attain balanced groundwater resources management. Therefore we highly recommend a national hydrogeological survey as a solution which showed its usefulness in Poland in the difficult period of joining the structures of the European Union.

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International Association of Hydrogeologists


AGH University of Science and Technology

2-vol. set + CD
ISSN 0208-6336
ISBN 978-83-226-1979-0