Polish Hydrogeological Survey – the response to European Directive implementation

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A b s t r a c t. The Water Framework Directive (WFD) established in 2000 expresses a general EU policy orientated towards protection, sustainable utilization and improvement of the quality of water bodies. Poland signed the accession treaty with the European Union in 2004. It was automatically obliged to comply with tasks specified in existing European directives. It was for that reason that in 2002, when Poland was preparing for accession to the EU, Poland transposed the requirements of the EU Water Framework Directive into the Polish legal document concerning the State's water policy known as the Water Act. Fulfilment of the WFD's objectives was defined in the Water Act through works of the Polish Hydrogeological Survey (PHS) established in 2002 within the Polish Geological Institute, following implementation of the Water Act. Since 2007, PHS received new duties resulting from the EU Groundwater Directive (2006/118/EU) on the protection of groundwater against pollution and deterioration (Official Journal EU L 372 from 12.12.2006). There are also hydrogeological obligations that result from another piece of national legislation called the Geology and Mining Act regarding thermal, saline and mineral waters, which are classified in Poland as mining resources. Fresh water resources are within the scope of the Water Act. At present, we observe a significant increase in usage of these resources, especially for geothermal energy and for recreational and therapeutic uses. Nevertheless, even curative waters must be considered in a systematic way, in connection with surface water and shallow groundwater, as their availability is controlled by infiltration from shallow groundwater or directly from infiltrating rivers and streams. Groundwater bodies delineated by the PHS have to be monitored and results of this monitoring are further transposed to river basin action plans. Some groundwater bodies are situated along the Polish boundary zones and these have to be controlled by both sides: PHS and the corresponding services of the neighbouring countries. The most important task for both sides is to achieve good groundwater status for trans-boundary groundwater bodies, water supplies for citizens and water dependent ecosystems. There are legal, organizational and research tasks within the monitoring schemes and water management planning projects, which belong to the duties of the PHS.

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Access to clean groundwater is no longer a problem of third world countries only. Similar problems occur in other parts of the world including the USA due to the widespread use of pesticides, which infiltrate into rivers and streams and, subsequently, to groundwater. The same problem is relevant to EU countries. Protection of groundwater resources is becoming a key element of policies in many countries, aiming to provide a guarantee for stable and sustainable economical development with respect of the environment. Natural disasters which occurred in Central Europe in the 1990s (including flooding that occurred in 1997) resulted in enormous losses of human lives as well as in local economies in the basins of the Odra and Elbe rivers, within the territories of Poland, the Czech Republic and Germany.

Since then, in Poland, the work of the administration, governmental organisations, as well as local authorities, academics and voluntary organisations has focused on developing support systems that would strengthen the functioning of national water management systems. Work has specifically focused on improving legal aspects as well as on strengthening international cooperation within transboundary river basins and reorganising the national water management strategy and monitoring systems for risk management. The main action taken was strengthening governmental water management services, which are responsible for ensuring that the required national quantitative and qualitative water needs are met.

The *Water Act*, which came into force on January 1st, 2002, determines rules of the national water management which are based on a concept of sustainable development and account for assessment, protection and exploitation of water resources (J.L. 2006, No. 129, pos. 902). The focus of this regulation is on *providing the population with the required water quantity and quality, maintaining and improving the quality of aquatic ecosystems and terrestrial ecosystems depending upon water, protecting against floods and droughts, meeting needs related to tourism, sport and recreation, as well as developing conditions for energy, transport and fishing exploitation of waters*.

The *Water Act* includes also a notion regarding the formation of the Polish Hydrogeological Survey (PHS – Fig. 1, 2 and 3). which operates under the Polish Geological Institute – National Research Institute and the Polish Hydrological and Meteorological Survey which operates under the Institute of Meteorology and Water Management.

Legally, the PHS is responsible for fresh groundwater, with TDS of less than 1 g/l, which is used for human consumption, waste water management, industry and agriculture.

The reasons for establishing the national hydrological and meteorological survey are obvious in light of Polish experience over the past 15 years, i.e. since the big flood in the Odra catchment basin. However, what are the reasons for establishing the national hydrogeological survey if national groundwater resources do not give such obvious indications to do so?

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Fig. 1. Headquarters of Polish Hydrogeological Survey (Polish Geological Institute – National Research Institute, Warsaw). Photo by J. Kaczmarzyk

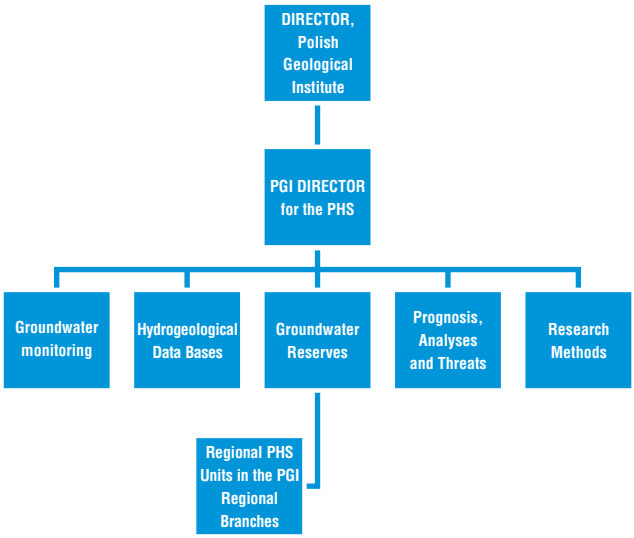

Fig. 2. Organization structure of Polish Hydrogeological Survey – www.psh.gov.pl

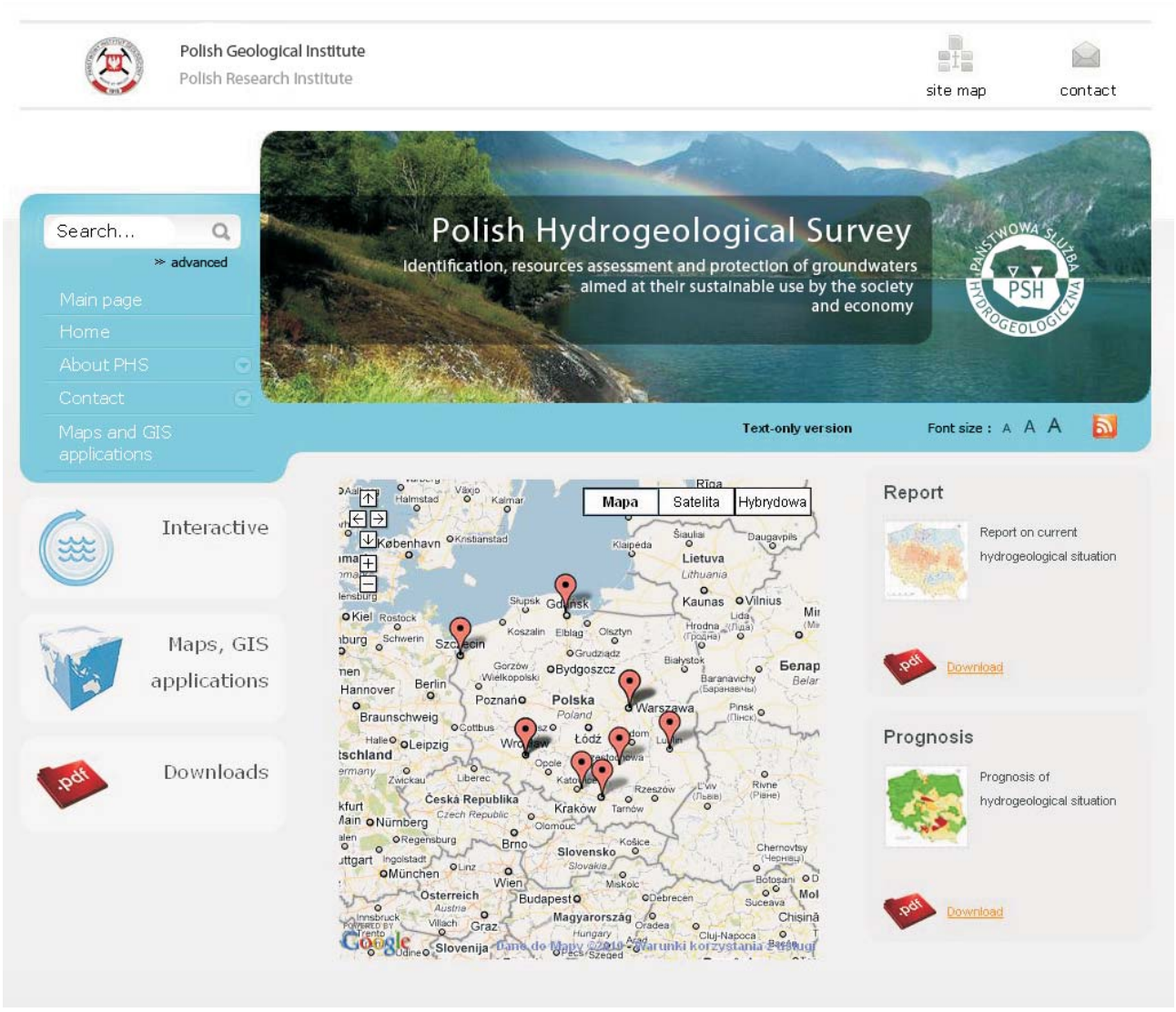

Fig. 3. New website of Polish Hydrogeological Survey – www.phs.gov.pl

Since 2000, Poland has been undertaking intensive measures aiming to adapt Polish water management policies to the requirements of the European Union, expressed in directives. Investments in groundwater protection and improvement of its quality have continued. Actions taken in these fields must respect EU ecological policy, specifically the decoupling rule (COM/2005/0670), which assures that fast socio-economic development does not compromise natural resources including groundwater and does not induce increased emissions into the environment.

The biggest challenge for Poland, with respect to protection of waters, is the fulfilment of the *Water Framework Directive* (2000/60/EC) and *Nitrate Directive* (91/676/EEC) requirements. These rules are foundations for surface waters achieving good chemical and ecological status and groundwater good quantitative and qualitative status, by 2015.

In order to protect surface water and sea waters from eutrofication, Poland should ensure a 75% reduction of national nitrate and phosphate discharges (from wastewater) by 2015.

Fulfilling the above complex tasks could be possible within a short time only by establishing a national organisation that would cover the entire country with its range of competence.

Groundwater resources

Surface water resources, that is water gathered in surface water reservoirs, in rivers and lakes, as wells as groundwater gathered in water bearing layers of rocks, reveal high changeability in time. In wet years, rainfall can be twice as high as in dry years. Climate change has an important bearing on rainfall volumes. The greenhouse effect and increasing tempo of climatic changes also affect natural changes in water resources. Long term prognoses, however, account for various climatic, economic and civilisation processes.

Surface water resources of Poland, counted for low flow conditions, are estimated at 34 km^3, and prospective groundwater resources are ~14 km^3 and are considered as a fraction of water infiltrating into groundwater bearing zones over a year. The total volume of fresh groundwater resources in Poland, which is the gravitational volume of water gathered in rocks, is estimated at around 5000 km^3 and some 20% of it is polluted with substances injected by humans. For comparison, the entire river discharge to the Baltic Sea, in an average hydrological year, does not exceed 58 km^3. Water resources gathered in rocks are over 100 times higher than surface water resources gathered in rivers and other surface water reservoirs. Groundwater discharge is therefore a dominating input of annual river recharge. How extensive groundwater resources are depends on their quality, the volume of free spaces in rock strata and groundwater renewal time, which depends on recharge by infiltration.

By groundwater resources we define the volume of groundwater that can be continuously exploited by water supplies for drinking, agricultural and industrial needs, considering all local ecological needs at the abstraction point. These are admissible volumes of extracted groundwater. Disposable resources (safe yield) are defined as the maximum and guaranteed abstraction volume from an aquifer without indicating a specific abstraction point. The concept of sustainable development and the pro-ecological rule of groundwater management require a part of the safe yield to be left for sustaining the needs of local ecology including flora and fauna. How difficult it is to correctly estimate these needs can be seen by different opinions on defining the minimum stream flows.

Considering valorising water resources, groundwater has a significant advantage over surface waters. Over 70% of current drinking water needs are assured by groundwater. In many parts of Poland there is no alternative for drinking water but groundwater.

Groundwater resources are less sensitive to pollution; however, once it occurs, it is much more difficult to remove. This can be certified by the results of remediation measures undertaken at sites polluted by industrial plants, in the close vicinity of petrol stations and waste disposal sites. Despite large investment funds, the effectiveness of remediation measures is limited and the time needed for full remediation extends over a human lifetime. At territories where large differences in site topography occur, floods can initiate landslides. Solving these problems is also included in the competence of the PHS. It is on the survey's work that the effectiveness of national and regional action plans depends. The PHS plays an important part in resolving water management problems within the transboundary basins of the Bug and Odra rivers.

For the past few years Poland has been implementing a new system for water management. The system aims to integrate water management action plans with measures taken within many different fields including agriculture, forestry, conservation, planning, energy, navigation, industry, wastewater management and recreation. It includes also public consultations with people during decision making processes.

Groundwater is very valuable from an economic point of view as it usually does not require complicated and expensive water treatment; its temperature is relatively stable and its chemical characteristics are also steady. When occurring underneath a series of low permeability layers, it is well protected from pollution from the ground surface. Therefore, it constitutes the strategic national water reserves.

Tasks of the Polish Hydrogeological Survey

Increasing problems regarding water management, including groundwater, prompted the legislator to turn more attention to gathering and distributing information on the state of these resources. The following tasks are the obligatory duties of the Polish Hydrogeological Survey as stated in the *Water Act* (Table 1):

- ❏ undertaking hydrogeological measurements and observations;
- ❏ gathering, processing, archiving and distributing data regarding groundwater quality and quantity as well as groundwater assessments;
- ❏ undertaking continuous real-time analyses and hydrogeological assessments;

- ❏ preparing and distributing prognoses regarding changes in groundwater resources, its quality and risks posed to it;
- ❏ preparing and distributing to local authorities warnings about dangerous natural forces occurring in recharge and abstraction zones.

Table 1. Tasks of the Polish Hydrogeological Survey of the Polish Geological Institute – present activities

No.	Name of PHS activity	Timeframe of activity
1	Groundwater measurements and observations	Continuous
2	Data gathering, verification and processing	Continuous
3	Evaluation of groundwater resources (water balance)	Up to 2015
4	Warning about groundwater and/or special threats	Continuous
5	Organising training and workshops, improving qualifications of staff, improving national standards regarding groundwater protection and exploitation	Continuous

The duties of the PHS as defined in the *Water Act* include the special role of groundwater monitoring, which produces data required for the preparation of analyses and assessments as well as prognoses of changes in groundwater resources and risks posed to it. Therefore, one of articles of the *Water Act* mentions the responsibility of the PHS for establishing and maintaining the national groundwater monitoring network, which comprises hydrogeological stations and observation posts (Fig. 4). The PHS undertakes hydrogeological observations, gathers, and distributes hydrogeological data and, by following national procedures, it provides ongoing analyses and assessments regarding the state of national groundwater resources, prepares prognoses of changes in groundwater resources, its chemistry and risks posed to it, as well as preparing warnings about dangerous natural changes that occur in recharge and abstraction zones and providing local authorities with them.

Measuring devices belonging to the PHS are legally protected and landowners are obliged to make their grounds accessible for building and delineating protection zones for these devices. The PHS workers, who undertake field measurements and visit monitoring sites to perform control and maintenance checks, are entitled to enter a site to complete their duties. Based on the *Water Act*, groundwater monitoring points and measuring devices belonging to the PHS are under legal protection. The groundwater monitoring system has been operating in Poland for over 35 years now.

Results of measurements are gathered in a digital database run, at present, in the Oraclé system. Results are also published in annual hydrogeological publications and quarterly bulletins, as well as being distributed *via* the internet, on the Polish Geological Institute web page. Collected data are verified, statistically tested and can be used as an input in decision support systems for economic and administrative resolutions as well being used in unusual risk management situations.

The groundwater monitoring system of the National Environmental Monitoring comprises an assessment of groundwater quality nationwide based on data collected from the groundwater monitoring network consisting of over 1200 points including piezometers, springs and wells. Observation wells and piezometers are filtered in layers of different stratigraphic units. Observation points for shallow groundwater constitute some 55% of all monitoring points. The remaining 45% of observation points monitor deep groundwater that is well isolated from anthropogenic pollution.

Laboratory analyses of groundwater and soil samples are undertaken by the Central Chemical Laboratory and Research Laboratory for Hydrogeology and Engineering Geology of the Polish Geological Institute in Warsaw, which are accredited laboratories (Fig. 5). Groundwater samples are tested for the following physio-chemical parameters: arsenic, ammonia, nitrates, nitrites, barium, boron, bromide, chloride, chromium, cyanic, fluorite, phosphates, aluminium, cadmium, lithium, magnesium, manganese, copper, molybdenum, nickel, pH, lead, EC, silica, sulphates, strontium, TSS, sodium, hardness, carbonate hardness, titanium, calcium, vanadium, hydrocarbons, carbons, TOC, alkalinity and iron.

Based on the *Water Act*, the Polish Hydrogeological Survey is responsible also for regional and local groundwater monitoring networks as well as for supervising and managing a monitoring network along the Polish border.

The range of measurements within the national groundwater monitoring network includes water level measurements in piezometers and wells and discharge volume measurements at spring sites. Measurements of groundwater chemical signature are undertaken once a year. At hydrological stations that are additionally equipped in automatic weather stations, supplementary measurements of rainfall, atmospheric conditions and water content in the aeration zone are taken. The entire process of groundwater monitoring, starting from field measurements, transporting water samples, laboratory testing and archiving, follows especially designed quality assurance procedures.

As is obligatory, PHS's procedures respect all (relevant to its field of duties) EU directives, international agreements, pacts and conventions signed by Poland as well as all bilateral agreements which Poland had signed with neighbouring countries with regard to common water management or environmental protection policies.

Another task of the PHS is estimating national groundwater resources (water balance) within river basins, hydrological regions and for the entire country. Results of these analyses are published by the Central Statistical Office, from the view point of changes in available groundwater resources and water reserves mainly. This information can be used as an input for making decisions, which in the case of water management is usually time-consuming and requires long-term thinking. Information about the state of groundwater resources and their potential usability is important information in high risk situations. The best examples of these are cases of recent floods and the power plant failure in Chernobyl when all surface water supplies had to be temporarily shut down.

Fig. 4. Location of the PGI-NRI groundwater monitoring hydrogeological stations (PHS material)

Reports on groundwater assessments and/or changes in the availability of groundwater resources are prepared by order of the Ministry of the Environment and, at their request, they can be distributed to other national government departments and institutions or can be used to prepare reports for the European Commission.

Another responsibility of the PHS is issuing warnings regarding the state of groundwater resources. High groundwater levels may result in local flooding. These are common in river valleys and in topographic depressions below banks and morphological thresholds at times when high water levels in surface waters occur. These tasks result also from the *Directive on the assessment and management of flood risks* (2007/60/EC). Other areas threatened by flooding are places where large abstractions or internal draining systems are being switched off, for example mines, building sites, large water supplies or agricultural drainage areas. Prognoses include also information on extremely low groundwater levels to warn about surface droughts, for example. These are slow processes, which can last from a few up to several dozen years. The PHS estimates when these events will occur and how long they will last.

Fig. 5. The test soils permeability coefficient measuring system *Trautwein*. Photo by B. Ruszkiewicz

High water levels and high soil wetness resulting from prolonged rainfall events induce increased draining pressure on slopes and in high banks of river valleys, and are the most common causes of landslides and ground movements (surface mass movements). Assessments of these threats as well as assessments of areas threatened by them are also the responsibility of the PHS.

Coordination of work aiming at identifying, documenting, and monitoring the major groundwater aquifers in Poland and their protection also belongs to the PHS duties. Information about groundwater availability, its spatial occurrence and quality is forwarded to the National Committee of Special Threats or to regional anti-crisis headquarters.

The Polish Hydrogeological Survey is obliged by the *Water Act* to train its staff, increase their qualifications, and implement national standards with respect to protection and exploitation of groundwater resources. Correct groundwater monitoring programmes, preparation of reports, prognoses and water balances require the introduction of unified procedures and techniques for taking measurements, sampling, undertaking analyses, collecting and processing data. The PHS prepares such procedures and technical guidelines which are published and handed out during training and scientific workshops. Professionals from inside the survey as well as from other institutions of similar profile can benefit from training and workshops offered by the survey. Training concerns also report writing, assessment methodologies and preparations of prognoses. National standards are necessary even for unifying graphical presentations of groundwater data. This is developed on a national level by introducing standardised GIS systems as well as methods for digitised cartography and visualisations prepared for people who make decisions based on spatial analyses. Employees of the Polish Hydrogeological Survey can participate in the preparation of local development plans providing local authorities with information and/or sometimes restrictions on, for example, options for land use within a delineated groundwater protection zone of an abstraction point or a major groundwater aquifer. Training and various forms of workshops are advisable in order to develop methodologies for establishing and evaluating groundwater resources, accessibility, verification and actualisation of data referring to groundwater resources and their assessments.

It is important also to popularize and to disseminate information about groundwater resources, its protection and usage as part of the ecological education of our society. The Survey considers groundwater resources as one of many elements of the environment which is indispensable for the functioning of all ecosystems.

Summary

The tasks of the Polish Hydrogeological Survey and problems resulting from exploitation and changes in groundwater resources as defined in the article are very varied in particular parts of Poland. The *Water Act* resolved these problems by founding a specialised survey created from professionals within the Polish Geological Institute, which is the most experienced institution in that matter and possesses a well organised national groundwater monitoring network. Their experience includes also building and managing numerical databases, report writing, preparation of guidance documents regarding assessment methodologies and hydrogeological cartography.

Taking into account experience of almost 10 years of PHS activity we would like to recommend the organization structure inside the state and regional administration.

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