

Polish State Hydrogeological Survey — tasks and goals

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The Water Act of 1st January, 2002 (Act Journ. No. 115, it. 1229) lays out Polish regulations of water management according to a concept of sustainable development adopted in the environment-friendly policy of the State which accounts for forming, protection and exploitation of water resources. The new legal regulations aim at “providing population with the required water quantity and quality,

maintaining and improving the state of aquatic ecosystems and those depending upon water, protecting against floods and droughts, meeting needs related to tourism, sports and recreation, as well as developing conditions for energetic, transport and fishing exploitation of waters”. These objectives are similar to the rules defined in the European Water Framework Directive.

The new Water Act includes an entry in the Art. 102 that appoints the Polish Hydrogeological Survey (PHS) conducted by the Polish Geological Institute and the Polish Hydrogeological and Meteorological Survey (PHMS) located in the Institute of Meteorology and Water Management. The PHS was appointed to perform Poland’s responsibilities in managing fresh water resources with low content of soluble substances — up to 1 g/l. Therapeutical waters, thermal waters and brines which are fundamental minerals according to the Geological and Mining Act, are subject to the Polish Geological Survey.

Groundwaters, their exploitation and resources

Fresh waters are used for supplying population, industry, agriculture and serving other municipal purposes. They exist in the so-called groundwater bodies. Their resources are renewed through the infiltration of a part of precipitation to the rocky medium. They belong to the subsurface circulation, and are thus an inconspicuous component of a hydrological cycle. Polish water resources reveal significant variability in time. During wet years we receive twice as much rainfall as during dry years. We observe fluctuations in the amount of precipitation in multiannual cycles (Paczyński, 1992; Przytuła, 1995).

Climatic changes also have an impact on the magnitude of precipitation and flow of rivers. Greenhouse effect and dynamism of climatic phenomena also influence natural changes in water resources. In long-term forecasts, changes in water resources must account for varying interactions of various climatic, economic and civilisation processes. The construction of deep dewatering systems in

opencast mines and underground mines had a considerable impact on the degradation of water resources within the area of hundreds of km². Presently, the decommissioning of these drainages alongside with the closures of mines creates flooding hazards for the neighbouring areas. Structural changes in Poland and production restraints resulted in curbing the demand for water for industry and farming. Therefore, the areas previously suffering water deficits, presently reveal its excess, which causes difficulties in functioning of their technical infrastructure.

The appointment of the Polish Hydrological and Meteorological Survey is obvious in the light of the Polish experience during the last decade, i.e., since the cataclysmic floods in the Odra River basin. However, why was the Polish Hydrogeological Survey appointed, if groundwater resources do not create such noticeable problems? Groundwater resources exceed 5,000 km³ in Poland, and in 75% they are still not polluted with substances discharged by people into the environment. The total volume of waters gathered in surface bodies in Poland amounts to approximately 34 km³. Nearly 50% of potable water supply comes from groundwater resources. In many places there is no alternative source of a water intake apart from those screened in the aquifers. Taking into consideration the valorisation of water resources as potable water sources, groundwaters significantly predominate over surface waters and their falling level results in degradation of many ecosystems (Kleczkowski & Rózkowski, 2001). Due to the climatic changes and growing anthropopressure, it is vital



Fig. 1. Hydrogeological station (observation wells) of the Polish Geological Institute

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to control groundwater resources and their quality permanently, and to assess the trends of the changes. According to the Water Framework Directive, monitoring of groundwater bodies should be provided.

Groundwater resources are not so prone to pollution, yet once contaminated they are difficult to get purified. This is confirmed by the results of the undertaken remediation, for instance in the areas contaminated by industrial plants, in the neighbourhood of fuel tanks and landfills. Despite huge cost, the ecological effectiveness of these remediation means is relatively low, and the time needed to eliminate pollution exceeds a human life span. During the floods in the areas of large denivelations of the terrain there are mass surface movements—landslides. Their occurrence coincides with floods. Therefore, monitoring appears indispensable. These tasks are undertaken by the Polish Hydrogeological Survey. Its work will have an impact upon the effectiveness of the performed actions at both national and regional scales.

Identification and quantification of possible changes in the aquatic environment, including groundwaters, will be necessary in order to assess the influence the undertakings will have upon the environment. These problems are particularly noticeable in underground and hydrotechnical constructions during exploitation of mining resources, in line, transfer and communication investments (motorways, railway lines, pipelines), as well as at the stage of designing and environmental inspections of big industrial plants. In recent years, considerable attention has been drawn to agricultural pollution, which should be monitored according to the EU “Nitrogen Directive”. The Polish Hydrogeological Survey should produce data for the above assessment, environment state recognition, control and also forecasts of the changes.

Groundwater resources are defined by such quantities of groundwaters that can be used for social, living, farming or industrial needs, accounting for the protection of natural environment in the place of their capture (exploitation resources of groundwater intakes) or in a specific area, e.g., the catchment, without indicating the location of exploitation (groundwater resources). Sustainable development and the so-called pro-ecological rules to manage water demand that some part of the resources should remain available to animated nature, both plants and animals. How difficult it is to assess this part can be demonstrated by discrepancies in the assessments of the biological course of rivers.

The size of water resources is determined by their quality, water space volume in a rock medium, and the ability to restore as a result of infiltration supply. Waters either polluted by people or naturally through the ascent of brines from a deeper substratum, and waters contaminated are not included in water management balances. In Poland, within the total size of groundwater resources, it is estimated that polluted waters, which require advanced treatment technologies constitute not more than 20–25% of the total quantity of groundwaters. In the developed countries the main factors causing pollution of such waters are industry and farming. Therefore, low level of industry and closed industrial plants confine the size of polluting loads discharged into soil and groundwater resources. Hence, groundwater resources still constitute a big reserve of potable waters in Poland. They cover half of drinking water supply for all the population in Poland.

From an economic point of view, groundwaters are valuable as they do not usually require advanced and expensive treatment. During the year they have steady temperature and stable chemical composition. If they occur

under a series of deposits of very low permeability they are well protected against pollution coming from the surface of the terrain.

Tasks of the Polish Hydrogeological Survey

Growing problems related to the management of water resources, including groundwaters, encouraged the legislator to pay more attention to obtaining and making information on the state of these resources available. This is reflected in the Article 103 of the Water Act, which defines the following tasks of the PHS:

- performing hydrogeological measurements and observations;
- collecting, processing and providing information on the resources, conditions and quality of groundwaters;
- conducting current analyses and assessments of hydrogeological situation;
- compiling and passing on information about the forecasts of the changes in the resources, groundwater quality and hazards;
- compiling and passing on to the public administration authorities warning against dangerous phenomena occurring in the supply zones and groundwater intakes.

The Article 104 of the Water Act contains an entry about the obligation of the PHS to maintain a vital and special observation and measuring network which includes hydrogeological stations and stands with respect to groundwaters. Thus, the tasks defined in the Art. 105 involve conducting hydrogeological measurements and observations, collecting and archiving data, as well as making them available after processing by means of standard procedures, carrying out current analyses and assessments (hydrogeological) of the situation of groundwater resources, compiling and passing on to the public administration authorities any warnings against dangerous phenomena occurring in the supply zones and groundwater captures.

Hydrogeological measurements and observations

Measurement equipment of the PHS is legally protected and the proprietor of the ground is obliged to make the ground available for the purposes of constructing and establishing the protection zone of these apparatuses and their conservation or performing measurements. According to the Article 108 of the Act, the people conducting measurements, control or conservation works of the PHS are entitled to enter the ground and perform necessary activities within their responsibilities. The practice of groundwater monitoring by the Polish Geological Institute has indicated growing difficulty in conducting measurements in wells and springs. Social and economic situation has encouraged increasing devastation of several measurement points, located in the forested or rural areas. At present, these points are legally protected according to the Water Act.

The PHS supervises functioning of the national and regional monitoring networks of groundwater quality (Art. 106). A monitoring system has been registering and assessing changes or degradation of the resources for over twenty-five years.

The measurement results are collected in a digital database working in the Oracle system. These results are also published in hydrogeological bulletins and yearbooks, or are made available in the internet on the website of the Polish Geological Institute. The compiled data are verified and undergo statistic analyses. They may be used to

support economic and administrative decisions or serve in emergency situations.

Groundwater monitoring of the Polish Environmental Monitoring System comprises examinations of fresh groundwaters all over Poland apart from therapeutical and thermal waters. The Polish Geological Institute has been conducting such measurements since 1981. The Monitoring Team at the Central Environmental Protection Inspectorate (CEPI) directly supervises the programme of examinations. At present, the monitoring studies are being carried out based upon the *Project of Monitoring Fresh Groundwater Quality* (Hordejuk, 1996). They are adapted to the binding Programme of Polish Environmental Monitoring (PEM). According to the premises of the PEM, the number of examination points is increasing. They represent bigger intakes, which constitute the sources of potable water captures. The examinations of the quality of fresh groundwaters are carried out in the observation network comprising 650 study points. These are drilled wells, piezometers, dug wells and springs. Observation points of waters of a shallow circulation (ground waters) constitute 55% of the total number of the points. The remaining 45% are observation wells taking in deep waters, well isolated from the influence of anthropogenic factors. The range of monitoring in the Polish network comprises: the measurements of their condition — the depth of the groundwater tables and yield — in case of a spring. The examination of water chemical composition is conducted once a year. Additionally, the atmospheric conditions, amounts of precipitation and waters of an aeration zone are examined at the hydrogeological points equipped with automatic measuring devices. The entire monitoring process from performing field observation to sampling and transport, from an analytical process in the laboratory to archiving and analysing results — are all conducted within a quality control system.

The laboratory research of groundwater samples is carried out in the Central Chemical Laboratory of the PGI in Warsaw. It possesses a certificate of quality. The range of markers includes the following physical and chemical properties: arsenic, ammonia, nitrate, nitrite, barium, boron, bromine, chlorides, chromium, cyanides, zinc, fluorides, phosphates, aluminium, cadmium, lithium, magnesium, manganese, copper, molybdenum, nickel, lead, potassium, electrical conductance, silica, sulphate, strontium, sum of solubles, sodium, general hardness, carbonate hardness, titanium, calcium, vanadium, total organic carbon, mineral alkalinity, general alkalinity, and total iron.

The Polish Geological Institute manages two national monitoring networks of groundwaters; several regional networks, and the so-called monitorings in the exclusion zones, along the borders of Poland. It also participates in designing, organising and exploiting several local monitoring networks, mainly groundwater intakes areas. By the force of the Act, the Polish Hydrogeological Survey supervises regional monitorings of groundwaters. The network of Groundwater Stationary Observations — named the national network — was established as a result of the decision by the Central Geological Office in 1969, and the then Geological Institute was entrusted with its realisation. The objective of the measurements was “to develop knowledge of groundwater regime, protect water resources against overexploitation and quality degradation”. Deep waters and exploited water-bearing levels in the natural circulation zones were the subject of measurements.

The new *Project of the Network of Groundwater Stationary Observations in Poland and its Functioning* was developed in the PGI in 1984 (Kazimierski & Pich). The

project assumed adaptation of points' location and observation organisation to the new catchment's management of water resources carried out by the Regional Boards of Water Management. Main groundwater bodies in Poland were also taken into consideration (Kleczkowski, 1990). The new project focuses on the problems related to archiving, compilation and making the results of the observations available (Kazimierski & Sadurski, 1999). The concept of a uniform national network organisation with distinguished areas and observation points also covers the areas of mineral and thermal waters coexisting with fresh waters and the areas of noticeable anthropopressure.

The Network distinguishes two types of points:

I order — hydrogeological stations, fundamental points of the Network with constructions and equipment providing a full range of hydrogeological observations and research — i.e., the observation of all water-bearing levels, and in the selected stations — wetness of the zone of aeration, the state of atmosphere and rainfall.

II order — examination points (wells and piezometers) and springs with constructions allowing for the measurement of water conditions (or spring yield) and sampling water for marking physical and chemical parameters.

The currently binding right of ownership requires clarifying the legal status of property of the ground where hydrogeological stations and stands are located. These areas must be owned by, or leased to, the Polish Geological Institute in order to provide protection and the right of access. The change of legal regulations and a growing range of stationary measurements of groundwaters, as well as organisational activities centrally coordinated for several years, have indicated the necessity to appoint the Polish Hydrogeological Survey.

Changing legal regulations, mostly related to the adaptation of the Polish Law to the law of the European Union, create the need to consider them in the monitoring activity and implement the changes in the organisation and functioning of the observation networks. With respect to the external regulations and guidelines, such as the Directives of the European Union, international agreements, pacts and conventions signed by Poland, and all the bilateral agreements signed with the neighbouring countries that concern water management or environmental protection of the transboundary water bodies.

Other tasks of the PHS

The Water Act defines another task of the PHS whose aim is to balance the changes of groundwater resources in river basins, regions and in entire Poland. The balance results are published in the reports of the Main Statistical Office, primarily from the point of view of the magnitude of those changes in water resources and bodies. Such information may be a signal to take decision which are time-consuming in water management, and require a multi-year time horizon. The state of groundwater resources and the possibility to use them are especially vital in emergency situations. The 1997 floods and the Chernobyl nuclear power plant breakdown, when surface water intakes could not be used in large areas, prove this point.

The reports on the condition of waters and changes in groundwater resources are made by the order of the Ministry of Environment and according to its divisor, other proper departments and institutions may gain access to them. This information is of official character, and may not be published without the consent of the Ministry of Environment. The *Hydrogeological Yearbook* is published by the Polish Hydrogeological Survey every year. It contains pro-

cessed information on the quality, state and dynamics of groundwaters in Poland. This information is processed through standard procedures. The report concerning the balances of Polish water resources, river basins and regions ought to be prepared jointly with the Polish Hydrogeological and Meteorological Survey.

The PHS is also responsible for warning against threats coming from groundwater environment or in the cases of emergency situations in Poland. High levels of groundwaters pose a threat of land flooding. These usually occur when there are high states of surface waters in river valleys, land depressions below scarps and morphological basins, or landslides. Mining areas are also under the threat of flooding, especially after shutting down mining drainage systems or big construction dewatering, huge groundwater captures and farming drainage. The prognoses also account for the alert states of ground water resources, for instance to warn against ground drought. These processes change slowly and occur over a period of tens of years in the case of mine dewatering. The PHS prepares forecasts of the range, scale and term of these threats.

High states of groundwaters at the time of precipitation and high wetness of ground cause additional downflow pressures in the case of scarps and high boundaries, which most frequently result in landslides and soil creep (mass surface movements). The threats also result from flooding. It is necessary to identify the areas of an elevated risk of high groundwater states (river valleys, land depressions), and to delineate water inundation areas in the vicinity of closed mines or big drainage systems in the construction and farming. The description of procedures to manage actions in the areas threatened by floodings and the forecasts of the extent and magnitude of water inundation are the objectives of PHS, too. Threat assessment and the recognition of the endangered areas belong also to the responsibilities of the PHS.

Should a natural disaster, war, terrorist attack or surface water contamination occur, groundwater resources are the only potable water reserves in Poland. Supervision over strategic groundwater bodies lies in the hands of the PHS. Information on the availability of groundwaters and their location and quality are forwarded to, for instance, the Committee for Environmental Emergencies in Poland or Voivodeship Anti-Crisis Headquarters for defense purposes.

According to the Water Act, the Polish Hydrogeological Survey is obliged to train its employees, develop its staff's qualifications and introduce the national standards in the range of protection and exploitation of groundwater resources. Proper monitoring and preparation of the reports, prognoses and balances of groundwater resources are related to the necessity to introduce uniform procedures and techniques of the measurement, water sampling, analytics, data collection and processing. Standard procedures and techniques are prepared by the PHS in the form of publications, trainings and scientific workshops. Methodological handbooks will be published for training purposes and standardization of examination methodology. The trainings may be attended by both the employees of the Polish Hydrogeological Survey and other professionals from the institutes or services of a similar scope of activity.

The undefined tasks of the PHS involve implementing standards with respect to the management and protection of water bodies in Poland. Polish standards are necessary even with respect to the graphic presentation of database results. For those professionals who take decisions, computer graphics should be developed through conducting standard GIS systems (the systems of spatial information),

methods of computerised cartography, and visualisation of the results. The Polish Hydrogeological Survey should participate in the preparation of spatial management plans by providing information and the range of the required restrictions to exploit the land in the protection zones of water captures, main and strategic groundwater bodies. Trainings and other forms of workshops are recommended for the development of methodology in determining and balancing groundwater resources, allowing access, verification and update of the data on water resources and their state, for instance in a graphic manner. These trainings must involve popularising obligations deriving from the directives of the European Union.

It is essential to popularise knowledge on groundwaters and their protection, apply it to ecological education of the Polish population. The Survey deals with water resources as an element of the environment, indispensable to the functioning of the ecosystems.

Conclusion

The presented tasks of the Polish Hydrogeological Survey and the problems arising from the exploitation and changes of groundwater resources vary in particular regions of Poland. The new Water Act meets these problems by the appointment of a highly specialised service among those professionals of the Polish Geological Institute who have the greatest experience and who have used the implemented national network of groundwater monitoring for many years. This experience also comprises development and maintenance of databases, reports and methodological handbooks with respect to the assessment of the state and cartographic visualisation of the size of the water bodies, their resources, and availability of groundwaters.

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