The Polish Hydrogeological Survey Database Integrator — a new GIS tool for the hydrogeological database management useful in mapping process

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A b s t r a c t . The PSH Database Integrator as a sophisticated tool for groundwater management answers the needs of the Polish Hydrogeological Survey. At the first stage it is a functional integration system for all hydrogeological databases existing in the Polish Geological Institute such as those of Groundwater Monitoring, HYDRO Bank and Hydrogeological Map of Poland. The final stage of all kind of analysis involves cartographical representation of the results. Using the PSH Database Integrator in this process reduces labour input and time as well as helps keeping standards. Next stage in the system development will enable internet access for users.

Key words: *cartography, mapping process, groundwater, groundwater monitoring, database, analysis of hydrogeological datasets, groundwater management, GIS, hydrogeological survey, IT*

In the Polish Geological Institute (PGI), there exists over one hundred and fifty digital databases; several contain hydrogeological and cartographical information. They were designed and developed during the last 30 years. The datasets are stored in many different computer programs or systems and some of them are accessible for very limited groups of users.

In July 2001, the Parliament of Poland established the Polish Hydrogeological Survey (PHS) and entrusted fulfilling its task to the Polish Geological Institute. Implementing this decision requires taking advantage of the existing hydrogeological database resources (Sadurski & Nowicki, 2004). Therefore, it was essential to integrate previously dispersed groundwater monitoring databases (Kazimierski & Sadurski, 2002) in order to develop and implement a multi-purpose geographical information system (GIS). This allows easier access to all necessary data from existing hydrogeological database. GIS is a technology that manages, analyzes and disseminates geographical knowledge. PHS Database Integrator was designed to be an effective tool for integration, retrieval, and analysis of hydrogeological datasets for the PHS. This GIS database integrator decreases the time needed to research existing specific data. In addition, it will reduce redundancy of data collection by making data readily accessible between database administrators. The updated information is obtained without delays. The platform for this database is GeoMedia Professional with data storage and retrieval managed by an Oracle database. The project work was conducted by the staff of the the PGI Hydrogeology and Engineering Geology Department in close cooperation with personnel of Intergraph Poland. At the completion of the project the selected information from all databases would be accessible online. The system would be adjusted to the requirements of the EU Water Framework Directive and Nitrate Directive which are now implemented in Poland as well as to the Daughter Directive related to groundwater (Kazimierski & Macioszczyk, 2003; Działalność…, 2005).

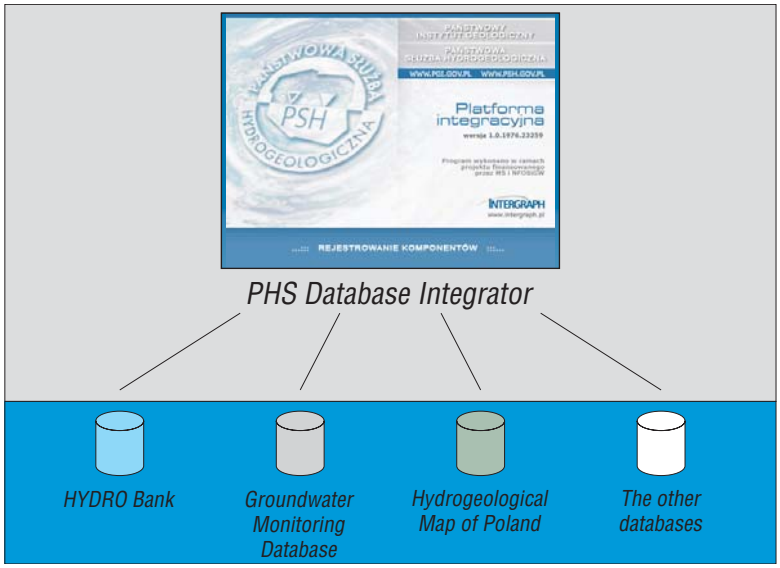

Fig. 1. PSH Database Integrator scheme

Now, at the first stage of this project, personnel at the PHS possess a single system capable of connecting data from the HYDRO Bank, the Groundwater Monitoring and (partly) the Hydrogeological Map of Poland. The relationships between the databases are shown in Fig. 1.

The aforementioned databases play important roles in all cartographical work in hydrogeology. The HYDRO Bank stores the basic information on hydrogeological items, the Groundwater Monitoring is a kind of assisting database in mapping process with information on groundwater fluctuations and chemical properties. And, finally, the Hydrogeological Map of Poland stores the results of analyses made by authors of each map sheet.

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Central Hydrogeological Data Bank called **HYDRO Bank** (www.pgi.gov.pl/hydro) is a computer information and registration system for potable, therapeutic and thermal groundwater intakes — hydrogeological boreholes and springs, situated in Poland. The data base holds selective hydrogeological documentation datasets covering full information on:

- ❏ addresses and coordinates of groundwater intakes;
- ❏ litho-stratigraphical logs of the boreholes;
- ❏ drilling data (pipe scheme, filtration columns);
- ❏ field (measured) hydrogeological data such as pumping test results, recharge (injection) test results and groundwater level fluctuation;
- ❏ laboratory data is physical-chemical properties of groundwater samples and dissolved gases, granularity test results;
- ❏ calculated data on hydrogeological objects discharge, admissible volume of extracted groundwater, disposable resources (safe yield);
- ❏ water permits, concessions for therapeutic and thermal water exploitation.

The information resources have been collected for over 25 years. Currently the database contains data about some 124,000 hydrogeological items. The database is constantly updated. There are over 1000 new hydrogeological items introduced annually. The data are examined for quality and relevance. Since 2000, the platform for this database is Geomedia Professional with data storage and retrieval managed by an Oracle database. In 2004 the database structure and applications for its management — HYDRO-2000plus and GeoHydro, were modified and adjusted for the cooperation with the PHS Database Integrator (Fig. 2). The existing data management tools allow to make attribute and spatial analysis of the data. A simple SQL inquiry to the database allows retrieval of any collected data: information on actual hydrogeological survey of the region, database reports, according to user's needs, well location maps; it is easy to create charts, visualize lithologic logs (profiles) and well cards. The GIS tool (GeoHydro) enables graphical presentation of the Hydro Bank data, display of information with the bitmaps (e.g., topographical maps) as a background, performing spatial analysis, creating theme maps, generating hydrogeological cross-sections, integration

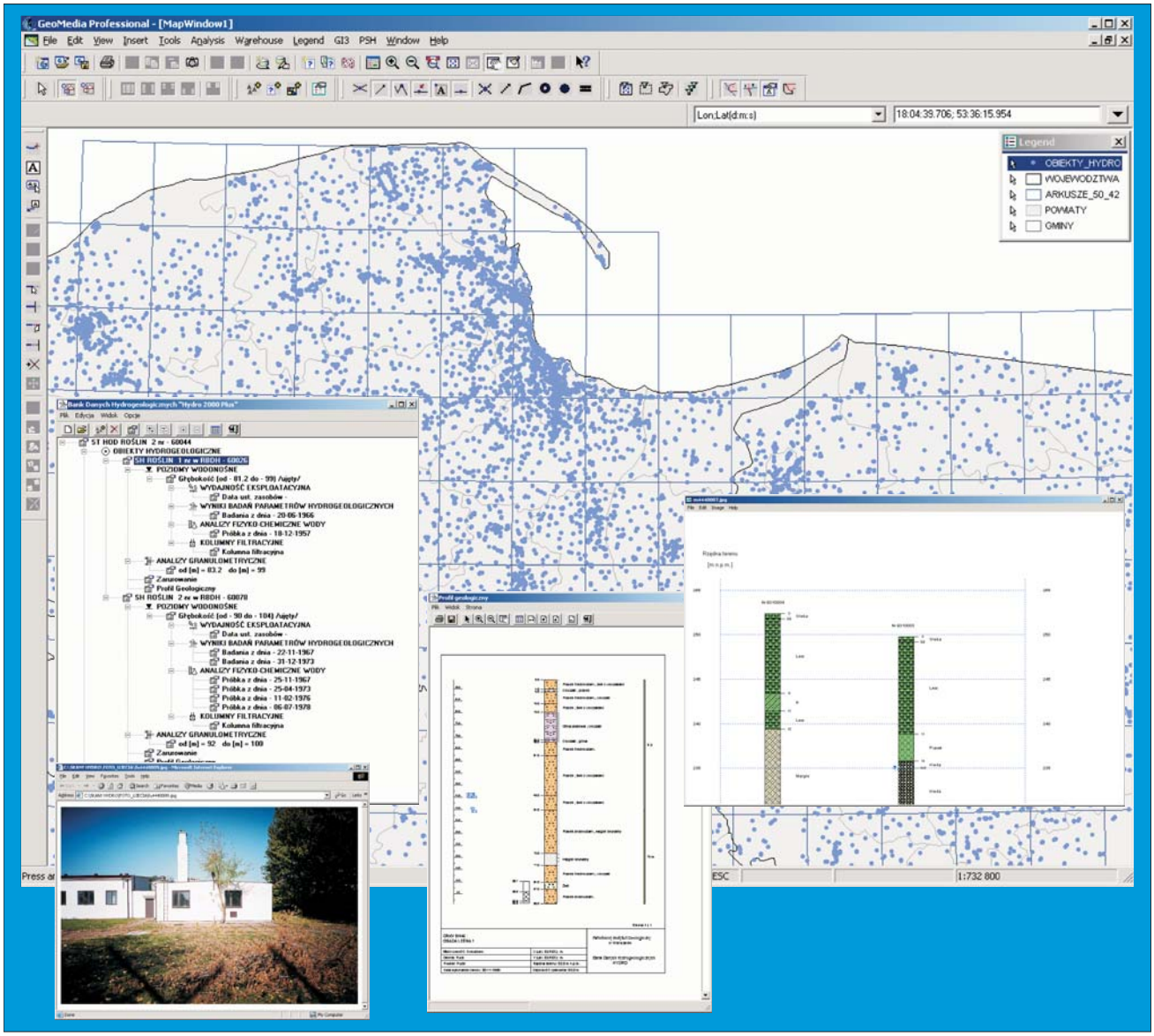

Fig. 2. Hydro2000plus — examples of screenshots

with descriptive and graphical information derived from other databases. The PHS Database Integrator provides full functionality of the HYDRO2000plus and GeoHydro. Fig. 2 shows the examples of data interpretation performed by the PHS Database Integrator: the map with location of hydrogeological items, structure of a groundwater intake with its photograph, hydrogeological log and basic cross-section. One of the most important tasks of the Hydro Bank is rendering the data resources accessible for users. The resources of the Hydro Bank serve project and documentation purposes in the area of hydrogeology, geology, water management and environment protection (Skrzypczyk, 1997). The main users of the resources are the Ministry of the Environment, Regional Boards of Water Management, scientific institutes, Polish geological enterprises and companies, environment protection foundations, provincial and district agencies, academies with geological and mining profile, Polish Army and the State Inspectorate of Environmental Protection.

The Groundwater Monitoring Database (SOH/MONBADA) was launched in 2004 (Działalność…, 2005) and contains the resources of two groundwater monitoring systems operated by the Polish Geological Institute for many years (Fig. 3):

SOH (Groundwater Monitoring Network). The database has contained information on: observation points, results of groundwater level observation (measurements of depth to water table and spring discharge are performed every Monday) and physical and chemical analysis of groundwater samples (Kazimierski, 2000). The regular measurement system was established in 1972, for some points data were collected since 1966. Since the 1980s the monitoring data were held in different databases (Przytuła et al., 1997).

MONBADA (The Groundwater Quality Database) belongs to the Polish (State) Environmental Monitoring System and was launched in 1991. It collects the results of physical and chemical analysis of groundwater samples

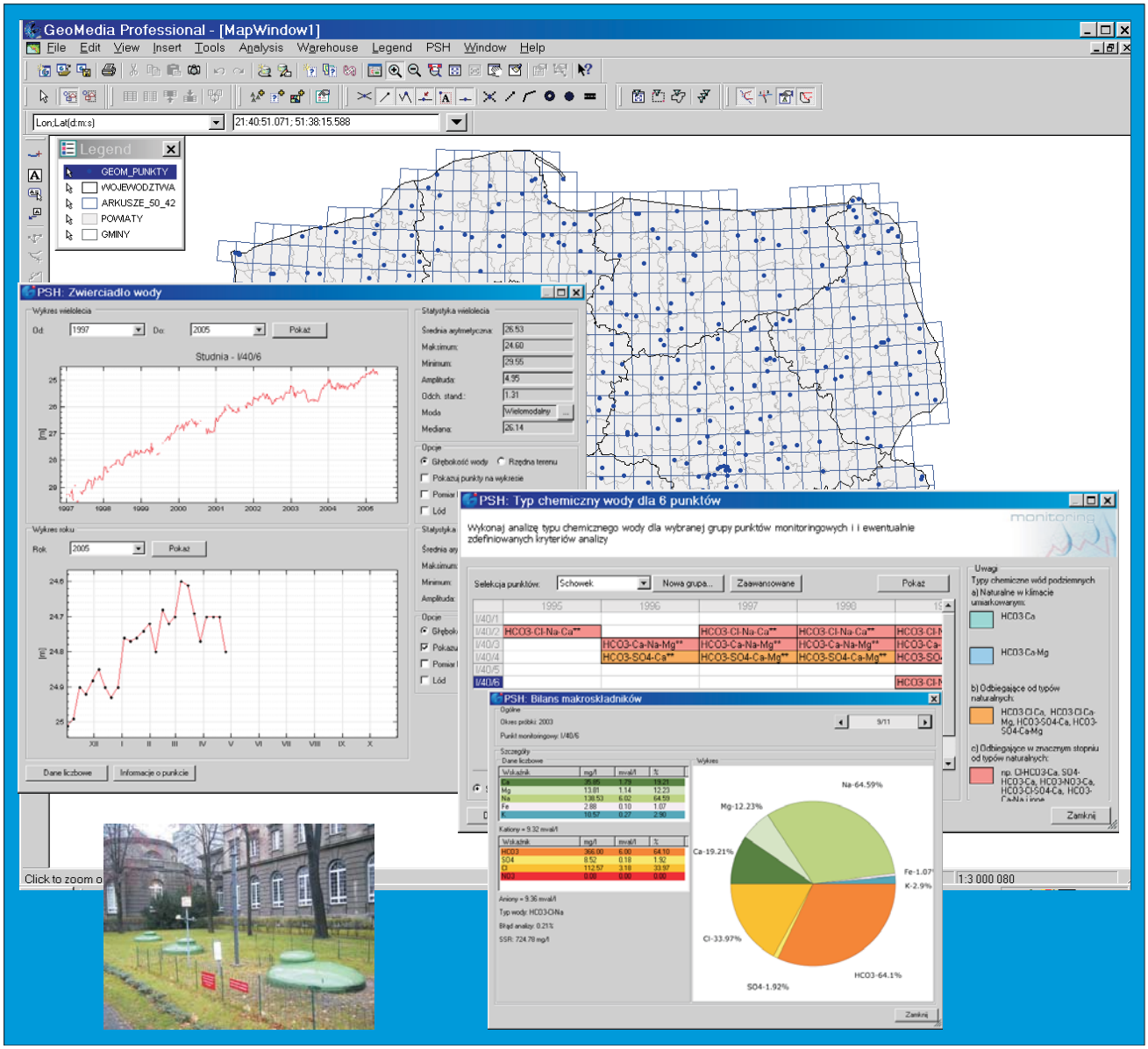

Fig. 3. The Groundwater Monitoring Database — examples of screenshots

which are used for the evaluations of groundwater quality (Hordejuk et al., 2000). On the basis of these datasets, Polish Reports of annual groundwater quality are compiled (Hordejuk & Hordejuk, 2003). The Groundwater Monitoring Database integrates the data resources as far as the functions of the previous database. The newly created database is essential for the whole national monitoring system as the only tool for the network management. It enables the administrator/supervisor to control the monitoring procedures and measurements quality. Besides the measurement results, which are necessary for reliable interpretation, there are databases containing the following information sets:

- ❏ wells and springs included in the monitoring network;
- ❏ surroundings of the wells and springs;
- ❏ parameters of the examined aquifer systems;
- ❏ environmental and human influence on each aquifer system.

Fig. 3 shows the examples of screenshots with chosen information on monitoring wells and springs such as the map with location, groundwater fluctuation, photograph and some chemical properties (type of water, pie-chart, main ion balance).

The interpretation results are presented as worksheets, tables, charts, diagrams, histograms and maps. The information from statistical, graphical and spatial analysis are used for the compilation of:

- ❏ bulletins of hydrogeological conditions;
- ❏ forecasts of hydrogeological condition development;
- ❏ warnings on droughts and flood risks;
- ❏ evaluations of groundwater level on the aquifer recharge areas, concentrated groundwater extraction areas and transboundary aquifers.

The results of the groundwater monitoring data interpretation are periodically published in the *Hydrogeological Annual Report* (Kazimierski et al., 2003, 2004) and *Quarterly Bulletin of Groundwaters* (Kazimierski et al., 2003–2005). All these publications are freely accessible online (www.pgi.gov.pl>Hydrogeology>Publications). Selected monitoring data — rough or computed, are rendered for recipients on demand.

The Hydrogeological Map of Poland. The project started in 1996 and was completed in 2005. This ten-year project produced 1069 map sheets in 1 : 50,000 scale outlining the hydrogeology of the whole country. Each map sheet contains a wealth of information on the groundwater system such as thickness and top of the major aquifer, its yield and transmissivity, depth to the water table, thickness of confining bed, aquifer quality and its vulnerability. Each map sheet was compiled using the Microstation (GIS System) as a separate database (Herbich et al., 2004). Now the dispersed databases are being merged into a single continuous one.

The PHS Database Integrator with its possibility of using the same cartographical background and coordinate system is very important in keeping common cartographic standards. Besides, as a GIS tool (GeoMedia), it allows for creating whatever map requested by particular user and tailored according to individual specifications).

It should be noted that the PHS Database Integrator is still under construction. It is continuously being developed and is open for new solutions and new functions which are created by the database users. In the future the PSH Database Integrator would provide access to other PGI data resources. Its aim is to help the civil service and self-government administration, providing free access to the information necessary for reliable decision making that can help improve water quality and control its pollution.

Considering technical possibilities and very limited access to specialized programs, providing online access via internet would be obviously the optimal solution for end users.

References

Działalność państwowej służby hydrogeologicznej w 2004 r. Synteza, 2005, CAG.

HERBICH P., ĆWIERTNIEWSKA Z., FERT M., MORDZONEK G. & WĘGLARZ D. 2004 — Hydrogeological Map of Poland in 1 : 50,000 scale. International Conference on Hydrogeological Transboundary Problems West and East European Bridge, mat. konf., Państw. Inst. Geol, Warsaw: 69–70.

HORDEJUK T. & HORDEJUK M. 2003 — Stan jakości wód podziemnych na podstawie badań monitoringowych w latach 1998–2002, Inst. Ochr. Środ., Warszawa.

HORDEJUK T., KAZIMIERSKI B. & SADURSKI A. 2000 — Monitoring wód podziemnych w Polsce. IV Międzynarodowa Konferencja Zaopatrzenie w Wodę, Jakość i Ochrona Wód, Kraków: 362–373.

KAZIMIERSKI B. 2000 — Sieć Stacjonarnych Obserwacji Wód Podziemnych na terenie Polski — zasady organizacji i współpracy z innymi systemami monitoringu. Prz. Geol., 48: 520–526.

KAZIMIERSKI B. & MACIOSZCZYK A. 2003 — Monitoring wód podziemnych w świetle nowych przepisów prawa. Współczesne Problemy Hydrogeologii, mat. konf., Tom XI, cz. 2, Gdańsk: 399–410.

KAZIMIERSKI B. & SADURSKI A. 2002 — Monitoring wód podziemnych w świetle nowych zadań państwowej służby hydrogeologicznej. Prz. Geol., 50: 671–679.

KAZIMIERSKI B., CABALSKA J., MIKOŁAJCZYK A. & RUDZIŃSKA-ZAPAŚNIK T. 2003–2005 — Kwartalny Biuletyn Informacyjny Wód Podziemnych PSH, Tom 1 (1), Tom 2 (2–5), Tom 3 (6–7). Państw. Inst. Geol.

KAZIMIERSKI B., CABALSKA J., MIKOŁAJCZYK A. & RUDZIŃSKA-ZAPAŚNIK T. 2003 — Rocznik Hydrogeologiczny PSH. Rok hydrologiczny 2003. Państw. Inst. Geol.

KAZIMIERSKI B., CABALSKA J., MIKOŁAJCZYK A. & RUDZIŃSKA-ZAPAŚNIK T. 2004 — Rocznik Hydrogeologiczny PSH. Rok hydrologiczny 2004. Państw. Inst. Geol.

PRZYTUŁA E., JANECKA-STYRCZ K. & KAZIMIERSKI B. 1997 — Komputerowa baza System Obserwacji Hydrogeologicznych: SOH — baza danych, SOH — graficzna prezentacja wyników. Prz. Geol., 45: 974–977.

SADURSKI A. & NOWICKI Z. 2004 — Polish Hydrogeological Survey. International Conference on Hydrogeological Transboundary Problems West and East European Bridge, mat. konf. Państw. Inst. Geol., Warsaw: 54–55.

SKRZYPCZYK L. 1997 — Zastosowanie banków danych hydrogeologicznych jako źródła informacji wyjściowej na potrzeby opracowań kartograficznych i dokumentacyjnych. Prz. Geol., 45: 932–934.