

Damian ABSALON

## APPLICATION OF GIS IN HYDROGRAPHIC AND ENVIRONMENTAL MAPS OF POLAND

**Absalon D.: Application of GIS in hydrographic and environmental maps of Poland.** Kartografické listy 2008, 16, 3 figs., 12 refs.

**Abstract:** The Environmental Map of Poland produced within the framework of the State Land Information System was one of the earliest maps in Poland which were elaborated using GIS tools. In the 1990s, an analogue (paper) and digital environmental map was prepared with the use of GIS tools. Digital and analogue hydrographic maps have been created since 1998. Environmental map is a thematic cartographic compilation which, in spatial expression and on the basis of scientific and objective assessment, presents the state of natural environment as well as the causes and effects of environment transformations (both negative and positive) taking place in the environment under the influence of various activities. It also presents the methods of protecting environmental values. Hydrographic map is a thematic map which presents, in a synthetic depiction, conditions of water circulation in connection with geographical environment, the degree of economic investment of the land and its transformation. Digital versions of thematic maps enable us to realize basic GIS functions: data input and storage, its completion and update as well as making analyses.

**Keywords:** GIS, cartography, thematic map, hydrology, environmental protection

### Introduction

From the geographical point of view, the map is a synthesis of phenomena which take place in space and lead to the transformation of natural environment. It is the best way of presenting all phenomena on the surface of the Earth, which allows presenting, among others, current state of particular elements of natural environment, and their deterioration and protection methods. In this article we would like to present the content of two thematic maps: hydrographic and environmental, compiled with the use of GIS tools, in two versions: analogue and digital.

In the 1990's, an analogue and digital environmental map was prepared with the use of GIS tools. Digital and analogue hydrographical maps have been created since 1998.

Both maps are created with the use of the MapInfo software and are available in this format, therefore in the paper some figures are screen captures from this software.

Printed versions of both map types are available in the 1:50000 scale. Thematic maps of Poland, environmental and hydrographic, are made in cooperation with regional academic centres and commissioned by the Chief State Geodesist.

### Hydrographic map

A hydrographic map is a multi-sheet thematic map which presents, in a synthetic depiction, conditions of water circulation in connection with geographical environment, the degree of economic investment of the land and its transformation.

Thematic content of the map consists of seven information levels:

1. Topographic watersheds
2. Surface waters
3. Underground water outflows
4. Underground waters of the first level

---

Damian ABSALON, PhD., University of Silesia, Faculty of Earth Sciences, Będzińska 60, 41-200 Sosnowiec, Poland, e-mail: damian.absalon@us.edu.pl

## 5. Ground permeability

## 6. Phenomena and constructions of water management

## 7. Hydrometric points of stationary measurement

An integral part of the map is a commentary prepared by the scientific consultant to the map sheet. It contains relevant information supplementing map content and characterizes among other things:

- natural conditions of the area,
- geological structure and lithology,
- watersheds,
- rainfall,
- surface waters,
- hydrological features,
- underground waters,
- characteristics of the research period,
- state of surface water purity,
- transformations of water relations.

The hydrographic map is produced by groups of geographers (specialists in hydrology, water management and climatology) and cartographers, computer specialists and co-operating representatives of the state administration supervised by cartographers. Current stage of development of the hydrographic map of Poland is presented in Fig. 1.

Particular elements of the thematic content of the map are compiled on the basis of the collected materials and results of field mapping (Absalon, 2002).

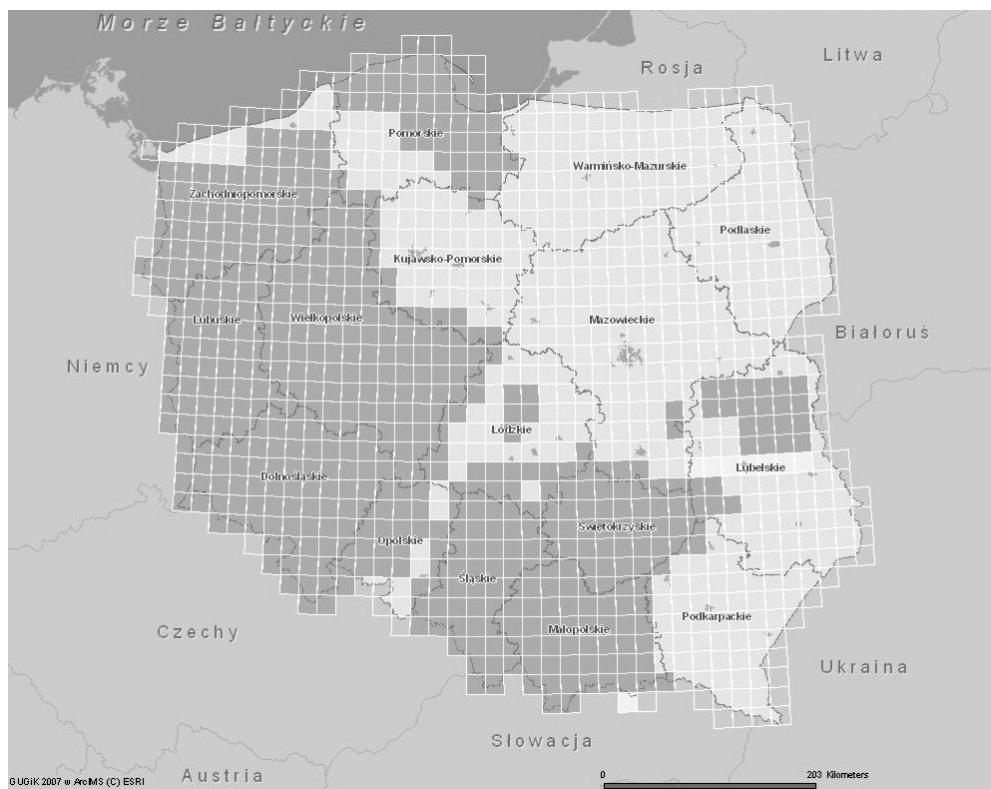


Fig. 1 Current stage of development of the Hydrographic Map of Poland – dark grey areas signify finished map sheets (<http://serwisy.codgik.gov.pl/temap/hydro.html>)

## Environmental map

An environmental map (in Poland called sozological map) is a cartographic thematic compilation which, in spatial expression and on the basis of scientific and objective assessment, presents the state of natural environment as well as the causes and results of environmental transformations (both negative and positive) taking place in the environment under the influence of various activities. It also presents the methods of protecting environmental values.

The merits of an environmental map are formed by 5 separated and overlapping sheets - information levels, displayed on the topographic background. These are:

1. Organisational forms of natural environment protection
2. Degradation of natural environment components
3. Counteraction to the degradation of natural environment
4. Reclamation of natural environment
5. Wasteland

An integral part of the map is a commentary prepared by the scientific consultant to the map sheet. It contains relevant information supplementing map content and characterizes among other things:

- characteristics of basic components of natural environment,
- additional data to particular information levels of the map (text, charts),
- general assessment of the state of environment and the degree of its degradation,
- guidelines concerning environmental protection and management,
- other relevant information and assessment.

The environmental map is produced by groups of geographers and cartographers, specialists in the field of environmental management and protection, as well as computer specialists, with the cooperation of representatives of state and local administration, supervised by scientific consultants specializing in environmental and cartographic issues. Current stage of development of the environmental map of Poland is presented in Fig. 2.

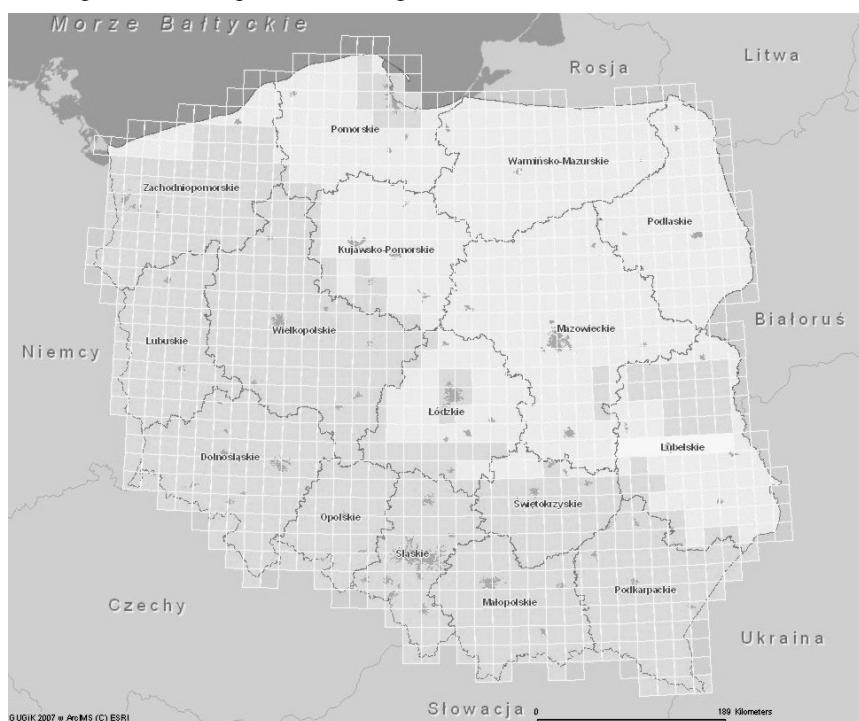


Fig. 2 Current stage of development of the Environmental Map of Poland – grey areas signify finished map sheets (<http://serwisy.cogik.gov.pl/temap/sozo.html>)

Environmental map at the scale of 1:50000, based on scientific, objective assessment of the condition of the environment on a given area, presenting tendencies of changes and transformations and the degree of admissible human interference with the environment is a significant tool in spatial policy of a given area. This map is also useful when locating economic and municipal objects (e.g. industrial works, animal farms, waste dumps and transport routes) as well as housing estates, protected areas, recreation centres, etc.

Particular elements of the thematic content of the map are compiled on the basis of collected materials and results of field mapping.

### **GIS and thematic maps**

Each sheet of an environmental and hydrographic map, apart from its analogue version, has also the digital version. Digital versions of both maps are created on the basis of MapInfo for Windows software.

Digital versions of both thematic maps fulfill the following conditions:

- have a layered structure,
- permit the exchange of information with other GIS systems,
- have the possibility of cartographic projection adjustment (consistent with the projection of the analogue map),
- permit map print-out in CMYK system,
- enable cooperation with a photo-exposure machine.

The content of the digital map is formed by all the elements found in the map content as well as vectorized supplementary elements: roads, railways, hydrographic network and administrative borders.

Computer versions of thematic maps enable us to realize basic GIS functions: data input and storage, their completion and update as well as making analyses. The most important qualities of the digital map which make analyses easier are:

- layered structure (each thematic layer contains vector objects of a given type),
- connection of database with vector objects (quantitative and qualitative data)
- possibility of connecting the neighboring map sheets into larger vector objects (e.g. administrative units, catchment basins).

Each object on the map is accompanied by information included in database what allows us to make analyses and supplementations according to our own needs.

### **Database structure**

Format of input data is the same for both thematic maps and it is based on the following general principles:

#### **Thematic layer:**

<Scope of input data> [<symbol number/s in explanations>]

#### **Digital layer:**

<Name of digital layer (up to 23 characters, block capitals)>

#### **Description:**

<Layer classification: line, point, polygon>

<Comments on how to enter elements>

#### **Database:**

| <Box name><br>Up to 30 characters – only block capitals,<br>no diacritic marks | Attribute | <Description with the information about<br>the way of inserting data> |
|--|-----------|---|
|--|-----------|---|

The following attribute designations have been adopted:

Cn – text box – of a maximum number of characters n

Nx,y – number box – x (maximum number of characters in a box), y (number of decimal places) e.g. N6,2 (3 decimal digits + point + 2 digits after the point = 6 characters in a box)

L – logical box (only two values are possible: T – true; F – false).

Examples of database structure for one layer of a hydrographic map and one layer of an environmental map are presented below (Wytyczne techniczne GIS – 3, 2005; Wytyczne techniczne GIS – 4, 2005).

**Thematic layer** (hydrographic map):

Natural or artificial water bodies and reservoirs or systems of artificial reservoirs which are impossible to be presented at the map scale [symbol numbers in explanations: 13, 14 and 33]

**Digital layer:**

„ZBIORNIKI\_WODNE”

**Description:**

Point and polygon layer.

Water reservoir which is possible to be presented at the map scale is entered as polygon.

Water reservoir or system of artificial reservoirs which is impossible to be presented at the map scale is entered as a point.

**Database:**

|                              |      |   |
|------------------------------|------|---|
| NAZWA_NR                     | N5   | Reference number of watercourse name – from the database BAZA WODY  |
| FUNKCJA_ID                   | C1   | Utility function of reservoir:<br>„B” – no function,<br>„H” – fishing pond,<br>„P” – fire pond,<br>„R” – storage reservoir,<br>„S” – recreational reservoir,<br>„W” – multipurpose storage reservoir,<br>„I” – other function |
| RZEDNA                       | N6,1 | Height of water table in m a.s.l.   |
| RZEDNA_Z_MAPY_TOPOGRAFICZNEJ | L    | „T” – height on the topographic map   |
| POWIERZCHNIA                 | N6,1 | Area in ha  |
| ZARASTAJACY                  | L    | „T” – overgrowing reservoir   |
| SLONE_ZASOLONE               | L    | „T” – salty or saline waters  |
| WYPELNIENIE_ID               | C2   | „S” – permanently filled reservoir,<br>„O” – periodically filled reservoir,<br>„ND” – not applicable (in the case when FUNKCJA_ID="B"),<br>„BD” – no data available   |
| PODPIETRZONE                 | L    | „T” – artificially raised surface waters  |

**Thematic layer** (environmental map):

Industrial emitters and devices reducing atmospheric air pollution [symbol numbers in explanations: 52, 59 and 60]

**Digital layer:**

„EMITORY\_PRZEMYSLOWE”

**Description:**

Point layer

**Database:**

|                          |       |  |
|--------------------------|-------|--|
| EMITOR_ODOROW            | L     | „T” – oppressive odours are emitted  |
| EMITOR_GAZOW             | L     | „T” – gas emission   |
| EMISJA_GAZOW             | N11,3 | Principles:<br>„-1” – stands for “not applicable”, when EMITOR_GAZOW = “F”,<br>„-10” – stands for “no data available”, when we know that a given facility emits gases (EMITOR_GAZOW = “T”, but we do not know the volume,<br>„>0” – volume of gas emissions in t year <sup>-1</sup>                            |
| EMISJA_GAZOW_BEZ_CO2     | N9,3  | Principles:<br>„-1” - stands for “not applicable”, when EMITOR_GAZOW = “F”,<br>„-10” – stands for “no data available”, when we know that a given facility emits gases (EMITOR_GAZOW = “T”, but we do not know the volume,<br>„>0” – volume of gas emissions in t year <sup>-1</sup> (without CO <sub>2</sub> ) |
| EMITOR_PYLOW             | L     | „T” – dust is emitted  |
| EMISJA_PYLOW             | N9,3  | Principles:<br>„-1” – stands for “not applicable” when EMITOR_PYLOW = “F”,<br>„-10” – stands for “no data available”, when we know that a given facility emits dust (EMITOR_PYLOW = “T”, but we do not know the volume,<br>„>0” – volume of dust emissions in t year <sup>-1</sup>                             |
| EMISJA_SUMA              | N12,3 | Total volume of gas and dust emissions in t year <sup>-1</sup>   |
| EMISJA_SUMA_BEZ_CO2      | N11,3 | Total volume of gas (without CO <sub>2</sub> ) and dust emissions in t year <sup>-1</sup>  |
| URZADZENIA_ODSIARCZAJACE | L     | „T” – emitter has devices reducing sulphur compounds   |
| URZADZENIA_ODPYLAJACE    | L     | „T” – emitter has devices reducing dust  |
| ZRODLO_REGON             | C14   | User ID – REGON statistical number from database BAZA_REGON  |
| NR_W_KOMENTARZU          | N3    | Consecutive number of emitter – in line with the numbering in comments to a given map sheet  |

The example of MapInfo Professional interface with an open map window and the window with database tables is presented at Fig. 3. An example of a sewage discharge database layer is shown (appearing both on the hydrographical and environmental map). Database window on users is also open; in this case it concerns users who drain sewage.

### Conclusions

The usefulness of both thematic maps in environmental management is unquestionable, and their complementary use guarantees comprehensive survey of issues connected with natural environment of a given area (Absalon, 1999; Absalon, Jankowski, 1998; Absalon, Jankowski, Matysik, 2002; Absalon, Jankowski, Leśniok, 1998, 2001 and 2004). This comprehensive approach is guaranteed, among other things, by the interdisciplinary makeup of the team of experts. For example, the specialists in the field of geomorphology, hydrology and water management, climatology, botany, environmental protection, cartography and computers formed the team preparing sheets of the environmental map.

In Poland, these maps are evoking greater and greater interest because of common software availability, because they are easy to manage, they are offered in both analogue and digital ver-

sions, and because there exists the possibility of immediate verification of data and bringing the map up to date as well as adjusting the map to one's own needs.

The value of the map can hardly be overestimated, especially of the one made in GIS system. It is these systems that are becoming an important analytical tool in the process of decision making (Absalon, Jankowski, Leśniok, 2002; Absalon, Jankowski, Leśniok, Kokociński, 1998; Jarzębińska, 1998).

*The article is a part of the project GA ČR 205/06/0965 „Visualization, interpretation, perception of space information in thematic maps“.*

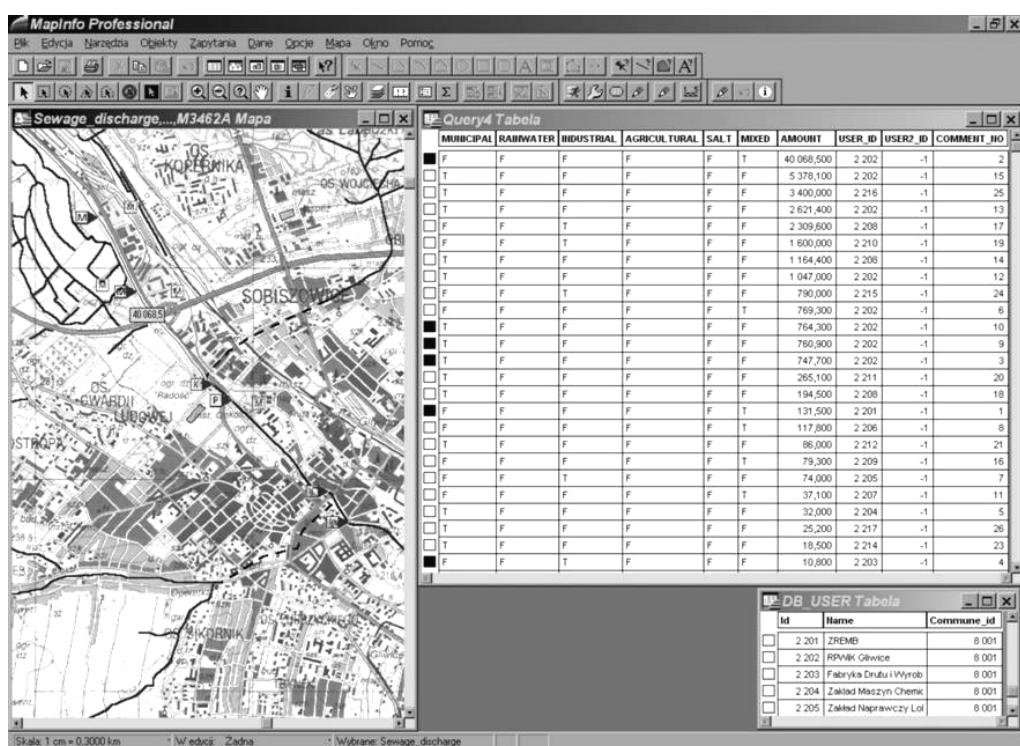


Fig. 3 Example of an MapInfo interface with an open window of the hydrographic map and database

### References

- ABSALON D. (1999). *Systemy informacji geograficznej (GIS) w badaniach dorzecza na przykładzie map hydrograficznych i zoologicznych*. Interdyscyplinarność w badaniach dorzecza. Instytut Geografii Uniwersytetu Jagiellońskiego, Kraków, s. 191-199.
- ABSALON D. (2002). *Teraźniejszość i przyszłość map hydrograficznych*, Rzeki. Kultura, cywilizacja, historia, t. 10, Wydawnictwo Naukowe "Śląsk", Katowice, s. 167-178.
- ABSALON D., JANKOWSKI A.T. (1998). *Problemy ochrony wód w dorzeczu górnej Odry w świetle opracowanych map zoologicznych*, Materiały IV Konferencji Naukowo-Technicznej „Problemy oczyszczania ścieków i ochrony wód w dorzeczu Odry”, Kudowa Zdrój, s. 425-434.
- ABSALON D. JANKOWSKI A. T., MATYSIK M. (2002). *Application of GIS in research and protection of springs within Upper Oder river basin*, GIS Odyssey 2002 Proceedings, GIS Forum Croatia, Zagreb, s. 146-154.
- ABSALON D., JANKOWSKI A.T., LEŚNIOK M. (1998). *Application of GIS for the estimation of the natural environment hazards (on example of environmental maps)*, Proceedings GIS Brno '98 Conference - Geographic Information Systems: Information Infrastructures And Interoperability For The 21st Century Information Society, Brno, s. PS 1-7.

- ABSALON D., JANKOWSKI A. T., LEŚNIOK M. (2001). *Thematic maps in environmental and water management*, Proceedings GIS Polonia 2001, Warszawa, s. 124-130.
- ABSALON D., JANKOWSKI A. T., LEŚNIOK M. (2002). *Application of GIS in planning nature conservation on the example of "Parkowe" reserve conservation plan*, GIS Odyssey 2002 Proceedings, GIS Forum Croatia, Zagreb, s. 287-298.
- ABSALON D., JANKOWSKI A. T., LEŚNIOK M. (2004). *Geographic Information Systems (GIS) in Environmental Research and Water Management*, Miscellanea Geographica. Vol. 11, s. 333-348.
- ABSALON D., JANKOWSKI A. T., LEŚNIOK M., KOKOCIŃSKI P. (1998). *Application of GIS for the estimation of the natural environment hazards on the example of Upper Silesian region*, Proceedings GIS Croatia 1998, Osijek, s. 49-51.
- JARZĘBIŃSKA T. (1998). *Możliwości zastosowania GIS w modelowaniu gospodarki wodnej w zlewniach rolniczych*. Gospodarowanie wodą w zlewniach rolniczych, IMGW Warszawa, s. 15-23.
- WYTYCZNE TECHNICZNE GIS – 3 MAPA HYDROGRAFICZNA POLSKI SKALA 1:50 000 W FORMIE ANALOGOWEJ I NUMERYCZNEJ (2005). Główny Urząd Geodezji i Kartografii, Warszawa.
- WYTYCZNE TECHNICZNE GIS – 4 MAPA SOZOLOGICZNA POLSKI SKALA 1:50 000 W FORMIE ANALOGOWEJ I NUMERYCZNEJ (2005). Główny Urząd Geodezji i Kartografii, Warszawa.

## R e s u m é

### Aplikace GIS ve zpracování hydrografických a sozologicických map Polska

Sozologiccké mapy Polska zpracovávané v rámci Státního Systému Informací o Území byly jedny z prvních polských úředních map, na kterých byly použity GIS. Sozologiccké mapy byly v analogové i digitální formě vytvářeny již v 90. letech minulého století. Hydrografické digitální a analogové mapy byly zpracovány od roku 1998.

Sozologiccká mapa je tematická mapa, která z prostorového pohledu prezentuje hodnocení stavu životního prostředí, příčiny a následky pozitivních i negativních změn v prostředí a to pod vlivem různých druhů činností člověka. Hodnocení jsou opřená o výsledky vědeckých výzkumů mnoha vědních oborů. Mapa též prezentuje způsob ochrany zvláště cenných oblastí životního prostředí.

Hydrografická mapa je tematická mapa, která představuje v syntetickém pohledu podmínky oběhu vody ve vztahu k životnímu prostředí, k jeho přetváření a také k úrovni ekonomického investování.

Digitální verze obou tematických map umožňují základní funkce GIS: vkládání, navýšování dat, jejich verifikaci, aktualizaci a také provádění prostorových analýz.

Použitelnost obou tematických map v řízení životního prostředí je nesporná. Využívání možnosti skládání informací z více vrstev umožňuje komplexní pohled na problémy spojené s životním prostředím daného regionu. Komplexní pohled na problémy garantuje, mimo jiné, i interdisciplinární zpracování problematiky. Např. do kolektivu odborníků zpracovávající listy sozologicckých map vstupovali specialisti z oblasti: geomorfologie, hydrologie, vodního hospodářství, klimatologie, botaniky, ochrany životního prostředí, kartografie a informatiky. Obě mapy se v Polsku těší stále většímu zájmu, a to především z hlediska všeobecné dostupnosti software, jednoduchosti jeho obsluhy, možnosti současněho využívání analogové i digitální verze mapy, možnosti okamžité verifikace dat, možnosti jejich aktualizace a především k vlastnímu využití.

Hodnota podrobných map jako nositele informací zpracovaných v systému GIS, je nedocenitelná. Mapy zpracované v GIS se staly důležitým analytickým nástrojem v procesu podpory rozhodování managementu řízení životního prostředí.

Obr. 1 Stav rozpracování hydrografických map Polska – tmavě šedě jsou označeny hotové listy (<http://serwisy.cdgik.gov.pl/temap/hydro.html>)

Obr. 2 Stav rozpracování sozologicckých map Polska – tmavě šedě jsou označeny hotové listy (<http://serwisy.cdgik.gov.pl/temap/sozo.html>)

Obr. 3 Příklad interface MapInfo s otevřeným oknem hydrografické mapy a současně s databází

### Lektoroval:

**Doc. RNDr. Jaromír KAŇOK, CSc.,  
Univerzita Palackého, Přírodovědecká fakulta, Olomouc, Česká republika**