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## CONCEPTION OF HYDROLOGICAL ATLAS OF UPPER ODER RIVER BASIN

### KONCEPCJA ATLASU HYDROLOGICZNEGO DORZECZA GÓRNEJ ODRY

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**Key words:** Oder river, hydrology, thematic atlas, GIS, cartography

Słowa kluczowe: Odra, hydrologia, atlas tematyczny, systemy informacji geograficznej, kartografia

### Introduction

The initial idea of the Hydrological Atlas of the Upper Oder River Basin was conceived in 1993–1994 as a joint project between geographers and hydrologists from the Faculty of Earth Sciences of the University of Silesia and the Faculty of Science of the Ostrava University (Kaňok, 1993; Absalon, Jankowski, 1994). The scientists returned to the idea in 2007 during the conference “First Cartographic Day” organised by Palacký University in Olomouc, where, among other papers, a Climate Atlas of Czechia (Tolasz, Míková, Valeriánová, Voženílek 2007) and thematic maps of Poland (Absalon, 2008, in print) were presented.

The Atlas is intended to:

- define hydrological conditions;
- define quantitative and qualitative transformations of river runoff;
- capture the impact of the Czech and Polish industrial and urbanised areas on runoff regime;
- present an assessment of hydrometeorological and anthropogenic flood risk factors;
- present an assessment of the frequency and magnitude of floods;
- identify areas threatened with floods and areas protected from floods.

Collaborative scientific research by geographers from the Faculty of Earth Sciences of the University of Silesia and geographers from the Ostrava University, together lately with a team of geoinformaticians from the Faculty of Science of the Palacký University of Olomouc, has mainly focused on widely understood issues of environmental protection and environment shaping (Absalon et al., 1995; Absalon and Matysik, 2007; Czaja, 1999).

Besides, the hydrological problems of the Upper Oder River Basin have received a lot of attention, in particular regarding hydrographical network assessment of changes in the river runoff regime caused by natural and anthropogenic factors (Absalon et al. 1997; Absalon and

Jankowski, 2002; Kaňok, 1994, 1997), flood risks (Absalon, 2001; Absalon et al., 2006) and assessment of yield and water quality of selected springs (Absalon, et al., 2002; Absalon and Matysik, 2004; Kaňok and Matysik, 2004). This is represented by the grant supported collaborative research project “Changing trends in water cycle in the Upper Oder River Basin” (Absalon et al. 1996, 1997).

Other work focuses on the use of cartography and GIS in environmental studies (Absalon and Jankowski, 1999, 2001; Absalon and Leśniok, 1999; Absalon and Matysik, 2003; Absalon et al., 2004; Kaňok, 1999, 2002).

The collaboration has also prepared a commentary and map of anthropogenic modification to the relief of Upper Silesia, issued by the Ost und Südosteuropa Institut in Vienna (Jankowski and Havrlant, 1999).

## General information about the Atlas

As mentioned above, the Hydrological Atlas of the Upper Oder River Basin is an interdisciplinary project undertaken by a Polish and Czech team.

The Atlas will be prepared at the following scales:

- 1:200 000 – basic hydrological map scale,
- 1:500 000 – synthetic map scale,
- 1:50 000 – detailed map scale.

Besides the basic maps, the Atlas will also contain diagrams and charts illustrating the relevant issues. It is assumed that the Atlas will have analogue and digital versions; the digital version will be available in ArcGIS and MapInfo formats and include appropriate data.

No thematic atlas in this form and concerning such an area have yet been developed. Currently, the only Atlas available in this field is the hydrological Atlas of Poland, developed at scales from 1:500 000 (only 10 maps) to 1:3 000 000, and issued by the Institute of Meteorology and Water Management (IMGW) in 1987. There is no digital version of this Atlas, which predates the extreme hydrological events of the last decade of the 20<sup>th</sup> century (e.g. the 1997 flood).

Between 1995 and 1997, 4 maps were issued that concerned the incidence, use, hydrological conditions and groundwater table dynamics in the Upper Silesia Coal Basin. These maps (without digital versions) were issued by the Polish Geological Institute.

The area to be covered by the planned Atlas is partly covered by the Atlas of Lower and Opole Silesia issued by the Wrocław University (1997), but this also does not have a digital version and the majority of maps in the Atlas have scales between 1:1 000 000 and 1:3 000 000.

The Atlas floodplains Oder was issued in 2000, after the floods in 1997.

The Silesia Province was also represented in the Climate Atlas of the Silesia Province, issued by Institute of Meteorology and Water Management (2000).

Some hydrological elements are also included in the Evaluation of Natural Environment and Identification of Hazards in the Silesia Province, issued by the Polish Geological Institute and Marshal Office of Silesian Voivodship (2001). In this case most maps are scaled at 1:650 000 and only three maps at 1:300 000.

There is, therefore, at present no Atlas covering the proposed region and thematic scope. The proposed scales are also more detailed than current products and a digital version is planned, in contrast to most of the other studies. GIS methodology is going to be extensively used to elaborate individual issues.

This proposal requires detailed development by a team comprising both map creators and their beneficiaries. The final version will form a kind of a manual describing how to create individual maps and other components of the Atlas. Participation of representatives of the map beneficiaries in the team to develop the final shape of the Atlas will ensure its maximum utility and functionality.

## **Territorial scope**

The Atlas will cover the area of the Upper Oder River Basin in the Czech Republic and Poland down to the Koźle gauging station. This area covers a region of 9.174 km<sup>2</sup>.

Closing the river basin at the Koźle gauging station is justified because it makes it possible to account for the impact of big urban and industrial conurbations (Ostrava-Karvina, Rybnik and Upper Silesia) on hydrological conditions.

The magnitude and regime of runoff and water quality in highly developed areas depends to a great extent on anthropogenic factors and the intensity of such impact is connected with the direction of economic processes. One of the important reasons for undertaking research in this area is a marked change in the intensity of anthropogenic transformations after 1990. It was also characteristic of the last decade of the 20<sup>th</sup> century that extreme hydrological events occurred here (droughts in the years 1992–1994, the July flood of 1997). It is also important to understand the reaction of Upper Oder River Basin to global changes.

## **Aims of the study**

In preparation of the Atlas, scientific research and utilitarian goals have been assumed.

Scientific research goals:

- research and definition of hydrological conditions of the Upper Oder River Basin (discharge, unit runoff and trends in their changes);
- research and definition of the impact of natural and anthropogenic factors on changes in river runoff and hydrological conditions;
- identification of meteorological conditions of raised water levels.

Utilitarian goals:

- evaluation of water resources and usage potential;
- evaluation of the risk of raised water levels, identifying areas threatened with floods and areas protected from floods;
- evaluation of flood probability and pace of flood wave movement;
- defining the water balance of the river basin;
- evaluation of surface water quality and underground water pollution hazards, with the identification of the main pollution hotspots;
- creation of databases of water management structures and their hazards in extreme conditions.

## Methodology outline

The following groups of methods will be used in the preparation of the Atlas:

- analytical;
- mathematical and statistical;
- cartographic, digital, and GIS.

Research analysis will be carried out in the case of basic data of most elements. Some hydrological issues (e.g. river network, watersheds, water management structures and phenomena) also require field work and research.

For the purposes of the project it is planned to create a geographic information system, which will make it possible to collect, process and present data and enable easier analyses. Some of the GIS methodology will include mixed data analysis (in raster and vector formats), map overlay, map reclassification and the analysis of neighbourhood, distance, connections of spatial objects with each other and non-spatial attributes.

## Team of authors

The maps and other issues of the Atlas will be prepared by specialists (geographers, hydrologists, hydrogeologists, climatologists, geologists, geomorphologists, cartographers and geoinformaticians) from the University of Silesia, the Ostrava University, the Palacký University of Olomouc and other scientific research institutes from Poland and the Czech Republic.

The final composition of the executive team will be determined after the proposal for the Atlas and, in particular, the scope of the maps has been approved. The assumption has been made that each map will have at least two authors (one from Poland and one from the Czech Republic).

## Thematic scope

The Atlas will comprise about 45 basic maps (Tab. 1). The issues are grouped in the following thematic blocks:

1. General and introductory maps – e.g. physical maps, geologic maps and a map of measurement points;
2. Maps of meteorological and climatic issues – e.g. temperature and precipitation distribution maps;
3. Maps of hydrological issues – e.g. maps of surface waters, underground waters, unit runoff;
4. Water management maps – e.g. maps of areas threatened with floods, water resources;
5. Maps of issues connected with anthropogenic changes in hydrological conditions – e.g. maps of quantitative runoff changes, water quality.

Individual maps will be accompanied by diagrams and charts containing supplementary data. A few maps will also have authors' comments presenting or supplementing the most important issues shown on the map. Databases developed for all maps will be an integral part of the Atlas.

Thematic maps will be created on the basis of a generalised topographic map. The scope of the digital version will be determined after consultation with a larger team and agreement with the beneficiaries.

**Table 1.** Proposed basic maps

No.	Name of the map	Scale	Scope of study
1.	Physical map	1:500 000	to frame
2.	Physico-geographical units	1:500 000	to frame
3.	Geomorphological units	1:500 000	to frame
4.	Topographic map	1:200 000	to frame
5.	Hydrographical map	1:500 000	to frame
6.	Bedrock map	1:500 000	to frame
7.	Superficial deposit map	1:500 000	to frame
8.	Geomorphological map	1:500 000	to frame
9.	Types of relief	1:500 000	to frame
10.	Types of soil	1:500 000	to frame
11.	Ground permeability	1:500 000	to frame
12.	Forest cover	1:500 000	to frame
13.	Observation network	1:500 000	to study's borderline
14.	Mean annual air temperatures (XI-X)	1:500 000	to study's borderline
15.	Mean annual air temperatures (XI-IV)	1:500 000	to study's borderline
16.	Mean annual air temperatures (V-X)	1:500 000	to study's borderline
17.	Average number of days with temperatures below 0°C	1:500 000	to study's borderline
18.	Air humidity	1:500 000	to study's borderline
19.	Mean annual precipitation total (XI-X)	1:500 000	to study's borderline
20.	Mean annual precipitation total (XI-IV)	1:500 000	to study's borderline
21.	Mean annual precipitation total (V-X)	1:500 000	to study's borderline
22.	Snow cover	1:500 000	to study's borderline
23.	Evaporation	1:500 000	to study's borderline
24.	Synoptic situations favouring the occurrence of floods	?	to frame
25.	Topoclimatic map	1:500 000	to study's borderline
26.	Climatic regions	1:500 000	to study's borderline
27.	Surface waters	1:200 000	to study's borderline
28.	Mean discharge	1:200 000	to study's borderline
29.	Maximum discharge	1:500 000	to study's borderline
30.	Minimum discharge	1:500 000	to study's borderline
31.	Mean unit runoff	1:200 000	to study's borderline
32.	Runoff index	1:500 000	to study's borderline
33.	Hydrological regime of surface waters	1:200 000	to study's borderline
34.	Flood inundated and protected areas	1:200 000*	to study's borderline
35.	Surface waters quality	1:200 000	to study's borderline
36.	Water resources	1:500 000	to study's borderline
37.	Water balance	1:500 000	to study's borderline
38.	Hydrological regions	1:500 000	to study's borderline
39.	Water management structures and phenomena	1:200 000	to study's borderline
40.	Flood-threatened structures	1:500 000*	to study's borderline
41.	Anthropogenic runoff changes	1:500 000*	to study's borderline
42.	Underground waters	1:200 000	to study's borderline
43.	Springs	1:200 000	to study's borderline
44.	Hydrogeological regions	1:500 000	to study's borderline
45.	Anthropogenic transformations of underground waters	1:500 000*	to study's borderline

\* selected areas will be presented on maps scaled 1:50 000.

The estimated circulation of the Atlas as a printed book or/and as separate maps in a cardboard box is about 500–750 copies. PDF and digital versions provided on CDs, DVDs and Internet versions are also planned.

## Beneficiaries of the Atlas and Individual Maps

The possible beneficiaries and institutions interested in the whole Atlas or specific maps include:

- State Water Management Board;
- Regional Water Management Boards in Gliwice and Wrocław;
- Departments of Geodesy, Cartography and Real Property Management of Marshal Offices (Poland) and regional authorities (the Czech Republic);
- Departments of Environmental Protection of Marshal Offices (Poland) and regional authorities (the Czech Republic) concerning rational use of water resources, water management as well as environmental protection and shaping;
- Departments of Spatial Development and Strategy of Marshal Offices (Poland) and regional authorities (the Czech Republic) concerning spatial development;
- Departments of Land and Water Transport of Marshal Offices (Poland) and regional authorities (the Czech Republic) concerning water transport;
- Departments of Crisis Management of Voivodship Offices (Poland) and regional authorities (the Czech Republic) concerning flood protection tasks;
- Departments of Environment and Agriculture of Voivodship Offices (Poland) and regional authorities (the Czech Republic) concerning environmental policy;
- Departments of Regional Development of Voivodship Offices (Poland) and regional authorities (the Czech Republic) concerning spatial policy;
- Unified administration units (Voivodship Inspectorates for Environmental Protection, Regional Water Management Boards, Land Melioration and Water Units Boards, State Fire Service),
- Scientific research units (Institute of Meteorology and Water Management, Institute for Ecology of Industrial Areas, Institute of Environmental Engineering, universities).

Corresponding units of lower levels of local administration dealing with hydrological and related problems may benefit from the maps.

## Duration of the study

The study should be completed in about three years after receiving funds.

Framework schedule:

- Year 1 – preparatory work – collecting literature and buying necessary data and materials and their elaboration; field work;
- Year 2 – preparation of specific maps and supplementary charts; field reconnaissance, elaboration of comments;
- Year 3 – final editing of the maps and of the digital version, printing, implementation.

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#### Abstract

*Following the publication of the Climate Atlas of Czechia in 2007, the concept of creating a Hydrological Atlas of Upper Oder River Basin is revisited. This Atlas will include both the Czech and the Polish part of the Upper Oder River Basin down to the Kožle gauging station. The Atlas is planned to contain about 45 main (basic) maps scaled at 1:200000 and 1:500000. It is assumed that each map will be prepared by two authors – a Czech and a Pole. GIS tools will be used to prepare both the cartographical and database components of the maps. In addition to the maps the Atlas, will contain comments, diagrams, tables and photographs.*

*The following scientific and research goals are to be met while preparing the Atlas:*

- *research and definition of hydrological conditions of the Upper Oder River Basin (discharge, individual runoff and trends in their changes);*
- *research and definition of the impact of natural and anthropogenic factors on changes in river runoff and hydrological conditions;*
- *identification of meteorological conditions of raised water levels.*

*The main utilitarian goals of the Atlas include:*

- *evaluation of water resources and possibilities of their use;*
- *evaluation of the risk of raised water levels, identifying areas threatened with floods and areas protected from floods;*
- *defining the water balance of the river basin;*
- *evaluation of surface waters quality and identification of underground water pollution hazards with the main pollution hotspots.*

#### Streszczenie

*Po opublikowaniu w 2007 roku Atlasu klimatu Czech powrócono do koncepcji opracowania Atlasu hydrologicznego dorzecza górnej Odry. Atlas ten zawierałby mapy z polskiej i czeskiej części dorzecza zamkniętego profilem w Koźlu. Atlas zawierałby około 45 głównych plansz w skalach 1:200 000 i 1:500 000. Przewiduje się, że każda mapa byłaby opracowywana przez 2 autorów – jednego ze strony czeskiej i drugiego ze strony polskiej. W procesie przygotowywania Atlasu zostaną w szerokim zakresie wykorzystane metody GIS, zarówno w części kartograficznej, jak i przy opracowywaniu bazy danych. Oprócz map Atlas będzie zawierał komentarze, diagramy, tabele i fotografie. Przy realizacji Atlasu założono realizację następujących celów naukowo-badawczych i użytkowych.*

*Cele naukowo-badawcze:*

- *zbadanie i określenie warunków hydrologicznych zlewni górnej Odry (przepływy, odpływy jednostkowe i tendencje ich zmian),*
- *zbadanie i określenie wpływu czynników naturalnych i antropogenicznych na zmiany odpływu rzeczniczego i warunki hydrologiczne,*
- *poznanie meteorologicznych uwarunkowań pojawiania się wezbrań.*

*Cele užitelné:*

- ocena zasobów wodnych i możliwości ich wykorzystania,
- ocena ryzyka wezbrań, wskazanie obszarów zagrożonych zalewaniami powodziowymi i obszarów chronionych przed zalewem,
- ocena prawdopodobieństwa pojawiania się wezbrań, szybkości przemieszczania się fali powodziowej,
- określenie bilansu wodnego zlewni,
- ocena jakości wód powierzchniowych i zagrożeń zanieczyszczenia wód podziemnych wraz z identyfikacją głównych ognisk zanieczyszczeń.

## KONCEPCJE HYDROLOGICKÉHO ATLASU POVODÍ HORNÍ ODRY

Klíčová slova: Odra, hydrologie, tematický atlas, GIS, kartografie

### *Shrnutí*

Po publikování Atlasu klimatu Česka v roce 2007 jsme se vrátili k vylepšení koncepce zpracování Hydrologického atlasu povodí Odry. Atlas by obsahoval mapy z české a polské části povodí Odry po profil Kožle. Atlas by obsahoval přibližně 45 hlavních map v měřítkách 1:200000 a 1:500 000. Předpokládá se, že bude každá mapa zpracována 2 autory – jeden z české strany povodí a druhý z polské strany povodí. V procesu přípravy Atlasu budou ve velké míře využity metody GIS a to nejen v části kartografické, ale především v datové základně. Kromě atlasových map bude obsahovat komentáře, diagramy, tabulky, fotografie. Při samotné realizaci Atlasu byly stanoveny následující vědecko-výzkumné a užitelné cíle.

*Cíle vědecko-výzkumné:*

- průzkum a vymezení hydrologických podmínek povodí horní Odry (průtoky, specifické odtoky, tendence jejich změn),
- průzkum a vymezení vlivu přírodních a antropogenních činitelů na změny říčního odtoku a na hydrologické podmínky,
- poznání meteorologických podmínek na výskyt povodní.

*Cíle užitelné:*

- vyhodnocení vodních zásob a jejich možnosti využití,
- vyhodnocení rizika povodní, ukázat oblasti povodněmi ohrožené, tak jako ukázat oblasti před povodněmi uměle chráněné,
- vyhodnocení pravděpodobnosti výskytu povodní, rychlosti povodňové vlny,
- stanovení vodní bilance povodí,
- hodnocení jakosti povrchových vody, ohrožení podzemních vod a také identifikace hlavních ohnisek možného znečištění.

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