

DATABASE MODEL OF NATIONAL PARK GIS AS AN ELEMENT OF SPATIAL DATA INFRASTRUCTURE

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ABSTRACT

Environmental protection is undoubtedly one of the most important areas where GIS technologies are the most extensively used. Geographic Information Systems for environmental protection, due to their complexity and importance, require large number of diversified data. Consequently, quality of spatial data is fundamental for proper functioning of GIS. The data of highest possible accuracy and quality are being crucial for the offered system functions.

Describing a model GIS for National Parks, particular attention has been paid to the issue of standardisation. Increasingly popular in many aspects of life, often global in scope applications of GIS providing various kinds of spatial data were forced to set and introduce standards for development of such systems. The standards for GIS for National Parks are based, inter alia, on guidelines developed within the EU INSPIRE (Infrastructure for Spatial Information in Europe) initiative. Therefore the goals of the system creation include, between others, common data availability and easy data exchange between systems – the features demanded by the community of users and limited only by existing legal restrictions (eg. special data protection).

The paper presents the database model developed by the authors for the Tatra Mountains National Park GIS. The model takes into account spatial data related to the whole range of activities of a National Park including environmental protection, forestry, park protection planning, tourism, infrastructure and resource management.

INTRODUCTION

One of the common measures of modernity in our times is utilization of advanced information technologies. According to many world reports, by the end of the 20th century information technology was the most rapidly developing scientific field, influencing the progress in many crucial domains of our life.

Consequently, the modern information technologies have found their place in widely understood earth sciences. Modern technologies are especially important in environment protection, which nowadays is undoubtedly one of the biggest challenges. This challenge demands wise, effective and creative use of the possibilities offered by information technologies.

From the combination of information technology and earth sciences emerged the new science discipline called geomatics, while Geographic Information Systems (GIS), incorporating "processes of spatial data acquisition, storage, verification, integration, transformation, analysis, presentation, transfer, management and dissemination as well as appropriate organisational and technical infrastructure and spatial databases" (Gaździcki, 2001), serve as a widely known

example of the presence of information technologies in environmental studies (including protection).

Spatial data form the basis of GIS operations. The need of effective data processing is the reason for creating such systems. Spatial data analysis, performed with the support of sophisticated GIS tools and technologies is the foundation for the further development in our knowledge of environment. Those tools offer invaluable support for the necessary decision processes and effective monitoring, leading to successful preventive actions, reducing, for example, the negative effects of antropopression.

National Parks are the most important form of nature protection in Poland. Their priority is “to study and protect all environment systems of the area including the conditions of their existence and to reconstruct damaged or destroyed elements of native nature” (Dziennik Ustaw nr 114, 1991 “Nature Protection Act” - printed official gazette announcing current legislation). The creation of Geographic Information Systems based on spatial databases is without a doubt a necessary condition for the realisation of statutory obligations of national parks. These conditions were noted and reflected in National Parks Statutes (Dziennik Ustaw nr 136, 2003 - printed official gazette announcing current legislation).

SPATIAL DATABASE MODEL FOR THE NATIONAL PARK

National Parks gathered large amounts of data. Only part of this data exists in numerical form and is used for everyday tasks (with varied effectiveness). Less than a half of 23 National Parks in Poland use Geographic Information Systems in their current activities, usually of the Desktop GIS category (data gathered in May 2004 during I Workshop “Geographic Information Systems in National Parks”).

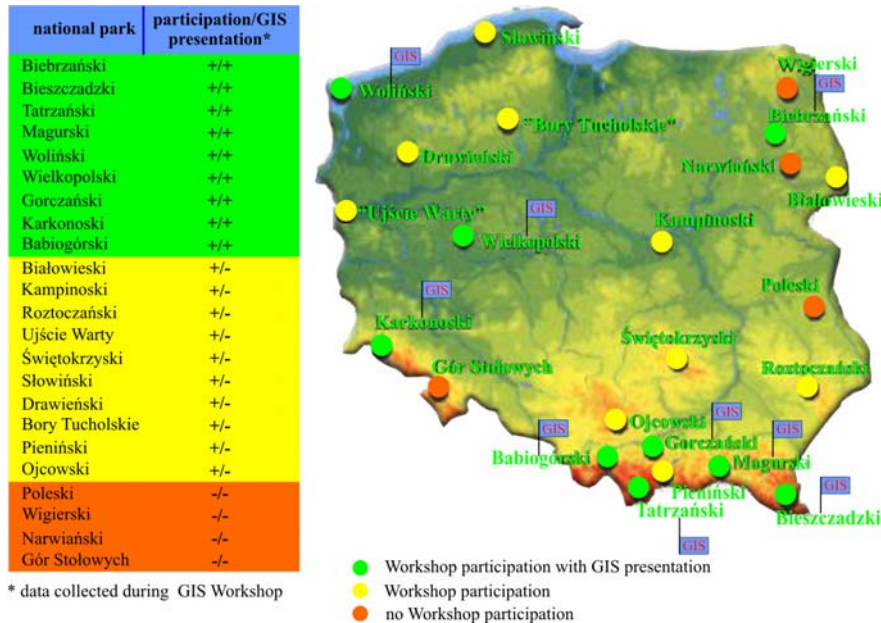


Figure 1: GIS in Polish National Parks

In other parks appropriate data is being gathered (or converted to digital form) and such systems are being created, but in some parks no steps are taken to create such systems. The situation is a consequence of many factors, one of them being the lack of appropriate standards. Therefore there is need for common spatial database model that would serve as a base of National Parks Geographic Information System, and would meet all the determined needs and peculiarities as well as international standards and current initiatives related to the creation of spatial data infrastructure.

The choice of the area for the model solution

In authors' opinion the Tatra National Park (TPN) is the best choice for the creation of model GIS solutions and especially for the creation of spatial database model. This opinion is based on the following premises:

- Tatra National Park was created to protect unique environmental qualities of high mountain landscape of Polish Tatra Mountains. This area is very popular among tourists, sportsmen (also those interested in extreme sports such as climbing or cave exploration) and scientists. To fulfill its task, the park cooperates with other institutions such as emergency units, State Cable Railways, sport institutions and others,
- TPN area is visited every year by the biggest number of tourists of all national parks in Poland, and in consequence it is exposed to particularly strong antropopression,
- TPN is a part of UNESCO International Biosphere Reserve (together with TANAP in Slovakia) and therefore its tasks involve international cooperation,
- The state border requires the cooperation with Polish and Slovak Border Guard,
- TPN lies within the administration borders of City of Zakopane, which provides the appropriate infrastructure for the park visitors, hence the need for cooperation with Zakopane municipal office,
- There are many research and educational projects conducted in TPN by academics from many Polish Universities. This requires a cooperation with scientists but also gives the possibility of planning and encouraging research activity targeted at the park needs, which is at the same time the source of up-to-date, high quality spatial data.

The above-mentioned premises form the basis of our conclusion that TPN is an area of the most intensive activity of all Polish National Parks. That is why the effective management of both the protective and administration tasks requires well organised support mechanisms, such as GIS. Additionally, a special attention was given to the need of the necessary cooperation with many institutions that directly or indirectly perform their tasks within the Park.

The fact of advanced stage of intensive works on Geographic Information System and spatial data acquisition (or conversion to digital form) was equally important. Considering these facts, there is no doubt that TPN is currently the best area for the development of GIS spatial database model solutions. These solutions should be adequate for other Polish and foreign national parks



Figure 2: Institutions cooperating with National Park (using case study of TPN)

Assumptions for the database model design

Prior to the work on the database structure model, the detailed analysis of the National Park needs and requirements for the spatial data resources was made. Requirements for the scope of necessary data connected with protective (statutory) and administrative tasks were given meticulous attention. The existing guidelines for geographical data designed for applications in the National Park management were consulted and the current state of data resources and the plans of new data acquisition were verified. As a result the content-related scope of the data was defined, including all the data deemed to be necessary for the park management decision processes within its statutory tasks. Besides it was necessary to include in the model the group of data connected with cooperation between the Park and other institutions in performing statutory tasks (Border Guard, mountain emergency units etc.).

A special attention was given to existing spatial data describing different ranges of National Park activity such as: environmental protection, forestry, park protection plan, tourism, infrastructure and estate management (e.g estate and building registers).

The most important of these activities is forestry, dealt with in all Polish national parks. According to organisational structures in forestry, National Park has a function of Forestry Inspectorate and has all responsibilities connected with that status. To improve forestry management a State Forests Information System (SILP) was introduced at the organisational level of forest inspectorates. It supports gathering of the data from lower organisational units. SILP introduced some standards in data structures, which were taken into account and incorporated into the part of the spatial data model describing forestry management in the Park. In the similar way some other dependencies between National Park Geographic Information System and the systems of other institutions were taken into consideration (a special attention was given to spatial data types and formats of data storage).

The structure of spatial database model

Spatial database model for the national park Geographic Information System, designed on the basis of above-mentioned factors, divides the data into five thematic groups:

- Land and Building Register,
- Infrastructure (e.g. TPN internal roads),
- Nature (flora, fauna, inanimate nature),
- Influence on environment (data on the influence of “infrastructure” and other factors on the environment),
- SILP (part of the data related to SILP).



Figure 3: Model of spatial database for National Park GIS

Additionally the model includes the separate area of “common objects” describing common part of spatial data and connecting above-mentioned five categories.

The spatial data that fall within these categories were chosen on the basis of the analysis of the real demands that the Geographic Information System should meet to effectively support the substantial functions of a national park, which in the same time is a part of International Biosphere Reserve.

National parks use spatial data of various types, such as: descriptions, vector geometry, images, maps with or without georeferences, sketches, photographs and many others. These technically

diverse data is used to perform everyday statutory tasks. The database model takes into account all above-mentioned, varied data types used in common vector formats (geometry data layer), „shape” format and raster formats (tiff, geotiff, png etc.). Such approach makes the system more flexible and allows integration of data from different sources, which is the crucial requirement for the model functionality.

Database model versus existing standards and initiatives

One of the necessary requirements for the model database is taking into account commonly used standards in spatial data databases for Geographic Information Systems. Therefore the authors gave special, but not uncritical, attention to international spatial database design standards as well as to EU INSPIRE initiative guidelines. One of the most important characteristics of the designed spatial database is the possibility of its functioning as a data warehouse in organised structure, as a so called local or regional SDI “node” (SDI – Spatial Data Infrastructure). This approach provides fast and easy scalability of data structure to the local, regional (euroregional!) or broader scale by adding another spatial data warehouses as well as easy data exchange between the data warehouses. Data exchange between data warehouses is also easier and more effective within organised structure. Metadata architecture based on ISO 19115 is another important element for the operation of SDI data warehouse. It makes the work with large spatial databases faster and more efficient with the use of Internet geoportals, which can be built on the different levels of the structure (regional, national, euroregional).

THE POSSIBILITIES AND POTENTIAL WAYS OF CREATING THE (INTERNATIONAL) STRUCTURES OF SPATIAL DATABASES FOR NATIONAL PARKS BASED ON EU INSPIRE INITIATIVE

The proposed spatial database model, metadata system and the EU INSPIRE initiative guidelines enable the creation of complex database structures (data warehouses working as SDI nodes), providing the possibilities of easy and effective use of spatial data for the needs of the single national park as well as for the combined structures of many parks. Such a common system could be created, for example, for parks with similar type of protected environment. Similar, in this case transborder system could be created for International Biosphere Reserves, or other, effectiveness enhancing organisational structures.

The understanding of both the functions of spatial database in management processes and the advantages of the database operating within bigger structure (group of parks, transborder biosphere reserve) as well as the fundamental fact that national park doesn't work in separation (and it shouldn't!) underlies the possibility and will to develop common geographic information systems for parks, local authorities, Euroregion or other territorial structures. The access to the spatial data gathered in data warehouses on different levels (SDI) can be provided from one point via geoportals. The existence of spatial data and often high costs of their acquisition, conversion, integration and storage should serve the purpose of possibly wide availability of this data. We are in the situation, when spatial data is present in national parks thanks to taxpayers' money – national parks depend on national budget (Dziennik Ustaw nr 114, “Nature Protection Act”, 1991). That is why the taxpayers - tourists or scientists or just connoisseurs of a particular part of environment protected for them - have a moral right to possibly unrestricted access to spatial data, and the national parks should provide that access.

It is a well-known fact that spatial data are needed in many research programmes, environment protection initiatives and also for various public administration needs (e.g crisis management).

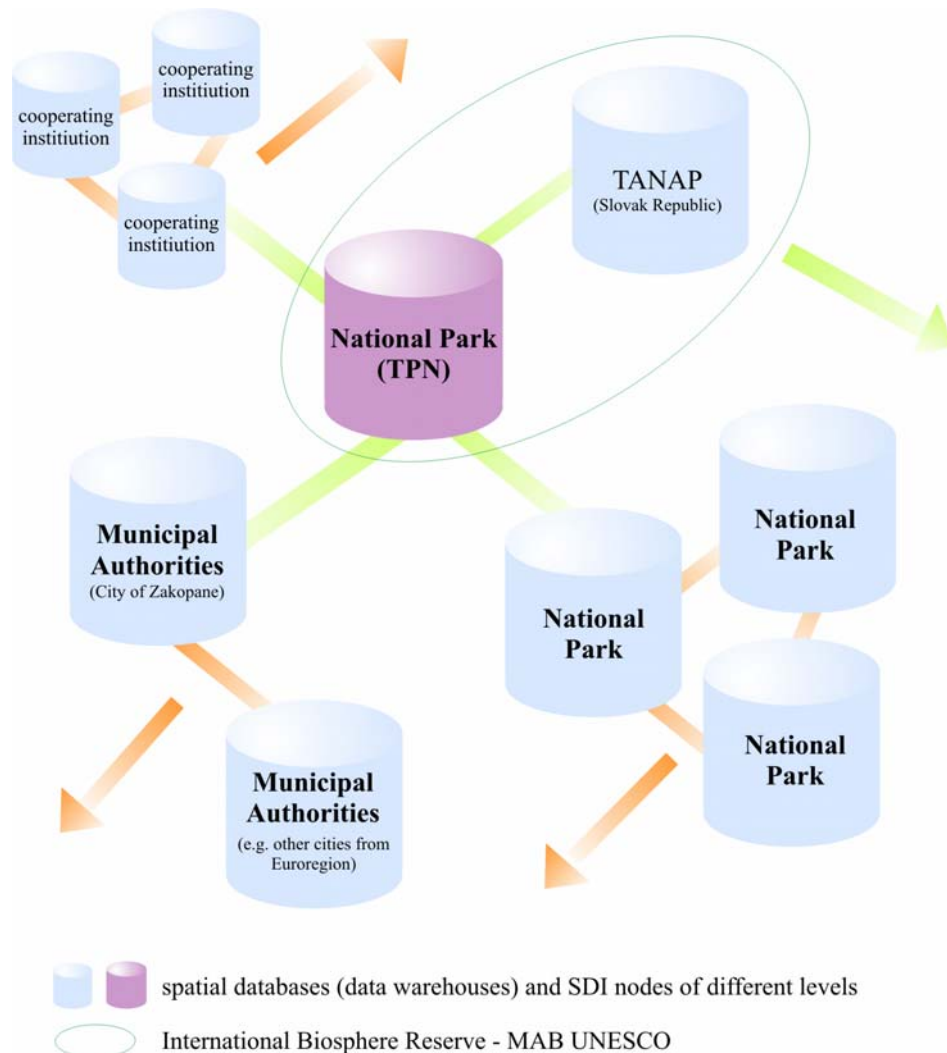


Figure 4: Model of potential ways of creating structures of spatial databases (as SDI nodes)

Common data availability, limited of course by the law (copyrights, data protection) is usually beneficial for both the owner of data and the people or institutions that analyse the data e.g for the purpose of research. Besides, providing the access to the data by a national park can contribute in practice to much broader and advanced knowledge of the park than it would be possible by analysis limited to the park, as the research departments in national parks often have very limited resources.

All these facts should be popularised among the managers of national parks and should lead to effective use of spatial data, gathered for many years often at a great expense, and to their common

availability. Undoubtedly, the careful, scientific analysis of gathered data resources is the requirement for extracting information and on its basis for new and better quality of inference and decision support, which in turn leads to better effectiveness in performing statutory tasks.

SUMMARY AND CONCLUSIONS

Spatial data plays a significant role in our world, especially in processes of decision making on different levels and in different domains of life. Because of this role the data resources are nowadays a kind of „synthetic raw material” produced by people. All the activities connected with natural environment are among the most important areas of widespread usage of data. Environmental studies and nature protection lead in practice to better quality of our life.

The spatial data prove their worth in numerous ways, such as the following:

- as the data source for analysis, that underlies new possibilities of inference and, consequently, the development of knowledge on the scale unreachable ever before,
- as the basis for decision processes,
- as the source of a so called „popular” knowledge,
- in many other applications.

Above-mentioned applications of data have their special place in the protection of environment institutionalised in the form of national parks. For the effective and possibly widespread usage of spatial data in national parks an appropriate approach is needed. That means: appropriate data organisation, easy access to data and creating suitable infrastructure. Therefore the development of flexible, open-structure model solutions and standards is indispensable.

Spatial database model for the National Parks Geographic Information Systems is an example of a flexible, open-structure solution, enabling future extensions. Spatial databases (data warehouses) created according to this model can work as SDI nodes on different levels of spatial data infrastructure (e.g understood like in EU INSPIRE initiative). This attitude enables the creation of data structures for data exchange, for example between parks with the similar type of protected landscape, within the same administration unit, between all parks in Poland or in Euroregion in order to use the data for the purposes of statutory tasks in a most effective way.

The other possibility of creating similar structures is the cooperation of National Park with many types of institutions (emergency units, border guard, sport organisations etc.). The goal of such a structure would be the same: easy, effective and cheaper way to use spatial data for the purposes of each institution.

The third criteria that could be adopted, is the fact that protected territory is a part of the territory governed by some local authorities.

In general, any „direction” of extending or creating spatial infrastructure that assumes better cooperation in effective, cheaper and easier access to spatial data resources for the purposes of National Parks statutory tasks is acceptable, irrespective of territorial scope or nationality.

The effective and appropriate use of spatial data should also include ways of delivering the data for the purposes of research, tourism and also for the popular interest. Such attitude is justified as the gathering, analysis and storage of data are financed by taxpayers – national parks depend on the national budget. The access to data should only be limited by the restrictions imposed by data

protection laws.

It is the ambition of the authors to apply the presented approach and the conclusions to other domains of life, where the effective and correct usage of data and the related issues (especially providing access to data!) are vital and often also have a commercial character.

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