

# INFORMATIONAL SUPPORT ON CREATION OF THE GEOPORTAL “ENVIRONMENTAL SAFETY OF UKRAINIAN-POLISH TRANSBOUNDARY TERRITORIES” BY TECHNOLOGIES OF ROBOTIZED MONITORING

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## Abstract:

The concept of creation of the geoportal “Environmental Safety of Ukrainian-Polish Transboundary Territories” has been developed. General principles and methodological approaches of spatiotemporal geographically distributed thematic data integration were substantiated. The geoinformation system, which is based on results of monitoring researches of objects of the nature reserve fund in the biosphere reserve “Roztochya”, is considered. The geoinformation monitoring technologies ensure ecological safety management. The proposed geoportal determines directions of information technology implementation for transboundary monitoring of ecosystems in the euroregions.

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**Key words:** geoportal, environmental safety, monitoring, geographic information system, the biosphere reserve

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## INTRODUCTION

Modern European safety is characterized by the absence of differentiation of traditional external and internal aspects. Integration processes of the European Union formation lead to erasing borders between external and internal safety. The environmental component of the European safety turns into a dominant factor of internal and external policies of the Ukraine and of the EU (Law of Ukraine “On the cross-border cooperation.” June 24, 2004. 1861/IV). Ensuring environmental safety and maintaining the ecological balance of states, the territory is among the priorities of environmental communication in the cross-border regions.

Environmental safety of Ukrainian and Polish cross-border regions is a key element to establish a regional and global safety system of central and eastern European states. The basic form of the transborder cooperation in economic and social, scientific and cultural, educational and environmental fields is expressed by development of euroregions.

The euroregion is a form of transborder cooperation between local communities and local governments of bor-

der regions in both states (Cabinet of Ministers of Ukraine Resolution, 2002). Poland and Ukraine are involved in two euroregions “Euroregion Bug” (Ukraine, Poland, Belarus) and “Carpathian Euroregion” (Ukraine, Poland, Slovakia, Hungary, Romania); both are different in size, intensity of activity and scale of investment involved.

Features of interstate relations of Poland and Ukraine border areas in the field of environmental management define issues of prevention and elimination of existing and possible ecological threats. Preservation and restoration of transboundary Ukrainian-Polish territorial ecological potential, the importance of their ecological and economic role in the European Union define directions of information technologies implementation for cross-border ecosystem monitoring of euroregions.

The urgency of developing of the geoportal “Environmental Safety of Ukrainian-Polish Transboundary Territories” with using of the geographical information systems (GIS) and the environmental and economic monitoring’s data, is caused by a need to improve the level and quality of information support of large-scale, marketing informa-

tional, infrastructural and investment strategy of the development of the border areas in the EU. Ukrainian and Polish Euroregions are direct consumers of environmental information from designed geoportal which is combined like a global network. The geoportal provides collection and distribution of information related to a protection and rational use of natural and economic territorial systems.

Therefore, the scientific and applied monitoring problem is actual and of great scientific and practical importance in central and eastern Europe in a context of environmental threats by creating the geoportal “Environmental Safety of Ukrainian-Polish Transboundary Territories”. The geoportal implies a compliance with the international standards and its operation and management; the network access to distributed departmental databases and integrated; the complex processing and use of information.

Databases which describe the environmental condition of the main components of natural European landscapes have been created. The works of scientists in Central and Eastern Europe are devoted to them: J. Kowalski, T. Gerlach, L. Starkel (Poland), L. Bashsha (Hungary), O. Mikulyk, A. Vajschar, V. Chnilichka (Czech Republic), A. Goffman, H. Hajermann (Germany), D. Dimitrov, M. Sniejeva (Bulgaria), P. Jordan (Austria), O. Adamenko, V. Kuchma, I. Klymchuk, O. Stelmach (Ukraine) and many others (Adamenko, 2011). The map “Natural resource management and environmental problems in central and eastern Europe” in scale 1:3 000 000, edited by P. Jordan, was published in 1992 in Vienna. It gave rise to drafting of the European monitoring network interstate computerized system of environmental safety. Based on 199 geo-ecological landfills, located at 15 monitoring profiles that cross the 19 countries of Central and Eastern Europe there have been defined a pollution of soil, surface water, air and vegetation with heavy metals; the database have been constructed (Adamenko, 2011).

## REGIONAL SETTING

Natural researches contributed to organization of the transboundary protected areas in the Ukrainian-Polish euroregions. Two transborder biosphere reserves (TBR) have been created in the “Euroregion Bug” – “West Polissia” (Ukraine, Poland, Belarus); “Roztochya” (Poland, Ukraine) (The biosphere reserve “Roztochya”, [www.loda.gov.ua](http://www.loda.gov.ua)). In the “Carpathian Euroregion” there the TBR “East Carpathians” (Ukraine, Poland, Slovakia) was formed. Thanks to work of many generations of Polish (Bogucki, 1998; Rąkowski, 2000) and Ukrainian naturalist, an ecological network of transboundary protected areas in Poland and Ukraine emerges. However, a complete monitoring of natural resources at the Ukrainian-Polish border is wanting.

## MATERIAL AND METHODS

Solving the problem of environmental safety monitoring of Ukrainian-Polish cross-border areas using the GIS

technology was initiated by the authors (Mokryyy *et al.*, 2014). Based on current approaches to integration of spatio-temporal geographically distributed data, a concept of creating the geoportal “Environmental Safety of Ukrainian-Polish Transboundary Territories” has been suggested. The geoportal is an efficient means of online analysis and prediction of dynamics of anthropogenic, natural and social factors that require database monitoring of technogenic processes (Electronic catalog of geographic information resources, <http://geoportal.org.ua>).

Advanced and detailed, but fragmented and separated environmental research of Polissia, Roztochya and the Carpathians are not integrated in spatiotemporal geographically distributed databases system of environmental monitoring results. There are no network access to distributed departmental and integrated databases. The complex processing and practical using of ecological and economic information is not performed.

The continued landscape and geophysical, geomorphological, soil science, forestry, botanical and zoological research shows the intensification of man-caused threats, as well as the lack of passive environmental protection, which does not ensure preservation of landscape and biological diversity. Due to degradation of meadow and marsh complexes of Polissia and Roztochya, the populations of rare species of flora and fauna were reduced. There is a decrease in forest cover of Polissia, Roztochya and the Carpathians.

A research was performed for the purpose to design the methodology of information support of the designed geoportal “Environmental Safety of Ukrainian-Polish Transboundary Territories” by the integrated use of modern information and analytical methods, technologies and tools.

The aim was attained by solving the following tasks:

- increasing the informative data of environmental monitoring for management of environmental safety of natural and man-caused ecosystems of the Ukrainian-Polish euroregions;
- identification of satellite images of nature reserve fund objects and man-caused landscapes using optimized methods;
- study methodology of creating a computerized system with technologies of robotic monitoring;
- information support of information software system of the designed geoportal;
- creation of thematic, information and analytical environmental and mapping models of ecosystems.

The object of research are the man-induced and natural processes and phenomena of dynamic ecosystems in Polissia and Roztochya. The research subject is environmental safety monitoring of local hydrologic, forest, meadow and wetland and urban complexes of environmental facilities in Polissia, Roztochya and surrounding areas. The methods of research are systematic scientifically grounded analysis of ecosystem functioning, GIS technology, software systems and tools of analysis of the proximity of geospatial objects. The synthesis of environmental and mapping models of ecosystems was implemented using GIS technologies of MapInfo Professional.

**RESULTS**

The main functionality of geoportal is to minimize and neutralize threats to the environment by using information support, proactive and monitoring information by competent management institutions, administrative agencies in border regions. The geoportal provides international standards of information support of public by using network access to distributed departmental and integrated databases, complex systematization and use information.

The developed concept of creating geoportal is based on common principles and methodological approaches of integrating of spatiotemporal and distributed data (<http://geoportal.org.ua>). In specificity of information support of geoportal design, trend in the development and location tools and technologies of robotic monitoring was separated. The functioning of geoportal is caused by the institutional foundations of geospatial data, technologies of environmental and cartographic modeling, level of development of information support of society, volumes of geographic information resources, availability and specific information and analytical system of ecological and economic monitoring. These factors determine the efficiency of geoportal and management of environmental safety of cross-border areas.

The results of the research consist of algorithms, methods and technologies for environmental monitoring, which are presented by thematic GIS models of natural reserves areas of the both transboundary Ukrainian parts of biosphere reserves – “Roztochya” (Trofimchuk *et al.*, 2015; Mokryy *et al.*, 2016) and “West Polissia” (Mokryy *et al.*, 2007; Mokryy

and Butenko, 2012). The synthesized GIS applications are functional components of the projected geoportal.

The information and analytical technology of computer monitoring of digression of recreational forest ecosystems (Mokryy, 2012a), natural and man-made landscapes (Mokryy, 2012b), recreational transformations of lakes (Mokryy, 2009), surface water, man-caused impact on soil West Polissia. The ecological and cartographic models of man-induced factors of environmental safety, such as road network and settlements of Roztochya, were done. The algorithms of information support of environmental and cartographic modeling of natural reserves and man-caused systems for information support and management of environmental safety of the Ukrainian-Polish euroregions were developed (Mokryy *et al.*, 2014).

For creation a digital map of the biosphere reserve “Roztochya”, MapInfo Professional was used. It allows solving complex problems of geographical analysis, which is based on the realization requests and creating different thematic maps, to communicate with remote databases, export geographic features and other software products. MapInfo is a desktop mapping system, thanks to its advanced thematic mapping capabilities. Using combination of thematic layers and methods of buffering, zoning, partitioning and merging objects, spatial and attribute classifications, it was created a synthetic multi map with a hierarchical structure of legend (Fig. 1).

The integration of cross-disciplinary methods of data analysis provides radically new requirements to the solution of the problem of operational, probable and complete

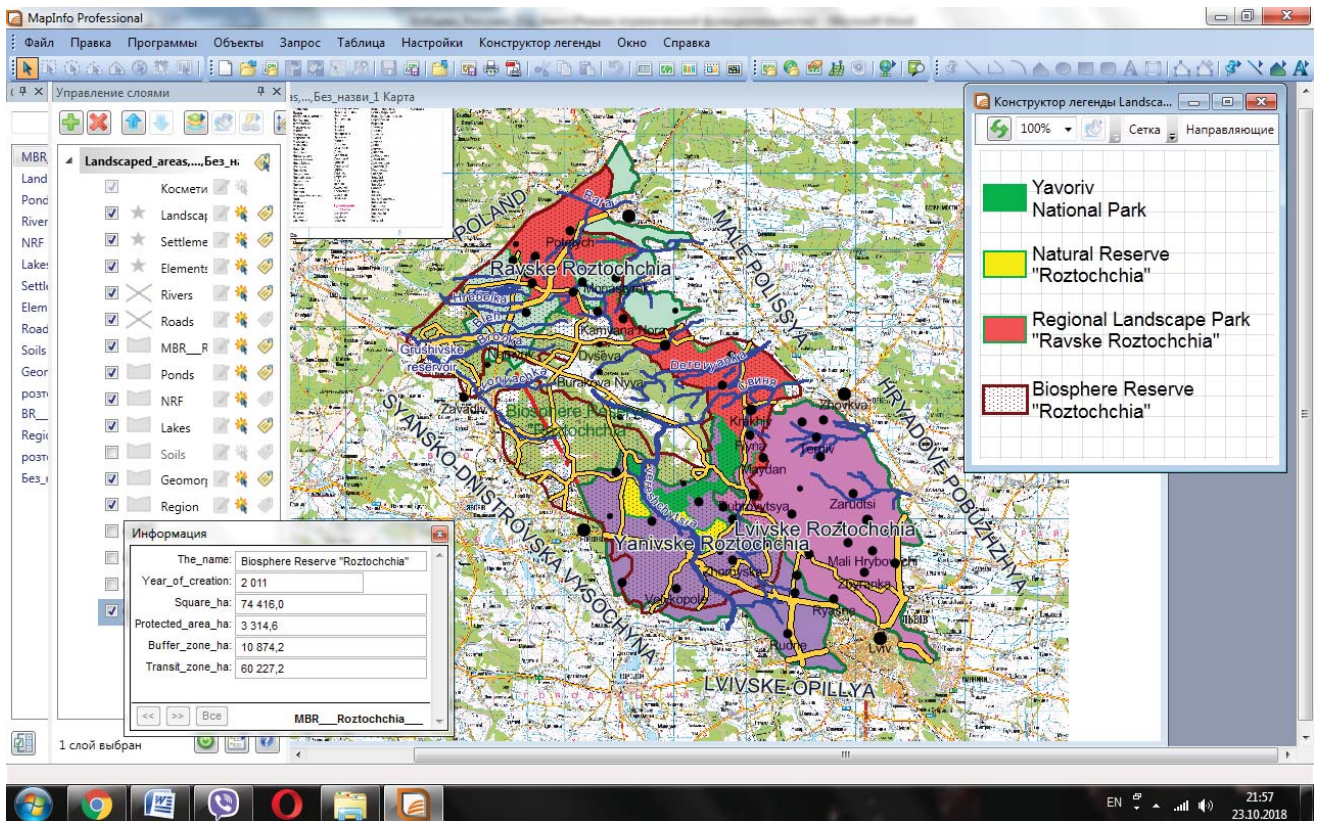


Fig. 1. Operating window with GIS MapInfo Professional with a thematic layer “Natural Reserve Fund of the Ukrainian Biosphere Reserve “Roztochya”.

information support of well-balanced and ecologically safe management of Roztochya ecosystems. For the subject systematization of inventory and monitoring research results, organized saving, search for the necessary information, its processing and analysis we use GIS, the modern computer technology. Created thematic GIS-layers provide connection of the territory model images (maps, schemes, space images of earth surface) with the information of tabular type (diverse statistical data, subject lists, ecological-and-economic indicators etc.) Geoinformation system of management of geospatial information and attributes associated with it provides possibilities of use, preservation, editing, analysis and display of geographical data. The use of GIS-technologies is efficient for taking of appropriate managerial decisions in the field of resources consumption; they provide opportunities for integrated interpretation of accumulated information of monitoring data, its immediate updating and analysis.

The projected geoportal is created as a conjunction of internet-media, which supports combined information on geoinformation resources in a selected territory and with services of geospatial data, and it provides access to this data in the internet network. The geoportal creates integrated media of geospatial data (producers, owners, distributors) with users (population, authorities of regional and municipal development management). Hardware and software means of geoportal analyse operational, probable and complete information of the modern condition of anthropogenic, wildlife, recreational-and-domestic complexes of the Ukrainian-Polish euroregions. Data of the Earth remote sensing (ERS) of Landsat systems (USA), SPOT (France), space images of high spatial precision of Quick Bird orbiter (USA), as well as the results of the state ecological monitoring of Ukraine and Poland. Presentation and archiving of information is performed in 2D and 3D-formats for the development of ecological-and-economic models of territory resources potential.

The geoportal is realized in accordance with the architecture "client/server" with a three-level logical structure of software: local server (system server), database server and clients' workbenches based on the DHTML conception with the use of the following programming languages: Javascript, PHP, C++, HTML, CSS, AJAX, JQUERY. For geospatial data navigation SVG, Canvas language is used on the client.

For the convenience of users it is feasible to form the monitoring results in sections – components of natural environment, natural objects, natural-and-anthropogenic objects and technogenic objects. The geoportal should include general information on application and activities of the reservation. The home page of a website is formed with the help of subparagraphs, which include all information on the functioning – general information, information of the scientific, ecological-and-educational, nature oriented, social work. The next level includes information on the geographical position and natural resources – climate, landscape, flora, fauna and leisure-touristic objects. Operational, probable and complete information on the modern condition of wildlife, recreational-and-domestic, urbanized

complexes of eco network is analyzed. On the basis of development and coordination of methods and technologies of surface and remote monitoring of condition and dynamic pattern of local ecosystems we can identify the threats to the landscape and biological diversity: karst, landslides, floods, forest fires, afflux and invasion.

The ecological safety of the Ukrainian-Polish euroregions is determined by functions of preservation of biological diversity and landscapes, conducting of scientific research, as well as the solution of problems of sustainable social-economic development of natural and administrative regions, support of traditional non-depletable exploitation of natural resources, most closely approximate to the nature of forest exploitation and ecological-educational work with local communities.

The conception of TBR creation as nature conservation territories, which perform global monitoring of ecological state of biosphere appeared in the 1970s. TBR "West Polissia" and "Roztochya" were created upon the initiative of the Ukraine and Poland for collaborative activities regarding the preservation of unique ecosystems on a trans-border hill of Roztochya. The Polish and Ukrainian sides have chosen the scheme of BR organization as a single formation. It requires coordination of actions of partner countries on the stages of functional zonation, planning of collaborative work in BR creation and formation of organizational structures, which can guarantee BR operation.

In accordance with MAB UNESCO requirements concerning a functional zonation of TBR during the project realization there was a training and coordination with the Polish projectors of plans regarding introduction of certain territories to a wildlife area (area A) and arrangement of its protection, preservation and reproduction of biological and landscape diversity.

For the provision of ecological safety it is appropriate to hold further coordination of approaches and principles of buffer areas indication (area B) and coordination of activities in the transit area (area C) of this international environmental facility. At the present moment it is reasonable to optimize prepared principle schemes of functional zonation of reservation within the borders of Polish and Ukrainian parts of Roztochya, which has to be coordinated with land users.

## CONCLUSION

Creation of the portal "Environmental Safety of Ukrainian-Polish Transboundary Territories", based on the ecosystem-graded landscape-aggregated bases and data models is an exit condition of efficient management of environmental complexes. Conceptual geoportal model based on the service-oriented architecture is built upon the transformation of complex monitoring information of territory anthropogenization and denaturation processes, the possibility of optimization of geoportal hierarchy structure with consideration of direct and feedback links.

It is appropriate to coordinate methodological approaches of Ukrainian and Polish scientists in geoportal

development for adoption of information technologies in management of cross-border cooperation processes, governmental coordination, population and business in favour of forecasting and minimizing of consequences of possible threats in the field of ecological safety of the Ukrainian-Polish euroregions.

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