

INCOLAB information system for better management of ecosystems in the transboundary region of the Danube River

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Abstract. The article presents the INCOLAB information system for the management of four protected areas for the protection of wild birds included in the European ecological network Natura 2000 in the cross-border region of the Danube River - ROSPA0102 Suhaia and ROSPA0024 Confluence of Olt Danube - Romania, BG0002018 Ostrov Vardim and BG0002070 Ribarnitsi Hadzhi Dimitrovo - Bulgaria. The main purpose of its establishment is to support the control institutions in the decision-making processes and take measures to protect the protected areas and the protected species.

The process of creating the system, part of the Joint Bulgarian-Romanian Plan for the Management of the Four Protected Areas for the Protection of Key Bird Species, has been traced, as an innovative model for monitoring and reporting, a new approach for collecting, using and sharing technical, scientific and environmental data. The main functionalities of the information system and the available applications, both for the control authorities and the public, are presented.

The visualization of the components of the physical architecture of the information system allows a meaningful structured presentation of the process of building a database with information from different sources.

The main benefits of the common information system for the joint management of protected areas and cross-border cooperation are analysed.

Keywords: database, incidents, inspections, key species, model, monitoring, Natura 2000, reporting

I. INTRODUCTION

The development of information systems to support the processes of management, control and monitoring, and decision-making is a current trend in all areas of activity - educational and scientific research, early warning and notification of disasters and accidents, environmental monitoring, process management in branch and business organizations, the production

process, human resource management, etc. The “digital acceleration” [1] in recent years has been provoked by the aspiration to develop society, to achieve a stable and greener economy, to achieve sustainable growth.

The existing national information systems in the field of environmental protection in Bulgaria provide the necessary data for the analysis and assessment of the status of environmental components and factors. Available on the website of the Executive Environment Agency - <https://eea.government.bg/bg/dokladi/inf-systems>, they provide public access to information on the state of the environment and serve as a basis for the preparation of documents for the implementation of policies in this area both nationally and internationally.

For the specific needs of the control institutions (as exemplified by the Regional Inspectorate for Environment and Water - Veliko Tarnovo (RIEW) - a specialized territorial administration of the Ministry of Environment and Water - Bulgaria), systems are developed to support the effective performance of the main functions of the institutions in terms of “monitoring, analysis and communication” [2] in the ever-changing natural conditions. Moreover, “the multi-component, multi-factor nature of the management process raises the issue of appropriate data structures”, the use of which plays an essential role in management activity [3].

On the one hand, information systems and technologies give the opportunity to present and track the trends in basic indicators of the state of the environment, and on the other - support the analysis of processes that lead to impacts on ecosystems [4]. The fact is that modern man is increasingly required to make full use of them, both in the professional sphere and in everyday life [5].

Print ISSN 1691-5402

Online ISSN 2256-070X

<https://doi.org/10.17770/etr2024vol2.8019>

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V. Kraeva et al. [6] note that the implementation of new technologies requires know-how that incorporates information about new technologies, economic effects and costs and best practices in their implementation.

According to Troshani et al. [7], „information systems are not standalone entities but contribute to environmental sustainability as part of the social and material relations that form the infrastructure underpinning environmental management practice“.

The aim of this study is to present, characterize and analyze the INCOLAB information system as an innovative model for transboundary environmental management. The relevance of the topic is related to the processes of digitization on a global scale, the transboundary and transnational movement of information and data exchange, which appear as an opportunity and resource for better ecosystem management, to support management decision-making and the provision of technologies to people.

Information system INCOLAB, the subject of this research, is one of the results of the project “Innovative and collaborative management of Natura 2000 sites in the Danube border region” (INCOLAB) ROBG-10 (<https://www.riosvt.org/project-interreg/>), financed by INTERREG V-A Romania-Bulgaria Programme and realized by two environmental partners, the National Environmental Guard, Romania - General Commissariat and the Regional Inspectorate for Environment and Water - Veliko Tarnovo, Bulgaria [8].

II. MATERIALS AND METHODS

Scientific publications in the field of implementation and development of information systems in different thematic areas and spheres of activity were studied for the purpose of the research. The theoretical analysis proves information systems’ relevance and significance for societal development.

The basis of the article is the material on the establishment and development of the information system INCOLAB, as part of the implementation of a Bulgarian-Romanian project for cross-border cooperation in the field of biodiversity conservation. The summaries and conclusions drawn are based on the author's personal experience as a direct participant in its implementation in the period 2016-2018 and in the process of subsequent reporting on its sustainability to date.

The information has been systematized, analysed and interpreted based on project documentation and empirical data obtained during work in a real environment. Problems and prospects for development are outlined.

III. RESULTS AND DISCUSSION

Development of INCOLAB information system

The protected areas included in the European ecological network Natura 2000 are designed to protect or restore the favourable condition of the natural habitats included in them, as well as of the species in their natural range. They are designated in accordance with two key European Union Directives - Directive 2009/147/EC on the conservation of wild birds (the Birds Directive) and Directive 92/43/EEC on the conservation of natural

habitats and of wild fauna and flora (the Habitats Directive).

The idea, set in Natura 2000, is that people are an integral part of nature and that it is best for them to interact. Economic activities are not prohibited, but should be limited in order to conserve valuable species and habitats.

Biodiversity is important in its own right, but it also provides a never-ending flow of goods such as food, fuel and medicines, and provides essential services such as climate regulation, flood prevention, water purification, pollination and soil formation. All of these things are necessary for economic prosperity, security, health and quality of life.

Economic pressures and inefficient management of natural resources are the cause of many activities in protected areas and zones, such as illegal exploitation, tourism, construction, poaching, industrial development, etc. These activities cause irreversible damage to the natural environment.

Within the framework of their power to implement and enforce the European environmental legislation, the employees of the National Environmental Guard and the Regional Inspectorate for Environment and Water - Veliko Tarnovo carry out preventive and control activities with regard to the conservation of biodiversity, of species of interest to the community, of the preservation of their integrity in the areas under protection. They carry out on-site inspections, according to an annual plan and on signals and incidents, and they have the right to issue mandatory prescriptions and to impose fines and penalties on violators. A database with information and documents is maintained for each site.

The involvement of the public in monitoring process further contributes to protection and conservation of birds and habitats, of the ecosystems as a whole.

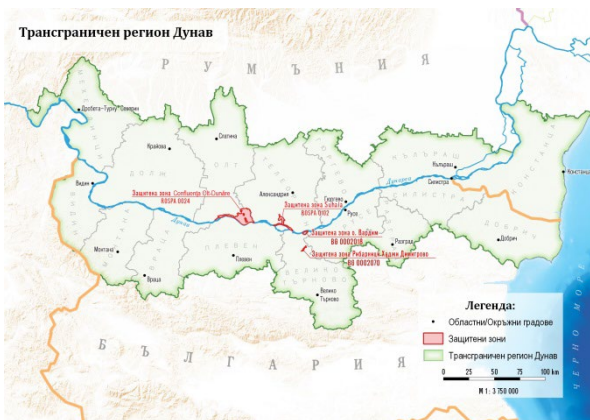
The objectives and resources of the INTERREG V-A Romania-Bulgaria Programme have enabled the development of innovative cooperation measures in the cross-border Danube region, expressed through joint planning, management and the creation of modern, coordinated instruments related to biodiversity conservation, landscape protection and the promotion of protected areas of the European Natura 2000 network.

To understand the philosophy of creating an INCOLAB information system, we provide brief information about the project (Table 1).

The selection of the four sites has been made on the basis of their similarity as habitats for important bird species and because BG0002018 Ostrov Vardim and ROSPA0024 Confluence of Olt Danube are close to the Danube border area and have the same characteristics, BG0002070 Ribarnitsi Hadzhi Dimitrovo and ROSPA0102 Suhaia are used for fish farming. In addition, anthropogenic activities with potential negative impacts on populations are common - poaching, change of land categories used near water bodies, influence of external factors such as avian influenza, etc.

TABLE 1 BRIEF INFORMATION FOR THE PROJECT "INNOVATIVE AND COLLABORATIVE MANAGEMENT OF NATURA 2000 SITES IN THE DANUBE BORDER REGION", ROBG-10

Overall project objective	Sustainable management of ecosystems in European Natura 2000 protected areas by establishing a joint model for their better planning, conservation and use in the transboundary Danube region, introducing a common approach to biodiversity conservation and supporting transboundary investments in Natura 2000 sites.
Outcomes of the project	<ul style="list-style-type: none"> ➤ better administration of Natura 2000 sites and their surroundings; ➤ support for common management through an established information system; ➤ achieving a better conservation status of 27,046 ha of protected areas for the conservation of wild birds - BG0002018 Ostrov Vardim (1,167 ha) and BG0002070 Ribarnitsi Hadzhi Dimitrovo (446 ha) in Bulgaria and ROSPA0024 Confluence of Olt Danube (20,960 ha) and ROSPA0102 Suhaia (4,473 ha) in Romania; ➤ raising public awareness of Natura 2000 sites.



Map 1. Protected sites along the Danube river, included in the project (in Bulgarian)

And here is the place of information system INCOLAB – it is constructed in a way to allow the structured management of all information about the four protected areas - building a database with information from different sources, recording information about events/ incidents with environmental impact in the protected areas and which may require the intervention of the two institutions, within their competences.

The process of development the system went through the following phases:

- provision of data by conducting preliminary and field surveys, mapping and preparation of an assessment of the conservation status/security status of the bird species subject to conservation in protected areas BG0002018 Ostrov Vardim, BG0002070 Ribarnitsi Hadzhi Dimitrovo, ROSPA0024 Confluence of Olt Danube and ROSPA0102 Suhaia;
- preparation of an Action Plan with measures to maintain and restore the favourable conservation

status of the habitats and populations of bird species. Preparation of a Monitoring Plan with a timetable for the implementation of the proposed measures and monitoring route maps to serve the two monitoring institutions;

- preparation of a Joint Management Plan for the four ecosystems in the transboundary Danube region;
- development of an information system to support the implementation of the Joint Management Plan.

The information system is intended for use by the following categories of users:

- employees of the territorial structures of the National Environmental Guard and of the Regional Inspectorate for Environment and Water - Veliko Tarnovo;
- operators of protected areas in Romania;
- citizens who report violations/ incidents through the public portal or the smartphone app in Bulgaria and Romania.

The information system is customized for the National Environmental Guard and the RIEW - Veliko Tarnovo - it has a dual administration and interface. P. Milev mentioned that “the implementation of web-based user interfaces implies the application of appropriate logical software architecture” [9]. In our case, it covers and manages the following types of information: about protected areas and protected species in them, users of the system, register of permits in force in the protected area, database of reported violations/incidents, register of sanctions imposed by the experts, reports and protocols with findings issued by control institutions as a result of planned and unplanned inspections. That information can also be visualised in a geographical context. The possibility to produce reports based on the information entered in the system is available.

Architecture of the information system INCOLAB

The physical architecture of the system is presented in Fig. 1:

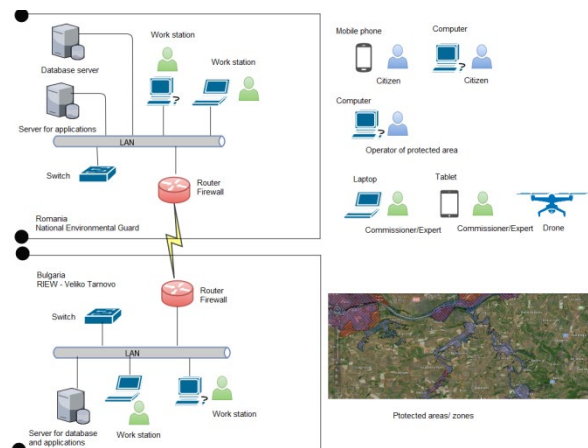


Fig. 1. The physical architecture of the INCOLAB information system

The main components of the system, required by the two administrations, are physical servers (server for applications and database management server), stationary work stations, the existing local LAN, existing switch, laptops, tablets, drones, routers with firewall.

The main components of the system required for citizens' use are:

- tablet, mobile phone - any person interested in finding information regarding protected areas or in reporting incidents noted in the field can download the INCOLAB client application on his mobile phone from the Google Play Store. The Android app is free.
- work station - citizens can use the public web interface of the software application through the external portal of the application server of the control institutions. The public portal can be accessed from any citizen's personal workstation, respectively in Romania and Bulgaria at the following addresses - <https://incolab.gnm.ro/> and <https://incolab.vt.riew.gov.bg/>

It is important to note that public participation, as a source of preliminary data for the common information system, is a new innovative and psychological approach that can make significant changes in the way these areas can be preserved in the future - in the transboundary Danube region that needs common protection. Despite the existence of the system, its use by users is still limited.

We should underline, that the public web interface and the mobile application have an easy to understand and use menu in Bulgarian, Romanian and English languages, and short instructions for the interface have been prepared and published to help the user.

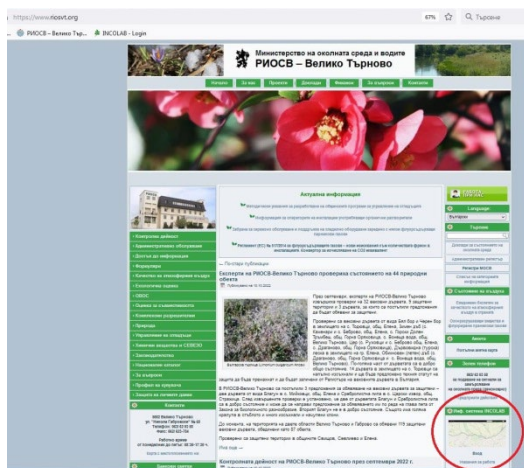


Fig. 2. View of the INCOLAB public web interface on the RIEW-Veliko Tamovo website - <https://incolab.vt.riew.gov.bg/>

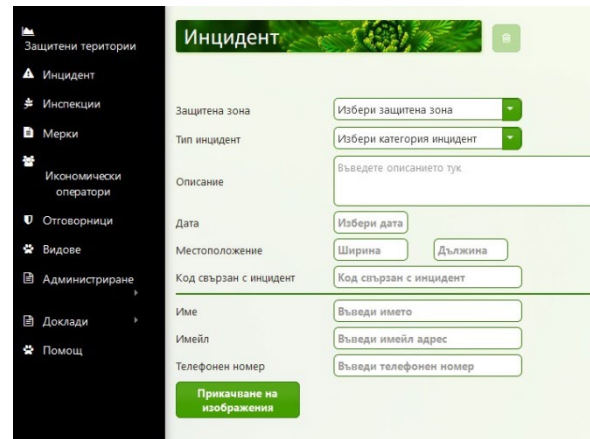


Fig. 3. View of the menu for reporting incidents in INCOLAB public web interface (in Bulgarian)

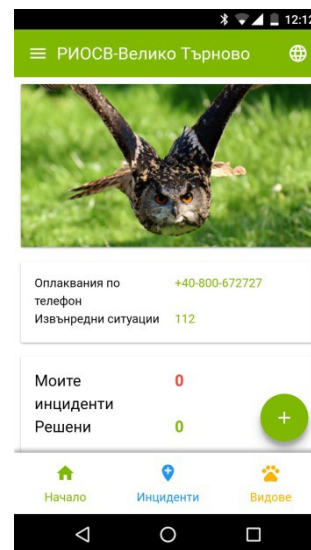


Fig. 4. View of the INCOLAB mobile application in Google Play Store (in Bulgarian)

There are seven main conceptual modules of the INCOLAB system:

1. *System Infrastructure Module* - supplies the central hardware platform, the underlying software platform and the communication platform to allow the implementation of the specific functionalities of the system; supplies the individual equipment for users to allow them to access the functionalities of the system (laptops, tablets);
2. *INCOLAB platform administration and access Module* - implements the administration functions of the software platform, including the defined parameters; manages the management of user authentication and the granting of usage rights; allows access to the different functional modules of the platform; implements the management of the application logs;
3. *Protected areas Module* - allows the definition and updating of their types and characteristics, including the attachment of photographs; allows the definition of areas, including their perimeter in the form of GIS

(Geographic Information System) coordinates using map mode;

4. *Incident Module* - allows the registration of incidents within the platform, both through the public web interface of the portal and the use of the smartphone application; allows the management of the process of tracking and dealing with incidents;

5. *Inspections/verifications Module* - allows the recording of the results of inspections carried out by the environmental commissioners/experts through inspection reports and findings; allows the recording of information relating to the inspections carried out, including penalties imposed;

6. *Map Module* - includes the GIS technology elements that allow the import of the outlines of the protected areas, the display of vector features and the base map, and the localization on the map using GPS coordinates of incident information;

7. *Reports Module* - includes functionality to search for information by alphanumeric or spatial criteria, allows query results to be displayed both in alphanumeric format and on a map background.

As the information system is accessible via the Internet, functionalities have been implemented to collect and analyse potential security incidents, including the identification of malicious behaviour or attempts to use the system inappropriately.

System operation in a real environment

In general, no reports of violations in the two protected areas BG0002018 Ostrov Vardim and BG0002070 Ribarnitsi Hadzhi Dimitrovo, such as fire, destruction of nests, littering, pollution, dead animals/birds, poaching, destruction of vegetation, trees and shrubs, unauthorized picnicking, etc., have been received by the RIEW through any communication channel - telephone, e-mail, information system. The areas have limited access as they are island and fishponds, which does not imply frequent violations of the regimes in their use and management.

The staff of both environmental institutions records data in the system on planned annual spot checks carried out.

The situation is similar on the Romanian side, for protected areas ROSPA0024 Confluence of Olt Danube and ROSPA0102 Suhaia.

The lack of administrative capacity to manage the INCOLAB information system and financial resources to maintain it is proving problematic for its long-term use. Direct access to the internal architecture of the system is needed from each control institution - user of the system for continuous updating of software applications, for changes in the structure of the database, for ensuring the security of shared information.

Perspectives for the INCOLAB information system development

With regard to the multiplication of the system, the following ideas are embedded:

1. Application to other sites in the European Natura 2000 network

The model for developing a common management strategy and information system for the four sites could be applied to all other sites in the Bulgarian-Romanian border region. To scale up, investments related to technical upgrades of equipment, training of users, and technical updating of the system to allow inclusion of new sites are needed.

2. Benefits of common management and cross-border cooperation

The common management and cross-border cooperation approach in an innovative way creates a real basis for new common projects to the benefit of all participants. The expectation is to increase the speed of solving cases that involve common competences on both sides.

3. Setting reporting standards and monitoring tools for the territory

The information system sets a model standard for cross-border data exchange, reports, templates and represents a new type of monitoring tool.

IV. CONCLUSIONS

The INCOLAB information system has been developed as an innovative model for monitoring and reporting on the status of protected areas of the Natura 2000 network for the conservation of wild birds. The recording of facts, data and information from different sources in the Bulgarian-Romanian part of the Danube River aims to implement a new approach in the management of these areas, to allow the exchange of information and data between the control institutions of both countries to serve for interpretation, analysis and preparation of joint reports.

The work in real conditions has shown that the system needs to be promoted, expanded, continuously maintained and serviced for the real exercise of transboundary cooperation with common management and sharing of technical and scientific data.

“Faced with the challenge of the global information society” [10], administrations continue their efforts to digitize and automate processes, data and services, including the search for financial instruments to improve the INCOLAB information system for its effective use for monitoring and reporting purposes.

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