

DEVELOPMENT OF MONITORING SYSTEMS WITH APPLICABILITY IN ENVIRONMENTAL PROTECTION FOR THE ELABORATION OF PREVENTIVE SOLUTIONS

SUMMARY

The habilitation thesis presents a general overview of the research activities carried out in recent years in the environmental protection field, materialized by the development of the DKRControl method, for the monitoring and control of the geomechanical phenomena, the development and implementation of DKTB and DKMR fixed and mobile remote sensing systems. Moreover, there are presented the actions of monitoring the hydrodynamic parameters of the Danube River, in order to develop *win-win* solutions for shore-protection in the adjacent wetland areas for avoiding interruption of longitudinal connectivity between the wetlands and the river.

Thus, the habilitation thesis represents an embodying of the research activities undertaken until the present, which ultimately resulted in the development and implementation of monitoring systems with special utility for environmental protection, having the main purpose to develop preventive solutions. The research focused on the activities performed after the PhD thesis elaboration, undertaken within various research institutions, mainly within the National Institute for Research and Development in Environmental Protection, Bucharest.

This habilitation thesis is structured around actual issues in the field of environmental protection regarding the monitoring of sturgeon migration routes, species protected by the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES), analysis of the potential impact on the environment using the DKRControl method developed by the author, elaboration of preventive solutions for conservation of protected wetlands, maintenance of lateral connectivity with the river and determination of pollution status and pollutants dispersion in the environment.

In this context, the development of the DKRControl method allowed the correlation of the various obtained data, laboratory investigations and *in-situ* measurements, in order to identify the most adequate method with minor impact on the environment. Compared to the classical calculation methods used at national level, the DKRControl method ensures an improved informational volume that can be used in prognosis and establishment of the necessary measures for the occurrence of different phenomena which may affect the environment.

Among others, the development of monitoring systems with applicability in the environmental protection allowed monitoring of sturgeon migration routes, monitoring the impact of Bastroe channel on sturgeon migration routes and habitats as well as monitoring the hydrodynamic parameters of the Danube River.

All the presented results were obtained through research projects in which I was responsible or member of the working team and in which I had significant scientific contributions.

In the first chapter of the habilitation thesis are presented some of the results obtained during the research regarding the prognosis of saline cavities stability that influence the surface terrain and the actions taken in order to protect the environment. Thus, by using the DKRControl method, which focuses on the obtained database as well as on ensuring its continuity in time and space, is evaluated the existing informational volume at a given moment. For the implementation of this method, a special focus is given to the elaboration of the numerical models for which the finesse degree necessary for discretization of the solid body must be considered, according to the area of interest, and also taking into account the particularities of the analyzed problem. In this context, a SMC-TDA01 monitoring and control system was developed and implemented at the Praid mine for the dry exploitation of salt deposits. The investigations results showed that after five calibration and calculation stages, the resulted overall stability of the Praid salt cavity was good, excepting the local phenomena such as rupture and exfoliation that presented an increase in their amplitude over time. It was also determined that the most exposed area is the one below the central pillar of the old salt mines and salt cavities located at more than 300 m deep.

In chapter 2 is presented a detailed analysis of the therapeutic effects of the saline environment due to the underground air and its physical parameters (purity, humidity, temperature, pressure, vapour content, negative ionization, etc.). From the practical experience gained from saline environmental monitoring resulted that there is a significant role in the positive effect of sustainable salt exploitation through the interaction between the underground air conditions and the salt wall which comes in contact with it. In this context, it has been implemented a monitoring program that includes the parameters of underground saline air and microbiological parameters in the air and the salt wall, that ensures their curative character.

Chapter 3 presents the research on the monitoring of the sturgeon species migration on the lower course of the Danube River, for which acoustic telemetry was used, considering that it constitutes the only viable solution to difficult hydrological conditions (significant variation of turbidity, level, flow rates, presence of natural obstacles and water meshes) and to sturgeon behaviour: swimming at high depths. For this purpose, were used ultrasonic tags and reception stations that record all the signals received from the ultrasonic tags implanted into sturgeon specimens, and later convert them into data that can be processed (temperature, swimming depth, time). Under the hydromorphological conditions of the Danube River, the DKTB and DKMR-01T monitoring systems have been installed to receive the signals emitted from the ultrasonically tagged sturgeon specimens, thus, reducing the risk of losing information, as happened in the case of other systems. Is important to note that was obtained an informational volume unique in the world regarding the migration routes of sturgeon specimens tagged with ultrasonic emitters. Additionally, through the implementation of the monitoring system on Bala Branch was scientifically possible to demonstrate that sturgeon specimen's migration routes were not interrupted by the submersed hydrotechnical construction.

Chapter 4 shows the juvenile sturgeon specimens monitoring through acoustic telemetry, on the Danube River sector between Corabia (km 633) and the Black Sea on its three branches: Chilia, Sulina, Sfantu. Gheorghe. The DKTB and DKMR-01T monitoring systems have been installed in various key points in order to determine the routes of the tagged juvenile specimens and their

behaviour such as swimming velocity, day/night swimming, and migration according to water hydrodynamic parameters.

The fifth chapter presents extremely important research performed in the context of the construction works on the Danube channel – the Bastroe Channel. For this, in two research projects of strategic importance was analyzed the status of the physical, chemical and biological components of the Danube Delta and the adjacent coastal area (in 2013 and 2014). The main negative effect consists in the fact that the dredging/ deepening of Bastroe channel poses a major risk to the sturgeon migration routes. Thus, the possible risks induced on the Chilia branch caused by Bastroe channel were scientifically proven, based on the DKMR-01T monitoring systems, in 2014, although the environmental impact of this channel has been studied since 2004.

The sixth chapter highlights monitoring of the environmental factors in order to propose a solution for protection of the Divici-Pojejena wetland area, located at the Serbia state border in Caras-Severin County, this area being a special avifaunistic protection area of European interest. Therefore, several field investigations and monitoring activities (geo-electric, bathymetric, topogeodezical) were undertaken for analyzing the hydrological characteristics of the investigated river sector. The DKTB monitoring station was used in the area of interest for quasi-continuous monitoring of water quality and water level. Moreover, the extension of the floodplain of the interest area, was determined at 18000 m³/s water flow, all this research allowing the selection of a win-win solution to answer at the identified necessities and opportunities of the interest area, solution concretized in a patent request.

In chapter 7 is presented research on galvanic sludge (dangerous waste) deposit monitoring for the purpose of establishing the degree of pollution and dispersion of pollutants in the environment. Within the research, was used the principle developed through the DKRControl method, that implied in the first stage the evaluation of the existing information volume. Thereby, in situ monitoring campaigns were performed, for the detailed establishing of a potential contaminated area in the interest zone. For the characterization of the interest zone and the establishment of the pollution degree in the proximity of the galvanic sludge deposit, 26 drillings were conducted, their location being determined on the basis of a preliminary decisional analysis carried out to ensure a high level of confidence. In the end, it was possible to quantify the contaminated surface with cyanide and heavy metals, as well as the necessary volume of material used for decontamination.

In the future, the research activity will be developed on new criteria/will explore areas related to environmental protection, namely:

- Water quality monitoring and reducing of flood risk that will be achieved through the development of a SMART monitoring system ensuring both preventive and predictive character.
- Air quality monitoring and development of solutions to ensure thermal comfort and increase the quality of life in cities through implementing a SMART monitoring and control system that ensures both preventive and predictive character.

- Monitoring of wildlife sturgeon specimens to identify proper solutions for reducing / eliminating of the existing anthropogenic pressures that threatens these endangered species
- Establishment of integrated monitoring and control systems in the field of environmental protection through cooperation with the Romanian Space Agency in order to provide favourable premises for the identification of preventive and remedial solutions in the context of the intensification of the climate change phenomenon.