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Use of hydrodynamic models for the management of the Danube Delta wetlands: The case study of Sontea-Fortuna ecosystem

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ABSTRACT

Due to its high biodiversity the Danube Delta, in Romania, is recognized as a UNESCO World Heritage Natural Site and it is listed as a RAMSAR wetland. The Danube River variable discharges have a great impact on the habitats and the overall ecological status of the delta. One of its most vulnerable parts, from both hydrodynamic and morphological point of view is the Sontea-Fortuna wetland located in the upstream of the Danube Delta. Sontea-Fortuna wetland is susceptible to both floods and droughts. On a long term, decision makers in the area need to know which measures to implement and how these will impact/improve the environment.

This article presents how a 3D hydrodynamic model can be used as support for making sound decisions regarding the management of deltaic ecosystems. In particular, the methodology is applied on the Sontea-Fortuna wetland. The case study is part of a wider research in the area, which was developed within the EnviroGRIDS EU FP7 research project. EnviroGRIDS aimed at building capacity for scientists, decision-makers and the general public in the Black Sea Catchment, through collection and sharing of environmental data and models at the basin scale.

1. Introduction

In 2000 the European Union (EU) introduced the Water Framework Directive 2000/60/EC (WFD), which is a major policy directive in the area of water resources management in EU. The WFD sets requirements for the approaches to water resources management at national level, as well as requirements for regional international cooperation in the same area. In terms of water planning and management WFD main assumption is that river basins are the basic units for actions. This can be achieved by the development and implementation of River Basin Management Plans (RBMP) for each European river basin. Jonoski and Popescu (2004) emphasize that access to data, information and knowledge is crucial for the successful development of RBMP. Moreover, the authors are presenting the advantages of using latest ICT developments and mathematical models for decision support or impact assessment, while implementing the RBMP. These models are hydroinformatics tools that are easy to be used by specialists in hydraulics, hydrology and decision makers in water resources (Jonoski and Popescu, 2012; Popescu et al., 2010, 2012).

As part of river basins, it is well known that wetlands located in the river floodplains play a key role in the

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maintenance of the ecological status of the river itself. They are characterized by high biodiversity and the preservation and restoration of the wetlands have become an important issue not only at European level but also worldwide (Rebelo et al., 2012). RAMSAR Convention recognizes wetlands as elements that need to be treated as part of the river system, and not as standalone units. Two of the main advantages of having wetlands are that they reduce flood peaks and provide habitats for endangered species hence they need to be conserved and included in management plans.

Signatory countries of the RAMSAR Convention have committed to conserve wetlands existing in their own river basins by integrating them into river basin management planning and decision-making. In order to achieve this goal the RBMPs should consider wetlands as essential components of a river system (Baart et al., 2012).

In order to comply and help with the implementation of the RBMPs, and to integrate wetlands in these plans, as required by WFD, several research projects funded by different international donors, such as UNDP, World-Bank, and the EU FP7 Research Framework, looked at the possibilities of developing analytical frameworks and tools that could be used by decision makers. Danube Delta is Europe's largest remaining natural wetland, valuable for its specific delta wildlife and biodiversity, therefore there is an ongoing effort to preserve and restore it. Present article focuses on a wetland of the Danube Delta hence a summary of some efforts in projects that addressed the restoration of the Danube River is presented below.

In 1998 the International Commission for the Protection of the Danube River (ICPDR) was formed, as a platform for coordination and assistance in the implementation of the legislation and operative actions in the Danube basin. Currently the highest priority of ICPDR is the implementation and compliance with the two main water-related EU formal directives; the WFD and the Flood Directive 2007/60/EC (FD).

The EU FP7 funded, WETwin project (2008–2012) that developed a set of tools by which comparison of different wetland management options can be carried out in an analytical manner. The tools offer the framework to structure the information regarding the management options of wetlands in terms of their impact, feasibility and vulnerability (Johnston et al., 2013).

The EU FP7 EnviroGRIDS research project (2009–2013) contributed to the assessment of the past, present and future water resources in the countries of the Black Sea Catchment. The project aimed at supporting environmental research for policy development, based on different development scenarios. The project involved 30 research institutions from 15 countries, mainly from the Black Sea catchment. All project results were discussed and presented to stakeholders, who evaluated how the results of the project's research can be further implemented in practice (Almoradie et al., 2013).

In parallel with the research work carried by different projects World Wildlife Fund (WWF) initiated the Danube Pollution Reduction Programme (DPRP). The wetlands of the Danube basin together with its floodplain, represents a unique ecosystems, although only few of the existing areas are still in their natural state. In the last two centuries, the construction works on the Danube aiming at improving flood protection, navigation, agriculture production, and energy production resulted in draining of the wetlands and disappearance of the floodplains. DPRP identified the wetlands along the Danube that would be best suited for restoration back to their almost natural state. The study area that is the focus of this paper, Sontea-Fortuna wetland, is one of the identified wetland to be restored.

The Danube Delta (DD) is the largest wetland belonging to the complex Danube River system. Danube Delta consists of a complex network of river channels, bays, lakes, sand banks and hundreds of swamps that help to improve water quality of the Black Sea by forming a buffer zone which filters pollutants from the Danube River, as well helping to reduce flood peaks by storing water. A large part of the delta is located in Romania (84%), where management of the DD is done by several Romanian institutions, such as Danube Delta Biosphere Reservation Administration (DDBRA); Administration of the Natural Patrimony (ANP); National Forrest Administration; Tulcea County Council and local authorities. The first two institutions' main role is to restore and protect the physical–geographical areas of DD. Among the main prerogatives of these institutions is to define and implement a long term management plan of the Danube Delta Biosphere Reservation (DDBR). The management plan is an official document that issues policies on all the activities carried out in the nature protected area of the delta and its surroundings, and is based on several components: research results about the natural values of the reservation, legal framework in Romania and consultations with all parties involved or interested in settling the management measures to be taken in order to reach the general objective of DDBR (ICPDR, 2009).

This article presents the work carried out within EnviroGRIDS project, where the hydrodynamic modelling was used to demonstrate the possibility of using hydroinformatics approaches to support decision-making and planning in the Sontea-Fortuna wetland area of the Danube Delta. The purpose of the research was to create a scientific knowledge base of the functioning of the system, in order to help and justify the decisions made on protection and ecological reconstruction of the wetland and preservation of protected areas.

The main objective, as defined by the DDBR management plan, is to establish an ecological equilibrium which ensures protection and preservation. However wetlands are dynamic systems, for which the proper functioning is difficult to be quantified. In order to determine the status of functioning of a wetland a number of indicators are used to assess their condition (EU WFD, 2000). Indicators are concrete and commonly quantifiable measures, used in many fields of research to show the condition of a system and the main factors that put a system under stress (Weilhoefer, 2011). In case of wetlands, indicators are used to assess the condition of the ecosystem, by monitoring trends in time and space, in order to determine both the causes of changes and the adaptation measures to be taken (Balica et al., 2013; Dinh et al., 2012; Ockenden et al., 2012; Young and Ratto, 2009; Wardrop et al., 2007).

The studies carried out by the above mentioned projects concluded that DD's wetland ecosystem is a combination of three types of habitats; humans, hydrology and vegetation cover (Giosan et al., 2006; ICPDR, 2009). Hydrology is the