RESTORATION OF THE AQUATIC AND TERRESTRIAL ECOSYSTEM COMPLEX OF FUNDU MARE ISLAND, ROMANIA

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The National Park Small Wetland of Braila (SWB) in SE Romania holds one of the largest bio-diversities among the National and Nature Parks in Romania and is part of the Lower Danube River System, a river reach of 840 km between Black Sea and the Iron Gate II dam, which has been heavily affected by human activities during the last centuries. Fundu Mare Island is located in the northern part of the SWB National Park and has gone through a profound change in terms of its hydrological regime, climate, and social conditions, with negative consequences for aquatic biota and human life. The extent of aquatic habitats has been diminished and the periods and length of fish reproduction are reduced. A currently ongoing restoration project aims at investigating various restoration scenarios for ecosystem improvement and implementing adequate measures, as required. Within the present paper, we hereby show the first results of the UAV based surveys and hydrological observations.

1 FOREWORD

The Nature Park Small Wetland of Braila (SWB) stands for a group of wetlands in the Lower Danube area (Figure 1) and has been a natural reserve ever since 1994. Comprising seven small islands with a total surface area of 15,000 hectares, it contains a representative sample of habitats characteristic of floodplains as well as an ancient inland delta. SWB is an internationally important bird protection area (RAMSAR site 1074), due to the quality of its habitats and its location on the migration routes between the nesting areas in the north of Europe and the wintering areas in Africa.

As in many other wetlands in Europe, the loss of biodiversity in this area is the result of the pressure exercised by human activities, such as the construction of dams, water pollution and over-exploitation of resources through hunting and fishing [1]. At present, the problems faced by nature conservation in this region are related to modified flow and sedimentation processes, pollution, vegetation and land use changes. Fundu Mare Island is the northernmost of the seven islands in SWB and covers an area of 1945 ha (Figure 1). About half of the areas stands for aquatic habitats, represented by two shallow lakes: Chiriloaia (300 ha) and Misaila (630 ha). In spring, lakes are usually flooded, while the water level reduces during the following months subject to the water level regulation in the Danube.

In recent years the lakes happened to completely dry out in summer. This fact has sped up vegetation encroachment in formerly open areas and has had adverse consequences in terms of fish and birds, such as the reduction of the periods and length of fish reproduction. A currently ongoing multi-national and interdisciplinary

restoration project aims at collecting data and investigating various restoration scenarios for ecosystems improvement, hereby using UAV based surveys and hydrodynamic modelling. The project also includes the implementation of optimal restoration measures. The present paper shall hereby provide you with the first results of data collection.

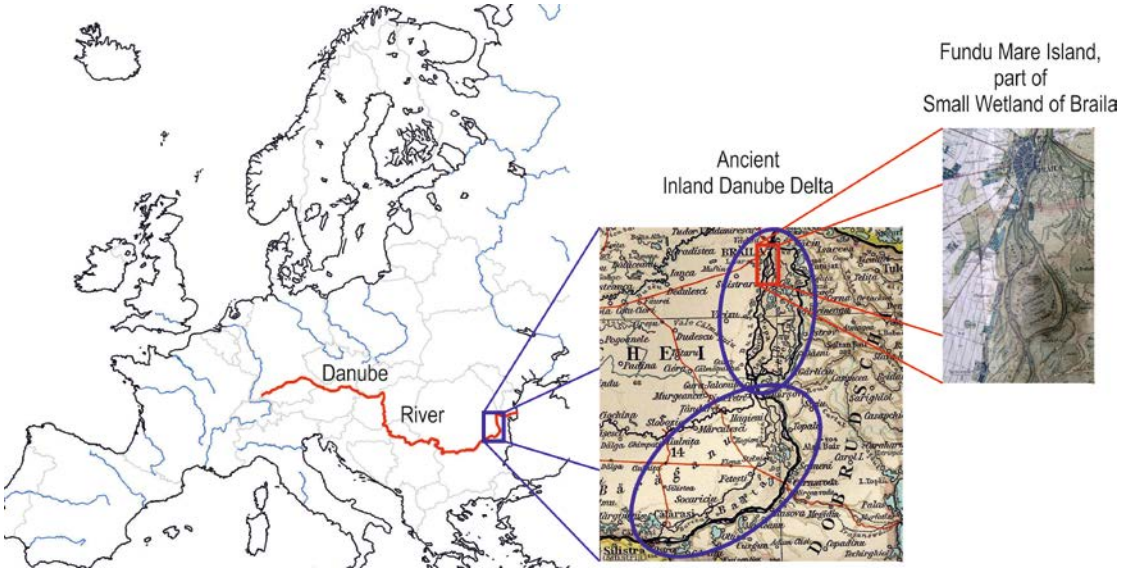

Figure 1. Danube River, the Ancient Inland Danube Delta and the Small Wetland of Braila - Overview map

2 STUDY AREA AND METHODS

2.1 History and situation of Fundu Mare Island

Before the 1950s and 60s, the area between the Danube main channel and Măcin Channel used to cover approximately 100,000 hectares of natural floodplain. In an attempt to increase the farmland areas, in the 50s and 60s about 80,000 hectares of land were reclaimed from the flood area, surrounded by dams and then dewatered. Thus, during floods the Danube flow area got 5 times smaller, and this has triggered the first known major changes on the ecological processes in the area: i.e. an increased Danube River stage and reduced floodplain and sediment deposition areas.

The second stage of major changes in the protected area was also due to other human activities, namely the intensive use of the remaining aquatic areas for industrial fishing purposes. The existing channels that used to feed the lakes with Danube water, were regularly blocked by dams so as to retain fish in the said lakes and then to harvest the same. The changing of the natural course of water into the lakes and out of the latter has altered the sediment deposition process both in the lakes and within the channels existing between them. The changes at Fundu Mare Island are visible by the landscape change (extended areas covered with shrub and forest vegetation, the reduction of water surface areas) as well as by the impact on this particular area biodiversity.

On Chiriloaia lake there nestles on one of the three mixed colonies of water birds in the SWB. By 2006 the colony had a relatively balanced structure, with some common annual changes (less than 5%). During the last years, however, one could notice some substantial changes in terms of the specific composition of this colony: the larger species (Egretta alba, Plegadis falcinelus, Platalea leucorodia) have reduced their herds to a few pairs, instead the number of Ardeolla raloides and Nycticorax nycticorax increased from about 50 to over 150 pairs. Reducing lakes surface and the water retention period also has a negative impact on the ichtyofauna species - reducing the time of reproduction, the disappearance of favorable places for oviposition, unfavorable conditions for juveniles development. The lack of data on island bathymetry and hydrology made it difficult for one to apply effective management measures.

2.2 Data collection using unmanned aircraft systems

Within the present project, the aerial imaging activities were carried out by using Parrot SenseFly eBee [2], a professional survey-grade mapping UAV (Unmanned Aerial Vehicle). The greatest advantage provided by using

UAVs is the ability to take-off and land in a very small area by circling the home-point until the desired altitude is reached. Flights altitude was typically about 100 to 130 m above the water level. The size of the UAV corresponds almost to the size of adult gulls that are living in large number in the Danube River and wetland, so the flights caused no disturbance to the ecosystem. Images were captured when the UAV flew in the vicinity of the desired GPS coordinates, so that the method enabled the production of ortho-photographs and digital elevation models with an horizontal accuracy down to 3 cm without Ground Control Points (GCP) and even greater upon adding GCPs. The precision in getting the land surface elevations was approximately 9-10 cm. The data were processed by means of a software tool (Agisoft).

2.3 Hydrological investigations

The hydrological investigations aimed at enhancing the understanding in terms of water balance and flow processes as far as the island was concerned, as well as at providing calibration data for the planned hydrodynamic modelling. Water levels in the aquatic areas of the island have been recorded for several weeks by using three loggers with pressure sensors. Discharges and flow velocities in the main outlet channels were measured using an Acoustic Doppler Current Profiler (ADCP; River Surveyor M9, Sontek) and a handheld Acoustic Doppler Velocimeter (Flow Tracker, Sontek) at selected dates during a field campaign in the beginning of July 2015 (**Error! Reference source not found.**).

3 SELECTED RESULTS

3.1 Maps and elevation models obtained from the aerial survey

The aerial survey provided a large number of high-resolution data sets of Fundu Mare Island and the surrounding river areas, including aerial photos, aerial videos, and 3D maps of the terrestrial and aquatic areas (Figure 3). In addition to their relevance for the 3D modeling of the wetland, these detailed aerial photos offer additional info, such as the type of the vegetation (based on the height profile, leaf color and area distribution), the extent of lakes, and the animals in visible areas. Also one can calculate the interior lakes water levels upon consideration of the sun position and the shade of the birds floating on the water surface.

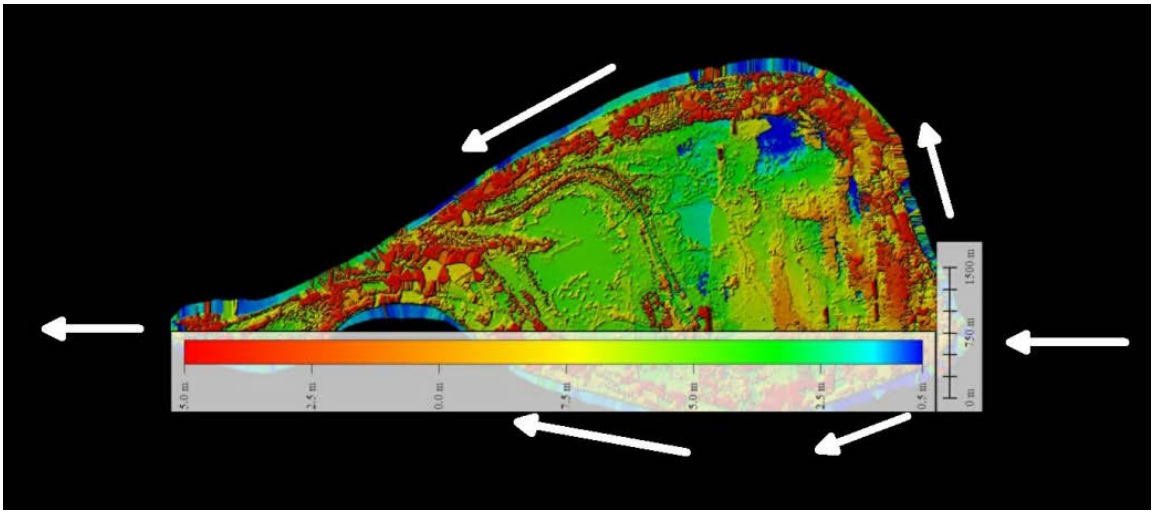

Figure 2. Digital Terrain Model of Fundu Mare Island, obtained from the orthophotograph

3.2 Hydrological monitoring

The measured water levels at Fundu Mare Island were analyzed together with the Danube river stage at the hydrological station Braila (6 km downstream), as shown in Figure 3 for one of the loggers placed in the middle of the island.

The lake water levels on the island are regulated by a weir at the Păioasa outlet channel with a crest height of about 4.50 m MNS. For higher Danube stages, the water level in the lakes nearly equals the water level in the Danube. For lower Danube stages, the lake water level reflects the combined effect of the flow over the weir and

through a side channel, ground water conditions, and evaporation and precipitation. In the period between 9 June and 13 July 2015, the water depth in the shallow lake lowered by about 1m. Figure 3 shows a steep decrease until 15 June (i.e. when the lake water level was again coupled to the Danube), followed by a slower regression afterwards.

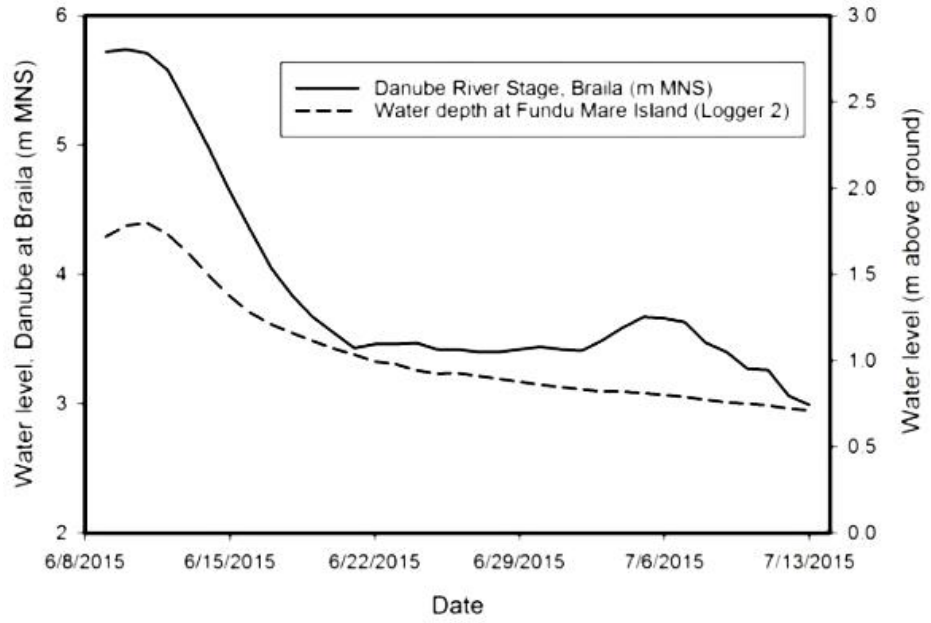

Figure 3. Hydrograph of the Danube River Stage in Braila and the lake water depth at Fundu Mare Island

4 SUMMARY AND OUTLOOK

The high biodiversity of Fundu Mare Island is threatened by the reduction of aquatic habitats. Before now, the lack of data on the bathymetry and hydrology of the lakes did not allow for the enforcement of any efficient management measures. Within the on-going restoration project, we have used remote sensing techniques and hydrological measurements so as to get a number of high-resolution data sets. The latter shall enable the study of ecological relationships and the suggestion of a series of measures aimed at maintaining a higher level of water in lakes even in less favorable times. The next tasks in the project are to include hydrodynamic simulations for different flow situations, restoration scenarios, and vegetation growing stages, so as to identify optimal restoration measures.

By transferring river restoration and risk information into spatial planning one also ensures that the vision and strategy for sustainable development in the Lower Danube Valley can be defined as a win-win scenario and as an instrument for Integrated Water Management (ecosystem oriented and adaptive management) [2].

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