RESTORING THE DANUBE FLOODPLAIN ECOSYSTEM BETWEEN OLTENIȚA – CĂLĂRAȘI BY ENHAVING THE LATERAL CONNECTIVITY

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ABSTRACT

The Lower Danube River in Romania has been considerably modified in the second part of the 20th century, being altered by the construction of dams or other human activities on or around its floodplains, resulting in a minimization of its lateral connectivity. The aim of this paper is to identify potential spaces to create permanent wetlands and polders where water could be stored and controlled during extraordinary floods by using GIS techniques and methods. The importance of lateral connectivity is represented by the periodic interaction between the river and its floodplain, in which matter, organisms and nutrients are exchanged, being vital for a healthy ecosystem. The study site is a 60 km-long section of the lower Danube, between the Oltenița (Danube river-km 430) and Călărași (Danube river-km 370), a sector affected by the recent extreme floods in 2006 and 2010. Enhancing the lateral connectivity along the lower Danube would ensure an optimal floodplain ecosystem and would reduce the effects of flooding.

Keywords: Danube, floodplain, lateral connectivity, ecosystem, restoration

INTRODUCTION

Floodplains are labeled as a low relief fluvial landform which are periodically flooded and are one of the most biodiverse and fertile ecosystems, but large river floodplains have been severely reduced due to the intense modifications brought by human activities especially throughout the 20th century [1]. The Danube floodplain is no different as it has been subjected to damming or to other human activities, therefore minimizing its lateral connectivity and causing a loss in its biodiversity. The construction of dams and dikes as well as the flood events produced in the lower Danube floodplain affected local communities not only economically but also culturally and in terms of the local infrastructure. The importance of lateral connectivity for a healthy floodplain ecosystem has been confirmed by many studies [2], [3], [4], [5], [6]. The lateral connectivity is associated with the periodic inundation of a floodplain, an important interaction between the river and its floodplain during high levels of waters. During this interaction, sediments, matter, organism and nutrients are exchanged, being crucial for an ecosystem. Reduced lateral connectivity lessens the typical habitat of floodplains [7]. Fluvial dynamics can change its connectivity [8], [9]. Connectivity is defined as the transfer of energy, matter and organisms through a hydrological landscape. Lateral connectivity is endangered by damming, river bank consolidation, river regularization etc. and they have multiple impacts on floodplain vegetation, minimum runoff, drainage, fish spawning areas, and biota in general.

The study area is a 60 km-long section of the lower Danube located in the southern part of Romania between the river-km 430 at Oltenița where the Argeș river flows into the Danube and river-km 370 near Călărași where the Danube splits into two branches, the Danube (main channel) and the Borcea branch (Figure 1). The first dike works were carried out in Romania at the end of the 19th century in Dobrogea and during the early 1900's the first dikes were built in the county of Călărași, part of our study area. In 1990 around 81.4% of the Romanian Danube floodplain was dammed. Since then, only 5% of the floodplain was restored.

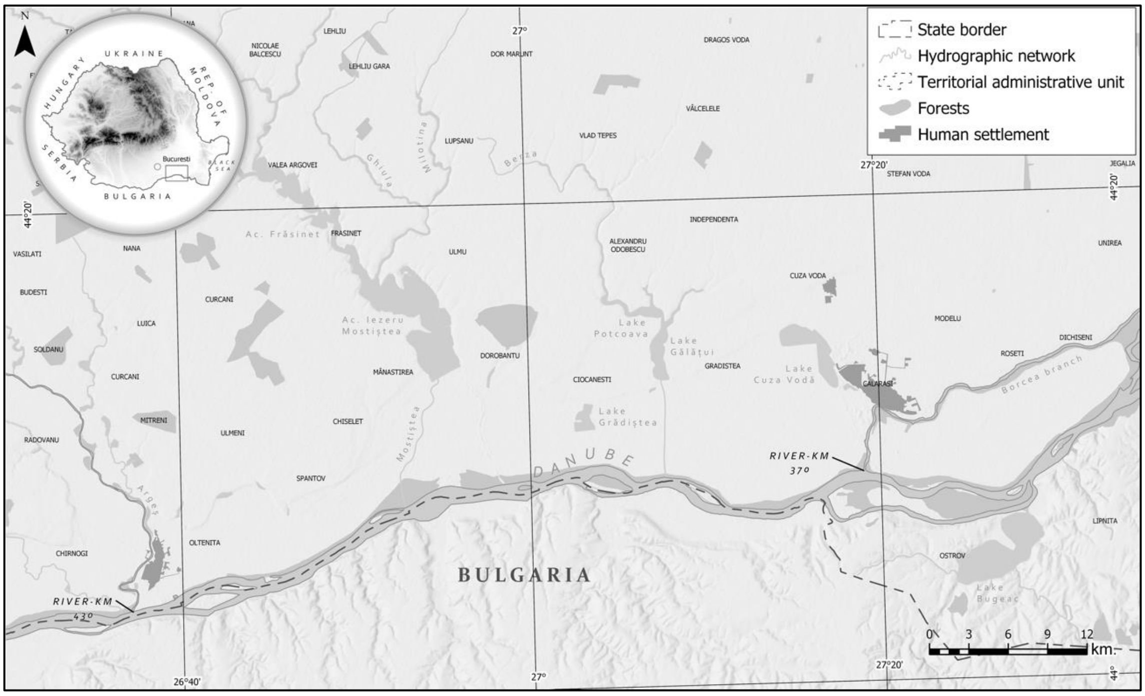

Figure 1. Study area, between Oltenița and Călărași, Danube river

The hydrological regime of the Danube presents periods with floods especially during Spring (from April to May), floods resulting from precipitations, snowmelt and the high flows from its tributaries [10], [11]. According to the National Administration "Romanian Waters", the most catastrophic floods which occurred in the Romanian sector of the Danube were the ones from 2006 (March - May) and 2010 (June - July), both having a duration of 60 days and a frequency of 1%. Previous studies and measurements carried out in periods with high flows on the Danube indicate that from a historical point of view, the highest flows recorded were in 1940, 1942, 1970, 2006 and 2010 [12]. Floods affected the stability of dikes, eventually destroying some of them and flooding thousands of hectares.

The actions resulting from human activities as well as from destructive natural phenomena leave a negative impact on the biodiversity of a river. The problem of the restoration of the Danube floodplain is a real priority, debates on this issue have taken place both in the governments of the countries through which the Danube passes, as well as in previous studies [13], [14], [15], [16]. Such a governmental action for the protection of the biodiversity in the Danube floodplain was formalized following the signing of an agreement between the Governments of Romania, Bulgaria, the Republic of Moldova and

Ukraine in 2000, by creating the “Lower Danube green corridor”. Other floodplain restoration projects were carried out by the World Wildlife Fund (WWF) in which they restored 5% (around 2000 hectares) of the potential areas for this purpose. An ecological restoration by creating such spaces helps new ecosystems develop and provides optimal conditions for aquatic flora and fauna and new spaces that can be used for tourism and recreational purposes [17].
The paper aims to identify potential spaces for creating permanent or semi-permanent wetlands as well as polders where water can be stored and controlled during an extraordinary flood discharge and which would have the ecosystemic functions of a wetland.

METHODOLOGY

The analysis carried out in the study used raster and vector open-source data such as the CORINE Land Cover 1990 and 2018 datasets, EU-DEM and Sentinel II images from 2017 alongside with the topographic map of Romania at 1:25.000 from 1990, the 3rd Military Mapping Survey of Austria-Hungary from 1910 and the Soviet military topographic map from 1976 at 1:50.000. Based on these data sources, the maps were generated. To get a better understanding of how the Danube changed in time and see the variation in the connection of the side branches with the main channel, based on the Sentinel II images (2017, L2A products) and the topographic maps, we extracted the shape of the Danube with its existing and former side branches and ponds (Figure 2). Land use around our study area was extracted and analyzed by using the CORINE Land Cover 1990 and 2018 datasets (Figure 3), downloaded from the Copernicus Land Monitoring Service, part of the European Environment Agency (EEA). The maps were created in the 1970 stereographic projection.

RESULTS

The Water Framework Directive 2000/60/ EC and Law 310/2004 provide the essentials for reaching a “good water status”, which implies also ensuring the longitudinal and lateral connectivity of a watercourse [18]. The morphological (structural) criteria are based on the type of works that physically modify the morphology of a river bed: hydrotechnical - accumulation lakes, dams and waterways adjustments, spillway – hydro-edilitary works, restitutions – agricultural works. The hydrological criteria relate to the flow regime.
Lateral connectivity improvement measures: wetland restoration, restoration of the river bed (renaturation), restoration of the floodplain relief, repopulation with fish.
Analysis of the cartographic database shows the usage type of the land in the sector being studied [19]. The damming activity of the lower parts of the Danube led to the confinement of wetlands and expansion of the surfaces used for agriculture (Figure 2).
In the Oltenița – Călărași sector major hydrotechnical works were undertaken in the 70s and 80s (dams, drainage). In the Oltenița – Surlari – Mănăstirea sector, 13200 hectares were dammed, 8391 ha drained, with drainage networks built for a surface of 1438 ha, irrigation networks for 6107 ha and rice-growing paddies (with easy water access) on 4809 ha. In the Boianu – Sticleanu – Ezerul – Călărași sector, the dammed surface was 22960 ha, 20960 ha were drained, drainage works were created on 185 ha, with irrigation networks on 19177 ha and fish-growing infrastructure on 922 ha.

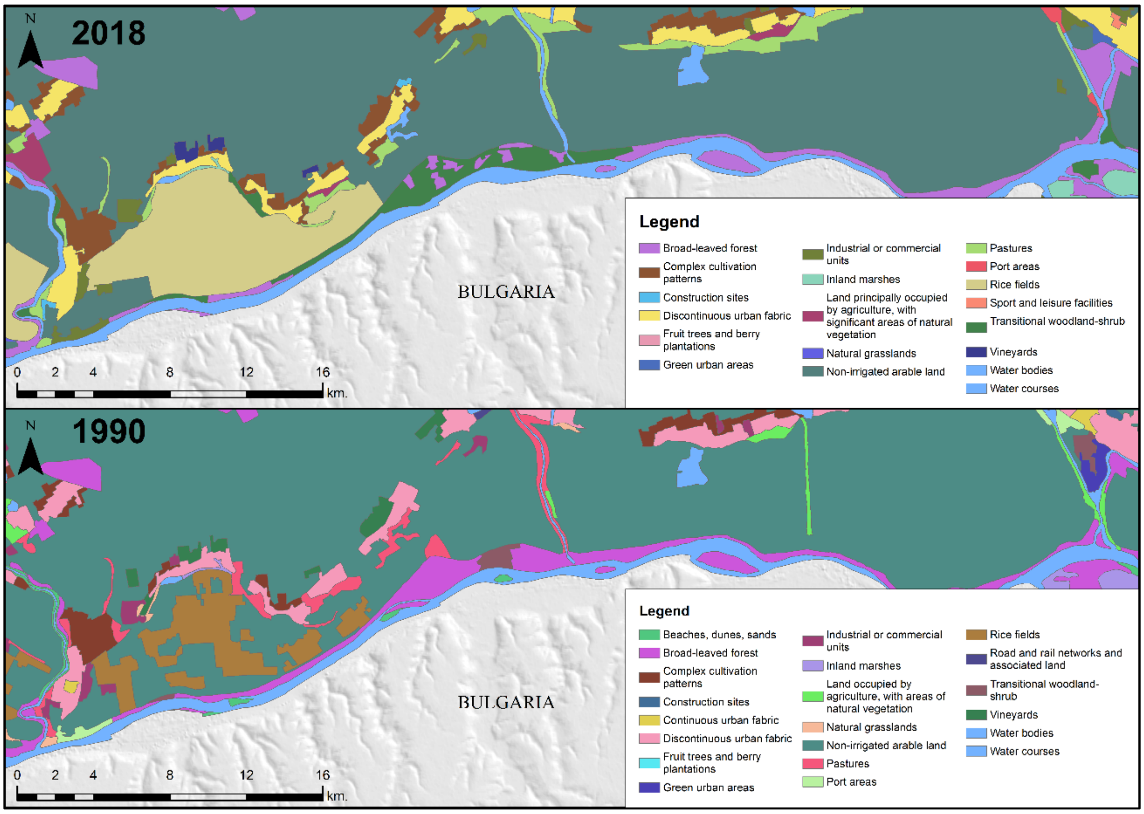

Figure 2. Usage of land in the Oltenița – Călărași sector, Danube river

In the analyzed sector, agricultural land covers around 86%, with 9% wetlands, 1% forest and the rest used for other purposes (communication networks, civil and industrial constructions). Productivity of agricultural land decreased from the moment the constant damming activities began, due to a lack of organic matter which the Danube would bring when its water levels are high. Accordingly, fishing capture figures in the Danube also decreased, due to habitat modifications and changes in reproduction conditions.

Analyzing the usage of land and its productivity, a digital model of the land and surfaces affected by exceptional flooding, we can mark and propose extension of Danube river wetlands [20], [21].

The proposed extension is based on two types of areas: the first would offer natural water access throughout the year, while the second would only store water in the intervals in which flooding because of the Danube would occur (Figure 3).

The first choice offers the premise of an extension of the natural environment typical of everglades, lateral connectivity being permanent and leading to restoration of the wetland ecosystem naturally over a few years.

In the second proposal the areas would be used for agricultural purposes, but will be controllably flooded in exceptional situations, will store water for a certain amount of time, after which it would drain gravitationally back into the Danube or would be used for irrigation. The river deposits will restore land fertility, thus raising its productivity.

This research, by delimitation of wetlands, wishes, compared to similar works, to contribute to territorial awareness of the extension and space which a river needs in order to manifest itself.

Local authorities, administrators of water resources and land users must understand that green infrastructure is more than beneficial for all users [22], [23].

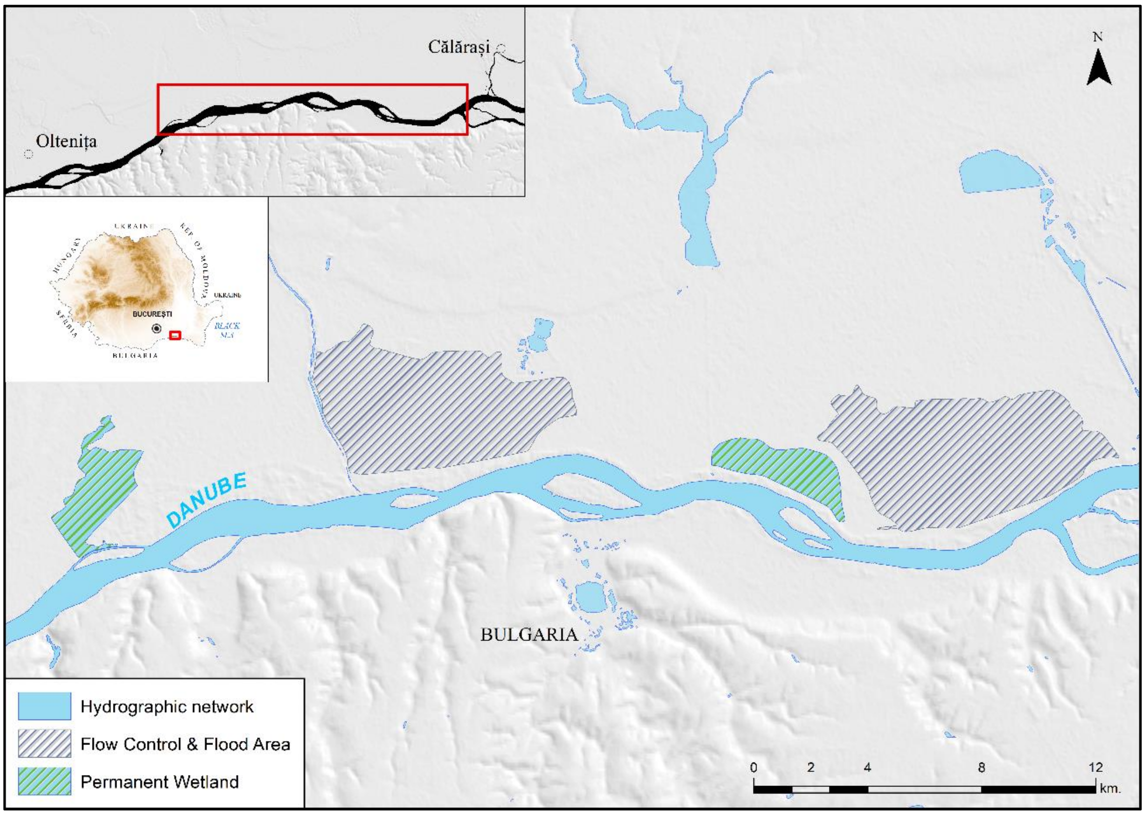

Figure 3. Location of the areas proposed as permanent or temporary wetlands in the Oltenița – Călărași sector, Danube river

In this study we will not present the improvements necessary in order to create the functionality of these wetlands (permanent or temporary). They will be made by taking into account existing infrastructure, its layout and the characteristics of the land. Supplying the permanent wetlands with water will be done from the Danube via hydrotechnical improvements which would allow water supply both when the water levels in the Danube are low, as well as when they are medium or high-level.

CONCLUSIONS

The proposal for improvement of the Oltenița – Călărași sector wishes to reduce the degree of artificiality of the land, to not imperil the flooding protection system and to raise the level of control over water volumes and lower the danger of flooding downstream of this sector, but especially intends to help with ecosystem restoration of the wetlands present in the Danube everglades.

Even though these improvements involve taking important surfaces of land out of agricultural use for temporary periods or permanently, the economic benefits of the ecosystem services of the wetlands will compensate reduction of income from agriculture. Also, using certain areas in both agricultural and water storage roles in periods of exceptional flooding can lead to increases in land productivity due to the natural organic material brought by the Danube which would make chemical fertilization unnecessary. This would lead to lower costs, output of products with a lower chemical substance content (so, more natural) and give the Danube lower quantities of nitrogen and phosphorus, thus reducing the degree of eutrophication.

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