

Analysis of Ecosystem Services of Wetlands along the Bulgarian Section of the Danube River

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Abstract: This investigation covers five wetlands situated on the Bulgarian section of the Danube River floodplain and four – on Danube islands. The significance of 12 different ecosystem services was assessed and plotted on six- point scale, using both reference data and interviews of local stakeholders. For the wetlands on the floodplain a comparison was made between the period before the 1940s and their current state. The potential ecosystem services after the implementation of measures for rehabilitation or conservation of the selected wetlands were also evaluated. Natural resources (*e.g.* fish, reedbeds, flooded meadows, floodplain forests), nutrient reduction and carbon retention were identified as the main types of ecosystem benefits and services provided by the wetlands on the Bulgarian section of the Danube River floodplain before the 1940s (at natural flooding regime). Currently the ecosystem services provided by these wetlands are limited mainly to the development of education or research activities. At present, albeit to a much lesser extent than in the past, the main ecosystem benefits provided by wetlands on the Danube islands are the natural fish resources used by the local community. After eventual rehabilitation or conservation and appropriate management of the wetlands on the Danube River floodplain an increase could be expected mainly in the ecosystem capacity for the development of tourism and recreational activities, education or research activities, nutrient trapping and carbon retention. Significant increase in the exploitation of natural resources seems hardly possible.

Keywords: Wetlands, Danube River, flooding regime, ecosystem benefits, natural resources

Introduction

According to the priorities of the EU "... by 2014, Member States, with the assistance of the Commission, will develop a strategic framework to set priorities for ecosystem restoration at sub-national, national and European Union (EU) level. Member States, with the assistance of the European Commission, will map and assess the state of ecosystems and their services in their national territory by 2014, assess the economic value of such services, and promote the integration of these values into accounting and reporting systems at EU and national level by 2020". Among the main effects of human activities on the environment, land use and the re-

sulting land cover changes are important drivers of environmental dynamics. Such changes impact the capacity of ecosystems to provide goods and services to the human society. To describe respective states and dynamics, appropriate indicators and data for their quantification, including quantitative and qualitative assessment, are needed (BURKHARD *et al.* 2011).

The wetland ecosystems can provide variety of services and goods thanks to the complex of aquatic and terrestrial components. The majority of wetlands along the Bulgarian section of the Lower Danube River were modified strongly in the second half of

the 20th century. Currently some rehabilitation activities have been undertaken but so far a summary analysis of their capacity for ecosystem services has not been published.

In the present study an attempt was made for primary quantitative evaluation of the main identified types or groups of ecosystem services provided by wetlands situated on the Danube River floodplain and on some Danube River islands. This assessment is seen as a first step for further mapping, quantification and valuation of the ecosystem services of wetlands.

Material and Methods

The investigation covers nine well studied wetlands along the Bulgarian section of the Danube River, situated on the Danube floodplain or on Danube islands (Table 1).

Information about the use of resources of the wetland ecosystems were obtained from published papers related mainly to fishing in the Danube River (BULGURKOV 1958, MARINOV 1978, HIEBAUM *et al.* 2000, PERSINA NATURE PARK 2005), our own observations and field surveys (PEHLIVANOV 2000, PEHLIVANOV *et al.* 2005, PEHLIVANOV, PAVLOVA 2012), inquiries of stakeholders (local authorities, environmental and forestry administrations, non-governmental organisations, etc.) and oral communications of the local people. Relevant data from the literature were used for assessment of the capacity for nutrient reduction, reduction of sediments and carbon retention (BESHKOVA, BOTEV 2004, KALCHEV *et al.* 2007, BESHKOVA *et al.* 2008, VASILEV *et al.* 2008, KALCHEV *et al.* 2010, KALCHEVA 2011, KALCHEV *et al.* 2012, UZUNOV *et al.* 2012).

Twelve identified types of ecosystem services were plotted on six-point evaluating scale: floods prevention, regulation of discharge (including tributaries), reduction of suspended matter in the Danube River, nutrient reduction, removal of dissolved toxic substances, erosion control, carbon retention, water supply (including for irrigation), use of natural resources (commercial fishing and poaching, forestry, cattle grazing etc.), agriculture and aquaculture, tourism and recreation (including angling and hunting), and education or research activities. The values in the evaluating scale comply with the significance of the given service according to the expert judgment as follows: 0 – non significant, 1 – very low significance in a quite restricted area, 2 – low local significance, 3 – moderate local significance, 4 – high local significance, 5 – moderate regional significance, 6 – high regional significance.

For the wetlands on the floodplain and on the Persina Island the ecosystem services were evaluated in three periods: past (until 1940th – at predominantly natural flooding regime), current (under dramatically modified flooding regime) and potential (predictive estimations in eventual implementation of rehabilitation or conservation measures), while for the other 3 islands only the current situation was analyzed because of the lack of historical data.

Results and Discussion

The provision of natural resources (fish, flooded meadows, floodplain forests, grasslands, reedbeds) to the local community was reported as the main ecosystem service of the wetlands along the Bulgarian section of the Danube River before the 1940s. According to the data in the literature (BULGURKOV

Table 1. Location of the studied wetlands along the Bulgarian section of the Danube River. Coordinates indicate the center of the wetland

Name	Rkm	N	E	Placement
Orsoya Marshland	762–756	43°47'9"	23°04'34"	Floodplain
Kozloduy	689.7–701.8	43°47'2"	23°45'31"	Island
Persina Marshes	576–560			Island
Vardim	546.7–541.6	43°37'41.5"	25°28'53.6"	Island
Batin	529.6–522.9	43°40'44.5"	25°40'34.6"	Island
Kalimok-Brashlen Marshland	453–436	44°01'15.6"	26°27'21.5"	Floodplain
Malak Preslavets Marsh	414	44°05'40.1"	26°50'16.1"	Floodplain
Garvan Marsh	407	44°05'47.4"	26°54'11.4"	Floodplain
Srebarna Lake	393–391	44°06'25.8"	27°04'19.2"	Floodplain

1958, MARINOV 1978) the organized commercial fishing in the Danube River and its adjacent wetlands was one of the main occupations of the local people (Fig. 2). A common practice was the use of flooded meadows and the seasonal cattle grazing on large islands (e.g. Persina Island). The reedbeds in some wetlands (e.g. Srebarna Lake) were used for domestic purposes and for handicraft articles. During that period one may not talk about any touristic activi-

ties and in addition only single scientific research on wetlands has been conducted.

For that period there are no data about some functions of the wetlands, such as carbon retention, reduction of sediments and nutrients, removal of toxic substances and erosion control. Nevertheless, for the needs of this primary analysis, some speculative estimates could be done based of the general principles and current knowledge (Fig. 2).

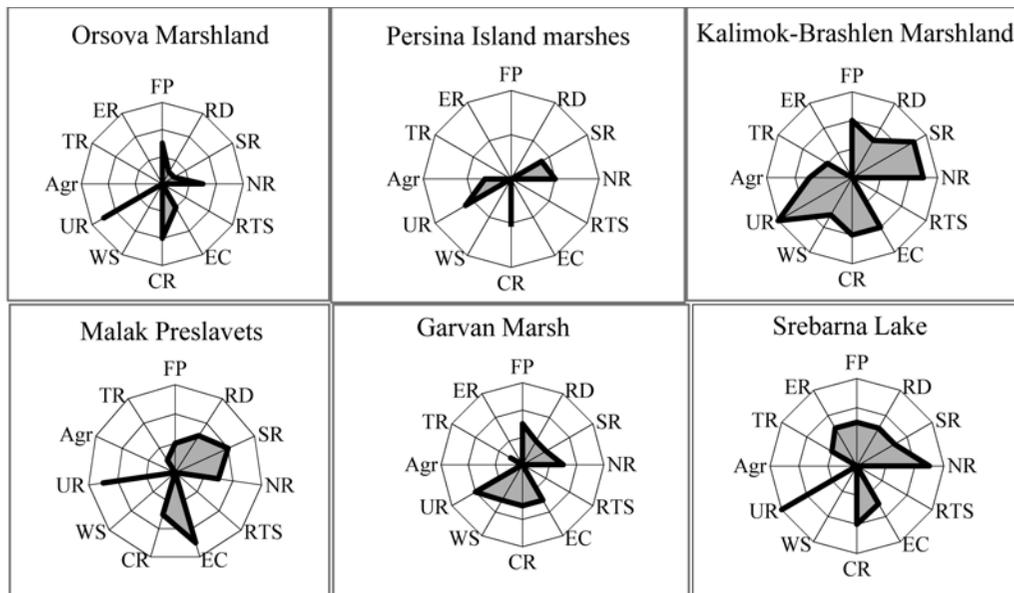


Fig. 1. Plots of the ecosystem services, provided by the studied wetland ecosystems until 1940th

Legend: FP – Floods prevention, RD – Regulation of discharge of both the Danube River and its tributaries, SR – Reduction of sediments, NR – Nutrients reduction, RTS – Removal of dissolved toxic substances, EC – Erosion control, CR – Carbon retention, WS – Water supply (including irrigation), UR - Use of natural resources (commercial fishing and poaching, forestry, grazing, etc.), Agr – Agriculture or Aquaculture, TR – Tourism and recreation (including angling and hunting), ER – Education and research activities.

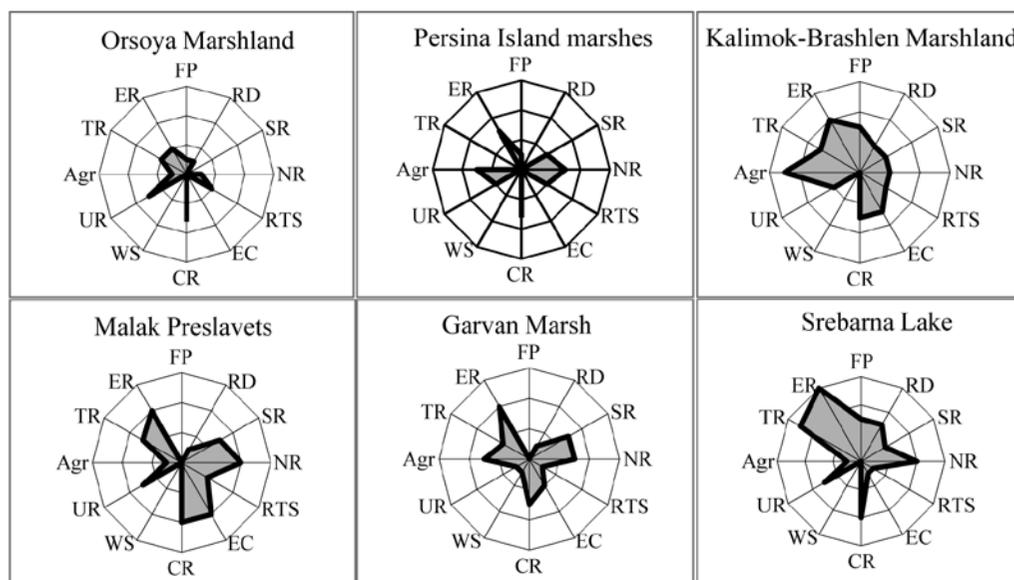


Fig. 2. Plots of the ecosystem services currently provided by the studied wetland ecosystems. Abbreviations are the same as in the legend of Fig. 1

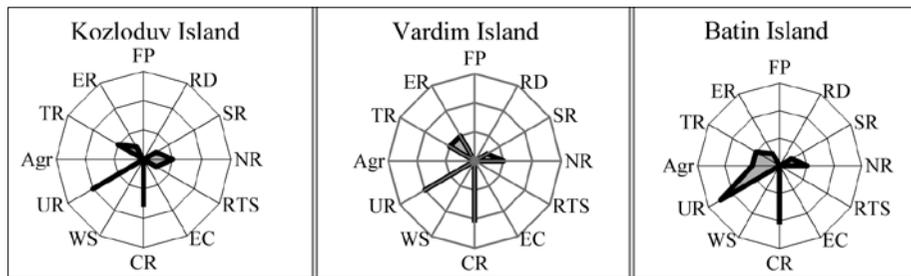


Fig. 3. Plots of the ecosystem services currently provided by the Danube islands. Abbreviations are the same as in the legend of Fig. 1

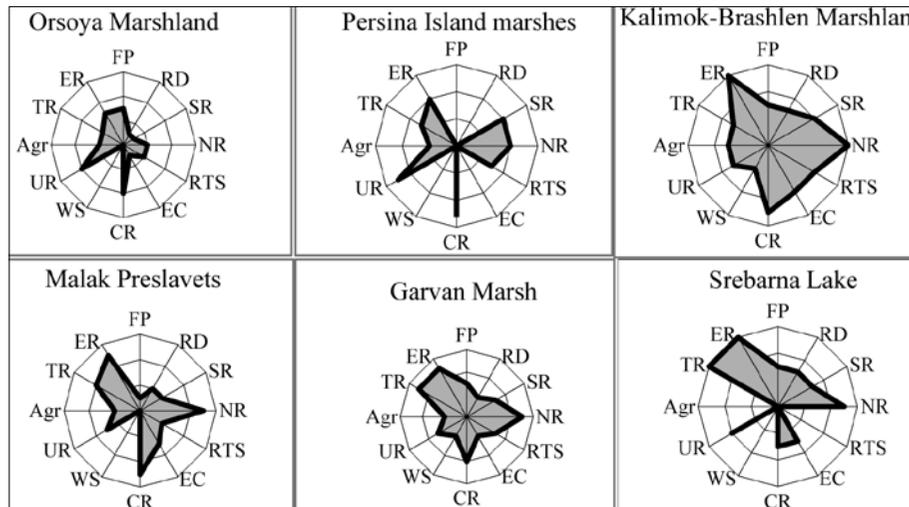


Fig. 4. Plots of the potential ecosystem services of the studied wetland ecosystems after implementing of eventual rehabilitation and conservation measures. Abbreviations are the same as in the legend of Fig. 1

After the embankment of the Danube River the wetlands on the floodplain and those on the Persina Island were isolated from the river, the flooding regime dramatically changed and the wetlands were partially drained. High reduction and modification occurred in both diversity and range of ecosystem services (Fig. 3). The use of natural resources by the local community contributes much less added value than in the past. Traditional commercial fishing in the wetlands was terminated due to the changed environmental conditions (BULGURKOV 1958). For the Srebarna Lake another reason was also the declared status of Nature Reserve.

Moreover, the significant recession of commercial fish catches in the Danube River (MARINOV 1978) was also considered an effect mainly of the disconnection of the oxbow lakes and the marshes from the river. During that period increases the significance of agricultural (including aquaculture) component of the ecosystem services provided by wetlands (Fig. 3) as portions of the wetlands were turned in arable lands and other portions – in fish

farms. In the recent decades the wetlands along the Bulgarian section of the Danube River has become subject to increasing bird-watching tourism and education or research activities. Some wetlands, such as the Srebarna Lake, marshes on the Persina Island and the Kalimok-Brashlen Marshland, are subject to restoration activities in order to recover and protect the biodiversity and to reduce the nutrients load in the Danube River Basin (Persina Island, Kalimok-Brashlen Marshland). For comparison, the main ecosystem benefits provided currently by the islands Kozloduy, Vardim and Batin, which are much smaller than the Persina Island, are the natural fish resources used by the local communities (Fig. 3). Only within the Batin Island also forestry (poplar plantation) is developed.

After eventual implementation of measures for restoration and conservation, and appropriate management of the wetlands an increase of ecosystem potential for the development of tourism and other recreational activities and for strengthening of education and research activities could be expected. The

capacity of wetlands for regulation of the discharge, nutrients retention and reduction of sediments seems also relevant for the Danube River (Fig. 5). However, a further significant increase in the exploitation of natural resources seems hardly possible when taking into account the changes in the Danube River discharge regime and the priority of the dominating now paradigm focused first of all on the conservation significance of the wetlands.

Regarding a potential increase of the fish resources in the Danube River after eventual reconnection of the oxbow marshes and lakes on the Bulgarian side of the river, the expected effect seems quite restricted because of their small area. MARINOV (1978) mentioned that the oxbow marshes on the Romanian side of the Danube River floodplain are much more

significant for maintaining of the Danube River fish populations.

Conclusions

Measures for recovering and conservation of the wetlands on the Danube River floodplain are necessary in order to enhance the capacity of ecosystem services mainly in tourism and recreation activities, education and research activities, nutrient and sediment reduction and carbon retention. A significant further increase in the exploitation of natural resources seems hardly possible taking in account the changes in the discharge regime of the Danube River and the priority of now dominating paradigm focused first of all on the conservation significance of the wetlands.

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