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# CONSERVATION OF HYDRO(GEO)LOGICAL HERITAGE SITES FOR PROTECTION OF PLAINS ENVIRONMENT (THE MOSTONGA EXAMPLE, WESTERN BAČKA)

**Abstract:** Protection of environment is particularly important for plains where agriculture and industry are developed, population density is high and land use is intensive. Drainage is generally controlled against frequent floods and high ground water. In addition, irrigation systems are developed for agriculture. Consequently, few water bodies have retained their natural shape and function. Even these are used to receive excessive stream flows and to balance the hydrologic system. Because water resources are vital for any environment, the purpose of their maintenance and protection in the original form is not only landscape conservation but also environmental protection. An example is given of the Mostonga meander relicts.

**Key words:** water bodies, plains, environmental protection, the Mostonga, western Bačka.

## Introduction

Water bodies or occurrences are part of natural landscape geodiversity and biodiversity, sometimes symbolizing a country or a region as in the instances of Podunjavlje (the Danube valley), Pančevački Rit, Zasavica, etc. Each of these regions is distinctive for its origin, characteristic water resources, different hydrologic function and hydrogeologic manifestations. Being the most important, but also a factor that may threaten land use, many water resources in plains are adjusted to a designed control, which also secures long-term use and integral management of water resources, but in a modified landscape. Relict water bodies and stream channels, not integrated into the control system, are commonly treated as free areas to be covered by some land use plan, even if these features were part of and formed the given environment.

Surface and subsurface waters occur in different forms, each having characteristic morphology. Their importance is assessed in context of their function, attraction or cultural value, because some of waters are natural

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hydro(geo)logical heritage. Instances of this kind are Slano Kopovo, a group of salt lakes in paleomeanders of the Tisa, Stari Begej-Carska Bara, Kovilje-Petrovaradin Rit, Jegrička, and others.

Bačka plain is an interesting example of conflicting interests of land users, particularly where the pollution of the Big Bačka Canal is concerned, which is a common receiver of industrial effluents and a source of irrigation water.

**Bačka Plain Landscape Diversity**

Apparently monotonous Bačka plains in northern Serbia may be divided in context of morphometry, geology and morphogeny into loess plateaus (Titel Hill and central Bačka loess plateau), loess terrace, alluvial plains and Subotica sand plain (Bukurov, 1975). Area around the Mostonga and its meander in Deronje is closely connected with the loess terrace and the Danube alluvial plain.

Alluvial plain of the Danube is the lowest and youngest topographic feature in the region. Composed of two sub-units, alluvial terrace and flood plain, it differs essentially from the eastern, loess terrace. According to Bukurov (1975), the alluvial terrace extends from the imaginary line Bogojevo-Karavukovo mostly coinciding with the old Mostonga channel. It is a tract of undulated land, at heights from 82 m to 85 m, remained after the stream had abandoned its former channel, subsequently filled with alluvial materials. The flood plain, at altitudes from 80 m to 83 m, is made up of recent sand and silt deposited by the Danube overflows. Autochthonous life of rit[1] differs from other lands. Prevailing vegetation consists of poplar, willow and oak woods. There was also a broad area of wetland meadows. Animal life is also interesting, particularly big game. Marshlands have always provided resources to sustain life, as indicated by archeological excavations. One of major sites in this part of Europe is Donja Branjevina.

While the loess terrace has a limited extent, alluvial plain of the Danube has preserved its authentic character or, in combination with human interventions, is a partly natural landscape. Abandoned stream channels, fluvial lakes, wetland vegetation, oak woods and salt ponds are some of distinctive features of this Bačka area. Moreover, an important is geodiversity feature is a Mostonga oxbow in the village of Deronje by the loess terrace and alluvial plain border.

[1] Rit is colloquial and reference (Bukurov, 1975a) term for alluvial plain area.

Sites of geodiversity and biodiversity in Bačka part of the Danube valley, the alluvial plain in particular, are located also in a belt of protected nature that extends from the Hungarian border to Bačka Palanka[2]. Thus, Gornje Podunavlje Special Nature Reserve is located in the northernmost sector of the Danube through the national territory. The Reserve area is largely the Danube alluvial plain under municipal administrations of Sombor and Apatin bordering on Odžaci. Another nature reserve, Karađorđevo, again in the alluvial plain, is administered by Bač and Bačka Palanka municipalities.

A problem associated with the evaluation of Bačka plains geodiversity and biodiversity is the unawareness of their ecological and aesthetic, consequently economic, values. Similar problems are recognized also in developed countries (Burgess, 2003), which renders difficult and complicates nature conservation and environment protection.

## Description and Water Engineering History of the Mostonga

The Mostonga is one of three major rivers in Bačka region, besides Krivaja and Jegrička, which runs through western Bačka length, parallel with the Danube. The riverhead consists of several depressions in northwestern Bačka, with the main spring stream at Rađica. Riverhead ponds have several names: Severna Mostonga, Koć Mostonga, Istočna Mostonga, Šikara Mostonga, all communicating in the wet season of the year and running off to the south. The spring streams meet a few kilometers north of Sombor forming the river (Milošev, 1998), which bypasses the town on west and southwest and flows southward to Mladenovo over a river gate into Bukinski Rit. The river sector between Sombor and Bač is regulated within the Danube-Tisa-Danube Hydrosystem. In consequence of the river regulation and other irrigation and drainage works, hydrogeological regime of the Mostonga ceased to be natural.

Evaluation of the Mostonga meander largely depends on human activities. From ancient times, the river was a resource that attracted people to build settlements on or near its banks and to carry out various activities that had impact on the stream. There are several groups of direct impacts: floods, river channel erosion, water abstraction for water supply, wastewater discharge and channel regulation for navigation (Clifford, 2001). Almost all of these impacts have been or are at work in the Mostanga.

[2] The Danube right bank is protected also in Croatia, as the Danube-Drava National Park.

The history of human interventions that affected the Mostanga had its beginning in 15th century, when the river was regulated for navigation from the Danube to the Bač Fortress (Dudas, 1896). At the turn from 18th to 19th century, excavation of the Great Bačka Canal intersected the river. The Canal used the Mostonga channel in a length of 2.5 km. Because water level in the Mostanga was relatively high, drainage of excessive water was difficult. Local population of the villages Riđica, Stanišići, Sombor, Svetozar Miletić, Čonoplja and Kljajićevo had to fund the initial river-channel regulation works.

Situation in the southern part of the river was similar. Bukino Cooperative for Drainage was founded in 1888. The Mostanga "delta" west of Bukino frequently flooded very fertile land. A river gate was constructed between the alluvial terrace and Rit from 1889 to 1894, and a "high-bank canal" excavated in the Danube embankment from this to the next gate. These works controlled Mostonga overbank flow from the alluvial terrace. Later, at the end of the 19th century, five more gates were constructed in Deronje, Karavukovo, Odžaci, Srpski Miletić and Doroslov. Still, 5200 hectares of land were flooded. In the thirties of the 20th century, the provincial administration (Danube Province Administration) appointed a professional committee to prepare a Mostonga regulation, drainage project (Dedić, Božić, 1998).

It was only in the latter half of 20th century that the Mostonga regulation was completed under the Danube-Tisa-Danube Hydrosystem Project, which included all existing streams (Fig. 1). The Mostanga sector, regulated and included in the Hydrosystem, was the one from Sombor to Bač, a length of 58.4 km. The Mostonga abandoned meanders without communication with the D-T-D System are located northeast of Prigrevica, at Doroslov, Deronje and Bač (Milošev, 1998).

Milošev (1998) describes poor status of the meanders and unexploited socio-economic potential of these landforms. For instance, Deronje meander of the Mostonga is about three kilometers long in north-south direction. Until the middle 20th century, the river bordered the village on the west; now the village has spread well over this border. North of Deronje, the meander is subparallel with the canal Karavukovo-Bački Petrovac, and surrounded by farmlands.

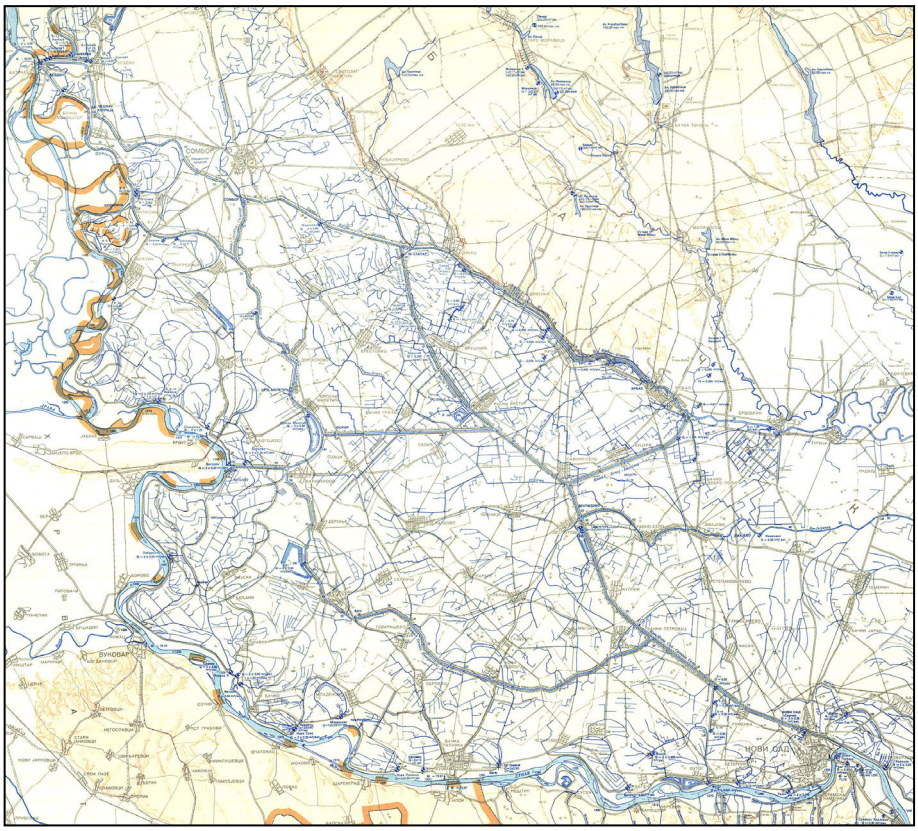

**Figure 1 - Map of hydrotechnical works in Western Bačka**

The abandoned meander has been neglected to the point of being used for a rubbish dump. The Mostonga meander is a feature that may be utilized in geographic reconstruction of a part of Bačka, in context of geomorphology and hydrology. It is a landscape diversity feature in agricultural western Bačka.

## Hydrology of Western Bačka

Hydrologic system of western Bačka consists of the Danube-Tisa-Danube and the regional North-Bačka canals and relevant structures, and natural streams Bajski Kanal, Mostonga Čik, Krivaja, Jegrička, etc. managed in accordance with the Water Management Plan (WMP, 1996). In addition, a large area of the Danube flood plain, from Bogojevo to Bačka Palanka, is well-controlled, where

natural high flows are retained within embankments. Many water features typical of plains, such as eye, pond, pool, periodically drained fossil meander and others, have disappeared. Moreover, ground water has also changed in both quantity and quality. Because water table is continuously lowering, water for irrigation is commonly taken in from canals, wherefrom about 226,800 hectares are irrigated at present in Bačka (WMP, 1996). Surface water from the System, though inferior in quality, is used in industries. Waste waters, fully or primary treated, are discharged into the Hydrosystem canals, which is an impact on the environment. Only four locations are designated for recreation: over Apatin, Bačka Topola, near Vrbas and Bačka Palanka.

Odžaci area, according to land use plans, reveals some stretches that might have had a hydrologic function, but disappeared through urbanization. These are Bareš, Vigure, Slatine, Vodice and Peskulja.

## Hydrogeology

The area between Bogojevo and Bačka Palanka belongs geologically to the large geotectonic unit Pannonian Basin. The area is made up exclusively of lacustrine and marine sediments of Neogene or younger age, undeformed by tectonic events (Dimitrijević, 1995). Sedimentary deposits are various clastics (sand, gravel, clay) mostly of fluvial derivation, and there are minor areas of pelite (near Odžaci, Dubrava and Selenča, and Ruski Krstur and Savino Selo).

Widespread sedimentary deposits, characterized by intergranular porosity, are dense aquifers either confiner or unconfined and overlain by fertile soils. Ground water behaviour directly depends on irrigation and drainage systems operations. Old single sources of water (shallow wells, ditches, etc.) are almost disused and without influence on ground water level. There are still some consequences of past practices, however, such as soil saturation, stagnant ponds and ground water pollution. Less common, but still present, are local deformations from filtration, or local fluidization, suffusion and, the commonest, colmation of ditches and channels, and consequent autrophication.

Sources of public water supply are deep (120 m to 200 m) sub artesian aquifers. An example is the water supply to Bačka Palanka from two sources, Ristića Put and Mali Vodovod-Grad. The former is a group of thirteen wells, yield from 90 to 110 l/s, and the latter two wells of maximum yield about 12 l/s (Babac and Babac, 2000). To meet the water demand, new wells are planned to increase the supply to about 250 l/s.

Upper Podunavlje, the Danube valley sector from Bezdan to Bogojevo (Km 1425 to Km 1366), is the area of a potential water resource (Soro, Dimkić, Josipović, 1996).

Supply of thermal or thermomineral water for health resorts is a particular kind of water supply, developed at present only for Banja Junaković near Prigrevica, Apatin. The source consists of five hydrothermal wells, from 600 m to 730m deep. Water is of the chloride-hydrocarbonate-sodium group, with total solids 6.16 mg/l (Milošević, 2005).

## Matching Economic Interests and Conservation of Hydro(geo)logical Features

Complexity of hydro(geo)logical circumstances in plains is primarily a mater of harmonizing economic interests, environment and conservation of characteristic landscape features. Nature protection has also become an important segment of land use policy, water resources in particular, and relevant regulations are often prohibitive in the efforts to accord different interests.

In view of the present situation in western Bačka and the change in management of resources, a good baseline for coordinated development may be the following:

- Detailed field investigation for delineation of areas with controlled water resources (water wells, irrigation and drainage systems) and definition of the areas of influence, surface and ground water regimes;
- Definition of surface and subsurface water relationship, particularly quantitative properties and hydrochemistry;
- Inventory of polluters, particularly individual users who have converted old water intakes into latrines and those whose cess-pits are not watertight;
- Definition of seasonal ground water level fluctuation impact on valuable biotopes, or ecosystems which are or will be protects;
- Assessment of hydrogeological environment vulnerability, primarily aquifers that are essential for each habitat;
- Monitoring surface and ground waters outside the Hydrosystem for coordinated planning of all water resources;
- Coordinated utilization of water resources in the Hydrosystem and the nature protection areas with view to the genetic resource maintenance;
- Decision on the number of carp ponds, because earlier was planned a total area of about 6600 ha of this fish ponds; disposition of fish ponds to be decided with respect to the depth of water table, to avoid pollution;

– Designation of hydro(geo)-heritage sites, representative of water resources and fluvial landforms, and of hydrogeological environment, "rare" water occurrences (with concentration of petroleum, or salt, thermomineral, etc.) and so on.

## Summary

Exploitation of water resources is increasing and drastically modifying their character, which is affecting the immediate environment. Impacts of water use in plain areas quickly produce degradation processes and their effects, and change the landscape and even the economic activities.

The Mostonga example may encourage conservation of old river system relicts. Abandoned meanders northeast of Prigrevica, then at Doroslov, Deronje and Bač are links of the old and present landscapes of western Bačka. Activities recommended for their recognition are the following:
- renewal, landscaping and protection of hydrogeological sites;
- protection of unique biodiversity reserve of plains;
- development of areas for recreation hunting and tourism; and
- development of ecological education centres.

Conflicting interests are different economic activities that are degrading the environment, to mention only fishponds, surface storage reservoirs for irrigation, wastewater-receiving streams, growing of Canadian poplar trees, agriculture, rubbish and other waste dumps. Left uncontrolled, these practices will change the already modified plain landscape.

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