

**MANAGEMENT OF THE NERETVA RIVER ESTUARY:
PAST AND FUTURE OF A RICH AND FRAGILE NATURAL HERITAGE**
UPRAVLJANJE UŠĆEM RIJEKE NERETVE: PROŠLOST I BUDUĆNOST
BOGATOG I KRHKOG PRIRODNOG NASLJEDA

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Izlaganje sa stručnog skupa

Abstract

This paper presents highlights of the geography, history, and management of the Neretva River estuary.

Current threats to the estuary's valuable natural resources, including changes in its hydrologic regime, loss of native habitat, changes in biodiversity, and pollution are reviewed.

Different proposals for the area's development, and possible conflicts associated with their implementation, are mentioned. Aquaculture, properly practiced, can make a significant contribution to the Neretva estuary's near- and long-term development.

Key words: Neretva river, management, development

Sažetak

U ovom radu opisane su zemljopisne i povijesne značajke ušća rijeke Neretve kao i upravljanje tim područjem. Trenutne prijetnje vrijednim prirodnim izvorima, kao i promjene u hidrološkom režimu, gubitak prirodnih staništa, promjene biološke raznolikosti i onečišćenja estuarija su pregledno opisane.

Navedeni su različiti prijedlozi za razvitak područja i mogući sukobi u svezi s njihovom primjenom. Ispravno upravljanje akvakulturom može značajno doprinijeti kratkoročnom i dugoročnom razvitku estuarija Neretve.

Ključne riječi: Delta Neretve, gospodarenje, razvitak

Introduction

Uvod

Croatia is endowed with a long coastline rich in natural resources. It has, however, only few estuaries. Of these, only the estuary formed by the Neretva River qualifies as being of the 'classic' type; that is, it features extensive wetlands and lagoons.

For many centuries the estuary's varied inhabitants have exploited its resources for purposes of transportation, fisheries, agriculture and, more recently, tourism and recreation.

Insuring the type of development that protects these resources for future generations begins with a comprehensive understanding of the structure and functioning of the Neretva's ecosystem. Despite numerous investigations conducted over the past fifty years, many important facts related to this central topic remain to be elucidated. Further, because of significant changes in the nature and intensity of economic activities in the region, previously good data rapidly are becoming unsuitable for future planning.

This paper reviews the management history of the Neretva River estuary, documents present threats and conflicts, and discusses different ideas for its future development.

Description of the Neretva Estuary

Delta Neretve

The Neretva River, the most important of the eastern Adriatic, is 218 km long, with a source located deeply in the hinterland of Bosnia-Herzegovina, roughly at a height of 1085 meters. Along its course to the sea it flows through various

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geological structures, mostly through deep canyons. Only after the town of Čapljina, Bosnia-Herzegovina (B&H), does it form a delta which, prior to 1881, emptied into the sea through twelve branches.

Three relief and morphological sections can be distinguished in the delta: the Karst frame on the both sides; the low-lying delta area along the mainstream and its tributaries; and the coastal belt, consisting of fine sand over a few kilometers. The most important of these is the low-lying area composed of different kinds of soil: peat, clay, various kinds of sand and gravel, and also featuring different levels of soil salinity. The delta itself is formed over sunken Karst coves, a fact manifested by the presence of distinctive Karst hills inside the delta (Glamuzina M., 1986).

Before the beginning of waterway regulation, the whole area was composed of wetlands, freshwater, brackish lakes, and lagoons. At that time water covered more than 80 % of the area, while today it covers only about 25 % (Glamuzina M. *et al.*, 2001).

Brief summary of historical management strategies

Kratki sažetak strategija upravljanja u prošlosti

The Neretva Delta long has drawn the attention of those interested in exploiting its resources. The particular economic activities carried out in the estuary naturally were influenced by the different objectives of the varied local peoples and states that governed this territory. For convenience, five historical periods, each identified by the controlling state and the strategic activity in which they were involved, are defined here:

1. The Classical and the Middle Ages - use of contemporary natural resources

This period was characterized by low use of living natural resources, mainly fish. The area was important as a transportation route between the Balkan hinterland and other parts of Greek and, later, Roman states.

In the Middle Ages, the area served as a starting point for the overseas transport of goods. One of the most important trade items was salt produced in the Ston saltworks of the Ragusan (Dubrovnik) Republic. (These saltworks are still in production.) Salt was transported by ships from Ston to large warehouses in Fort Opuzen (presently the town of Opuzen) and, from there, by horse caravans to inland Bosnia, then under Ottoman rule.

2. The Venetian Period- fishery enhancement

This area came under Venetian control at the end of 17th Century. Soon after, they established an intensive fishery based on their experience with similar areas in Italy, like the estuary of river Po River. They planned development of large fishponds in the lagoon, and the government even provided

financial subsidies for their implementation at the end of 18th Century. Shortly after this, however, Napoleon's army occupied, and ended, the Republic. These plans subsequently were abandoned. The main source of income during this period came from fisheries, mainly for eels and mullets (Fig. 1).

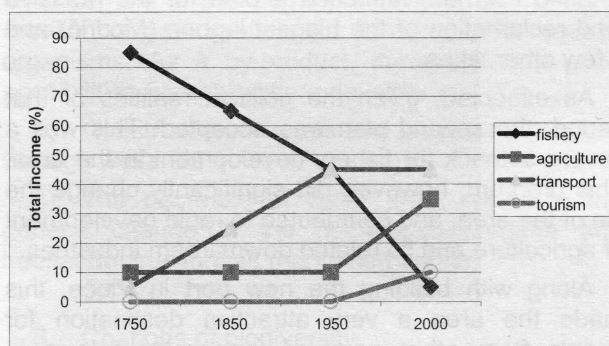


Figure 1. Composition of total income in the Neretva delta during different history periods based on domination of different economic activities.

Slika 1. Sastav ukupnog dohotka u području delte Neretve u različitim povijesnim razdobljima na temelju dominacije različitih gospodarskih aktivnosti

3. The Austro-Hungarian Period - transportation

After the short-lived French occupation, the area reverted to the Austro-Hungarian Empire. Although some contemporary experts tried to promote the earlier Venetian plans for fishery development, another approach was followed. The main strategy, especially after annexation of Bosnia-Herzegovina, was development of the transportation infrastructure for efficient trade of raw materials, principally minerals and wood.

This required construction of a railway and port in Metković, and also a waterway from the river mouth to Metković, roughly of 20 km in length. As part of this task, the flow of the Neretva was regulated between 1881-1889. This had a negative influence on the fishery: Most lakes and lagoons, the areas of the most productive fisheries, were left without a sufficient inflow of freshwater.

After a particularly dramatic decrease in catch, certain experts proposed that the lagoons again be opened to the sea. This was done, and did indeed improve the catch in the lagoons; the yield from several important lakes located farther from the sea, however, did not improve, and so total catch did not regain earlier levels.

Despite the bad consequences for the fisheries, this strategy did improve significantly the local quality of life. For example, better transportation of goods contributed to higher fish sales, which also increased local income, despite the decrease in catch.

4. Second half of the 20th Century – large-scale agriculture development

The second half of the last century was marked by the conflict between two development strategies for the lagoon area.

On the one hand, scientists from the Institute of Oceanography and Fisheries (namely, Prof. Šoljan and Dr. Morović) proposed a plan for aquaculture development. This was, in fact, similar in its intent to the Venetian plan proposed some 200 years earlier.

On the other hand, the local communist leader (Stanko Parmać) launched a plan for the massive land reclamation of the biggest lagoon (Modrič) and a few other lakes.

As expected, given the political realities of that period, the second plan was accepted. This was a severe setback for fishery development in the area. This program, however, did significantly change the life of the area, and contributed to rapid development of agriculture and its related downstream industries.

Along with building the new port in Ploče, this made the area a very attractive destination for people from other parts of former Yugoslavia in search of fresh economic opportunities. In fact, during this period the total population of the area increased more than tenfold.

Economic growth of Ploče was based on port and railway transport services, while fishery activities contributed only an additional source of food (Fig. 1).

5. *End of the 20th Century* – resource protection and conservation

The first suggestions to protect significant parts of the delta were raised at the beginning of the 1980s. As a direct result, newly protected fish, bird, and 'special' habitats were proclaimed in the Parila lagoon, the Kuti and Modro oko lakes, Orepak, and Prud.

However, this official protection was—and still is—just a nice piece of paperwork: In reality, these so-called 'protected' areas are without any guards or enforcement agents. Thus, even the most environmentally dangerous activities—such as illegal land reclamation—are undertaken with impunity, without the least concern for the legal intervention of the controlling government authorities

So, at present, nobody prevents destruction of the area's officially protected wetland habitats. Many times, government explanations of this illegal behavior do not comprehensively address the critical issues involved.

These activities significantly have affected, and continue to affect, water level in the estuary. This alters key properties that control the ecology of the native flora and fauna. Further, unregulated agriculture activities on 'new' land generate huge loads of pollution through fertilization and pesticide treatment. Although such activities clearly break a variety of existing laws, and although everyone in these relatively small communities knows the identity of the transgressors, the situation has remained the same for the past ten years.

Present threats

Postojeće opasnosti

The whole Neretva estuary is under the continual pressure of a variety of conflicting activities that damage the native ecosystems. These activities include agriculture, new settlements, construction of new roads, and unauthorized use of its various natural resources. The major impacts may be classified into the following categories:

1. Hydrological Impacts

a) Dam construction on the upper Neretva. Over the last 30-years, five dams were built on the Neretva above Mostar (BiH). This naturally has changed the hydrology of the lower delta. The main effect has been a significant decrease of sediment deposition in the delta, located in Croatia. The Croatian Water Management Authority did not incorporate this change in their decision to permit sand exploitation in the river mouth. At the same time, many illegal gravel excavation sites are found up-river, in BiH. The full impact of these activities on local habitats is yet to be investigated.

b) Dam construction and flow regulation in the southeastern branch of the catchment area (Popovo field and the Trebišnjica River)- This mainly influences springs on the southeastern side of the delta, mainly in Hutovo Blato and the Kuti wetlands. The very low quantity of summer water affects, and will affect in future, life in these wetlands, mainly through decreasing water level and the concomitant heating of wetland water.

Table 1. Milestones of changes during history
Tablica 1. Povijesne promjene

1880	Regulation of the flow of the lower Neretva River from its mouth to the port in Metković; start of transportation strategy
1950	Huge land reclamation of brackish lagoons and lakes; development of intensive agriculture
1950	Construction of the port in Ploče and the railway to serve it; in the wetlands of northwestern part of estuary, development of modern sea and railway transportation
1990-1995	Fall of the whole state-owned agro-industrial complex (i.e. three wineries and distilleries), as well as decrease in port and railway traffic, owing to the war in Bosnia-Herzegovina and Croatia and the negative effects of subsequent transition period
1990-2000	Total collapse of all management policies

c) Excavation of mineral materials (sand and gravel) in the mouth and lower Neretva.

d) Illegal and unplanned land reclamation, leading to creation of huge water bodies and small parcels of land (Fig. 2).



Figure 2. Examples of illegal and unplanned land reclamation. The right side of second picture features a remaining section of the original wetland habitat, along with a small lake.

Slika 2. Primjeri nezakonitih i neplaniranih isušivanja. Desna strana druge slike prikazuje ostatak močvarnog staništa uz malo jezero

Each of these changes has provoked unfavorable conditions in the estuary, especially during summer. Their combined effect has been especially dramatic. The main river flow—from the mouth up to the town of Metković (20 km)—is becoming more saline, with only a thin layer of fresh surface water. This has been accompanied by the migration of marine fish deep inland. The southeastern branch of the estuary, representing the main agricultural area, is protected with dams (Opuzen area); but agricultural activities along the unprotected northwestern branch are threatened, a situation evident by problems with the main crop in that area, tangerines.

2. Native habitat loss:

a) Illegal and planned land reclamation - creation of new land and water channels destroys the structure of native wetlands. It is important to emphasize that most of the present land reclamation is illegal. The good thing—which is not an endorsement of this illegal practice—is the resulting creation of new habitats for fish and other aquatic organisms. As a by-product, there also are good possibilities for aquaculture development (Fig. 2).

b) Construction of roads and other infrastructure through wetlands

c) The decrease of water level, owing to the general change in the hydrological regime and habitat destruction, as mentioned earlier.

3. Changes of biodiversity:

a) Owing to the loss of habitat- because of wetland reclamation, the breeding and nesting habitats of native birds have disappeared. This has, of course, dramatically influenced the abundance and diversity of the local bird community. However, on the other hand, new agricultural land offers habitats for new species, which somewhat mitigates the overall negative effect on the area's biodiversity. Habitat destruction and loss also influence other species, such as the European eel and water lilies.

b) Human use- The local population has taken advantage of the area's rich natural resources, mainly fish and birds, throughout its history. This exploitation was—likely owing both to the rudimentary technology available and the low population density—conducted in a sustainable fashion. Today, however, because of high fishing and hunting pressure and the more sophisticated technology, many species are being driven to endangered status.

c) Changes in water-quality parameters (*i.e.*, higher temperature, lower dissolved oxygen, higher salinity, elevated nutrient salts, *etc.*)- The best example for this is building of the dam on the Svitava wetlands, which formed the Svitava lake. Once rich in endemic fish species, today the lake is dominated by introduced carp, catfish, and pumpkinseed fish. Endemic species remain only in isolated parts of the lake, close to relatively isothermal springs. These water-quality changes had terrible effects the leech, *Hirudo medicinalis*. Perhaps surprisingly, this somewhat despised animal was a significant source of income in the area from 1930 to 1940 (Smoljan, 1988). Today it is extinct.

d) Introduction of non-endemic species- The history of introduced species is at least a century old—and probably much older—when the common carp, *Cyprinus carpio*, was introduced into the Hutovo Blato wetlands. Today, non-endemic species outnumber native species; and while some are edible and make up a part of the local diet, others represent a threat to the native ecosystem. This is especially the case with the pumpkinseed, *Lepomis*

gibossus. This fish first was noticed in the early 1970s, though it then was encountered only sporadically. Today, it lives throughout the delta, and in the Hutovo Blato it represents 10 % of all fish in that wetland system.

4. Pollution Sources:

a) Municipal sewage- Sewage from all three towns and villages in the immediate area is released directly into the river and sea without any treatment.

b) Intensive agriculture- Besides fertilizers, the main problem here is uncontrolled use of pesticides and herbicides. These end up in the water where they naturally enter the food web, moving from fish to humans.

c) Intensive road traffic- The main threat here is emission of lead from automobile and truck exhaust, and its subsequent deposition on plants growing close to roads.

d) Pollution from the upper river - The aluminum industry in Mostar poses a threat in this regard. Before the war, it frequently polluted the river with so-called "red mud". The impact of this activity was never fully investigated, owing to the political climate of that era.

Future development and possible conflicts

Budući razvoj i mogući problemi

As mentioned earlier, in addition to numerous research projects undertaken in the Neretva estuary over the past several years, there yet is no clear, precisely-defined plan that details how the future of the area best can be managed. Keeping well in mind that many groups and lobbies are promoting their particular development concept, two development strategies are proposed here:

- Establishment of a *Neretva Delta Nature Park*, under the aegis of the national government and encompassing the whole delta area
- Development of agriculture, aquaculture, and related agro-industries, fully compatible with current principles of sustainability, and in close collaboration with local and county governments

Regarding aquaculture, it must be admitted that, of the many aquaculture plans that have been prepared over the past fifty years, only one project was executed: a relatively large-scale eel farm (300

tons) built in Rogotin. Unfortunately, owing to poor management, this farm was closed.

A new plan for aquaculture development in the region was launched during 2000 (Glamuzina B. *et al.*, 2001), financed by the County Government, and prepared by the Institute of Oceanography and Fisheries. The main idea of this initiative is to promote extensive breeding of freshwater and marine fish in the currently available water bodies. The three target species are mullet, eel, and carp. In addition, several intensive aquaculture facilities, including a marine hatchery and two intensive fishponds, have been proposed.

The potential annual production in the estuary has been estimated to be at least 1.500 MT, mainly of mullet and eel. These are traditional and highly esteemed commodities in the area, and thus enjoy a ready local market.

If the prospective sites for aquaculture facilities are executed *in toto*, aquaculture has the potential to generate an annual income of USD 10 million and create direct jobs for an estimated 100 people. This also will improve the area's tourism potential, as it will be able to provide a regular supply of fresh fish, which currently is not the case.

All plans for new activities, including aquaculture, must be included in an updated management plan based firmly on principles of sustainable—not only economic—development.

The first step along this path has been completed: The aforementioned eel farm in Rogotin has been purchased by foreign investors and is preparing to start production. If successful, this could be the catalyst for revitalized aquaculture development in the Neretva River estuary.

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