

ALLUVIAL WETLANDS PRESERVATION IN CROATIA THE EXPERIENCE OF THE CENTRAL SAVA BASIN FLOOD CONTROL SYSTEM

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Abstract

Large alluvial wetlands have been preserved until today in the Central Sava Basin, in order to reduce the maximum peaks of the Sava and Kupa rivers during high water. This concept has proved very effective since its design in 1972. It is an excellent model for flood control systems: not only are retention areas preserved as safety features, they also maintain a high biological diversity in the region. A new Environmental Assessment reviews the original concept, such, that in addition to flood control, the conservation of natural and cultural heritage is included in the project design. The World Bank has given Croatia a grant to fund the preparation of this Environmental Assessment. It offers a unique opportunity to the Croatian Water Management authority, in co-operation with EURONATUR and many Croatian organisations, to design and build a flood control system which will provide a model for flood control and regional development, also for other countries.

1. Background

Floodplains are the natural retention areas for the waters of rainfall and snow-melt flowing from the mountains. They are important for natural water purification and the regeneration of groundwater resources. Water management in Europe and other parts of the world over the last 150 years has, in retrospect, made some grave mistakes. In order to enlarge the area of agricultural land, for the production of energy and to improve shipping, rivers have been canalised and their floodplains 'ameliorated'. The formerly flooded lands were often quickly transformed by intensive agriculture, but also covered by towns, roads and industries: thus large retention areas, for the natural control of flooding, were lost. Such river regulation projects were regarded as secure and important for flood protection, without taking into consideration the higher levels of floods before this century, or the potential for greater damage resulting from the failure of constructed dikes and levees. Catastrophic floods in the valleys of the Rhine, Po, Elbe, Oder, Tisza, Mississippi and many other rivers have exposed the insecurity of these constructed 'control systems' against flooding (compare Philippi 1996). The problem of all such projects is that they do not allow the floodplains to fulfil their natural function of retaining water during times of high flow.

Croatia is a key Country for the preservation of flood plains in Europe (Schneider-Jacoby 1994). Along the Rivers Sava, Drava, Mura and Danube, the Country hosts the largest alluvial wetlands in the Danube Basin (DPRP 1999). The tributaries are important for the preservation of the high biodiversity and contribute to the ecological importance of the Danube River (Schneider-Jacoby 1996). The paper will focus on the Central Sava Basin/CBS, where large alluvial wetlands were preserved in the seventies

as retention areas. The flood control scheme was developed by the UN with help of local and foreign specialist (Consortium 1972; Direkcija 1975) and was based from the beginning on a catchment area approach for the whole Sava River. In 1999, an Environmental Assessment/EA of the project was done for the World Bank with financial help of the Japanese Trust Fund. The study was aimed to define priority projects for funding to complete the flood control system and describe the ecological and cultural values of the area. The study was done by Croatian Waters in co-operation with VPB and EURONATUR plus a team of experts (sector studies on forestry, agriculture, biodiversity, cultural heritage, demography, hydrology and climate). It resulted in a proposal for an Integrated Central Sava Basin Programme with a special emphasis on floodplain preservation and restoration.

2. Importance of the Central Sava Basin for Flood Control

The basic idea of the UN programme for the Central Sava Basin (Consortium 1972), i.e. to store flood waters in the natural inundation areas, is very sound; it also fulfils international criteria for the management of catchment areas. The system, only partly completed so far, has proved to be very effective in recent years, protecting important towns such as Zagreb and Sisak, and large agricultural areas, against flooding. About 40 % of the flood control system was built before the war began in 1990, leaving large areas of alluvial wetland unregulated. With 112 000 hectares extent, it is the largest floodplain ecosystem in the Danube River Basin (DPRP 1999) and an important nutrient sink for the Upper and Central Sava Basin.

The study area is a key site not only for Croatia, but for the whole Sava Basin (Figure 1). It has to store water from the upper catchment area, which includes Slovenian territory, and to prevent the flooding of large drained areas downstream, some of which lie within Bosnia and Herzegovina and some in Yugoslavia. The effect on the lower Danube has not yet been evaluated.

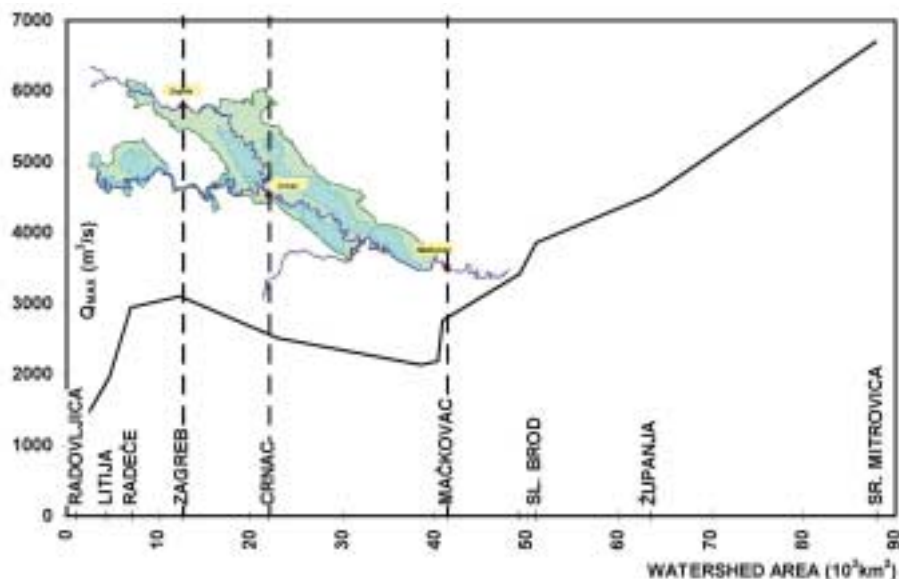


Figure 1. Effects of the Flood Control System in the Central Sava Basin on peak flood discharge in the Sava River (based on Direkcija 1975).

Manipulation of the water in the Central Posavina system is carried out via three relief channels protecting the towns Zagreb (Odra Canal), Karlovac (Kupa-Kupa Canal) and Sisak (Lonja-Strug Canal), fifteen distribution facilities and the alluvial retention areas, for storage. These channels and facilities are integrated into the existing limited flow river network. This is a system that, with the necessary retention and expansion areas in the low lying area of Central Sava Basin, and governed by the criteria established for the manipulation of the water masses, ensures an unaltered water regime in the Mackovac exit control profile (Figure 1, maximum = 3000 m³/s) toward the lower Sava valley (Braun 1999).

3. Values of the Floodplains

The economic value of wetlands has recently gained more attention (Barbier *et al.* 1997; Skinner and Zalewski 1995). The Lonjsko Polje Nature Park as a part of the CSB and its the alluvial wetlands have environmental assets important globally, nationally and regionally (Schneider-Jacoby 1999). To assess the value of the inundation areas, the concept of 'total economic value' (TEV) was used (IUCN/WCPA 1998), which has been developed for protected areas. Because about half of the area is already protected as a Nature Park, and the rest has outstanding features and international recognition of its worth (Grimmett and Jones 1989), TEV seems to be the best means of estimating the value of the whole area. In addition, other alluvial wetlands have been evaluated using similar methods within the Danube Pollution Reduction Programme (DPRP 1999).

The most important direct-use values are:

- Recreation area for 1.5 million people living around the wetland;
- Fishing and angling: about 10 000 – 15 000 people already use the area;
- The sustainable harvesting of timber: the timber standing on only 1 hectare of alluvial forest is worth 41 000 DM and the annual growth rate, which can be harvested sustainable, is 1000 DM per hectare;
- Hunting: the value of hunting is about 133 DM/hectare – and grazing and winter fodder.

The area offers also great possibilities for education, research, the preservation of genetic resources, collection of medicinal plants and animals and the direct marketing of local products.

The main indirect-use values are:

- Flood control (about 2 billion m³ of storage capacity);
- Climate stabilisation through the large forests;
- 'Ecosystem services', such as the self purification of water and ground water recharge, which affects the drinking water for over one million people.

Groundwater recharge is a vitally important function. In the Kupa depression and the upper part of the Sava in particular (where the river braids, upstream of Rugvica), the river and the inundated areas are closely connected with the ground water and large volumes of water are exchanged. In the meander zone of the Sava, those villages near the river use water which is recharged through the river banks. The quantity of water entailed has not been estimated, but the groundwater supplies from the study area.

The most important non-use values include biodiversity – there are two Ramsar sites, three Important Bird Areas (Grimmett and Jones 1989), and the Sava is a priority area in the Pan European Biodiversity and Landscape Strategy and a key site in the Danube River Basin programmes (EPDRB 1994). Cultural heritage, regional identity and cultural landscape - the landscapes of the Sava Wetlands, Odransko

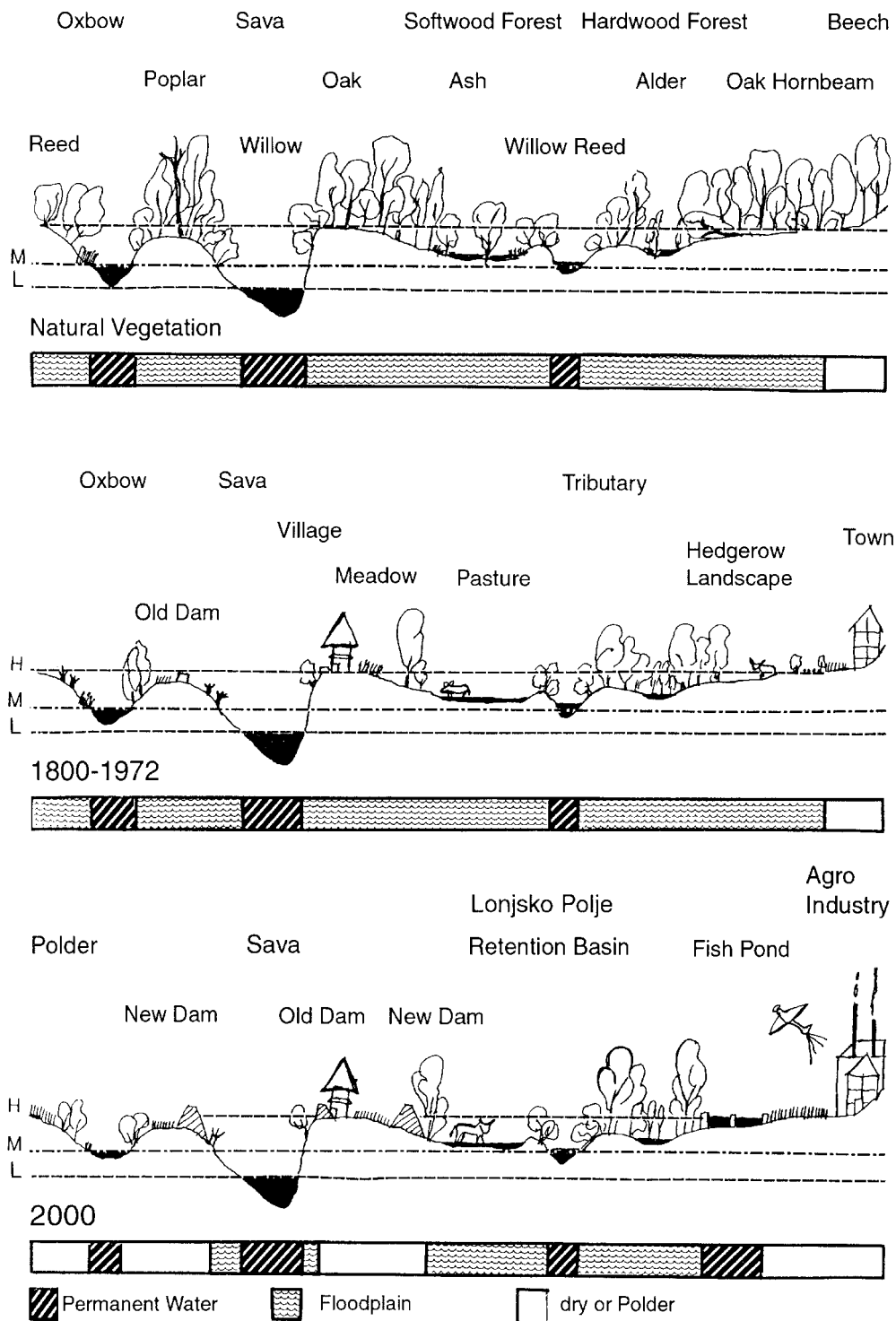


Figure 2a. Development of the landscapes of the Sava Wetlands.

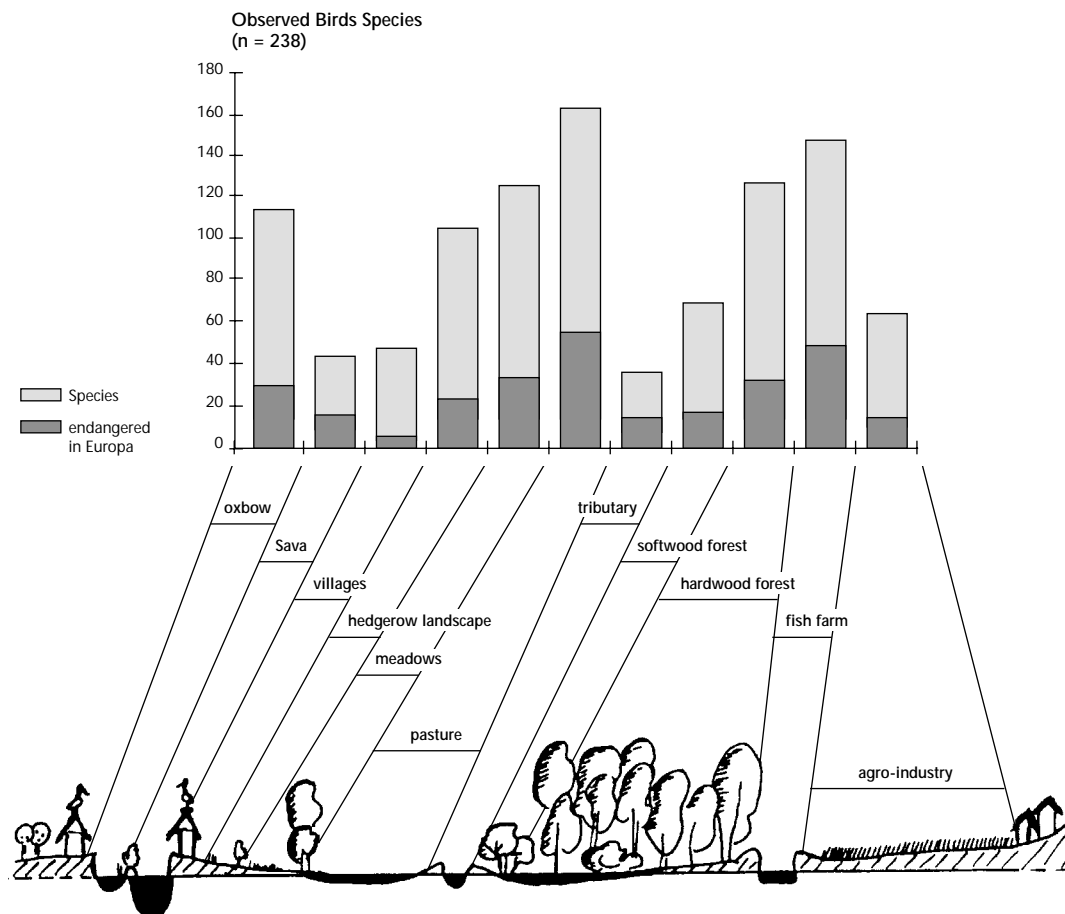


Figure 2b. Birds as indicator of the ecological importance of alluvial wetland. Most species have been observed in the large pastures characteristic for the alluvial depression in the Central Sava Basin (Schneider-Jacoby 1993).

Polje and the Pokupsko depression form an unique blend of natural landscape elements and of the European riverine lowlands (Figure 2). The landscapes of the Sava Wetlands are very impressive and have inspired, and will continue to inspire, artists to create new visions and new art, based on the ecology and the environment (Schneider-Jacoby 1992; Harrison and Harrison Mayer 1996).

4. The Proposed CSB Preservation and Restoration Programme

The preservation of floodplains for protection against flooding

The first step in the sustainable development of the Central Sava Basin is the preservation of the existing floodplains for flood retention (Figure 3). This is the most important basis for preserving the traditional economic activities of the large inundation areas (e.g. pastoralism, forestry) and their valuable natural and cultural assets (see values). The EA proposes the preservation of 99 600 hectares of inundation area in the Central Sava Basin, with a storage capacity of about 2 billion m³ (Table 1).

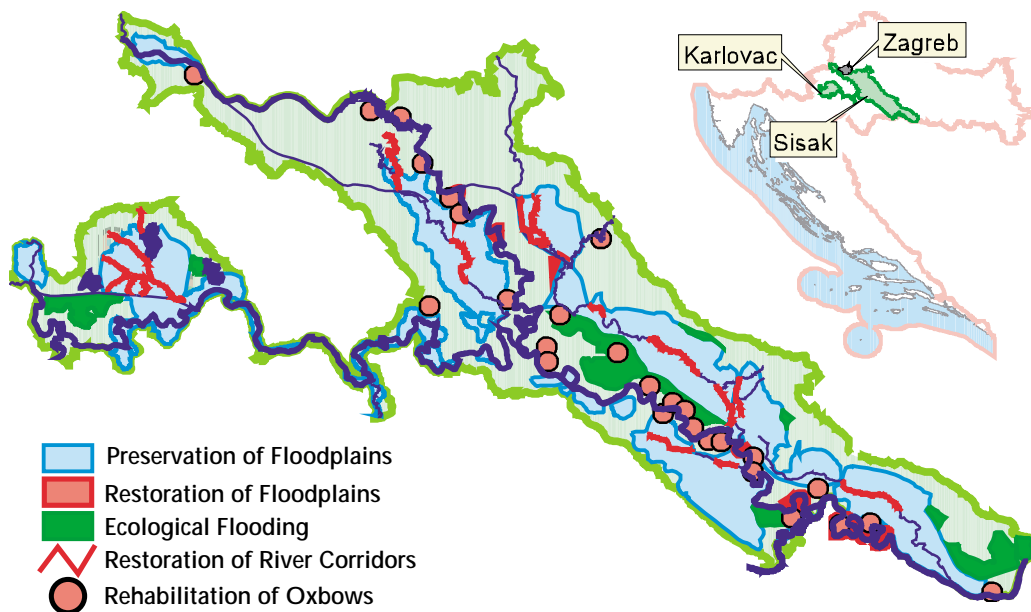


Figure 3. The proposed Central Sava Basin Preservation and Restoration Programme.

Table 1. Size (Hectares) and Storage capacities (Billion Cubic Metres/BCM) of the different sub-units of the Central Sava Basin before 1972 ('natural'), as planned by UN 1972 and proposed through the Central Sava Basin Preservation and Restoration Project.

Retention area	Natural		Planned		CSB PRP	
	Size of the Area (Hectares)	Storage Capacity (BCM)	Size of the Area (Hectares)	Storage Capacity (BCM)	Size of the Area (Hectares)	Storage Capacity (BCM)
Zutica + Lonjsko polje (*)	23 706	634	25 630	915	23 706	733
Tristika + Opeka						
Mokro Polje	22 294	611	20 510	581	22 294	611
Ribarsko Polje	16 956	175	7 400	132	16 956	175
Turopolje	15 630	316	0	0	15 630	316
Kupcina	22 242	203	5 050	150	13 599	150
Jantak	290	27	290	27	290	27
Kupa	5 899	50	0	0	5 000	50
Upper Sava	2 250	30	0	0	2 200	30
CSB Preservation and Restoration Project						
26 Flooded oxbows					500	2
8 Restoration areas					1 200	20
6 Ecologically flooded areas					15 400	10
Total	109 267	2 046	58 880	1 805	116 775	2 124

The territory has an international importance, safeguarding drained areas from flooding in Croatia, Bosnia and Herzegovina and Yugoslavia; it is also an important element in the Danube Pollution Control Programme, as a nutrient sink.

The reservation of land for restoration

In some places the polders, which were built during the first phase of the flood control programme (1972 – 1990), could be restored. In these territories, state-owned lands should be reserved for restoration and private land taken over in exchange for areas outside the floodplain during the de-nationalisation process. These restoration measures would increase the size of the floodplain and widen the Sava river corridor wherever possible. Only sites without settlements have been suggested. The area proposed for restoration extends to 1200 hectares, with a storage capacity of 20 million m³. The projects considered also have excellent potential for the creation of new habitats, recreation sites and nature watching facilities, thus contributing to the development of the region.

Former floodplains proposed for 'Ecological Flooding'

Large and important alluvial wetlands were protected from flooding during the first phase of the project and some areas have been meliorated (e.g. Crnec polje, large areas downstream of the study area). On the other hand some alluvial landscapes retained their character even though they were excluded from the floodplain. Along the southern levee (dike) of Lonjsko Polje, the land outside the retention basin remains a typical alluvial landscape, flooded partially by surface water during high floods and also by standing rainwater, thus preventing the conversion of the grassland into arable land. Thus the important white stork habitats here have been preserved (e.g. Schneider 1988). Also large areas outside the Mokro Polje inundation zone are still flooded, maintaining important habitats such as pastures and lowland forest.

To maintain the alluvial landscapes, 'ecological flooding' is proposed (compare MUV 1997). This means that the areas cannot be restored now by re-inclusion into the flood prone area, but their water levels would be maintained; if necessary, water could even be introduced during floods. Through such measures, the character and value of the riverine landscape could be maintained and their ecological importance, which is of an international standard, preserved. The proposed areas extend to some 15 400 hectares and their storage capacity is about 10 million m³.

27 oxbow lakes and floodplain areas, which were cut off from the 'live' river channel, need to be preserved in addition. The water levels should be managed in accordance with annual flood cycles, to maintain not only the important ecological conditions, but also important socio-cultural functions, such as recreation and semi-natural landscape features. An early example of such rehabilitation works is the management of the Spoonbill Colony at Krapje Dol (Dezelic and Schneider-Jacoby 1999). The ECONET Action Fund and the Zoological Society of Frankfurt did contribute to the rehabilitation project.

Excavation of material: New wetland sites

During the first phase of the Middle Sava Flood Control Project, good opportunities for creating new habitats were missed (compare Nienhuis *et al.* 1998). Nevertheless, in some areas such as along the southern dike of Lonjsko Polje, the excavation sites evolved into very valuable habitats, with very rare, even highly endangered, assemblages of flora and fauna, typical of oxbow lakes (e.g. Schneider-Jacoby 1990). Today these sites have a major role in the recreational aspect of the Nature Park concept, because many people use them for angling; in the park management scheme they feature as a visitor area (for nature observation and recreation).

In future, wherever excavations are intended to take place, ecological land use plans must be drawn up.

Because the exact locations of potential extraction of soil, sand and gravel are not known, only a draft plan can be made and general recommendations given. Detailed studies are needed in every case: where the material will be taken from and how the site will fit into the Integrated CSB Preservation and Restoration Programme. In the future, artificially created oxbow lake habitats will increasingly have to fulfil the functions of the natural oxbows of the Sava: even the rehabilitation measures cannot restore the alluvial cycles of the old lakes. Thus excavation sites will become an integral part of the floodplain morphology and become incorporated into the life cycles of the adopted fauna and flora.

Connectivity: Restoration of river corridors

A very important component of the CSB Preservation and Restoration Programme is the improved connectivity of water bodies. The restoration of river corridors is necessary for many reasons:

1. Some river stretches were straightened during the first attempts to drain the Sava Wetlands (i.e. the regulation of the Lonja, Sunja and Strug inside the floodplain);
2. The building of the Lonjsko Polje retention basin destroyed the parallel flows of the Lonja and the Strug through the floodplain;
3. Few roads cross the floodplain, thus there is little interruption of the wide flow of the water 'front'. Openings for water access must be wide, to prevent the build-up of fast currents and high water levels upstream;
4. The construction of forest roads, channels and drainage inside the forest has changed the water regime inside the alluvial zone;
5. In some areas such as the Pokupsko depression, new roads (e.g. the highway) create a barrier between the hinterland and the floodplain;
6. The new channels and the canalised rivers now enter the floodplains at different sites. Measures are needed to mitigate negative effects.

Economic analysis and viability

The alternative development proposal will save considerable costs, by reducing the amount of water engineering construction: both the length of dikes and the number of distribution facilities will be lessened. Accordingly maintenance costs will also be reduced. Additional costs will be incurred for designing the new facilities, for modelling the flood waves and for carrying out the risk assessment on the new system.

Incremental costs are needed for important improvements to the system, which will secure the long-term sustainable use of the floodplains. In addition to the existing planning (the basic costs), restoration and rehabilitation projects are needed to achieve an integrated water management programme for the CSB. Value added by the preservation and restoration programme results from the improvement of the nutrient sink capacity, protection of the valuable cultural and natural heritage, and the long-term conservation of large inundation areas for transboundary flood protection.

In Table 1 the size of the inundation areas and the storage capacities of the different phases of the Sava Flood Control Project are compared. The planned maximum retention volume of 915 million m³ for the Lonjsko Polje retention basin, is not used for the calculation of the alternative proposal (CSB PRP) because it should be only taken into account as a guarantee of the safety of the flood control system. The flood control problems should be solved without filling the retention basin above the natural water level. The impact on the alluvial forest can not be foreseen.

5. The Integrated Central Sava Development Programme

An integrated approach to the management of the Central Sava Basin is essential: this will combine the different use values to optimum effect and improve the development of the area. The first example of such an integrated management method is the Lonjsko Polje Nature Park. Although founded only recently and with its capacity limited by lack of staff, only 2 scientists, 4 wardens and one secretary, the park already co-ordinates and stimulates regional development and manages a large part of the still existing flood plain (Lonjsko Polje, Mokro Polje). The Dutch PIN MATRA Programme and EURONATUR supported the establishment of the protected area (Nature Park Lonjsko Polje 1999).

In Croatia the category of 'Nature Park' offers excellent opportunities for protecting cultural landscapes and promoting sustainable use, because it is as high ranked as a 'National Park'. Nature Parks such as Lonjsko Polje contain only small areas which are strictly protected, but large areas in the 'protected landscape' category, where a controlled use of resources is permitted. For example, traditional agricultural practices and sustainable harvesting of timber is allowed. For such large areas as the Central Sava Basin, comprising over 100 000 hectares of highly valuable international habitats, the UNESCO Biosphere Reserve concept offers additional management strategies, such as involving local towns and stakeholders, based around the protected areas in the 'Transition Zone', in the process of organising and developing the region. In such a concept the park managers take part, as well as the national and regional administrations and those enterprises which use the area.

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