TRANS-BOUNDARY MANAGEMENT CONCEPT
FOR THE OSTROVÁCI DUNA (HU) / TOPOLJSKI DUNAVAC (HR)

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Introduction

Within the framework of the “Danube River Network of Protected Areas – Development and Implementation of Transnational Strategies for the Conservation of the Natural Heritage at the Danube River” initiative (DANUBEPAKRS project) one of the main goal is the development and implementation of joint transnational conservation strategies and coherent management practices. The overall goals are to improve the ecological situation of the Danube wetlands and the habitat for flagship species, as well as strengthening the regional development by fostering nature tourism and cultural exchange (www.danubeparks.org).

Within the Workpackage 4 – Floodplain management and Habitat Network elaboration of the Trans-boundary Management plan for the Ostrováci Duna / Topoljski dunavac area is planned. This site, situated at the border of Hungary and Croatia represents a good example where joint transnational activities and coherent management practices are needed for the benefit of the protection of wetlands and wetland related species, as well as for the development of sustainable use of natural resources.

General description of the area and brief landscape history

Ostrováci Duna / Topoljski dunavac area is situated along the right bank of the Danube River at the border of Hungary and Croatia between the Erdőfű village on the north and Draž village at the south (Picture 1).

Picture 1. Location of the Ostrováci Duna / Topoljski dunavac area (Source: www.GoogleEarth.com)
The name of the site refers to the single oxbow, former Danube main channel, which is called Ostrováci Duna on Hungarian and Topoljski dunavac (or Stari Dunav) on Croatian language. Larger part of the oxbow is situated in Croatia; only the northern tip is divided by half by the state borders.

The northern part of the watershed area – called Gerechát – territorially belongs to the Kölked municipality (Baranya County in Hungary), while the southern part – called Budžak – belongs to the Draž (Darázs) municipality (Osijek-Baranya County, Croatia).

Prior the regulation works on the Danube River (16th century) the area was an integral part of the 10-km wide alluvial Danube floodplain along its right banks. Ostrováci Duna / Topoljski dunavac was the main, meandering channel of the Danube, with number of other smaller side-arms and channels such as Boki-Duna, Lorencijev dunavac, Šarkanjski dunavac (Sárkányi Duna), etc. West from this channel and south from the Beda forest and Holt-Duna, extensive floodplain marsh called Puškaš (Puskas) existed extending in the north-westerly direction along Topolje (Izsep) and Duboševecica (Dályok) villages and ending with Selska bara marshes. Ostrováci Duna / Topoljski dunavac and Selska bara are connected with the stream called Stara (Old) Borza (Borza patak).

After the battle at Nagyharsany in 1687, the Ottoman Empire was pushed south of the Drava and the area went under the jurisdiction of the Austrian-Hungarian monarchy. Under the new territorial division the whole area became part of the Bellye property that was extending from the Drava River on the south, up to the Kölked village upstream Danube. This property was bought by Maria Kristina from the Habsburg family during 1780. The members of the Habsburg family managed the area until the 1918 – the end of the First World War.

The most important and profound changes in the area were carried out during Danube river regulation projects at the first half of the 19th century. The old meandering Danube channel was cut through primarily to improve the flood protection and fasten the transport of the ice during winters. Thus, the Boki-Duna and Šarkanj meanders were cut through from 1814 until 1820 (Picture 2) (Bognar 1986).
Together with the shortening the main river course, the system of the flood protection dikes were built preventing the side connection of the river with its floodplain and regular flooding of the area. The main flood protection dike extending from the Mohács town downstream Draž village was built during the 1825-1835 period, and completed until 1874 (Marjanović & Mađar 2006). After the 1897 flood the dike was reinforced and made higher to prevent future flooding (DDNP 2008).

As a consequence of these works, the width of the recent floodplain remained from 200 (near Bok forest) to 3700 meters (at Šarkanj north of Draž village) (Picture 3) and most of the former floodplain was cut-off from the river and regular floods.

At 1888 the water levels, this time originating from precipitation and increase of the ground-water levels during Danube floods, were still high enough in the former floodplain to flood the depressions and former side-arms, consequently, large marshes were still present on the map (Picture 3.). Thus, the new era in the land-use started at the beginning of the 20th century by building the system of pumps and network of drainage channels in order to convert the wetlands into agricultural fields.

Sluice at Draž village on the Ostrováci Duna / Topoljski dunavac was built during 1875. It was placed at the deepest part of the Ostrováci Duna with the 4.5 meters wide gate of that went through the 42 m wide flood protection dike. The maximum capacity of this sluice is 40 m$^3$/sec (Marjanović & Mađar 2006). During 1906 Kölked pump has been built together with 35 km long channel that collected the water from the area south of Mohács town. The Budžak pump was finished in 1912 with installed capacity of 0.4 m$^3$/sec (Marjanović & Madar 2006). The Gerechát pump has been built during 1916, that transferred the water into Boki-Duna and then by gravitation to the Holt-Duna, from where it is pumped out into Külső-Béda (DDNP 2008). During 1986 reversible pump with installed capacity of 1.8 m$^3$/sec has been built at Puškaš area with the aim to drain/irrigate 2000 ha of area (Marjanović & Madar 2006).

Parallel with the building of the sluices and pumps, an elaborated network of drainage channels has been built with the aim to drain the excessive water from the newly colonized wetland areas. By the end of 1970-ties the average density of
drainage ditches was 13-15 m/ha in the Croatian Baranya region (Marjanović & Madar 2006).

Consequently, large changes in the land use practice were present during the past 120 years. For example, during 1881 at Gerechát agricultural land covered 48% of the area, 26% was forest, 13% were pastures and grasslands and 13% was declared “unproductive” – mainly representing marshes and reed-beds (ATA 2005). By 2004 situation was radically different and intensive agricultural land covered almost 80%, forests almost disappeared (0.3%) while pastures and grasslands were covering 4,1% of the area. So called, “unproductive land” covered 15.7% but most of that are drained reedbeds and degraded hunting areas covered by invasive species (ATA 2005).

Recent situation shows that largest part of the Gerechát is converted to intensively use agricultural land (Picture 4). Only smaller parts along the eastern part and flood protection dike (approximately 20 ha) are used primarily for hunting and forestry and they are covered with grasslands and alluvial softwood forests. In the middle of the Gerechát there is a natural depression with large reed bed, however due to the work of the pumping station it lacks water during the most of the year. This depression is connected with the Ostrováci Duna / Topoljski dunavac through small natural channel – called fok.

![Picture 4. Recent land use at Gerechát area (Source: www.GoogleEarth.com)](image)

Picture 4. Recent land use at Gerechát area (Source: www.GoogleEarth.com)

Quite similar situation is in the Budžak area (Picture 5). Most of the part is converted to intensively used agricultural land, and in the middle of the area there is a large depression covered with reed bed and grassland communities. This area has been regularly drained by the Budžak pumping station. Along the borders of the Topoljski dunavac there is a narrow strip of wetland vegetation, primarily reed beds in higher parts and sedge communities in the deeper parts.
The third unit of former alluvial floodplain is the Puškaš area (Picture 6). It is used for the purpose of the intensive agricultural production. At the west edge of Topoljski dunavac there is a part used for forestry and hunting. In the middle of the area there is a large depression covered with reed bed, but regularly drained by the Puskas pumping station. Along the Hungarian-Croatian border there is a strip of former agricultural land covered with mine-fields and invasive plant species particularly Solidago ssp.

Recent human population in the area is characterized with relatively small size (Erdofu – 51, Draž – 623, Gajić – 354, Topolje – 473, Duboševica – 690 citizens, respectively), negative demographic trends (higher mortality than natality), and low percentage of young population (18.75 % in average) present in all settlements.
Species and habitats with nature significance with special regard to NATURA 2000

Despite significant changes in the landscape and land use throughout the history, the Ostrováci Duna / Topoljski dunavac area retained some of the natural values that make the area worth of the legal protection.

Within the Ostrováci Duna / Topoljski dunavac area following major Habitats of community interest is present:

- 3130 Oligotrophic to mesotrophic standing waters with vegetation of the Littorelletea uniflorae and/or of the Isoëto-Nanojuncetea
- 3150 Natural eutrophic lakes with Magnopotamion or Hydrocharition – type vegetation
- 6440 Alluvial meadows of river valleys of the Cnidion rubii
- 91E0 Alluvial forests with Alnus glutinosa and Fraxinus excelsior
- 91F0 Riparian mixed forests of Quercus robur, Ulmus laevis and Ulmus minor, Fraxinus excelsior or Fraxinus angustifolia, along the great rivers

While the natural succession pattern – from the rivers with muddy banks with *Chenopodion rubri* p.p. and *Bidention* p.p. vegetation (NATURA2000 code: 3270), over oligotrophic to mesotrophic standing waters with vegetation of the *Littorelletea uniflorae* and/or of the *Isoëto-Nanojuncetea* (3130), natural eutrophic lakes with *Magnopotamion* or *Hydrocharition* – type vegetation (3150), alluvial forests with *Alnus glutinosa* and *Fraxinus excelsior* (*Alno-Padion, Alnion incanae, Salicion albae*) (91E0 *) to
riparian mixed forests of *Quercus robur*, *Ulmus laevis* and *Ulmus minor*, *Fraxinus excelsior* or *Fraxinus angustifolia ssp. pannonica*, along the great rivers (*Ulmenion minoris* (91F0)) - is disrupted due to building of flood protection dike and interruption of the connection between the river and floodplain, some of the grassland and forest succession processes are still possible.

The most characteristic vegetation types (associations) are as follows:

- Salicetum albae-fragilis
- Caricetum elatae
- Scirpo-Phragmitetum
- Lemno-Utricularietum
- Hydrochari-Strationetum

The fauna of the area is rich and represented with number of rare and threatened species, including those that represent the key species for the designation of NATURA 2000 sites.

- **Mammals**

Out of 12 species of bats (Chiroptera) that are recorded in the Beda-Karapandza area, nine species are recorded at Gerechat area:

- Barbastelle (*Barbastella barbastellus*)
- Daubenton’s bat (*Myotis daubentoni*)
- Pond bat (*Myotis dasycneme*)
- Natterer’s bat (*Myotis nattereri*)
- Noctule (*Nyctalus noctula*)
- Leisler’s bat (*Nyctalus leisleri*)
- Common pipistrelle (*Pipistrellus pipistrellus*)
- Nathusius’ bat (*Pipistrellus nathusii*)
- Grey long-eared bat (*Plecotus austriacus*)

This important group of insect feeding mammals could be divided into two groups based on the breeding habitats – first group breeds in the old forest/trees with available nesting holes, while the second one breeds in the under the roofs of nearby settlements and houses. All species feed on insects but each has a different ecological niche and prey preference. Thus, the diversity of the landscape features and feeding possibilities is increasing the bats species diversity. The availability of surface water is of special importance for Pond bat *Myotis dasycneme*. Barbastelle *Barbastella barbastellus* and Pond bat are NATURA 2000 qualifying species and strictly protected species both in Hungary and Croatia.

From the Carnivora class of particular conservation values are following species of mammals:

- European otter (*Lutra lutra*)

The European otter is widely distributed along the rivers, streams and oxbows with abundant prey source and it is present along the Ostrováci Duna / Topoljski dunavac area. It would use the melioration ditches for the dispersal and daily trips, but prefers sites that are not depleted of vegetation. It is threatened by the removal of the vegetation along streams and channels, lack of prey base due to drainage of wetlands.
and disturbance caused by anglers. The European otter is strictly protected species in both countries.

- **Wildcat (*Felis silvestris*)**
The Wildcat is typical species for the dense and undisturbed forests, but frequently can be seen along reedbeds and open grasslands that are used for hunting. It is protected species in both countries.

- **Golden jackal (*Canis aureus*)**
Golden jackal has recolonised the area during late 90-ties. It prefers habitats with dense but low vegetation (e.g. reed beds, scrubs, dense vegetation along streams, as well as abandoned agricultural lands due to mine-fields in Croatia) that enable cover, but often hunts in open habitats, particularly abandoned agricultural fields. Golden jackal is not protected in both countries and prosecuted by the hunters despite the fact that their population in the Ostrováci Duna / Topoljski dunavac is small.

From the Rodentia class only one NATURA2000 qualifying species is recorded in the area:

- **European beaver (*Castor fiber*)**
European beaver had spread downstream along the Danube river after the reintroduction scheme in Gemenc area. It is recorded in Croatia along the eastern part of the flood protection dike and Lorencijev dunavac, thus it is reasonable to expect that sooner or later it would cross the dike and enter Ostrováci Duna / Topoljski dunavac. The presence of the European beaver and its impact on habitat favours other wetland related species. For example, abandoned breeding holes could be used by otters, foxes or badgers, and creation of small pools favours other species such as amphibians, reptiles or wetlands birds. It is protected species in both countries, but in Croatia it is also considered as a game animal.

- **Birds**

  The Ostrováci Duna / Topoljski dunavac has a special importance for the bird fauna, particularly waterbirds. The northern part of the oxbow, as well as nearby Boki Duna are supporting the nesting of the following species (Table 1)
### Table 1. Breeding populations of NATURA2000 bird species in the Ostrováci Duna / Topoljski dunavac and Boki Duna (Source: Deme T., DDNP).

<table>
<thead>
<tr>
<th>Species</th>
<th>Ostrovac (HR)</th>
<th>Boki Duna (HU)</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Great Egret (Ardea alba)</td>
<td>23 pairs (2009)</td>
<td>10 (but up to 17-20)</td>
<td>33-43</td>
</tr>
<tr>
<td>Purple Heron (Ardea purpurea)</td>
<td>23 pairs (2009)</td>
<td>40-100</td>
<td>63-123</td>
</tr>
<tr>
<td>Little Egret (Egretta garzetta)</td>
<td>18 pairs (2009)</td>
<td>5 (but up to 20-25)</td>
<td>23-43</td>
</tr>
<tr>
<td>Black-crowned Night-heron (Nycticorax nycticorax)</td>
<td>100 pairs (2009)</td>
<td>90 (but up to 200-250)</td>
<td>200-350</td>
</tr>
<tr>
<td>Eurasian Bittern (Botaurus stellaris)</td>
<td>0</td>
<td>1-2</td>
<td>1-2</td>
</tr>
<tr>
<td>Little Bittern (Ixobrychus minutus)</td>
<td>10</td>
<td>10</td>
<td>20</td>
</tr>
<tr>
<td>Greylag Goose (Anser anser)</td>
<td>28 pairs (2009)</td>
<td>40-50 pairs</td>
<td>68-78</td>
</tr>
<tr>
<td>Ferruginous Duck (Aythya nyroca)</td>
<td>1-2 pairs (2009)</td>
<td>3-5 pairs breeding 160 in passage</td>
<td>4-7 pairs</td>
</tr>
<tr>
<td>Marsh Harrier (Circus aeruginosus)</td>
<td>5-6 pairs (2009)</td>
<td>3-4 pairs</td>
<td>8-10 pairs</td>
</tr>
</tbody>
</table>

All above mentioned species are strictly protected in both countries and NATURA 2000 qualifying species. Apart from that, as reed and sedge nesting species their breeding success is under direct influence of the water level in the Ostrováci Duna / Topoljski dunavac. If the water levels are too low at the beginning of the nesting season (the breeding place should have at least 0.5 m of water) the nesting would not start. On the other hand, if the water level suddenly drops during the breeding the nest would come under threat from terrestrial predators, particularly foxes (Vulpes vulpes) and wild boars (Sus scrofa). Thus, the proper management of the water levels is of key importance for the conservation of their breeding populations.

The area has also immense importance for the feeding of number of NATURA 2000 species that are breeding in the nearby forests, such as Black storks Ciconia nigra (12 pairs that are often feeding in melioration ditches), White-tailed eagle Haliaeetus albicilla (up to 4 pairs in total), or Black Kite Milvus migrans (4-5 pairs). Wet meadows and pastures are important feeding sites for White Stork Ciconia ciconia (10 pairs in total), while the agricultural areas as feeding sites for Greylag goose Anser anser (up to several hundreds during winters) or Hen Harrier Circus cyaneus (during winter).

### Amphibians and reptiles

Reptilia – Emys orbicularis,

As a former floodplain, the area is still important for the Amphibian populations with 13 species (10 frogs and 3 newts). Triturus dobrogicus, Bombina bombina and Hyla arborea are NATURA 2000 qualifying species.
Recent situation concerning nature protection

Natural values of the Ostrováci Duna / Topoljski dunavac are both of national and international importance and for the long time they are part of appropriate nature protection plans.

In the Hungary, Ostrováci Duna / Topoljski dunavac and forested parts of the Gerechát are protected as the part of the Danube-Drava National Park, Béda-Karapanca unit since its foundation on National Park in 1996. On the European level the importance of the site is confirmed by the inclusion on the NATURA2000 list (Béda-Karapanca HUDD 10004 and HUDD 20045). They are also part of the 1150 ha large Béda-Karapanca Ramsar site (DDNP 2006 at www.ramsar.org).

In the Croatia, Ostrováci Duna / Topoljski dunavac and Budžak are not formally protected under the one of the nine national protection categories declared by the Law on Nature Protection (Official Gazzette no. 70/2005, 139/08). However, these areas are declared as an integral part of the National Ecological Network because they are connecting, together with the Danube River, upper parts protected in Hungary with Kopački rit Nature Park situated downstream. Certain measures related to the use of natural resources as well as nature conservation, particularly NATURA2000 habitats and species, are already in place (Official Gazette no. 99/2009). The Ostrováci Duna / Topoljski dunavac and Budžak areas are proposed for the protection as NATURA2000 site as an integral part of the much larger site under the name: HR1000016 Podunavlje and Donje Podravlje (Picture 7) (www.dzzp.hr).

Since late 80-ies there is a strong plan to connect all protected areas along the Danube River in Hungary and Croatia by creating a joint trans-boundary protected site. Since then, numerous data and studies on the waterbird dispersal and migration have proved that the whole Danube floodplain from mouth of the Sió River downstream to the mouth of the Drava River represents one ecological unit and corridor that animals use without respect of the administrative borders.
Based on this initiative, a joint trans-boundary Biosphere Reserve Mura-Drava-Danube has been prepared under the framework of UNESCO’s “Man & Biophere” program. During fall 2009 the representatives of the two governments had signed the official Letter of intent to formalize the efforts of this initiative. It is expected that the formal designation of the “Mura-Drava-Danube” Biosphere reserve would take place during late 2010.

Locally, Danube-Drava National Park Directorate has a plan to improve the management and increase the natural values of the Gerechát area. Local experts have elaborated plan for the future management exists (ADTA 2005) that envisages the gradual conversion in the land use from intensive agriculture to grasslands and wet pastures (Picture 8 and 9). However, this plan could be achieved only with the trans-boundary cooperation of nature and water management authorities since the key part of the plan is reconstruction of the hydrological conditions with the existing water management structures (pumps and sluices) that are situated in Croatia (see chapter on the Characterization of hydrodynamics in the area).

Use of the area with relevance for nature conservation

The Ostrováci Duna / Topoljski dunavac area, including Gerechát, Budžak and Puškaš areas are used primarily for intensive agricultural production (Pictures 4-6). The major part of the Gerechát area is intensively managed. Puškaš area is managed by the large Croatian agricultural company – Belje d.d. – while the Budžak area is under the management of different private users. However, regardless of the land users, the overall management could be defined as too intensive concerning the use of heavy equipment, fertilizers, pesticides and herbicides as well as water resources. This agricultural management practice is characterised with establishment of large field parcels that are rotationally planted with classic monocultures (wheat, corn,
sugar-beet, sunflower). Immediately after the harvest the fields are ploughed and converted to “agricultural deserts” that are not capable of providing the shelter and food resource for any animal.

Intensive application of fertilizers, pesticides and herbicides is the second major activity that has a major negative impact on the biological values of the area. During 60-ties DDT and related pesticides were used. While today DDT is banned, the use of related chemicals is still a major practice, particularly in Croatia. From the agricultural field these chemicals are leaking or they are washed off in the nearby drainage channels, then further into wetlands and oxbows causing severe secondary poisoning problems (via bioaccumulation processes) and population declines, particularly among the water related animals such as amphibians, fish or water insects. Declining population of invertebrates and small vertebrates are consequently causing food shortages for the animals that are on the higher level on the food pyramid e.g., waterbirds (particularly storks, herons, spoonbills and egrets), bats (particularly Daubenton’s and Pond bats) or Otters.

Recently, plans for increasing the irrigation practice exist and they are applied in Croatia. The main need for the water is during the late vegetation season, particularly late spring and summer, hence the unsustainable water management practice comes to its full exposure: in the early spring the water is first drained from the area and transferred to the Danube, and later in the season the lack of water is compensated by the pumping of the ground water or excessive use of surface waters from the existing oxbow. Regardless of the source, this practice is causing severe hydrological disturbances of both surface and ground water levels and further destruction of the natural values.

Closely related to the intensive agriculture is the water management practice that further causes the decrease of the biological and landscape diversity. The negative influence of the current water management practice could be divided into following activities:

- Effects of surface water pumping and drainage – in order to intensify the agricultural production in the Ostrováci Duna / Topoljski dunavac surface waters are pumped out from the area during early spring. The timing of this activity is exactly opposite to the natural hydrological cycle and takes place at the time of the spawning and breeding season. Available depressions (called lapos) for the spawning of fish and amphibian populations are drained, while the breeding of waterbirds in the reed beds and other floating vegetation (particularly herons, egrets, Greylag Goose *Anser anser* and ducks such as Ferruginous Duck *Aythya nyroca*) is prevented or their breeding success is heavily influenced by the sudden water level drop. These wet depressions are also important feeding areas for the species like Lapwing *Vanellus vanellus* and Common Sandpiper *Actitis hypoleucos*. On the other hand, pumping the surface water out of the agricultural area causes increasing pollution of recipient waters (Boki Duna, Külső-Béda, Šarkanjski Dunavac) by nutrients and toxic chemicals (particularly pesticides, herbicides). Pumping of the surface waters from the Gerechát area would cause another negative effect by sudden water level increase in the Boki Duna causing the flooding of the existing nests of the Greylag Goose and Ferruginous Duck nests.
Effects of the maintenance of melioration and drainage ditches – as a part of the water management practice frequent removals of the vegetation by using heavy equipment or moving are applied causing the destruction of natural vegetation communities (many of them protected under the Habitat Directive). Apart from the destruction of natural habitats important for NATURA2000 species such as European pond-turtle *Emys orbicularis* or European otter *Lutra lutra*, such practice is causing severe decrease of the landscape diversity.

The third major land-use practice is related to **hunting practice**. Ostrováci Duna / Topoljski dunavac together with the Gerechát, Budžak and Puškaš areas are hunting areas. In the Gerechát the hunting is managed by the state forest agency Gemenci Erdő- és Vadgazdaság Rt. (Gemenc Rt.). In the Budžak and Puškaš areas the hunting rights are issued to private companies (Troga d.o.o. Gajić) or local hunting societies (LD „Sokol” Topolje). Regardless of name of the hunting rights holder, the hunting practice is characterised with following activities that have negative consequences to the existing natural values:

- **Game population exceeding the natural carrying capacity** – the ultimate desire of the hunting lobby is to have as large as possible populations of desired hunting animals, particularly big game species (Red deer *Cervus elaphus*, Roe deer *Capreolus capreolus* and Wild boars *Sus scrofa*). As a consequence, the game animal populations are maintained in numbers that are well exceeding the natural capacity of the area (e.g. the desired density for Red deer in Croatia is 8 deers/100 ha) including the artificial feeding during the hunting season. However, maintaining the game populations above the natural carrying capacity would prevent – due to the large grazing/browsing pressure – the natural rejuvenation and succession of the forest communities. Also, during the vegetation season the exceeding populations of the game animals would move into agricultural fields (particularly Wild boars) causing substantial damages on the existing crops.

- **Fencing and fragmentation of the areas** – in order to prevent damages and losses on the crops and newly planted forests caused by the excessive population of game animals, fencing the agricultural and forest areas is the common practice in the target area. Large - over 2.5 m high – fences are built between the forested and agricultural land, as well as around the newly planted forests. As a consequence, these fences are fragmenting the existing habitats and prevent free movement and dispersion of animals, including non-game species. Further example of the fragmentation of habitats is carried out through the building of different forest roads and maintenance of hunting lines for the purpose of shooting. Both practices are impacting the ecological integrity of the wetland and forest ecosystems as well as lower the landscape values of the area. Furthermore, forest roads and hunting lines are optimal areas for the dispersion of the invasive plant species such as *Amorpha fruticosa, Solidago canadensis, Ambrosia artemisifolia, Asclepias syriaca* etc.

- **Reed and other vegetation burning** – quite common practice in the target area is the burning of reed beds and other plant communities (sedges etc.). While the explanations for this practice are numerous (sedges etc.).
are profound. Burning is causing the complete destruction of the habitats for species that use reed beds as breeding, hiding and feeding grounds and they include, but they are not limited to species such as waterbirds (herons, egrets, goose, ducks), reptiles (European pond turtle), amphibians (inlc. Fire-bellied frog *Bombina bombina* and Tree frog *Hyla arborea*), mammals, insects and other invertebrates. Burning would completely destroy the invertebrate populations that serve as a food for higher animals, as well as breeding grounds of reed-nesting species such as Moustached Warbler *Acrocephalus melanopogon*, Bluethroat *Luscinia svecica* or Purple heron *Ardea purpurea*.

- Other disturbance of game animals to minimize the crops damages – closely related to intensive hunting activities and game populations exceeding carrying capacity of the area are attempts to prevent the damages on crops. Quite often, the big game animals are chased by dogs and hunters back into the fenced hunting grounds. Main problem originating from this practice is inability of hunting dogs to discriminate among the game animals, thus other species (particularly Roe deer, Brown hare, Red fox and Wildcat) are suffering from this disturbance and mortality of the offspring. On the other hand, recent practice is disturbance of foraging geese flocks from the wheat fields by the use of gas cannons. This method is also not species selective and it is causing severe disturbance of the wildlife, both protected and unprotected particularly during winter period when environmental conditions are harsh enough for the survival.

All of the above mentioned land use practices have also a cumulative effect on the biological and landscape diversity of the target area. They are also showing the clear need for the transboundary protection and management plan because nature conservation efforts on the one side of the border can be seriously hampered if they are not followed with appropriate mirror measures on the other side.

**Characterization of hydrodynamics in the area**

The target area (Picture 1) is part of the alluvial floodplain of the Danube river in the Pannonian biogeographic region and lays between 80-88 meters above sea level. The settlements are built above the 86 meter (e.g. Draž village) and the highest point in the former floodplain is the flood protection dike with 89.6 meter a.s.l. Area is characterized with flat topography but very subtle – with only few meters – differences along the horizontal gradient that are result of the hydromorphological evolution of the floodplain (Picture 10). Two oxbows (Boki Duna and Ostrováci Duna / Topoljski dunavac are remnants of the former Danube side branches and numerous depressions (*lapos*) and natural channels (*fok*) are still present. This is coupled with widespread network of melioration ditches.
The soil is formed mainly of riverine alluvial sediments as quaternary gravel, sand and clay deposits, as well as riverine alluvial deposits on the surface.

The climate is mild, humid continental (Cfwbx under Köppen’s classification) with hot summers and cold winters. The mean annual temperature is 10-11 degrees Celsius, while the average January temperature is 0°C (0.3°C at Brestovac-Belje station). The temperatures slowly rise through the year and reach its maximum during July with 22.4°C in average at Brestovac-Belje station (Table 2).

Table 2. Average monthly temperatures at Brestovac-Belje meteorological station during 1998-2008 periods (source: DHMZ, 2009)

<table>
<thead>
<tr>
<th>Month</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
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<th>10</th>
<th>11</th>
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<tr>
<td>T°C</td>
<td>0.3</td>
<td>2.3</td>
<td>7.0</td>
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<td>22.4</td>
<td>21.8</td>
<td>16.3</td>
<td>12.0</td>
<td>6.0</td>
<td>0.8</td>
<td>11.7</td>
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The annual precipitation is between 600-650 mm (an average 616 mm during the 1951-1996 periods on the Karapancsa station (DDNP 2008). The annual extremes are between 410 (1971) and 900 mm (1981) (Picture 11).
However, increase in the average annual precipitation of +22 mm has been detected comparing the 1951-1975 and 1976-1996 periods on the Karapancsa station (DDNP 2008). Similar trend has been recorded at the Brestovac-Belje station in Croatia where increase in the average annual precipitation of +36.6 mm were recorded comparing the 1948-1960 and 1998-2008 period (DHMZ, 2009).

During the course of year there are two peaks in the precipitation – primary maximum is in June and secondary in November while the dry seasons are recorded in late winter (January-February) and early fall (September-December) (Picture 12).


Picture 12. The average monthly precipitation at Brestovac-Belje meteorological station, Croatia (Source: DHMZ, 2009).
Hydrological conditions and hydrodynamics of the area are defined by the input values (precipitation, accumulation of runoff waters from upper parts, inflow through surface and groundwater increase) and output values (evaporation, transpiration, drainage by the watercourses and related ground water level decrease).

By the construction of the Mohacs-Draž flood protection dike the Ostrováci Duna / Topoljski dunavac, former old Danube river course, became an oxbow and the remaining floodplain has been disconnected from the river in a sense that flooding by the Danube river surface waters is prevented by the dike. This dike, 4150 m long from the Hungarian border to Draž village, prevents surface flooding of 775 ha of Gerechát and 2800 ha of Puškaš and Budžak areas. However, flooding is still possible by opening the Draž sluice and permitting the Danube floodwaters to enter the area by the gravitation.

The Gerechát area is drained by the Gerechát pumping station. Budžak is drained by the Budžak pumping station with capacity of 0.4 m$^3$/s that it is not reversible. On the other hand, Puškaš area is drained by the reversible pumping station with installed capacity of 2 m$^3$/s. In practice this means that water could be pumped from the Topoljski dunavac for the irrigation purposes. The water from the area is delivered to the Puškaš pump by the 6.2 km long drainage channel.

The surface water level in the Ostrováci Duna / Topoljski dunavac and other depressions depends on flood waters from the Danube River. During high water levels in the Danube (usually from March until June), that are originating from the snow melts and spring rains along upstream areas, the recent floodplain would be flooded reaching the eastern parts of the flood protection dike (Picture 13). Later during the course of the year, the Danube levels would slowly retreat and ground water levels would also decrease in the former floodplain.

![Graph showing mean monthly water levels at Bezdan gauging station](image)

Picture 13. Mean monthly water levels at Bezdan gauging station ("0" = 80.61 a.s.l) (Source: Bognar 1986).
As a consequence, the Ostrováci Duna / Topoljski dunavac primarily receive its water via three sources: a) precipitation, b) accumulation of the runoff waters from higher parts along Borza stream and Palfok, and c) by increase of the ground water levels during Danube floods. During rains and snow melt, the excessive surface waters would accumulate towards south-east direction reaching Topoljski dunavac, Boki Duna and western parts of the flood protection dike. Increasing pressure of Danube flood waters and soil type characteristics would cause ground water level increase along the western parts of the flood protection dikes, particularly in the Ostrováci Duna / Topoljski dunavac, as well as in the Gerechát and Budžak areas. At this time of the season, existing pumping stations would pump out the water from the area.

This process in the Gerechát and Budžak areas would be enhanced by the large evaporation from the surface waters and transpiration by plants, including agricultural production. During the vegetation season (March-September) the average precipitation during the 1998-2008 period was 394.8 mm (DHMZ 2009). At the same time, evaporation and transpiration values are estimated to 462.8 mm (Bognar 1986) creating the total deficit in the water balance of 68 mm. The deficit in the water balance would be present during the vegetation period and ranging from 0 (June) to 16.9 mm (September) (Table 3) (Bognar, 1986). At this time irrigation of agricultural land would be planned.

Table 3. Average monthly water deficit or surplus (in mm) at Brestovac-Belje station (Source: Bognar, 1986).

<table>
<thead>
<tr>
<th>Period</th>
<th>1</th>
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<td>1998-2008</td>
<td>39.6</td>
<td>34.8</td>
<td>45</td>
<td>52.9</td>
<td>55.6</td>
<td>88.8</td>
<td>73.2</td>
<td>63.1</td>
<td>61.1</td>
<td>51.1</td>
<td>63.1</td>
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<td>Evaporation</td>
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<td>and transpiration</td>
<td>1925-1956</td>
<td>10</td>
<td>16.4</td>
<td>44.3</td>
<td>64.4</td>
<td>64.5</td>
<td>68.5</td>
<td>84.6</td>
<td>80</td>
<td>56.5</td>
<td>36.3</td>
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<td>Surplus</td>
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Existing hydrological conditions in the water regime and water quality are further jeopardized by the following natural and anthropogenic changes and future plans:

- River bed incision – cutting through the meanders and the shortening of the Danube river has caused increasing water velocities and consequent river bed incision. According to the hydro-morphological data, the river bed incision is 1.3 meters in the past 100 years (DDNP 2008). This process has a profound consequences in the hydrological conditions of the Danube (decrease of water levels) (Picture 14 and 15), flooding potential (floods are less potent and shorter in duration), as well as groundwater levels (decrease of the groundwater levels)
Picture 14 Water levels and flows at the Mohacs gauging station (Source: DDNP 2008)

Picture 15 Decrease of the average low, middle and high water levels at the Mohacs gauging station (source: DDNP 2008)

- Increase of intensive agriculture practice and irrigation schemes – in the Croatian part of the Ostrováci Duna / Topoljski dunavac area recent plans of the Belje agricultural company are aiming towards the increase of the intensive agricultural practice and development of the new irrigation schemes. As a part of this plan, a new regional ground water pumping station near Topolje village is planned with maximum capacity of 150 l/s. These plans can further deteriorate the hydrological conditions,
particularly during late spring and summer when the water is needed for the development of natural plant and animal communities.

- Lack of water supply and water purification systems – no village in the Draž municipality is connected to the water supply system and households are getting their drinking water exclusively through private wells. Similarly, no wastewater treatment plants exists in the area and all communal and waste waters are stored in permeable septic tanks from where they are leaking into the natural watercourses causing substantial load of nutrients and toxic material. The need for the drinking water would be even larger with the advance of tourist development plans that are planned by Draž municipality and Mohacs town.

- Global warming and climate change – global warming and consequent climate change is evident during past 20 years. The temperature extremes are larger and summers are drier and hotter than in the recent past. These changes also affect the hydrological conditions due to the increasing evaporation and transpiration. Without proper measures applied lack of the water in summer period could jeopardize the well being of protected animal and plant species.

As a conclusion, a new water management and agricultural production practice is needed, not only for the nature protection purposes, but also for the sustainable use of natural resources. The aim of this management plan is to create a new platform for water management and agricultural production that would be nature friendly and long-term sustainable both for the biological and landscape diversity of the area, as well as for the well-being of the local population.

The basis for the new platform is to, as much as possible, mimic the natural hydrological cycle that were present before the regulation and melioration projects. In other words, the plan is to use the existing surface and ground water sources and hold them as high as possible during early spring and summer in the former floodplain to mimic the natural floods. During late summer, by natural processes (evaporation and transpiration) and water management facilities (pumps and sluices) the surface waters would be decreased to mimic the dry season.

The increase of the surface water levels during March-June period could be achieved by:

- accumulation of runoff waters from rain and snow melt
- increase of the Topoljski dunavac water levels allowing the Danube flood waters to enter the former floodplain via Draž sluice
- increase of the groundwater levels during Danube floods, and
- termination of the water pumping and extraction from the former floodplain

It is desirable to maintain the surface water level in Topoljski dunavac at 250 cm level at the Draž sluice. Also, to enhance the hydrological conditions in the Gerechát area it is necessary to reconnect the connection between Gerechát and Topoljski dunavac by the existing fok where this connection is now prevented by the small flood protection dike.

As a consequence of these activities and surface water increase the natural depressions at Gerechát, Budžak and Puškaš areas would be temporarily flooded
creating ideal breeding and spawning habitats for fish, amphibians and reed nesting birds and enhancing the living conditions for the protected plant species and wetland plant communities. Retention of the water in late spring and early summer would create conditions and help the desired irrigation plans during late summer and enhance the agricultural production.

Increase of the surface water levels would also benefit the recharging and water quality of the ground water sources that are based for drinking and use by local populations.

This plan has obvious benefits for the natural values but for the success it should be coupled with appropriate changes in the land use and agricultural and water management practice. During spring flooding the lowest parts of the agricultural fields would also experience ground water increase and became unavailable for the agricultural production. Instead of wasting resources in the draining attempts it would pay off to convert such areas into wet meadows and grasslands and maintain them with moving and grazing.

Such changes in the land use are developed in detail at the Gerechát area where National park Directorate plans to increase the areas under wet meadows and pastures and maintain them with traditional old breed species such as Podolian cattle. Together with the increase of wet meadows and pasture further increase of the rare and threatened populations would be possible such as Lapwing *Vanellus vanellus* or Lesser spotted eagle *Aquila pomarina* – species that ones bred in the area but they went extinct due to the loss of available feeding habitats.

Second important part of the land use change is abandonment of maintenance of drainage ditches and creation of hedges and bushes that would increase the landscape diversity and serve as green corridors through the area.

Coupled with the increase of biological and landscape values, an increase of the tourism and recreation potential can be expected that would at the end benefit local communities. Both Mohács town and Draž municipality already have strong plans for the development of tourism that is primarily based on the valuable natural resources.

**Recommendations for measures with nature conservation relevance**

**Vision**

The main vision of Ostrováci Duna / Topoljski dunavac Management plan is:

**Ostrováci Duna / Topoljski dunavac is the best example of the trans-boundary wetland management practice for the benefits of Nature and People, promoting the sustainable use of natural resources as well as efficient and adequate protection of natural values.**

To achieve the above Vision following long-term goals are defined:
1. Protect and conserve the biological diversity with special regards to rare and threatened species and habitats.
2. Protect and enhance wetland functions and values, including restoration of important hydrological processes
3. Secure the sustainable use of natural resources through appropriate water management and development of nature friendly practices of land use (including agriculture and husbandry, forestry, fishery, recreation and tourism) with respect to the needs of local population and benefits of existing and future generations.

The above long-term goals should be achieved with following short-term goals and activities:

A) Water management and water level regulation

Goals:
- To improve the hydrological conditions in the Ostrováci Duna / Topoljski dunavac area by using the existing water management system in order to mimic as close as possible the former natural hydrological conditions
- To increase the surface area that is regularly and temporarily flooded to prevent decrease of the wetland habitats and secure occurrence of natural processes such as migration and spawning of fish, breeding and feeding of bird species, as well as reproduction and dispersion of amphibians, reptiles and mammals
- To increase the total amount of surface waters in the target area through the accumulation of precipitation and by free-flowing through the Draž sluice
- To increase the surface area of melioration ditches that are no longer used for drainage and that alongside have developed natural wetland vegetation communities in order to increase the landscape values of the Ostrováci Duna / Topoljski dunavac area
- Secure that melioration ditches maintain conditions as natural as possible in order to enable dispersion, reproduction, and feeding of wetland related plants and animals

Activities:
- In cooperation with Hungarian and Croatian water management authorities (Kelet-Baranyai Talajvédelmi és Vízgazdálkodási Társulat (KEBAVIT) and Hrvatske vode) increase the total amount of surface water in the target area by use of existing water management system by following:
  1. Secure that during the period March-June the Topoljski Dunavac water level reach the average 250 cm value at Draž sluice
  2. Secure that during the period June-August the Topoljski Dunavac water level slowly drops to 100 cm value at Draž sluice
  3. Secure that existing pumps (Gerechát, Budžak and Puškaš) modify their pumping activities in accordance to the nature protection needs
- Stop the destruction of wetland vegetation communities, particularly reed beds and sedge communities, along the Ostrováci Duna / Topoljski dunavac and natural depressions at Gerechát, Budžak and Puškaš
- Secure the regular flooding of natural depressions and reed beds at Gerechát, Budžak and Puškaš by water level increase in the Ostrováci Duna / Topoljski dunavac
- Establish the network of water-gauges that would measure the surface- and ground water levels at Gerechát, Budžak and Puškaš
- Carry out regular monitoring of the surface of marshes and flooded depressions using remote-sensing tools and verification in the field
• Abandon the melioration and channel “cleaning” activities on the 3<sup>rd</sup> and 4<sup>th</sup> class of melioration ditches in the Gerechát and Budžak areas
• Secure enough amount of water in the melioration ditches, particularly during the vegetation season, to ensure their roles in the biodiversity protection and irrigation

B) Nature protection and restoration

Goals:
• To secure the survival and population increase of rare and threatened species
• To secure the survival and increase in cover of rare and threatened habitats
• To secure the evolution and quality of alluvial forest communities, including their natural rejuvenation, succession and ageing
• To secure the existing old natural forest communities that support the life of NATURA2000 and other protected species, and increase their quality and ability to carry out ecological functions
• To increase the surface area and quality of natural wet grassland communities by appropriate management methods (grazing or moving)
• Increase the populations of rare and threatened species related to wet grasslands

Activities:
• Develop appropriate Species protection action plans, including measures for their protection and necessary habitat restoration
• Carry out regular monitoring of rare and threatened species, including their distribution, population size and dynamics
• Develop appropriate Habitat protection action plans, including measures for their protection and necessary restoration
• Carry out regular monitoring of rare and threatened habitats, including their distribution and viability
• Carry out restoration works on the existing Gerechát fok in order to ensure hydrological connection of Topoljski dunavac and Gerechát
• Carry out inventory of the current state of the forest communities and their ecological status according to the botanical principles
• Carry out regular monitoring of the distribution and viability of forest communities, particularly which are important for NATURA 2000 sites
• Improve the quality of forest habitats with increasing their naturalness and ability to carry out ecological functions, including the replacement of plantations with autochthonous communities, increase of their age and species diversity
• Carry out on a regular basis protocols for the elimination of invasive plant species, particularly Amorpha fruticosa
• Map and legally protect from the logging the best examples of the natural forest communities that support species and habitat relevant to NATURA 2000 network, and let them to the natural processes of the evolution of forest communities
• Decrease the numbers of game animals to reach the carrying capacity of the target area
Stop the further fragmentation of forest communities by abandoning the use of certain forest roads and hunting lines
Carry out inventory of grassland communities and develop appropriate Action plans for their protection and restoration
Increase the surface area of natural wet grassland communities at Gerechát and Budžak areas via appropriate management measures
Stop the fragmentation and burning of reed beds and sedge communities as a result of hunting activities
Maintain the wet grassland communities by grazing with traditional breeds or regular moving

C) Agriculture
Goals:
- To use agriculture areas at Gerechát, Budžak and Puškaš in the nature friendly way that would be long term sustainable and for the benefit of Nature and Humans
- To increase the implementation of ecologically friendly agricultural production

Activities:
- Stop the activities that lead to further destruction of agricultural areas and habitats, and decrease of the populations of rare and threatened species in cooperation with agricultural companies (Bóly Rt., Belje d.d.), private users and other relevant institutions (particularly melioration and drainage of the area)
- Within the next 10 years through the cooperation with agricultural companies (Bóly Rt., Belje d.d.) and private users ensure that agricultural management practice change from the intensive production to the nature friendly management practice
- Secure that in the 10 year period at least 50% of the existing agricultural land at Gerechát and Budžak area is converted to the wet meadows and pastures
- Secure the cessation of vegetation destruction along the melioration ditches and rodenticide use on all agricultural lands at Gerechát and Budžak area

D) Husbandry
Goals:
- To use the wet meadows and pastures in the nature friendly way that would be long term sustainable and for the benefit of Nature and Humans
- To increase the population of traditional breeds and use them in the habitat restoration projects

Activities:
- Increase the area under traditional type of husbandry using traditional breeds

E) Forestry
Goals:
- To use the forest communities that would be long term sustainable and for the benefit of Nature and Humans
- To increase the area under autochthonous forest communities
Activities:
- In cooperation with forestry service (Gemenc Rt.) and other relevant institutions stop the activities that lead to further destruction of forest communities and habitats, ecological functions of forest ecosystems and decrease of the populations of rare and threatened species
- Within the next 10 years through the cooperation with forester service ensure that floodplain forest management change from the current to PROSILVA type nature friendly forest management that would increase age, species diversity of the forest ecosystems
- Within the next 10 years replace the existing forest plantations of alochtonous species and restore them into native forest communities

F) Fishery
Goals:
- To use fish populations in a sustainable way to ensure the long term stability of their populations
- To increase the area for the fish spawning in the Gerechát, Budžak and Puškaš area

Activities:
- Ensure the sustainable harvest of fish population through appropriate zoning, capacity determination, daily and annual fishing quotas as well as application of protection measures during the spawning period
- Increase the cooperation with angling societies to reach the above goals
- Promote the use of traditional fishing tools as a measure for conservation of ethnological knowledge
- In cooperation with angling societies organize actions for the removal of litter and other garbage from fishing posts

G) Recreation and tourism
Goals:
- To ensure visit, experience, and interpretation to all visitors within the limits of the carrying capacity of the area

Activities:
- Develop visitor action plan including zoning and calculation of carrying capacity
- Develop appropriate promotion tools for the wider region
- Include local population into regular management meetings

Zoning
In order to achieve the efficient and adequate protection of natural values the following zoning is proposed:

Translate from Kopackí rit nature park MP – include map
References:


