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The influence of hydrotechnical engineering works on the habitats along the Danube in Romania

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Abstract: This study is pointing out the main pressures on the river habitats along the Danube in Romania, like hydropower, agriculture, gravel extraction and navigation. The hydrotechnical works needed for these issues led to major connectivity issues, to important floodplain losses and to other river habitat alterations. The study is also providing a brief analysis of the main drivers for river restoration in Romania.

Keywords: Danube, habitat, fish migration, restoration, navigation, hydropower.

1. INTRODUCTION

15 % of the degraded habitats to be restored until 2020. This is the figure the participants at the Conference of the Parties 10 (CoP10), including Romania, committed to restore [1]. This determination is complementary to a large range of european directives and of national legislation which was assumed by Romania in the course of adheration to the EU.

Habitat degradation is the process by witch a habitat is modified to that extent, that it can no longer offer the natural life conditions to the species and communities naturally occurring at this site. A major habitat degradation leads inevitably to a loss of habitat.

If, at a global level, habitat degradation is the major cause of extinction and endangering species [2], degradation can be a result of natural causes, but is in the present induced by anthropic activity. In the EU, the majority of ecosystems and services offered by these have been degraded to a big extent as a result of habitat fragmentation. Almost 30 % of the EU surface is moderate to heavy fragmented [1].

Fragmentation can affect negatively populations, reducing the quantity and quality of habitats, raising mortality following impact with vehicles, by entangling with fences or nets, by transiting hydroscheme turbines or by blocking access to feeding or reproduction grounds, subdividing the populations in smaller vulnerable fractions, but, more important, by making dispersion and migratory movements impossible.

2857 km long, the Danube is after the Volga river the second largest stream regarding the size and flow. 1075 km are on romanian land, partially forming the borders to Serbia and Bulgaria. 29 % of the Danube river basin is formed by romanian land and 97.4 % of Romania is drained by this stream.

The Danube is the largest tributary of the Black Sea, forming the Danube Delta on 6750 sqkm, an area protected as a Biosphere Reserve, a wetland of international importance, included in the world cultural and natural heritage list.

This article will put an emphasis on the romanian stretch of the Danube, excepting the Danube Delta because of its outstanding complexity.

2. METHODS

For this study, literature up to date but also of historical importance has been consulted, along with historical and recent maps, as well as satellite imaging. Field trips during monitoring activities have broadened the perspective on this subject.

3. RESULTS

3.1 Hydromorphological alterations

Although mankind exerted its influence for millenia, human interventions in nature led in the last century to a catastrophic loss of biologigical diversity and natural landscape. Among these interventions is the longitudinal continuity interruption, reduction of the natural hydrodynamics of the Danube, draining of the floodplains, cutting of channels through the landscape, poaching or even clearing of the floodplain and terrace woods. The consequences are the amplification of the erosion and of the landslide at the terraces with catastrophic losses for the inhabitants. These areas are already in a state of natural instability [3].

According to [11], only short stretches of the Danube are in the reference state, having in mind the naturality of the banks and the connectivity with the floodplain. Such streches can now be found in Croatia, Serbia, Bulgaria and Romania: Kopacki Rit, Gronje Podunavlje and the right bank of the Insula Mică a Brăilei [4].

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As a consequence, according to the Water Framework Directive, with the exception of the Delta, the romanian strech of the Danube is designated as heavily modified.

3.1.1 Longitudinal river connectivity interruptions

The longitudinal continuity of rivers is often interrupted by human actions. Dams and artificial waterfalls represent a physical barrier for the natural migration of the aquatic fauna, impact that can be somewhat reduced by a fish pass.

On the other hand, a dam is associated with a reservoir that is radically changing the river: flowing speeds are reduced and a series of characteristics are dramatically altered: substrate, temperature, turbidity, oxygen level etc, with important effects on the natural fauna and flora. The survival rate of migratory species is negatively influenced by these reservoirs, the drift of the larvae and juveniles being slow or absent, the effects of all the other changes are accentuated, so that they are delayed in the migration in the best case [5].

For 2009, the Danube River Basin District Management Plan is mentioning 78 barriers, of which only 22 can be passed by fish [6]. Of these barriers, only 2 are on the romanian-serbian stretch on the Danube, but, being the first unpassable barriers encountered in the upstream migration, these represent the most stringent issue in addressing the conservation of the sturgeons that occurred naturally in the Danube.

For the exploitation of the huge energetic potential of the Danube, but also for a safer navigation, the chosen solution was to build a pair of hydrotechnical systems on the romanian – yugoslavian border. Beginning with 1965, the Iron Gates Dam I was built until 1972. With the maximal head of 34.50 m, the plant has been equipped with 2x6 vertical Kaplan turbines, 175 MW each. The year 1977 marks the beginning of the Iron Gates Dam II with a maximum head of 12.75 m, equipped with 2x10 horizontal Kaplan turbines, 27 MW each, finished 1986.

Historical accounts show that sturgeons used to spawn in the middle course of the Danube, as well as in its tributaries, like Tisa, Sava and Drava. But, after completion of the Iron Gates, in only 5 years have been captured 116 t Huso huso and Acipenser gueldenstaedti, 25 % more than in the previous years, only to drop then to 37 t for 1980-1984 [7]. The influence of these dams for the fauna is obvious, they are not fitted with fish migration facilities and the intake racks are not offering any kind of protection to fishes in the young stages.

Regarding the longitudinal river connectivity, there are also other interventions planned or even in progresses. Discussions are taking place between the governments of Romania and Serbia to build te Iron Gates Dam III for hydropower at Pesača [8], another dam is proposed at Islaz – Nikopol for navigation purposes [9], but also one at Călăraşi – Silistra for hydropower [9, 10].

The work is in progress on a series of ground sills on the stretch between Călăraşi and Brăila for the navigation [11] and for the cooling system of the Cernavodă nuclear power plant [9]. Another dam proposal is made at Măcin for hydropower and for the cooling system of the Cernavodă nuclear power plant [9, 10, and 12].

3.1.2 Hydrological alterations due to regulations and water abstraction

Already in the early seventeen hundreds, intensive regulation has taken place on the Danube. The solutions were to cut-off meanders and to narrow the riverbed, resulting in higher flow velocity, increased slope and shear stress. 62 major hidrological alterations are putting under pressure the Danube River:

- the Iron Gates Dams, affecting the whole romanian stretch and further upstream part of the serbian one;
- Slobozia deviation, transferring water from the Danube into the Ialomița basin for Slobozia city
- water abstractions for Călăraşi, Giurgiu, Galați, Brăila etc
- water abstractions for agriculture: Sadova-Corabia, Giurgiu-Răzmireşti, Gălățui-Călăraşi, Pietroiu-Ştefan Cel Mare, Terasa Brăilei, Carasu
- The Danube - Black Sea Channel, 64 km long, with a complex destination: navigation, cooling water for the Cernavodă nuclear power plant, water for Constanța city, industrial and drinking water through Gogoşu abstraction and irrigation water for 202386 ha land in Dobrogea. This Channel can abstract about 330 m^3 water at low levels of the Danube [13].

3.1.3 Loss of floodplains

After human interventions for erosion limitation through channel stabilization, the natural exchanges of the river with the floodplain cannot find an equilibrium. On one side, riverbed stabilization and dredging eliminate ecologically very important elements from this circuit, creating a uniform aquatic environment, but, on the other side, the erosion downstream can take to a vertical separation and hydrologic decoupling of the river from the floodplain through bed incision [14]

The recent reduction in floodplains is a direct consequence of agricultural expansion [3], resulting in changes of the hydrologic regime of the soils, loss of spawning areas for different fish species, reduction of habitats for birds, major changes in vegetation, loss of organic matter through mineralization, changes in sediment and pollutants transported by the river.

87 settlements are placed in the historical floodplain [3].

Historically, 10% of the Danube river basin was represented by floodplains. Today, only 19.5% of that area is regularly flooded [14]. Regarding the Danube, 32 % of historical floodplains still exist. In Romania, between Baziaş and Tulcea, the floodplains measured 1959 553.400 ha, with widths up to 24 km. Today, with dikes on 73 to 92 % of the length of different stretches [13], 462.000 ha of floodplain have lost the contact with the river.

Although pioneered by Grigore Antipa in 1910 [16], the concept "room for rivers" is gaining today more and more followers. Even in the Netherlands, with tradition in flood protection, the floodings of

1993 and 1995, solded with the evacuation of 200.000 inhabitants, showed the vulnerability of classical flood defense. The main objectives of this concept are safety of the inhabitants and spatial quality.

To illustrate the extent of floodplain loss, in Fig. 1 we present the 1880 map of the floodplain at Călăraşi and in figure 2 a 2009 satellite photography of the same area, with obvious alterations due to human interventions.

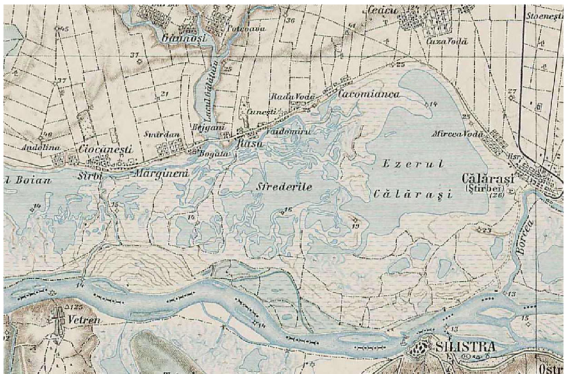

Fig. 1. The floodplain at Calarasi in 1880. Source: Franzisco-Josephinische Landesaufnahme 1910

Fig. 2. The floodplain at Calarasi in 2009. Source: Google Earth

3.1.4 Sediment transport alteration

The hydrotechnical interventions of the last 150 years, that aimed torrent control, dredging, hydropower, riverbank consolidation, but also the loss of 90 % of the Danube basin floodplains, altered severely the sediment transport, to the extent that this transport on the Lower Danube is today only 30% of the natural quantity [6].

Impoundments imply a low flow velocity, acting as a settling pit for the sediment, so that downstream there is a shortage of alluvium that must be compensated by artificial river bed stabilization, resulting in river channel incision, which for the romanian Danube is about 2 to 3 cm a year [6].

Another effect is the reduction of the self-cleaning capacity of the river, because the quantity of pollutants adsorbed to the particles in suspension is also reduced. On other hand, the settling of the sediment in impoundments is requiring intensive dredging for navigation purposes, altering even more the sediment balance in the river.

Aggradation is also the cause for the failure of the Iron Gates Dams to attenuate the 2006 floodings, causing high water levels in the upstream Danube and its tributaries [17].

3.2 Driving policies for river habitat restoration

For Romania, the main support for river and floodplain restoration is represented by the Water Framework Directive. Aiming to prevent deterioration of the status of all bodies of surface Waters and to achieve a good surface water status / good ecological potential, the directive considers for its environmental objectives quality elements like biological and hydromorphological elements, with emphasis on all native species. It is obvious, that without reconnection of the floodplains and without a longitudinal connectivity, these objectives cannot be reached.

Even if the Water Framework Directive is the main direct driver of river habitat restoration, with the background of the United Nations 1992 Convention on Biological Diversity, of the EU Strategy of the Danube Region, other directives and legislative instruments are complementary in effect: the Flood Directive, Habitats Directive, the Birds Directive, the Groundwater Directive, the Nitrate Directive, the Strategic Plan for Biodiversity of the United Nations, the Common Agricultural Policy, the Common Fisheries Policy, all supported by national legal instruments like the Environmental Protection Law, Protected Areas Law or the Fishing Law. Moreover, there are different organisms that are actively encouraging the river habitat restoration like the Food and Agriculture Organization of the United Nations, the International Commission for the Protection of the Danube River, the World Commission on Dams, the World Sturgeon Conservation Society or the World Wildlife Fund.

3. DISCUSSIONS

The natural course of a river is subject to a continuous hydromorphological change, creating permanently new habitats that will be modified in time through environmental influence and different faunistic and floristic successions. Understanding that the river is a living process, but also taking into account the river history are essentials for a correct approach of river restoration.

This study showed a few of the different pressures that are putting some of the water bodies of the Danube at risk of failing the environmental objectives stated in the Water Framework Directive and making the whole romanian section of the Danube to be designated as heavily modified.

Even if some of the alterations are of a major extent, there still is an important restoring potential for the Danube: the restoration of the floodplains for the flood and fishery management and the restoration of the longitudinal connectivity for the fish migration

Although the flood protection was supposed to offer security in front of the high waters, between 1970 – 2008, after the majority of the dikes were built, in Romania have been flooded 231.613 dwellings with the loss of numerous human life's [9].

This reality has to create a shift in thinking, by abandoning the traditional flood protection strategies. This already happened by implementing the Water Framework Directive, the Flood Directive and all the other conventions and by applying the strategies of "more nature for more safety" and "natural component of flood management". This necessity is accentuated by the fact that 73% of the romanian floodplain of the Danube, not less than 418.543 ha are marked by the anthropic influence, being in a phase of instability due to erosion, in lack of a permanent vegetation cover [3].

It is crucial to understand that the Water Framework Directive and the Flood Directive are addressing different needs, but are using complementary principles for the safety of nature and of the people, without contradiction between the objectives and the instruments of the two directives.

It must be emphasized that floodplain restoration will only reduce the risks of future flooding if it is accompanied by wetland restoration [17].

With a loss of 68% of the historical floodplains of the whole Danube, it is estimated that there is a potential of reconnection of 24% of the historical surface, the largest part of it being with 473.556 ha in Romania. By reconnecting these floodplains, the overall loss would be reduced to approximately 44%.

If the World Wildlife Fund is identifying 90.000 ha of reconnecting potential in Romania, it also shows that 40% of that surface was under water at the 2006 floodings, drawing once again attention to the inefficiency of the traditional flood defense [17].

Another sensible subject is represented by the fish fauna. Especially the sturgeons are affected by the dams of the Iron Gates, these being unpassable barriers in the migration route to the spawning grounds. The impact of the dams is so severe, that Romania, Serbia and Bulgaria banned the fishing of these fishes. The first steps being made, there is an urgent need to keep the poaching as small as possible and to restore the longitudinal connectivity. A preliminary assessment of the Food and Agriculture Organization of the United Nations is already presenting the possibilities of technical fishpasses, fish elevators, but also of natural-like fishpasses [18].

In the context of the energy shortage, it is obvious that the demand for hydropower will rise, since this is regarded as a renewable energy. But, as shown in this study, the habitats that are modified and the lost species cannot be seen as renewable. Practically, once out of its natural context, no habitat can regain 100% of its initial structure and functionality, not even with huge amounts of money spent on restoration projects.

As already described, there is already a legal base for the protection, conservation and restoration of the river habitats, but the implementation can take a long time. That's why public consultation and information are essential, and exactly why education plays a major role in every form and for every generation.

It is notable that in the field of restoration and conservation the romanian civil movement managed to coordinate different programs, to access different funds and to show a maturity in addressing environmental issues, sometimes with effects at the highest national or international level.

For the future, there is a need for a holistic approach: local measures can have effects on local scale, but sometimes are influencing distant parts of the world. The dynamics of the natural systems has to be respected in order to benefit of all the environmental services. The european initiative to address the waters at a basin level is an opportunity to communicate and cooperate, to take coherent measures based on similar principles.

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