RESTORATION OF LATERAL CONECTIVITY OF THE ROMANIAN DABUBE RIVER, STRATEGIES AND LOCAL ACTIONS

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Abstract: The reduction and degradation of floodplains along the Danube River have caused some shortcomings such as catastrophic floods, increasing water eutrophication, decreasing catches of fish, biodiversity loss, decreasing water quality. To mitigate these shortcomings that cause problems both in ecological systems and in the socio-economic systems, in the Danube River Basin it is promoted a new concept, namely "more space for rivers". The application of this concept is found both in the European strategies such as the Danube Pollution Reduction Programme, and in the national strategies such as Ecological and Economical Resizing of the Romanian Danube Floodplain, given in this paper. Implementation of this concept is presented by describing punctual space planning solutions of area between Macin and Isaccea, for reactivating a former floodplain of the Danube River.

Keywords: biodiversity loss, cooperation, flooding, projects

Introduction:

The Danube River has a special importance to navigation, hydroelectric power production, fish farming, water supply for industry, agriculture, population. On the Romanian territory the floodplain is situated between Gruia village, downstream the Iron Gates II (851 rkm) and Isaccea town (108 rkm) and has an area of about 530,500 ha.

In the last 100 years the Danube River and especially its floodplain have undergone deep changes in order to use its functions for the development of economic and social activities. Thus, drainage and damming activities begun in the years 1904-1906, were completed by 56 enclosures totalling in 1990 about 431,800 ha, representing 81.4% of the entire Danube Floodplain (Ioaniţoaia et al. 2007).

The reduction and degradation of floodplains causes the loss of large water retention areas which originally mitigated flood risks, the loss of functional wetlands and their resources and services they typically provide, e.g. groundwater replenishment, sediment and nutrient retention, water purification, resilience and recovery of river ecosystems after accidents, biodiversity (riparian ecosystems are critical for the conservation of key species and habitats, particularly pioneer habitats and soft and hardwood forests), river-floodplain products (wood, fish, game, reed), cultural values, recreation and tourism, and climate change buffering capacity.

However, the political changes in Central and Eastern Europe, as well as in EU policies (Water Framework Directive, Flood Directive as well as Habitats and Bird

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Directives) are fostering efforts to re-establish the lateral connectivity of floodplains along the Danube River and its major tributaries through restoration projects. Also the Ramsar Convention on Wetlands supports the conservation and restoration of floodplains. For about 20 years restoration projects have been under planning and implementation in various sizes and with different purposes and levels of success (Zöckler 2000; ECRR 2001, 2008).

The need to restore floodplains

Along the Danube River were assessed four types of floodplain (Fig. 1).

(1) Active floodplains with still more or less typical habitat conditions (near-natural), side-channels with pioneer stands, floodplain forests and pastures, wetlands and oxbows.

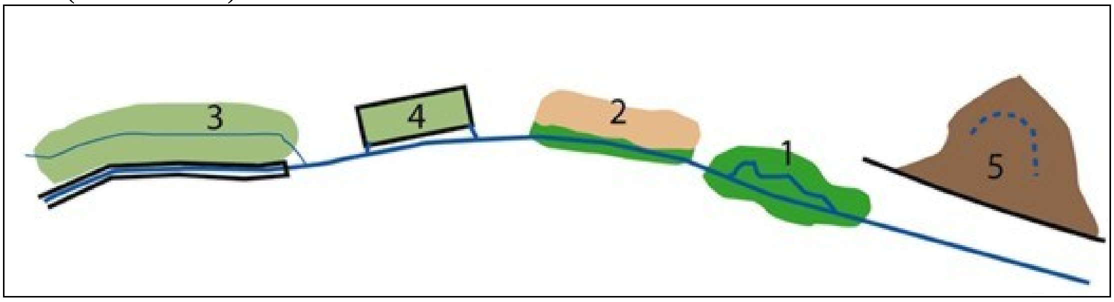
(2) Active elevated floodplains, strongly altered due to substantial sedimentation and mostly used for agriculture; but still potentially flooded during major flood events.

(3) Active floodplains along impounded reaches (often disconnected laterally from the main channel) still flooded during major flood events (from 5-10 year flood events and upwards).

(4) Polder (technical structures) completely surrounded by dikes, but opened in case of catastrophic floods.

In natural conditions floodplain ecosystems provide goods and services but after the destruction and degradation of these floodplain ecosystems these benefits were reduced, in addition there are a following malfunctions.

Figure no. 1 Floodplain types: 1-floodplain near-natural; 2-floodplain elevated by sedimentation; 3-floodplain along impounded reaches; 4-flood polder; 5-former floodplain disconnected by dikes and dams (Schwarz 2010)



Catastrophic floods

On the background of climate change extreme events like floods and droughts have gained an increasing frequency and magnitude (Yiou et al. 2006; Mareş et al. 2008). Thus, catastrophic floods in Romania had the following frequency: 10 during the XVI century, 19 in the seventeenth century, 26 in the eighteenth century, 28 in the nineteenth century and 42 the twentieth century. The frequency of floods and their magnitude have increased, mainly due to climate change but also due to reduction of transport capacity of beds by developing of settlements in the floodplain's watercourses (Pătruţ 2010).

The most important floods on Romanian Danube River, from the period when there are systematic hydrological observations, were in May 1930, April 1940, July 1942, May 1955, June 1970, June 1988, April 2004 (Gabor and Şerban 2004) and April 2005, April 2006, March 2009, July 2010, January 2011 (Pătruţ 2010). During the period 1965-2012 Danube floods with peak flow higher of 10,000 m^3/s were registered in 24 years. The following table (Tab. 1) shows the maximum values of these flows at Bazias and the moment of maximum flood (INHGA 2009).

Historical flood from April-May 2006 on the Danube River was the cause of accidental or controlled breaking of defence dams for 10 agricultural enclosures, totalling an area of 73,144 ha.

Table no. 1 Production of floods in last 40 years (INHGA 2009)

No.	Year	Month	Q max (m^3/s)
1	1965	VI	12250
2	1966	II	10810
3	1967	IV	11050
4	1968	I	10500
5	1970	V	13040
6	1974	XI	12100
7	1975	VII	12150
8	1976	VI	11400
9	1977	III	12200
10	1979	II	10900
11	1980	V	11900
12	1981	III	14800
13	1982	I	10500
14	1987	V	11610
15	1988	IV	12690
16	1998	XI	10280
17	1999	III	11100
18	2000	IV	12000
19	2004	IV	10800
20	2005	IV	12900
21	2006	IV	15800
22	2009	III	10700
23	2010	VII	13350
24	2011	I	10200

Intensification of water eutrophication

In the Danube basin, the total amount of nutrient discharge was about 1242 kt/year nitrogen and 32 kt/year phosphorus in the period 1990-2000 (Tab. 2). For both nutrients, the load is far from the natural background by 61 kt/year nitrogen and 7 kt/year phosphorus, these being the portion of the diffuse nutrient emissions into the river system caused by natural conditions and independent from human activities (DPRP 1999). The Danube River, the main river of the Black Sea basin, has 60% from the total fresh water runoff and brings maximum pressure to marine ecosystem (Tab. 2) (Berlinsky et al. 2005).

As a result, the phytoplankton "blooming" became a permanent annual process. Average biomass of phytoplankton in northwestern part increased from 1,030 mg/m^3 in 1960 to 30,000 mg/m^3 in 1980. Maximum values were registered in 90's years, up to 1,6 kg/m^3 (Berlinsky et al. 2005).

The eutrophication of the NW Black Sea due to Danube River inputs was one of the most problematic environmental issues of the last decades. A study done within 2006-2011 period show that the inorganic phosphorus content of NW Black Sea waters is influenced by the Danube's and WWTPs input. Due to different flows, the fluvial input is more significant. Long-term, were observed decreased concentrations up to comparable values with 60's, reference period thus, these low values give to phosphorus the feature of a limitative element for the phytoplankton's proliferation. But, the inorganic nitrogen content is mainly influenced by the Danube's input (Lazăr et al. 2012; Gomoiu et al. 2013).

One of the effect of eutrofication is hypoxia phenomenon. During the period 1981–2009, each year exhibits seasonal bottom hypoxia at the end of summer. This phenomenon essentially covers the northern part of the Black Sea – which receives large inputs of nutrients from the Danube River (Coops et al. 2006).

A study during 12 years of the current degree of eutrophication of Razim and Sinoie lakes, which are supplied with the waters of the Danube River, after these have been filtered in the floodable areas of the Danube Delta, show that there are least affected by the process of eutrophication (Godeanu and Galatchi 2007).

Data on the first blooms in the Danube Delta lakes associated with increase in phytoplankton abundance, particularly due to the increase of nutrient pressure, has been recorded by Oltean and Nicolescu since 1980

(Oltean 1985; Oltean and Nicolescu 1985). Studies performed in 15 lakes of the Danube Delta during the “bloom” of 2001-2006 period show that in 53.26% of the cases the density of algae exceed the threshold of bloom (14 x 10^5 cells/l). During 2001-2006 the highest value of recorded algae density (812 x 10^5 cells/l) was recorded in September 2001 in the Rotund Lake (Török 2005, 2008).

Table no. 2 Nutrients runoff characteristic of Danube River input to the NW part of the Black Sea (10^3 tons per year)

Period (year)	$N_{min.}$	$N_{org.}$	$P_{min.}$	$P_{org.}$	Si	Σ nutrients runoff
1950-1960	142	113	13	6	766	1040
1990-2000	188	1054	18	14	573	1847

A long-term analysis (1976-2011) of cyanobacterial blooms in Roşu Lake (Danube Delta) show that, after 1980, yearly averages of biomass exceeded 10-30 times the "water blooms" threshold. Monthly averages in July-September period exceeded 100-125 times the mentioned limit. The spectacular values of cyanobacterial abundance and biomass between 1980 and 1990 triggered also the dominance of potential toxic species. While in 2001 the diatoms and cyanobacteria biomass decreased, especially in the warm seasons, and the ecosystem tended to reach a functional regime, a more stable one due to a lower nutrient pressure, in 2011 the high values of phytoplankton biomass (78.72 mg/l wet weigh) showed new eutrophication signals, including intense cyanobacterial bloom episodes (Moldoveanu and Florescu 2013).

Decreasing of fish catches

The diversity and the stability of the ichtyofauna largely depends on the existence and the functionality of floodplains ecosystems. The reduction and degradation of floodplains directly affect the fish fauna by losing important breeding areas for the semi-migratory species and by loss of significant rearing areas with abundant and easily accessible food sources. Indirectly, the fish fauna is affected by the degradation of floodplains on account of the hydrological regime change, due to reducing the self-purification capacity of Danube ecosystems, as well as of reducing the food intake from floodplains.

An illustrative example is the correlation between the increase of floodplains damming from 10,000 ha in the year 1961 to 100,000 ha in 1993 year, simultaneously with the decrease of ciprinide catches from approx. 7,000 tonnes to less than 1,000 tonnes (Fig. 2). For the same period sturgeon and shad catches also featured a decreasing trend (Fig. 3).

The loss of spawning habitats due to impoundage along to Danube River had fatal effects, especially for the wild carp and the pike, whose number rapidly depleted. In general, the number of fish species, their density, and fish catch decreased significantly. The sturgeon, once providing livelihood for many communities along the Danube River, faces extinction due to overexploitation and habitat loss (disruption of migration routes, pollution, hydromorphological changes). Restoring the sturgeon fishery in the Lower Danube River is both an important ecological and economic goal (Paraschiv et al. 2006).

To improve the situation, it has been proposed to restore the bilateral connection between the main channel and the side arms, to ensure fish migration between the main channel and the side arms, and to simulate the original flooding of the floodplain (Holcík 2003; Hulse and Gregory 2004).

Figure no. 2 Decreasing catches of ciprinides in the period 1961-1993 (Staras 1995)

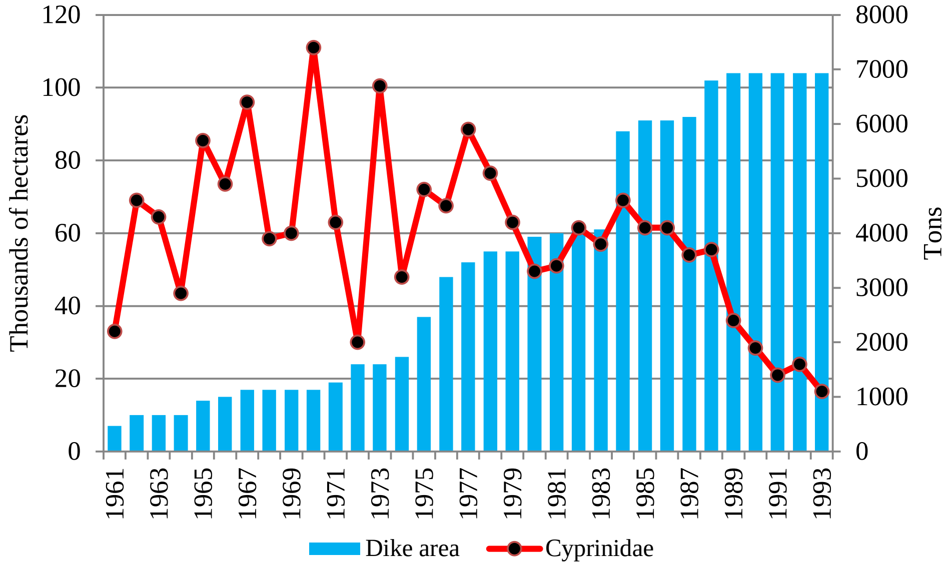
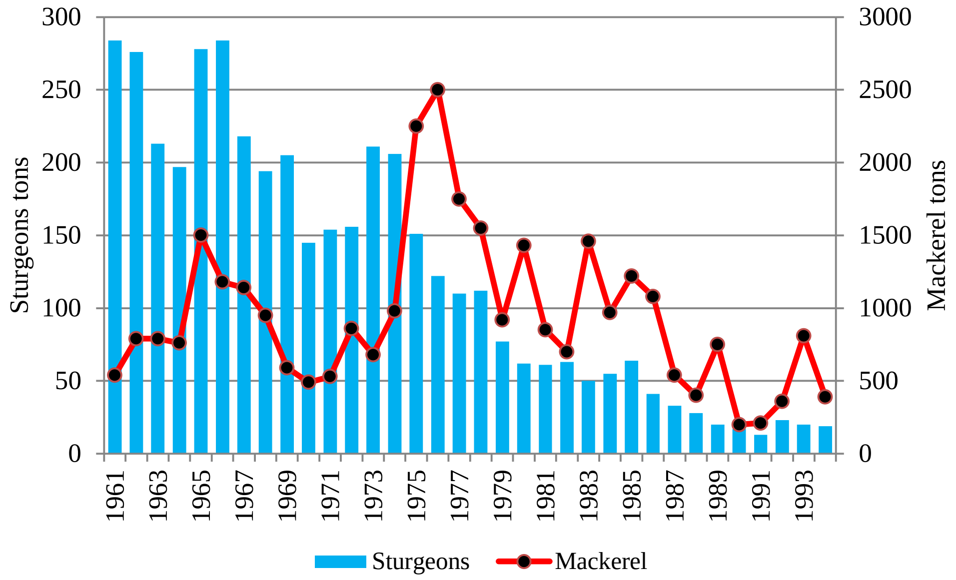


Figure no. 3 Decreasing catches of sturgeons and pontic shad in the period 1961-1993 (Năvodaru et al. 2001)



Decrease of biodiversity

Floodplains are biodiversity hotspots due to their transition between aquatic to terrestrial habitats, and have provided benefits to people since millennia. Larger parts of the active and former floodplain are already protected, mostly within the Natura 2000 network.

Biodiversity of floodplains is negatively influenced by habitat change, species exploitation, by the intentional or unintentional introduction of alien and invasive species, and by disease emergence as well as by climate change. All factors have an impact on habitat characteristics and species life-cycles. The major cause of biodiversity decline, widely recognized is habitat alteration and the second one is the impact of invasive non-native species. The impact of invasive non-native species in the Danube River is not yet fully assessed (ICPDR 2009).

Decrease of water quality

Floodplains are important areas of water self-purification. Due to the physical, chemical and biological processes that act synergistically, floodplains, named as the "kidneys of the planet" purify polluted water. WWF calculated the ecological and economical potential of floodplains such as some of the services that floodplains provide: nitrogen reduction potential is estimated at 100 kg/ha/year; P reduction potential is estimated at 10 kg/ha/year; nutrient reduction value is estimated at US $ 250 / ha/year (DPRP 1999).

New and emerging pollutants such as endocrine disruptors, persistent organic pollutants, recently launched pharmaceuticals and nano-materials pose yet unknown health hazards. Floodplains could contribute to their reductions through bioaccumulation processes (Chițescu and Nicolau 2014).

The restoration of floodplains

Water Framework Directive and the Floods Directive promotes a new concept regarding spatial rivers planning. Among their key objectives are the flood risk reduction and the biodiversity conservation of the floodplains ecosystems. "More space for rivers" represents the key words that illustrate the idea of the policy that currently dominates Western Europe, which supports the need to give rivers back what "we have taken", meaning theirs floodplains (INCDD 2010).

Danube Pollution Reduction Programm

Danube Pollution Reduction Programm (DPRP) presents a group of projects and measures, in the frame of the UNDP/GEF assistance, which respond to identified pollution and transboundary effects in the Danube River Basin and the Black Sea (DPRP 1999). In the context of DPRP, the earlier studies for evaluation of the total size of floodplains of the Danube River and its major lowland floodplains was undertaken under the guidance of the International Commission for the Protection of the Danube River (ICPDR). Floodplains also underwent a basic assessment for the Joint Danube Survey (ICPDR 2008, 2015). Even in still active floodplains the changes were substantial due to a decrease in flood dynamic (duration and magnitude of flooding and sediment dynamics) due to water stored in upstream reservoirs, to aggradation (fine sediment deposition) in floodplains caused by river regulation and short flood peaks with often very high suspended load concentrations (due to the changed hydrological regime and land-use practices). There is still no systematic floodplain inventory but it is known from red lists of habitats that floodplains can be seen as biodiversity hotspots that are highly endangered regardless of type and characteristic.

River restoration started in Europe in the early 1990s as a reaction to the permanent loss of the integrity of natural rivers and floodplains. Real enlargement of floodplains by reconnecting former floodplains is still underrepresented, typical restoration projects are often side-channel reconnections, channel widening and bank revetment removal.

WWF International Danube-Carpathian Programme commissioned a floodplain inventory of proposed potential restoration sites. Those already-existing projects and proposals were stored in the database. For each restoration area, basic parameters such as name, size, location, status, configuration, land use/habitats, ownership, nature protection and spatial planning was collected where possible (Schwarz 2010).

Table 3 (Annexes) shows that the total area of floodplain restoration projects is 514,180 ha from which the officially planned project represent 89.5% (460.410 ha), the proposed project represent 8% (41.680 ha) and the implementation project represent 2.5% (12.090 ha).

At European level in total about 55.000 ha floodplain area projects where implemented, but only a very minor area was actually reconnected along the Lower Danube River and in the Delta in Ukraine and Romania. In Germany and Austria, for example, only about 500 ha were actually reconnected, all other projects were in the already active floodplain.

Ecological and Economical Resizing of the Romanian Danube Floodplain

At national level this programme followed the flood of year 2006 and was designed and launched to assist the Romanian Government in planning long-term strategy for achieving the objectives of the Water Framework Directive, as well as for implementing tasks on prevention, protection and mitigation of floods, stipulated by the National Strategy Management Flood Risk. For this purpose in 2007 there was conducted a comprehensive scanning system LIDAR (Lidar Detection and Ranging) of floodplain surfaces in the area of the Danube River in order to develop a digital terrain model (DTM). Digital maps used were employed in the study of the flooding degree of the Danube floodplain. For the analyzed hydrological scenarios were taken into account all enclosures suitable for agriculture and for restoration, whereas from the enclosures suitable for storage there were not selected the small area and fish enclosures. Thus, on the whole Romanian Danube floodplains the optimal scenario (Fig. 4), where large floods occur, is the use of floodplain for agriculture in proportion of 43.3% (Tab. 4), for water storage in proportion of 40.8% (Tab. 5), and for restoration in proportion of 15.9% (Tab. 6) (REELD 2008).

Figure no. 4 The optimal use of enclosures for large floods hydrological scenarios

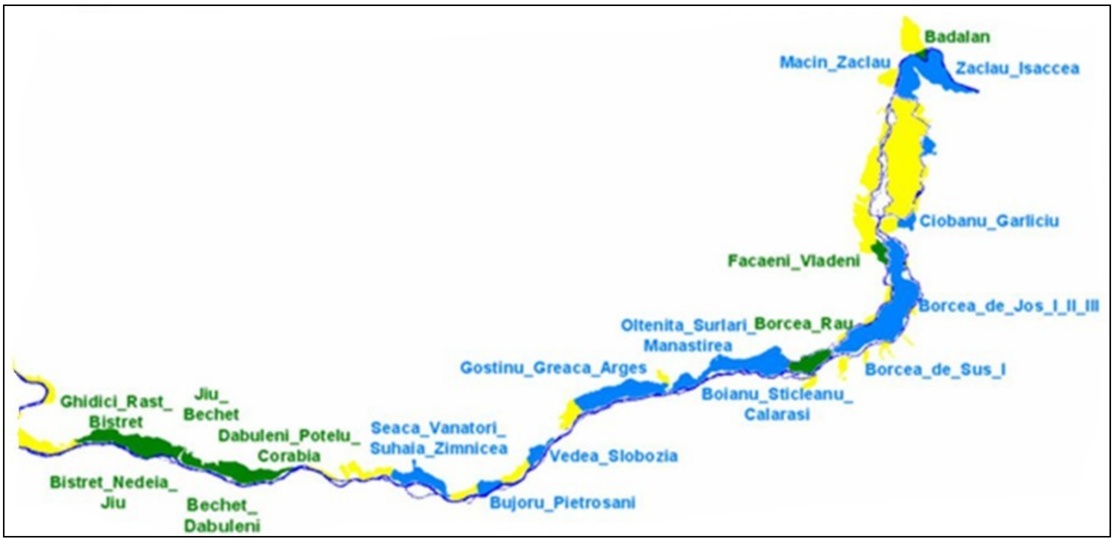


Table no. 4 The list of enclosures proposed for agriculture (REELD 2008)

No.	The name of enclosure	Surface (ha)
1	Balta Geraiului	1818
2	Borea Fetesti	1557
3	Braila Dunare Siret	5422
4	Brailita Giurgeni Calmatui	16506
5	Calafat Ghidici	15571
6	Calmatui Gropeni	15086
7	Chirnogi Arges	1966
8	Gropeni Chiscani	2140
9	Harsova Ciobanu	4944
10	Insula Mare a Brailei	72518
11	Islaz Moldoveni	2957
12	Lita Olt Flamanda Seaca	6211
13	Noianu	723
14	Pietrosani Arsache	5325
15	Remus Gostinu Baneasa	7496
16	Salcia	8949
17	Stelnica Bordusani	1787
18	Topalu	374
19	Unirea Gildau	917
20	Zimnicea Nasturelu	3722
	Total	175,990

Table no. 5 The list of enclosures proposed for storage (REELD 2008)

No.	The name of enclosure	Surface (ha)
1	Seaca-Vanatori-Suhaia-Zimnicea	14161
2	Bujoru-Pietrosani	4891
3	Vedea-Slobozia	5718
4	Gostinu-Greaca-Arges	29370
5	Oltenita-Surlari-Manastirea	12581
6	Boianu-Sticleanu-Calarasi	23452
7	Borcea-de-Sus_I	8881
8	Borcea-de-Jos (I, II,III)	50399
9	Macin-Zaclau	13808
10	Zaclau-Isaccea	21977
11	Ciobanu-Garliciu	3939
12	Peceneaga-Turcoaia	3934
	Total	193,111

Table no. 6 The list of enclosures proposed for restoration (REELD 2008)

No.	The name of enclosure	Surface (ha)
1	Badalan	1593
2	Bechet Dabuleni	6940
3	Bistret Nedeie Jiu	21894
4	Borcea Rau	11156
5	Dabuleni Potelu Corabia	14666
6	Facaeni Vladeni	4957
7	Ghidici Rast Bistret	9085
8	Jiu Bechet	5148
	Total	75,439

The decrease of Danube River level at the hydrometric stations according to scenarios developed is summarized in the Table 7.

Table no. 7 Decreasing Danube River level under hydrologic scenarios (REELD 2008)

No.	Hydrometric station	Level decrease (m)
1	Calafat	0.54
2	Bechet	0.58
3	Zimnicea	0.08
4	Giurgiu	0.32
5	Oltenita	0.95
6	Calarasi	1.27
7	Cernavoda	0.17
8	Harsova	0.25
9	Vadu Oii	0.25
10	Gropeni	0.25
11	Braila	0.26
12	Galati	0.24
13	Isaccea	0.20

„Room for the River and People in Cat's Bend, Romania"

The former floodplain, which is located between Macin town and Isaccea town, respectively between the riparian towns Braila, Galati and Isaccea, was known as "Crapina-Jijila" lake complex (Fig. 5). This area amounts to a total surface of about 30.000 ha from which the permanent aquatic surface reaches about 16.500 ha. During high floods of Danube River that area was completely covered by water. A complete description of services and functions performed by this area is done in 1961 (Botnariuc and Beldescu 1961).

In the case of this former floodplain area, in the year 2009, the Service for Land and Water Management (DLG) of the Dutch Government has developed the project "Room for the River and People in Cat's Bend, Romania", that came with several scenarios to mitigate the effects of possible prospective flooding but also the problems caused by drought in this region of the Danube River. Perhaps even more important than the need for flood protection and floodplain restoration is the need to solve the water scarcity seen as vital to the local economy (DLG 2009).

The integrative solutions developed by experts together with local actors tried to answer both to environmental problems, such as drought and flooding, as well as socio-economic issues, such as sustainable use of land both economically and ecologically. The three different design concepts which compose the "Schita Integrata" (Fig. 6) are indicated with the numbers 1, 2, 3 and are:

(1) Ciulinet Channel,
(2) Infiltration and drainage system,
(3) Space for river.

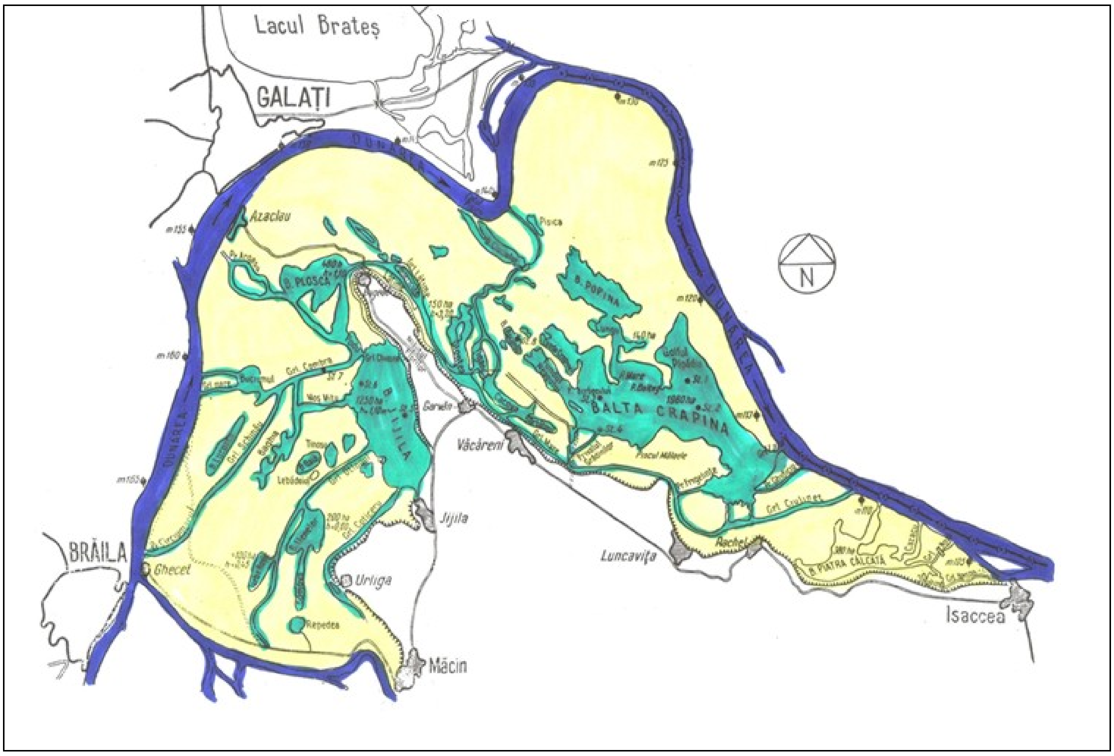
Ciulinet channel (1) is based on the principle of restoring and connecting a network of old Danube creeks and wetlands through a new west-east connecting channel, oriented along Macin mountains. This new navigable channel will particularly encourage economic development and bring benefits on the microclimate in the villages which are situated at the foot of Macin mountains. In case of large volumes of water of the Danube River, it will serve as a flood channel, contributing to reducing the water levels (DLG 2009).

The infiltration and drainage system (2) seeks to improve the current system of irrigation channels along with a historical pattern of creeks and streams. This concept strengthens in particular the potential for agricultural production and improves the microclimate (DLG 2009).

Space for river (3) is a concept that includes two steps: a dike-displacement north of Grindu and a construction of flood canal south of Grindu. These measures contribute to flood protection by reducing water levels on the Danube River (DLG 2009).

The probable effects on Danube water level were calculated, assuming a similar waterdischarge as during the floods of 2006. The results of these calculations show that, in the case of simultaneous application of the three concepts of planning, the Danube water level at Braila will drop by 23 cm, and at Galati by 24 cm (DLG 2009).

Figure no. 5 The former floodplain (Crapina-Jijila) between Macin town and Isaccea town (Botnariuc and Beldescu 1961)



Cooperation programme in Danube River Basin

The Danube countries have a long history of cooperation, which was carried out along the decades of geopolitical tension, economic transformation and cultural differences. Danube cooperation is an example of what is possible under difficult circumstances. Some cooperation forms for the Danube issues are summarized below.

European Commission of the Danube (ECD) - dating back to the 1856 was responsible for administration of the Danube River. Its primary goal was to ensure free navigation along the Danube River for all European countries (Ardeleanu 2011).

Bucharest Declaration – in 1985 eight riparians countries of the Danube River signed the „Declaration of the Danube Countries to Cooperate on Questions Concerning the Water Management of the Danube”. The Bucharest Declaration consolidate the principle that the environmental quality of the river is based on the environment of the whole basin. The riparians countries must to have an integrated approach in water management, must to have a basin-wide unified monitoring network.

Figure no. 6 The integrative solutions of spatial river planning between Macin town and Isaccea town (DLG 2009)

Environmental Programme for the Danube River Basin (EPDRB) - was launched at Sofia in September 1991. The countries and interested international institutions draw up an initiative to support and reinforce national actions for the restoration and protection of the Danube River. One of the major tasks of the EPDRB was the development of the Strategic Action Plan (Nachtnebel 2000).

Danube River Protection Convention (DRPC) - was signed in Sofia (Bulgaria) on June 29, 1994 and came into force in 1998. DRPC forms the overall legal instrument for co-operation on transboundary water management in the Danube River Basin and along with two important EU directives (EU Water Framework Directive and EU Floods Directive) are implemented by International Commission for the Protection of the Danube River (ICPDR). The ICPDR mission is to promote and coordinate sustainable and equitable water management, including conservation, improvement and rational use of waters for the benefit of the Danube River Basin countries and their people.

Joint Danube Survey (JDS) is the world’s biggest river research expeditions. So far, three JDS were carried out: the first in 2001, the second in 2007, and the third in 2013.

The Joint Danube Survey follows three main objectives: to collect data on parameters normally not analysed in the ongoing monitoring; to collect information about the water and the organisms that live there from a single source all along the river so that it is readily comparable between countries; and to raise awareness of the quality of the Danube waters and the efforts to protect and restore them (ICPDR 2008, 2015).

DABLAS (Danube - Black Sea) Task Force is platform of cooperation, was set up in 2001 and the overall goal is to develop financing mechanisms for the implementation of investment projects for pollution reduction and the rehabilitation of ecosystems in the wider Black Sea region (ICPDR 2004).

Danube Transnational Cooperation Programme, 2014-2020 (INTERREG) aimd to boosting innovation and entrepreneurship, preserving the natural and cultural assets of the Danube region, improving the connectivity and supporting the shift towards a low-carbon economy. INTERREG is built around four thematic priority axes, one of subprioritys are: strengthen transnational water management and flood risk prevention; foster sustainable use of natural and cultural heritage and resources; foster the restoration and management of ecological corridors; improve preparedness for environmental risk management (EC 2015).

Horizon 2020 – is the biggest European Research and Innovation Program for sustainable growth wich flagship initiative aimed at securing Europe's global competitiveness. Seen as a means to drive economic growth and create jobs, Horizon 2020 is open to everyone, with a simple structure that reduces red tape and time so participants can focus on what is really important. This approach makes sure new projects get off the ground quickly – and achieve results faster (EC 2014).

EU Strategy for the Danube Region (EUSDR), adopted in December 2010 by the European Commission end endorsed in 2011 by the European Council, is built on four pillars, encompassing 11 Priority Areas, focusing on sustainable development with a priority on economic growth and on balancing the socio-economic differences between the countries of the Danube Region (Winiwarter and Haidvogl 2015).

Danube: Future Programme is a joint contribution of the Danube Rectors' Conference and the Alps-Adriatic Rectors' Conference, thus integrating the largest pool of institutionalised knowledge in the Danube River Basin. Danube: Future aims to have a lasting effect on research and teaching, bringing young scholars to the forefront of international research and hence developing the strengths of higher education in the region in internationally competitive contexts. It will also be of particular importance for those Danube River Basin regions, which base the core of their smart specialisation strategy on sustainability of the economy and 'green jobs' (Winiwarter and Haidvogl 2015).

Recommendations towards a restoration strategy

It must be emphasised that successful restoration of floodplains depends on several aspects. The following list reflects some of the most important aspects for prioritisation (Schwarz 2010):

- Floodplain restoration meens mainly hydromorphological-lateral integrity of the river-floodplain ecosystem by restoration of lateral conectivity;
- The availability of land but also and other aspects, in particular hydraulic models for ecological planning, is very important to ensure successful restoration;
- Clear impact evaluations of the project on local, regional and international levels regarding floods, ecology and other ecosystem services is necessary for successful restoration;
- Requirements for local planning and approval by authorities (e.g. influence on local flood levels, water

quality and so on) must be considered from the beginning;
- Broad stakeholder involvement and interdisciplinary planning work is a pre-condition for successful restoration.

Conclusions:

In the last decade, the restoration of lateral conectivity of large rivers and their floodplains in particular, have been and will be a compromise between allowing natural processes to function and engineering solutions. Some of the most common floodplain rehabilitation techniques include: reconnection of floodplain features (e.g. channels, ponds); aggrading mainstem channels (e.g. submersible dams, logjams); creation of floodplain habitats; barrier or culvert replacement/removal; dam removal (FAO 2005). Most techniques can lead to improvements in physical and hydrologic and other natural processes, provide additional slow water habitats, and additional habitat for fishes. Dam or weir removal appears to be highly effective at restoring processes, though long-term monitoring of recovery is lacking. In the absence of dam removal, restoration of flood flows has shown promising results in terms of restoration processes, reconnecting habitats, and restoring flood-dependent biota.

Floodplain rehabilitation is a relatively new science and long-term studies documenting biological effectiveness are not currently available

Rezumat:

RESTAURAREA CONECTIVITĂȚII LATERALE A DUNĂRII ROMÂNEȘTI, STRATEGII ȘI ACȚIUNI LOCALE

Reducerea și degradarea luncilor inundabile de-a lungul Dunării au cauzat o serie de neajunsuri precum: inundații catastrofale, intensificarea eutrofizării apei, scăderea capturilor de pește, pierderea biodiversității, descreșterea calității apei. Pentru a atenua efectele pe care aceste neajunsuri le provoacă atât la nivelul sistemelor ecologice cât și la nivelul sistemelor socio-economice, în cadrul Bazinului Hidrografic Dunărea este promovat un nou concept, și anume “mai mult spațiu pentru râuri”. Aplicarea acestui concept se regăsește atât în cadrul strategiilor europene precum Programul de Reducere a Poluării Dunării, cât și în cadrul strategiilor naționale precum Redimensionarea Ecologică și Economică a Luncii Dunării, prezentate în această lucrare. Punerea în aplicare a acestui concept este prezentată punctual prin descrierea soluțiilor de planificare a spațiului dintre Măcin și Isaccea pentru reactivarea unei foste zone inundabile a Dunării.

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Annexes:

Table no. 3 The status of romanian floodplain restoration projects (Schwarz 2010)

Name	Size in ha	River	Status
Calafat Ghidici	15,560	Danube	Officially Planned
Salcia	7,600	Danube	Officially Planned
Ostrovu Corbului	1,620	Danube	Proposed
Ghidici Rast Bistret	9,220	Danube	Officially Planned
Bistret Nedeia Jiu	21,260	Danube	Officially Planned
Jiu Bechet	4,680	Danube	Officially Planned
Bechet Dabuleni	7,110	Danube	Officially Planned
Dabuleni Potelu Corabia	14,990	Danube	Officially Planned
Balta Geraiului	1,790	Danube	Officially Planned
Lita Olt Flamanda Seaca	6,540	Danube	Officially Planned
Seaca Vanatori Suhaia	14,400	Danube	Officially Planned
Zimnicea Nasturelu	3,960	Danube	Officially Planned
Bujoru Pietrosani	4,960	Danube	Officially Planned
Pietrosani Arsache	5,460	Danube	Officially Planned
Vedea Slobozia	5,560	Danube	Officially Planned
Remus Gostinu Baneasa	7,600	Danube	Officially Planned
Gostinu Greaca Arges	30,140	Danube	Officially Planned
Oltenita Surlari	13,040	Danube	Officially Planned
Boianu Sticleanu Calarasi	23,920	Danube	Officially Planned
Calarasi-Raul Island West	7,980	Danube	Officially Planned
Bugeag	2,060	Danube	Officially Planned
Piscicola Oltina	3,110	Danube	Officially Planned
Borcea de Sus I	8,740	Danube	Officially Planned
Unirea Gildau	970	Danube	Officially Planned
Borcea de Jos I II III	50,320	Danube	Officially Planned
Viile Dunareni	1,180	Danube	Officially Planned
Baciu Vederoasa	1,810	Danube	Officially Planned
Cochirleni	690	Danube	Officially Planned
Seimeni	840	Danube	Officially Planned

Topalu	380	Danube	Officially Planned
Borcea Fetesti	2,270	Danube	Officially Planned
Stelnica Bordusani	1,880	Danube	Officially Planned
Facaeni Vladeni	4,700	Danube	Officially Planned
Brailita Giurgeni Calmatui	16,590	Danube	Officially Planned
Calmatui Gropeni	14,480	Danube	Officially Planned
Gropeni Chiscani	2,230	Danube	Officially Planned
Noianu	710	Danube	Officially Planned
Insula Mare a Brailei	70,930	Danube	Officially Planned
Harsova Ciobanu	4,680	Danube	Officially Planned
Ciobanu Garliciu	3,850	Danube	Officially Planned
Ciobanu Daeni	1,340	Danube	Officially Planned
Ostrov Pecineaga	1,590	Danube	Officially Planned
Peceneaga Turcoaia	3,540	Danube	Officially Planned
Iglita Carcaliu Macin	3,020	Danube	Officially Planned
Braila Dunare Siret	5,370	Danube	Officially Planned
Badalan	1,530	Danube	Officially Planned
Macin Zaclau	13,760	Danube	Officially Planned
Zaclau Isaccea	20,790	Danube	Officially Planned
Calarasi-Raul Island East	3,560	Danube	Implementation
Holbina-Dunavat	7,720	Danube Delta	Officially Planned
Popina	6,250	Kiliya Channel	Implementation
Chilia Veche	3,230	Kiliya Channel	Proposed
Danube Delta, Pardina	28,640	Kiliya Channel	Proposed
Fortuna	2,340	Sulina Channel	Implementation
Danube Delta, Partizani	3,940	Sulina Channel	Proposed
Danube Delta, Balteni	4,250	Sf. Gheorghe Ch.	Proposed
Babina	1,920	Kiliya Channel	Implementation
Cernovka	1,580	Kiliya Channel	Implementation