DANUBE FLOODPLAIN

Report on possible restoration approaches for each type of water work

Authors: Coordinated by Experts team from National Administration "Romanian Waters", CUEI, NIHWM with contribution from all Project Partners

Project co-funded by the European Union (ERDF, IPA funds)

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1. Introductory note on Danube floodplains

The hydrological function of an active floodplain consists of retention of water during floods and thus floods attenuation, deposition of alluvium beneficial in soil formation, supplying and recharging groundwater with avoiding salinization. In addition, riparian areas also regulate the flow behavior of the river at low water situations. Water stored in the bottom of the floodplains is discharged into the river during dry periods.

The biochemical function results from hydrological function through maintaining the balance in carbon-nitrogen-phosphorus cycle, nutrients recycling, retention of toxic substances (pesticides, heavy metals due to the bio-filter role of alluvium), and mineralization of organic pollutants in inorganic compounds.

The consequences of disconnection of floodplains are numerous in terms of ecological aspects through alteration of habitats, biodiversity and genetic assets, of climatic and socio-economic aspects by reducing fish reproductive potential or recreational potential and tourism.

Nowadays Danube floodplain areas are reduced in size or no longer function as active floodplains, thereby significantly reducing their capability to provide ecosystem services to local and regional communities and economic activities. Many of river floodplains have been dammed and thus removed/dis-connected from their natural systems with its very important functions: hydrological, biochemical, ecological, climatic and socio-economical.

According to the International Commission for the Protection of the Danube River (ICPDR) data, compared with the 19th Century, less than 19% of the former floodplain area (7,845 km^2 out of 41,605 km^2) remains in the entire Danube River Basin (DRB).

In the Danube River Basin Management Plan Update 2015 (DRBMP) it is mentioned that in total 193,475 ha of wetlands/floodplains have been identified to have a reconnection potential. Out of these, 5,715 ha are totally and 40,920 ha are partly reconnected where some of the required measures were already completed but further measures are planned, having positive effects on water status and flood mitigation. The remaining wetlands/floodplains, covering an area of 146,840 ha, have a remaining potential to be re-connected to the Danube River and its tributaries in the next WFD cycles.

Having in view the last decades catastrophic floods along the Danube, there is a need for improving transnational water management and flood risk prevention while maximizing benefits for biodiversity through floodplain restoration measures.

There are many measures that aim to reduce flood risk that can have multiple benefits for regulating water flows as well as in terms of water quality, nature and biodiversity, and groundwater recharge in water scarce areas. River and floodplain restoration, whereby natural processes are restored, is likely to provide a significant contribution to both Flood Directive and Water Framework Directive objectives.

Acting in a suitable way for floodplain restoration it supposes as starting point an inventory of different already implemented measures, targeted on floodplain restoration and preservation. Solutions, like runoff control and appropriate land management, dyke breaches, sediment by-pass channels and oxbow lakes to improve retention in the floodplain need a solid documentation about their effectiveness, in order to identify and implement proper and efficient restoration measures for reaching both floods risk reduction and water bodies environmental objectives. Hereby, the projects already implemented with good results have been collected as best practices at the DRB scale and outside the DRB.

2. Concept of the collecting measures templates (elements addressed)

In order to tackle any floodplain restoration activity, it is important to identify and understand the system, respectively the natural processes in the frame of the floodplain, the pressures that directly affect the functioning of the floodplain, including land use. In this respect, in the process of setting and implementing proper measures for floodplain restoration both aspects of ensuring natural water retention capacity during floods and ecological, water quality and pollution issues should be assessed.

In general hydromorphological alterations involve changes in:

• the hydrological regime: quantity and dynamics of flow, connection to groundwater;

• changes in continuity and connectivity: the ability of sediment and migratory species to pass freely up and down rivers and laterally with the floodplain; and
• changes in morphology (i.e. physical habitat: compositions of substrate, width/depth variation, structure of bed, banks and riparian zone).

According to DRBMP (2009 and its 2015 update), the following three key hydromorphological pressure categories of basin-wide importance have been identified:

a) Interruption of longitudinal river continuity and morphological alterations;
b) Disconnection of adjacent wetlands/floodplains, and;
c) Hydrological alterations, provoking changes in the quantity and conditions of flow

Anthropogenic pressures resulting from various hydro-engineering works can significantly alter the lateral connectivity of the river and implicitly the connection with the floodplain. The disconnection of riverine floodplains and disturbance of the natural lateral connectivity of river systems can frequently result also in a deterioration of water status.

Lateral flood-protection works especially (e.g. dykes, river bank reinforcements, river bank calibration, meanders cut off) interrupts the river connectivity with floodplains. In the remaining active floodplain area, floods tend to become deeper than under natural conditions, due to reduction of the retention area. Agriculture use plays also an important role in wetland destruction. Never the less, navigation, power generation, and irrigation are also responsible for alterations in water and groundwater levels and the loss of wetlands and floodplains (*Danube River Basin Management Plan – DRBMP 2009*)

A schematic diagram of the interaction between floodplain natural processes, hydromorphological alterations and their effects on the functioning of the floodplain and restoration or mitigation measures is presented in Figure 1

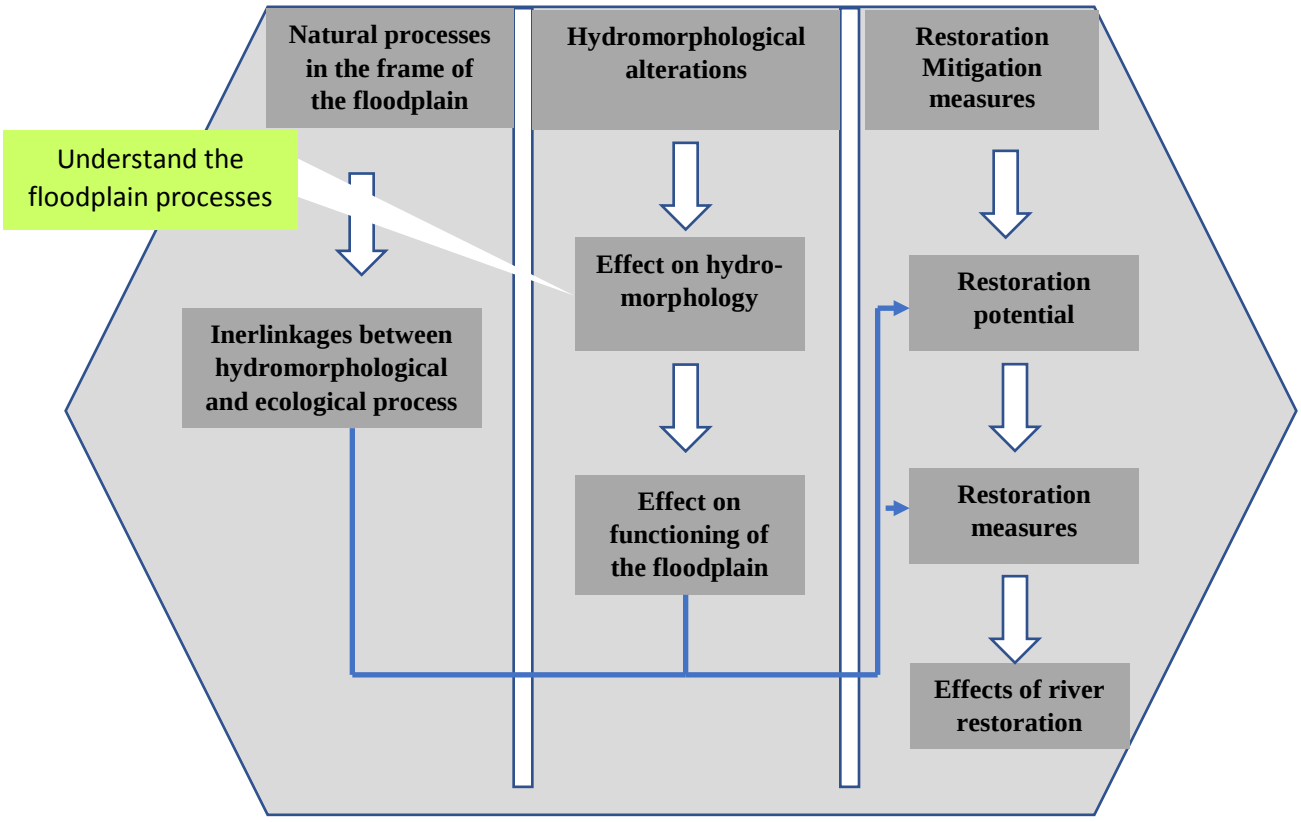


Figure 1 Floodplain process interactions

The complexity of floodplain management, with highly dynamic ecosystems and the one of socio-economical drivers and pressures requires holistic approaches in which scientific evidences, good practices examples and expert knowledge could be operationalized for policy needs.

Hereby approaches/examples/ concepts for floodplain restoration and preservation within and outside of the DRB have been collected.

The inventory of measures shows that Danube countries implement floodplain restoration measures which are addressed either on the Danube River but also on its tributaries. At the DRB level, a number of 68 projects have been collected. Out of these projects, 26 projects are applied for the Danube River and the Danube Delta. The DRB tributaries (Isar, Sulzbach and Vils, Traisen, Drau, Thaia, March, Drava, Mura, Lajta, Pinka, Ipel, Begel, Sava, Veszprémi- Sed, Lahn Brook, Berettyó, Hármas-Körös, Sebes-Koros, Tisza, Prut, Jijia, Hartibaciu) have been also subject of floodplain restoration projects.

In addition, flood restoration and preservation projects outside of DRB have been assessed, respectively in the Rhine and Elbe River Basins (26).

The projects were mostly financed under EU financing programs (EAFDR, Life), European Center for River Restoration Funds, European Economic Area (EEA) Grants, but also with local and national budget contribution.

Analysing of the collected renaturation projects showed that specific measures to restore hydromorphological changes in the flow conditions, the river bed, the river banks and the riparian areas had been envisaged as follows:

- Alteration of hydrological regime (due to river dams, drainage schemes)
- Alteration of hydrological regime (due to reduced forest/vegetation cover, increased impervious surfaces)
- Lateral continuity interruption (dykes and embankments, disconnection of floodplain)
- Channel incision
- Alteration of instream habitats (e.g. increased flow velocity / shear stress)
- Cut-off meanders
- Reduced hydromorphological processes (alteration of sediment regime)

The collected measures have been divided into three groups named by the implementation locality (figure 1).

Floodplain restoration measures have been measures, mostly located in different floodplain water types or in the riparian zone (102 from 131 collected restoration measures). All other measures (29) took place at the floodplain waters themselves, mostly reconnections of side waters like

backwaters, meanders or side arms of the river (17 times). In nine cases the pavements of the river bank were removed to improve the natural processes of the river. The flattening or a new structuring of the riverbank was implemented only three times in all 68 analysed projects in the DRB (figure 1a).

Measures in the water itself were found overall 55 times. The most common activity were dredging, structuring or renewal of the river bed (20 measures) followed by restoration/revitalization of floodplain typical waters like side arms, channels, backwaters or oxbow lakes (19 times). Bed load or sediment management measures were also done very often (11) in contrast the removal of barriers or weirs were done only 4 times. Only one time the creation of a soil ramp was necessary to counteract against the deepening of the river bed (figure 1b).

All other identified measures (47) concerned the terrestrial riparian zone (figure 1c). A very effective measure to extend the retention area, the removement or slitting of dikes or dams, were found nine times. In five restoration projects, the removement or slitting of dikes were combined with a land use change. The former reclaimed agricultural areas were returned into wetland habitats.

The creation of new water courses (10) or still waters (6) were used to improve the hydrological situation of the floodplain, to create new habitats for different species and to increase the connectivity between river and land habitats. In addition, groundwater management measures were implemented to improve the hydrological situation (4 times). Foreign or invasive plant species were removed to improve the naturalness of habitats in five times. To increase the naturalness of floodplains riparian forest trees were planted in four projects.

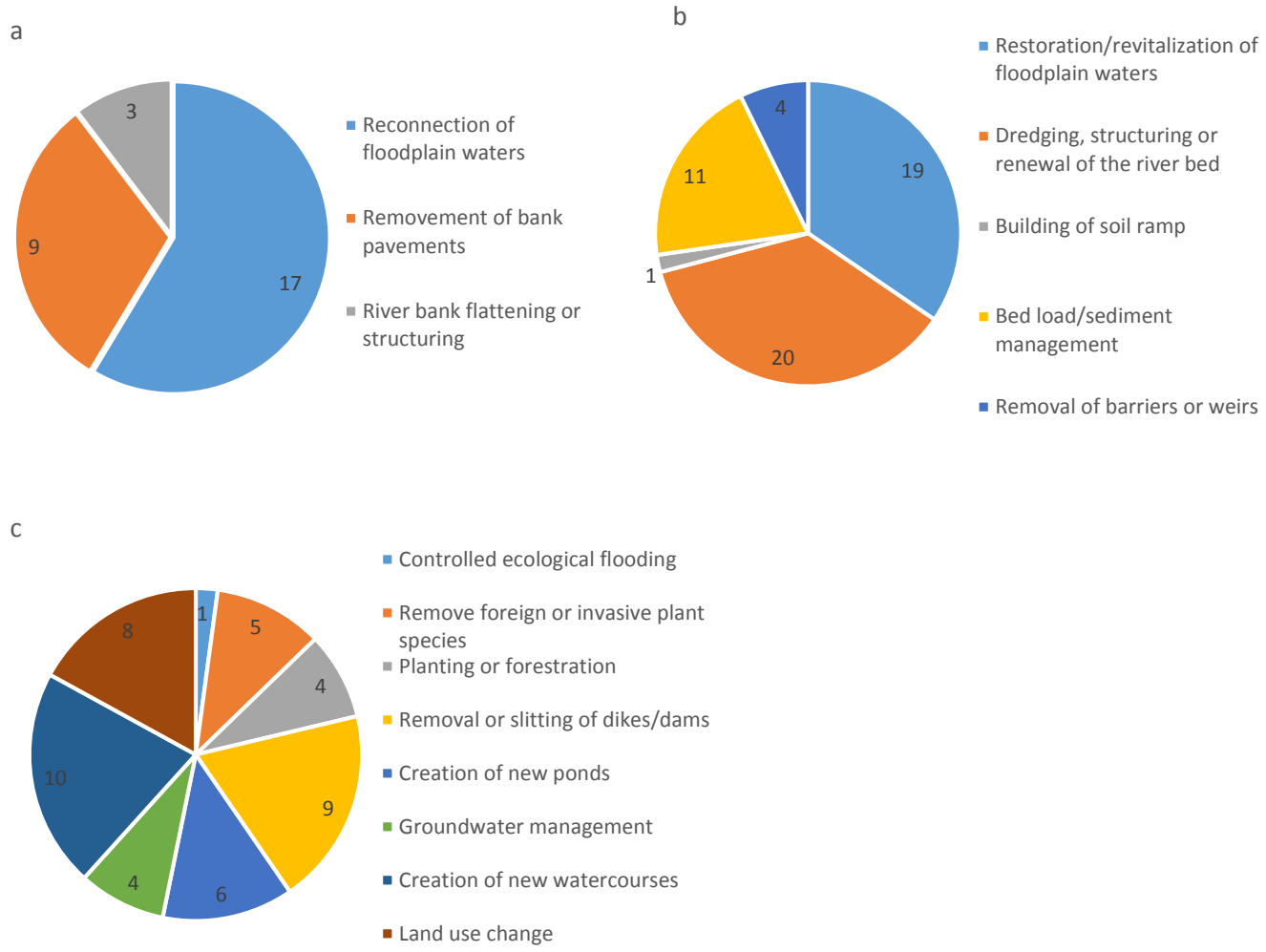


Figure 1: a: number of implemented measures at floodplain waters; b: numbers of implemented measures in floodplain waters; c: number of implemented measures in the terrestrial riparian zone.

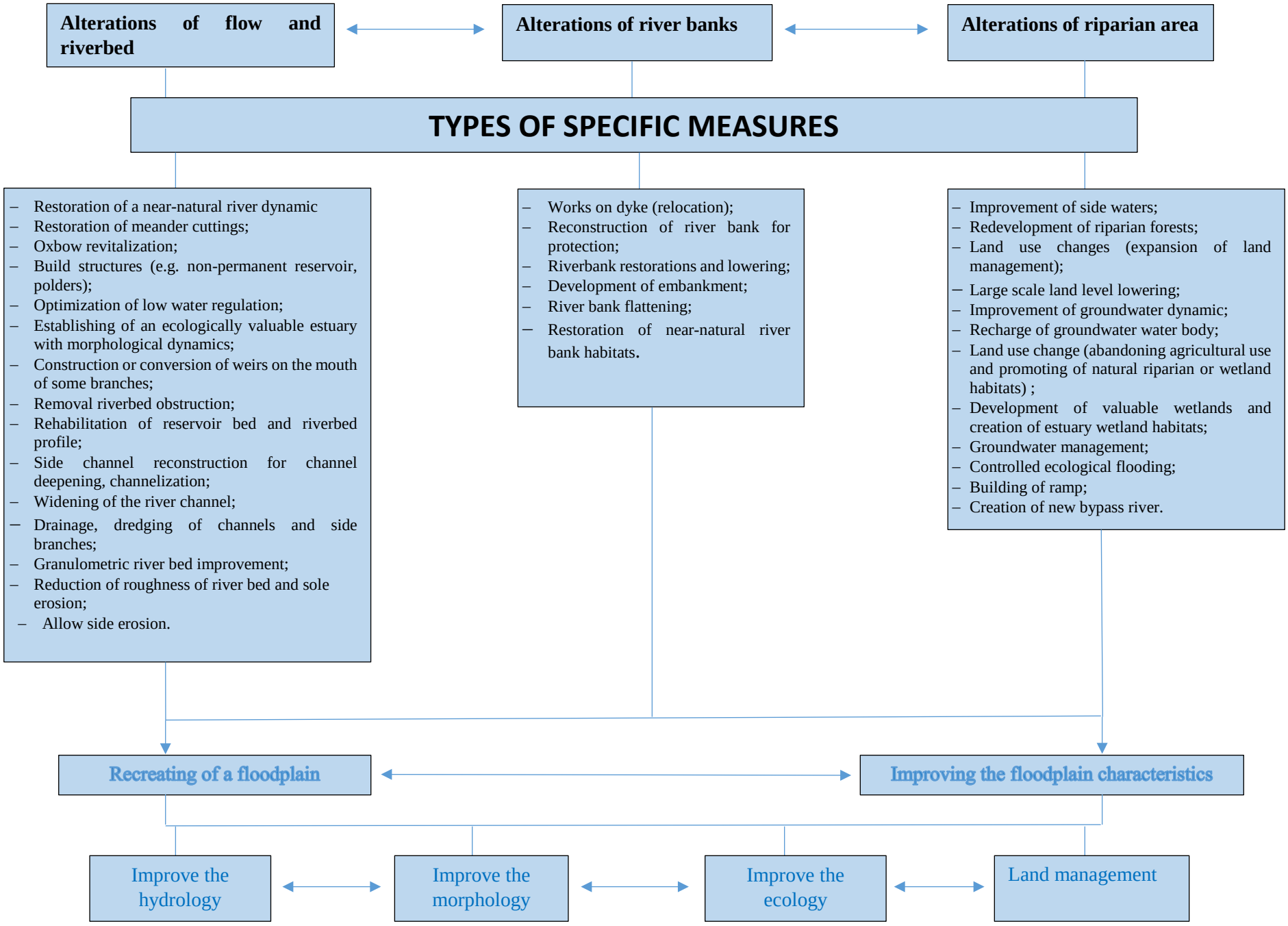
Different types of specific engineering works and measures in relation with the above hydromorphological alterations, have been applied on the Danube River, DRB tributaries but also outside of DRB with a clear goal of restoration and preservation of the floodplains.

Examples provided show that the floodplain restoration and preservation required a specific set of measures to reduce flood risk and improve natural floodplain functioning at the same time. Thereby, these measures have been aimed at both reducing the flooding probability and minimizing the potential damage and contribute to the restoration of the specific hydrological

and geomorphological dynamics of rivers and ecological restoration for biodiversity. Land-use management and planning were also generally adopted where floodplain restoration measures have been applied.

The below diagram presents in a synthetic way the collected types of specific measures addressing floodplain restoration and preservation, the interlinkages with hydromorphological alterations and hydrological, morphological and ecological improvements. Some of the measures listed below can have an influence on several functions. For example, the reconstruction of artificial bank structures can have an influence on the runoff or on the bank of the river, but can also have a positive effect on the floodplain ecosystem. Therefore, there are also multiple answers within the list of measures. The collected measures grouped applied for the Danube River, DRB tributaries and outside of DRB are presented in the Annex 1.

TYPES OF FLOODPLAIN RESTORATION MEASURES



Few examples of floodplain restoration and preservation projects and measures applied in the DRB are presented below:

Isar Plan (Munich, Germany)

Containment of floods, more space for recreation in a more natural ecosystem.

Schildauer Au (Danube, Austria)

One-sided connection of separated oxbow lakes, reconnection of the discharge regime of the Danube.

Life+ project (Danube, Slovakia)

Restoration and management of Danube floodplain habitats. Channel and its surrounding after filling up – the whole island came into life – storks came to see all the frogs.

Danube Delta (Romania)

Habitat restoration by reconnecting the former Carasuhat agricultural area to the Sf. Gheorghe Branch. © Cristian Mititelu Răileanu

Bilateral General Project Morava - Common management of hydro ecological & water management measures.
Morava (Slowakai & Austria)

Meander restoration

LIFE13/NAT/HU388 -Drava (Hungary)

Old Drava backwater reconnection near Barcs

3. Glossary of specific terms in relation with floodplain restoration

A glossary of terms including definitions, sources and related hyperlinks has been developed in order to facilitate a common understanding of the conceptual approach, technically and scientifically characteristics related to floodplain restoration and preservation processes. It includes relevant terms related to hydrology, hydraulics, water management, ecology and biodiversity, socio-economics, but also specific terms regarding Water Framework Directive (WFD), Flood Directive (FD), having in view the synergies of both Directives in the floodplain context. It is based on the related terms associated to technical activities of the project and having in view the dynamics of these activities and those future results it is a living document.

The Annex 2 presents the Glossary of terms, in alphabetical order.