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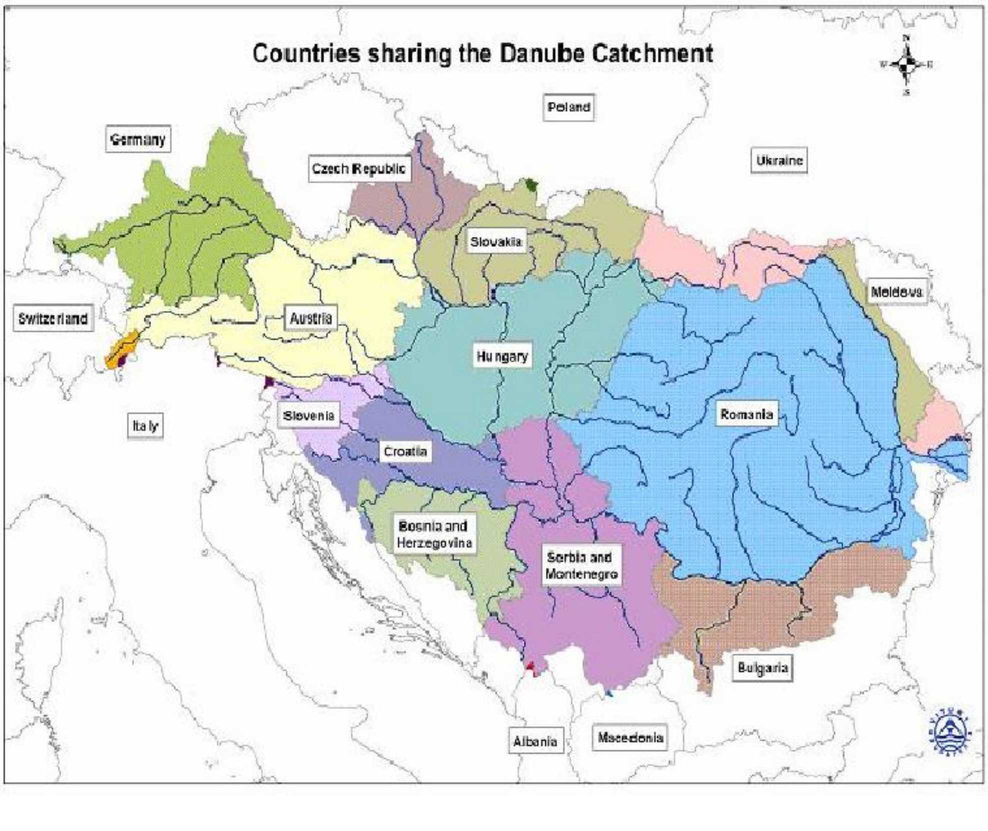
DANUBE RIVER'S MORPHOLOGY AND REVITALIZATION

TO THE SERVICE CONTRACT - STUDIES DEVELOPMENT NO. 414 / 2010

- REPORT -

Phase 1 - Preparation of the Danube River's Revitalization of the finalized proposed projects for the assessment with the selection at least two projects per every standard criterion



BENEFICIARY:

Danube Delta Biosphere Reserve Authority Tulcea

- June 2010 -

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STUDY NAME :

DANUBE RIVER'S MORPHOLOGY AND REVITALIZATION

PROGRAMME NAME:

TRANSNATIONAL COOPERATION PROGRAMME FOR SOUTH-EAST EUROPE 2007-2013

PROJECT NAME:

DANUBEPARKS - DANUBE RIVER NETWORK OF PROTECTED AREAS - DEVELOPMENT AND IMPLEMENT THE TRANSNATIONAL STRATEGIES FOR CONSERVATION OF DANUBE NATURAL HERITAGE

- REPORT –

Phase 1 - Preparation of the Danube River's Revitalization of the finalized proposed projects for the assessment with the selection at least two projects per every standard criterion

BENEFICIARY :

DANUBE DELTA BIOSPHERE RESERVE AUTHORITY TULCEA

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- JUNE 2010 -

TULCEA

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T A B L E O F C O N T E N T S:

Phase 1 - Preparation of the Danube River's Revitalization of the finalized proposed projects for the assessment with the selection at least two projects per every standard criterion

INTRODUCTION

Rivers have always been with huge interest for life's existence and development. The ecosystems created in the proximity of rivers are very complex including a large number of species of plants and animals that are interact. All these inter-relations are into a stable equilibrium. The intervention of human society on rivers has determined the instability of this equilibrium shifting towards the extreme limits. Rivers are an important component of the European landscape and of great significance for biodiversity.

In this sense we can recall some of the "interventions" that has determined the instability of the equilibrium: over-exploitation of the riparian resources (biotic and abiotic), planning the river course (damaging them by embankment, course changing etc.), establishment of the human settlements in lower floodplain.

The Danube River has suffered alteration processes of the ecological balance in order to development of the human society. From the existing studies it comes to the conclusion that in the alteration process of the Danube have been destroyed dominating natural systems and have created industrial structures with economical purpose (navigation, hydro-energy, agriculture, ports etc.) that is damaging the Danube river, because of losing the floodplains and morphological structures.

Danube River regarded like an entire system raised the idea of making some zones with potential for local revitalization with an entire system effect (Figure 1).

Transformations of these ecosystems in the floodplains into terrestrial ecosystems have reduced their functions (ecological, economical, recreational, esthetical and educational) to a single one – economical.

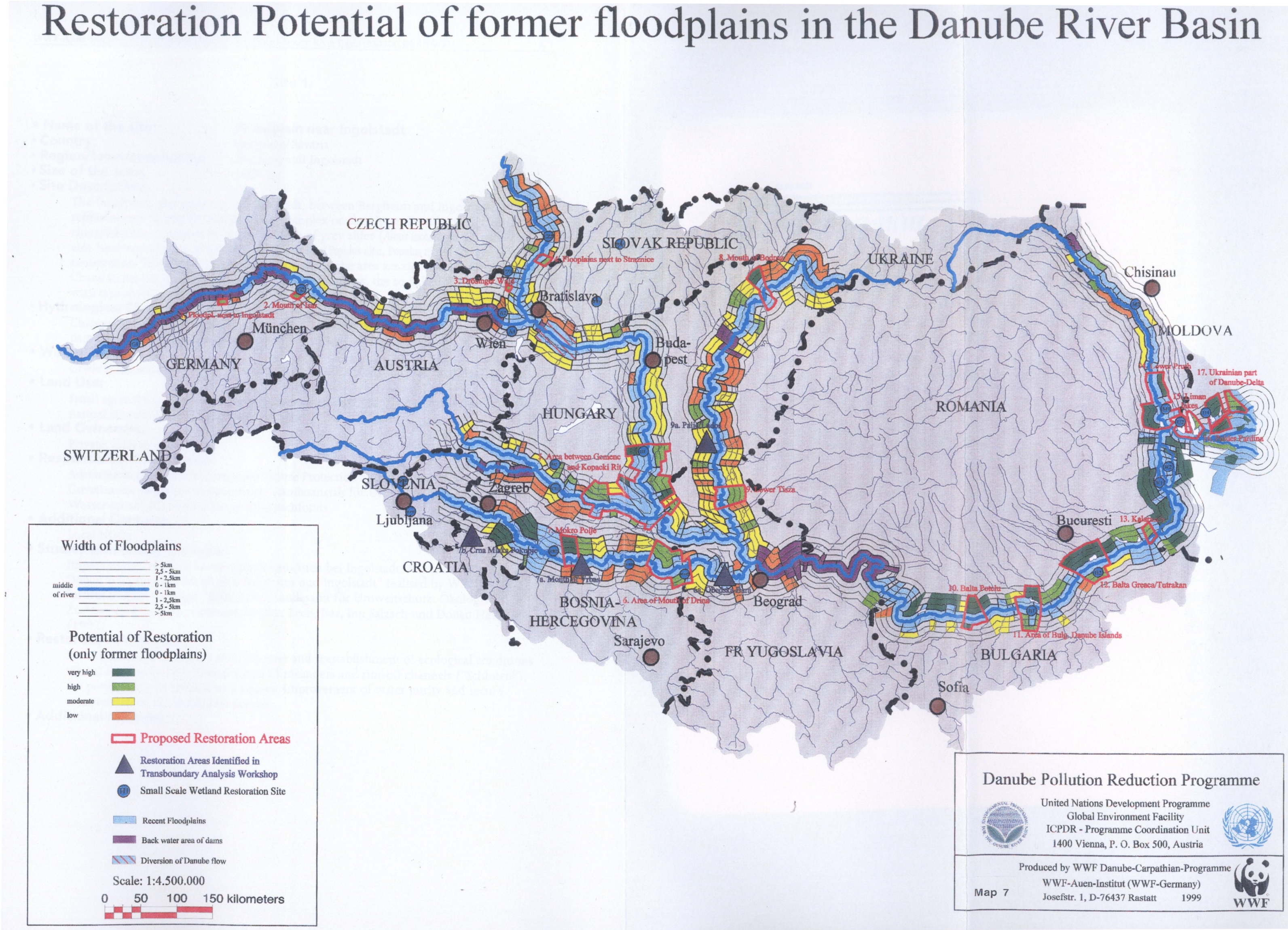

Fig. 1 – Restoration potential of former floodplains in the Danube River Basin (* * *, 1999)

The river restoration projects preconditions are ecological functions. This means that rivers are dynamic systems. They are formed by the natural characteristics of the drainage basin like climate, geology, tectonic, vegetation and land use. The discharge depending from precipitation is fluctuating. The power of running water and the amount of transported solids influence the morphological process and the geometry of the river channel. This includes bank erosion and sedimentation, natural restoration of riffle and pool and migration of the riverbed within the flood plain. The geometric features of the river channel e.g. plant form, longitudinal and cross sections as well the substrate in the river channel are depending from the conditions in the watershed area. River and floodplain are an unit. (Binder, 2008)

The part presented above forms the abiotical part of a river system. The biotic part molds the abiotic part.

The vegetation along the river and in the flood plain is in natural succession, its zonation spans from pioneer vegetation to alluvial woodland. The morphological structure housing a mosaic of biotopes for animals and plants. This explains why natural river systems offer such a wide range of habitats and why they are today in most European countries protected by Natura2000. Their reference status is equal to the high ecological status of the Water Frame Directive (WFD). (Binder, 2008)

Artificially modifying the Danube River to aid navigation, reduce flood risk or generate hydropower can systematically destabilize the river by disrupting its long stream bed material transport continuity. Heavy engineering works and regular maintenance dredging are often required to prevent degradation and aggradations and maintain the required river functions.

The management of international water resources and large transboundary rivers is a challenging task because of the administrative and socio-cultural differences within the catchments, the heterogeneity of the encompassing landscapes, the multiple and often competing water uses, and, not least, the difficulty of enforcing international laws at regional and local levels.

Moreover, managing landscapes as complex as large river-floodplain networks requires a comprehensive understanding of the underlying ecological structure-function relationships at various spatiotemporal scales. Hence, tailor-made water management strategies need to be properly selected, designed, and implemented based on sound ecological principles, the best available scientific knowledge, and stakeholder participation (after Uitto and Duda, 2002; Dudgeon et al.,2006; Hein et al., 2006; Quevauviller, 2010, quoted by Sommerwerk N. et al., 2010).

The Danube River Basin (DRB) is the most international river in the world, characterized by exceptionally diverse ecological, historical, and socioeconomic properties. Its unique biodiversity and high ecological potential make the DRB one of the Earth's 200 most valuable ecoregions (after Olson and Dinerstein, 1998, quoted by Sommerwerk N. et al., 2010).At the same time, the DRB is listed among the world's top 10 rivers at risk (after Wong et al. 2007, quoted by Sommerwerk N. et al., 2010).

Characterization of Danube River Basin (DRB)

in terms of morphology and revitalization

The DRB covers a total area of ~801.000 km² and collects water from the territories of 19 countries in Central and South-Eastern Europe (Germany, Austria, Switzerland, Italy, Poland, the Czech Republic, Slovenia, Slovakia, Hungary, Croatia, Serbia, Romania, Bosnia and Herzegovina, the Former Yugoslav Republic of Macedonia, Albania, Montenegro, Moldova, Bulgaria, and Ukraine)

Today, ~83 million people inhabit the DRB, and ~60 cities in the DRB have a human population of more than 100.000 (after Sommerwerk et al., 2009, quoted by Sommerwerk N. et al., 2010). Culturally, the DRB consists of a wide variety of languages, traditions, histories and religions. The political and social conditions and the corresponding economic status of the DRB countries are more diverse than those in any other European river basin.

The Danube is the second longest river in Europe (2826 km), and its large delta forms an expansive wetland (area: 5640 km²) of global importance. The mean annual discharge of the Danube at its mouth is ~6480 km³/s, corresponding to a total annual discharge of 204 km³. The Danube is divided into three sections that are almost equally long, and separated by distinct changes in geomorphic characteristics: the Upper, Middle and Lower Danube. A characteristic feature of the Danube is the alternation between wide alluvial plains and constrained sections along the main stem. Before regulation, active floodplain width reached > 10 km in the Upper Danube and > 30 km in the Middle and Lower Danube. In the Upper Danube, most floodplains and fringing wetlands have been converted into agricultural and urban areas, or have been isolated by dams and artificial levees, and therefore are functionally extinct. However, along the Middle and Lower Danube, large near-natural floodplains still remain. Vegetated islands form another (former) prominent landscape element in the DRB. Along the Austrian Danube, ~ 2000 islands were present before regulation today, only a few remain. However, islands are still abundant in the Hungarian/Serbian (Middle Danube) and the Bulgarian/Romanian sections (Lower Danube). Remaining near-natural floodplains and vegetated islands may serve as important nuclei for conservation and management actions; at the same time, they are sensitive indicators to assess the ecological state of river corridors (after K. Tockner, unpubl. data, quoted by Sommerwerk N. et al., 2010).

Zoogeographic and phylogeographic studies clearly pinpoint the DRB as a biodiversity hot-spot region in Europe. For example, ~20% (115 native species) of the European freshwater fish fauna and 36% (27 species) of the amphibian fauna occur in the DRB today (after Sommerwerk et al. 2009, quoted by Sommerwerk N. et al., 2010).

Moreover, the Palaearctic and Mediterranean biogeographic zones overlap in the Danube Delta, resulting in an exceptionally high biodiversity, especially for birds (total: 325 species, ~50% are breeding species). The corridor of the Danube River remained unglaciated during the last ice age and therefore served as a substantial glacial refuge area, as well as an important expansion and migration corridor for many species. Today, the DRB drains areas of nine ecoregions (after Illies, 1978, quoted by Sommerwerk N. et al., 2010).

Key water management issues

The Danube Basin Analysis in 2004 provided the first comprehensive characterization of the entire DRB (ICPDR, 2005). It comprised a basin-wide pressure and impact analysis to estimate the risk for water bodies of failing the management objective of the EU Water Framework Directive (WPD), i.e. to achieve ‘good ecological status’, by 2015 (European Commission, 2000). Mitigating hydromorphologic alterations, and reducing organic pollution, nutrient loads, and hazardous substances, have been identified as the main targets for the Danube

River Basin Management Plan (ICPDR, 2009). However, transport and contamination of sediments, as well as the spread of invasive species, have not yet been given sufficient attention. Adaptive strategies that take future global change into consideration are also missing.

Hydromorphological alterations

Hydropower generation, flood protection, land reclamation, and navigation are the main driving forces for hydromorphologic alterations in the DRB. Approximately 700 major hydraulic structures (dams and weirs >15 m), including 156 large hydropower dams, have been built in the DRB (after Reinartz, 2002; Bloesch, 2003; ICPDR, 2005, quoted by Sommerwerk N. et al., 2010).

Approximately 30% of the length of the main stem is impounded through 78 major hydraulic structures. Less than 15% of the Upper Danube remains free-flowing. The largest dams in the DRB are the hydropower plants fron Gate I and II (built in the 1970s) in the downstream part of the Middle Danube (Rkm 943 and Rkm 842). The Iron Gate dams, together with the Gabčikovo dam in Slovakia (built in the 1980s), disrupt fish migration in the Lower and Middle Danube, and significantly alter the sediment and groundwater regime (after Zinke, 1999; Kiaver et al., 2007, quoted by Sommerwerk N. et al., 2010).

As of 2009, 22 of the 78 barriers are passable for fish (ICPDR, 2009).

Notable areas of the Danube Delta have been embanked and drained, and the total length of the channel network in the delta doubled between 1920 and 1980 (at present 3500 km: after Gastescu et al., 1983, quoted by Sommerwerk N. et al., 2010).

The new Bystroye navigation-canal has cut through the Ukrainian part of the Danube Delta biosphere reserve since 2004.

Currently, the Danube is navigable for 87% of its total length (upstream to Rkm 2410). Approximately 1100 ships are registered along the Danube River (after www.icpdr.org, www.ccr-zkr.org, quoted by Sommerwerk N. et al., 2010).

The registered vessels along the Danube are 40 years old on average. Therefore, emission standards are most likely not up-to-date. The remaining free-flowing river sections and their mobile beds have been identified as ‘bottlenecks’ for navigation. Hence, the creation and maintenance of a continuous shipping channel of 2.8 m water depth and 160-180 m width, for most of the year, has been proposed. Thus, the Trans-European Transportation Network (after TEN-T, 'Corridor VII', http://tentea.ec.europa.eu/, quoted by Sommerwerk N. et al., 2010), of the EU competes with the concurrent projects to conserve unique habitats and species along the Danube River.

Alterations of the sediment regime

The dams along the main stem have severely interrupted sediment transport in the Upper Danube. The Iron Gate dams retain approximately two-thirds of the suspended solids. Therefore, sediment delivery to the Delta decreased from 53 to 18 million tone/year, resulting in severe coastal erosion (after WWF, 2008, quoted by Sommerwerk N. et al., 2010). River-bed incision further reduces low water levels and impedes the hydrological connection between the channel and its floodplains.

To mitigate the adverse effects of river-bed incision in the Upper Danube (downstream of Vienna, Rkm 1921-1880), the river bed will be stabilized by adding coarser gravel, and by widening the main channel by removing ~50% of the artificial bank protections (riprap) (after Reckendorfer et al., 2005, quoted by Sommerwerk N. et al., 2010). In addition, the bedload sediment deficiency is balanced by annual additions of 160.000 t of gravel, corresponding to ~20% of the load in 1850. These joint measures should lead to an 85% reduction in bed incision (WWF 2008). Commercial dredging is mostly banned in the Upper Danube, and dredged material is returned to the main stem ('no-net-loss'). In the Middle and Lower Danube, stopping the ongoing sediment removal remains an urgent issue.

Water pollution

Despite an overall improvement in water quality over the past few decades, the Danube and its tributaries remain exposed to multiple point and non-point pollution sources (after Schmid, 2004; Behrendt et al., 2005; Liška et al., 2008, quoted by Sommerwerk N. et al., 2010). The construction and upgrade of wastewater treatment plants (WWTP) have reduced the input of biodegradable organic matter in the Upper Danube during the past three decades (after Wachs, 1997, quoted by

Sommerwerk N. et al., 2010). In the Middle and Lower Danube, water quality remained relatively high until the 1970s, but then deteriorated owing to rapid industrial development, poor pollution control, and inputs from heavily-polluted tributaries (after Russev, 1979; Kalchev et al., 2008, quoted by Sommerwerk N. et al., 2010). However, the high self-purification capacity of the remaining natural river sections and alluvial wetlands has buffered these adverse effects, and at the same time has maintained a relatively high biodiversity up to now (after UNDP/GEF, 1999, quoted by Sommerwerk N. et al., 2010). Large cities along the main stem, like Belgrade and Budapest, or Bucharest along the tributary Arges, still lack WWTPs. In Budapest, a WWTP is under construction. The Budapest Central Wastewater Treatment Plant project is the largest environmental investment to be actually implemented in Central Europe (total costs €530 million: after ICPDR, 2010a, quoted by Sommerwerk N. et al., 2010). Zagreb, located along the Sava River, has recently completed a new facility.

The Danube discharges ~29 kt y -1 of total phosphorus (TP) and 478 kt y -1 of total nitrogen (TN) into the Black Sea. Despite the achieved reductions, pollution loads are still high enough to threaten the unique biodiversity and affect the fishery and recreational value of the Black Sea (after United Nations, 1997, quoted by Sommerwerk N. et al., 2010).

Hazardous substances like heavy metals, persistent organic pollutants (pentachlorophenols, PCPs; polycyclic aromatic hydrocarbons, PAHs, and organochlorine pesticides), hormone active substances and micro-pollutants are becoming an increasing issue in the DRB. Contaminations of sediments with DDT (dichlorodiphenyltrichloroethane) are common in the Lower Danube. However there is a lack of legal measures for obligatory monitoring of some of these hazardous substances. In the downstream DRB countries, adequate analytical equipment is also lacking. The International Commission for the Protection of the Danube River (after ICPDR, www.icpdr.org, quoted by Sommerwerk N. et al., 2010) and the Black Sea Commission have put the reduction of hazardous substances as a high priority issue on their agenda. The improvement of WWTPs and the application of best-available techniques for the industrial and agricultural sectors are considered as the most efficient measures to reduce the emissions of toxic substances, as well as of nutrients and organic matter.

Non-native and Invasive species

For centuries, European inland waterways have provided opportunities for the spread of non-native aquatic species. At present, a complex network of more than 28000 km of navigable rivers and canals connects 37 European countries, creating a biological ‘meta-catcbment’ that encompasses large parts of the continent (after Panov et al., 2009, quoted by Sommerwerk N. et al., 2010). The Danube River belongs to the Southern Invasive Corridor that links the Black Sea with the North Sea via the Rhine-Main-Danube Canal.

At present, 141 alien and cryptogenic taxa (41 fish, 67 macroinvertebrate, 24 aquatic macrophyte, 1 amphibian, and 8 parasite species) have been reported for the DRB (www.alarmproject.net). Several non-native species are true invasive species that currently represent prevalent components of the aquatic community: *Corbicula fluminea* (Asian clam); *Anodonta woodiana* (Chinese pond mussel); *Orconectes limosus* (spinycheek crayfish), and *Dreissena polymorpha* (zebra mussel) (after Liška et al., 2008; Graf et al., 2008, quoted by Sommerwerk N. et al., 2010). New introductions are constantly recorded (after e.g. LeppilkOski et al., 2002; Arbaçiauskas et al., 2008, quoted by Sommerwerk N. et al., 2010). The Ponto-Caspian Region not only serves as a suitable recipient for non-native species, but is also a key European ‘donor area’ for alien species.

The quantification of non-native species was a key focus of the Joint Danube Survey 2 (after Liška et al., 2008, quoted by Sommerwerk N. et al., 2010). There is clear evidence that channel stabilization and construction of artificial banks have favored the establishment of non-native species. Therefore, restoring hydrogeomorphic dynamics is expected to mitigate the spread of invasive species, as pioneer habitats are less prone to the establishment of non-native species (after Tockner et al., 2003, quoted by Sommerwerk N. et al., 2010).

Little is known about the ecosystem consequences of novel communities that are composed of a mixture of native and non-native assemblages. In addition, we need to improve our understanding of the interactions of species invasion with other pressures in order to better manage invasive species in the DRB. It will be important to apply risk assessment procedures and use those results for priority actions to reduce the rate of aquatic invasions and to combine these actions with awareness-raising measures in water management and the public (after Panov et al., 2009, quoted by Sommerwerk N. et al., 2010). It is also questionable whether all measures should be based on the *a priori* assumption that non-native species have a negative ecological and economic impact.

Legal frameworks of the DRB

A long history in developing and establishing national and international legal frameworks exists along the Danube River (after Bogdanovic, 2005, quoted by Sommerwerk N. et al., 2010). However, to manage a river basin as diverse and complex as the DRB poses major legal and political challenges to the public and stakeholders at various hierarchical levels. Since 2000, the WFD forms the guiding legal principle for the management of the DRB. The ultimate goal of the WFD is to achieve good ecological (and chemical) status for all surface waters by 2015 (with possible extensions to 2027). Basic elements to define good ecological status are the ecoregion, river type, and reference state, as well as the composition of aquatic assemblages (after Moog et al., 2004; ICPDR, 2005, quoted by Sommerwerk N. et al., 2010). If restoring good ecological status causes disproportionate costs or adverse effects on the environment and human society, water bodies might be designated as ‘heavily modified’. As such, ‘good ecological potential’ and ‘good surface water chemical status’ must both be achieved.

The ICPDR, founded in 1998, is responsible for the implementation of the WFD in the DRB. The Danube River Protection Convention (DRPC) forms the political framework that underpins the international cooperation within the ICPDR Fourteen out of the 19 DRB countries are contracting parties and legal members of the DRPC. In addition, the European Commission is a contracting party. Italy, Switzerland, Poland, Albania, and the Former Yugoslav Republic of Macedonia, which have only minor shares in the DRB, cooperate with the ICPDR. The WFD implementation is legally binding for the EU Member States of the DRB. Further, contracting parties that are non-EU Member States have made a voluntary commitment to implement the WFD under the DRPC. This undertaking represents a major step forward to the overall DRB management strategy, as well as to the environmental administrations of the respective countries.

The secretariat of the ICPDR coordinates the work of national delegates (i.e. high-ranked governmental representatives) and technical experts, integrates the members of the public, and cooperates with the scientific community. The ICPDR jointly prepares the content and calls for project tenders, as well as the documents for the implementation of the water protection and conservation issues, to be ratified by the national governments. The Roof Report (ICPDR, 2005), the Joint Danube Surveys (in 2001 and 2007), the Issue Paper on Hydromorphological Alterations (ICPDR, 2007a), the Action Program on Sustainable Flood Protection (ICPDR, 2004), the DRBM Plan (ICPDR, 2009), and the establishment of public participation strategies, are so far the main deliverables provided by the ICPDR. In ICPDR are sub-basin activities for the Danube Delta as well as for the Tisza and Prut Basins. An international commission had been established for the Sava River Basin (after www.savacommision.org, quoted by Sommerwerk N. et al., 2010).

The Espoo Convention 1991 on Environmental Impact Assessment in a transboundary context (after www.unece.org/env/eia, quoted by Sommerwerk N. et al., 2010) helps to solve environmental problems across political borders (e.g. for the Bystroye navigation-canal in the Danube Delta, bordering Romania and Ukraine). Finally, the Danube-Black Sea Joint Technical Working Group coordinates the work of the ICPDR and the International Commission for the Protection of the Black Sea, in particular to develop strategies for reducing nutrient inputs into the Black Sea.

The Belgrade Convention on Danube Navigation, the EU Flood Directive, and the Floods Action Program aim to further expand inland navigation and to implement flood control programs (European Commission, 2004; European Commission, 2007). However, these aims compete with that of the EU WFD, which states that the ecological integrity of surface waters must not deteriorate further. The EU Flood Directive itself is controversial in its recognition of the natural retention capacity of floodplains. Despite the various environmental directives, the Danube has been defined as a priority-axis of the TEN-T. In particular, the few remaining large floodplains along the Lower Danube River, as well as along the Sava, Drava and Tisza Rivers, are threatened by these navigation plans (after Schneider, 2002; WWF, 2002, quoted by Sommerwerk N. et al., 2010). Although these floodplains provide invaluable ecosystem services (i.e. water storage, recharge of groundwater, nutrient retention, retention of suspended and dissolved materials, biodiversity ‘hot spots’, ecotourism), these services remain mostly neglected by politicians. Given the expected increase in economy and large infrastructure projects in the DRB, sustainable strategies are required (after e.g. Brundic et al., 2001; for Middle Sava, quoted by Sommerwerk N. et al., 2010). The Joint Statement on Inland Navigation and Environmental Sustainability in the DRB aims to develop new navigation strategies (after ICPDR, 2007b, quoted by Sommerwerk N. et al., 2010). The feasible first steps to a more sustainable DRB inland navigation are to modernize the vessels and harbors along the Danube, and to harmonize the TEN-T guidelines with the WFD objectives (after WWF, 2005, quoted by Sommerwerk N. et al., 2010). Another step forward was the elaboration of the PLATINA-Manual for sustainable navigation where environmental aspects are respected and balanced with economic development (after ICPDR, 2010b, quoted by Sommerwerk N. et al., 2010).

Legal protection of endangered species remains a specific problem. For example, five out of six sturgeon species native to the DRB are critically threatened by extinction, and one species (*Acipenser sturio*) is already extirpated. The Sturgeon Action Plan, within the framework of the Bern Convention on the Conservation of European Wildlife and Natural Habitats, stipulates the reopening of sturgeon migration routes by making the Iron Gate hydropower dams passable and by conserving key habitats for recruitment (after Bloesch et al., 2006, quoted by Sommerwerk N. et al., 2010). Further, the Convention on International Trade in Endangered Species (after CITES, www.cites.org, quoted by Sommerwerk N. et al., 2010) regulates the trade of sturgeons and their products.

Pollution remains an important issue in the DRB. Since 2007, industrial emissions are regulated by the Integrated Pollution Prevention and Control (IPPC) Directive. Various directives are in force, some under the WFD, which serve as legal guidelines and back up international conventions to support river and wetland protection, conservation and management. All quoted conventions have been ratified by the majority of the DRB countries and are therefore legally binding, at least in theory. There is emerging mutual understanding among the Danube countries that the principles of ‘polluter and user pays’ (e.g. for pollution), ‘solidarity’ (e.g. for sturgeon protection), and ‘precaution and prevention’ (e.g. for flood protection) should be implemented. The application of economic instruments in water management is generally perceived as an effective tool to promote the protection of the environment (after Speck, 2006, quoted by Sommerwerk N. et al., 2010). For example, the ‘polluter pays principle’ forms the base of all European environment policies; it implies that people and private industries, but not the public and tax payers, should pay the damages and environmental impacts they cause through their activities. This principle is actually transferred to other sectors such as the ship-waste management sector (after www.wandaproject.eu, quoted by Sommerwerk N. et al., 2010). However, in the downstream DRB countries, the alignment and harmonization of the legal frameworks with EU policies, as well as its enforcement, are far from being satisfactory (after Speck, 2006, quoted by Sommerwerk N. et al., 2010). The precaution-principle (e.g. through preventing accidental spills) and the solidarity principle are complementary and must be ensured because impacts of upstream pollutants may cause major damages to downstream communities. Additional pressure towards reductions in pollution was gained by the Protocol on Pollutant Release and Transfer Registers. Internationally binding, it gives the statutory right to the public to have free access to emission data in national pollutant release and transfer registers.

Unfortunately, where economy meets ecology, the former is usually the winner (after Tockner and Stanford, 2002, quoted by Sommerwerk N. et al., 2010). Political compromises are inevitable, need to be based on scientific concepts for river basin management, and must include participatory methods to achieve win-win situations among the different user groups (after Bloesch, 2004, quoted by Sommerwerk N. et al., 2010).

Proactive and reactive management strategies

Proactive management activities

The EU WFD considers the river basin as the key spatial unit to understand and sustainable manage water resources. The DRBM Plan is the instrument to ensure good status in all water bodies by 2015 and beyond (after ICPDR, 2009, quoted by Sommerwerk N. et al., 2010).

The availability of high-quality monitoring data is crucial for the compilation of the DRBM Plan and allows for a cost-efficient implementation of the EU WFD. Building on existing national monitoring networks, the TransNational Monitoring Network (TNMN) was set up in 1996 (adapted in 2006 in order to comply with WFD requirements) under the umbrella of the ICPDR. The revised TNMN includes 81 monitoring stations that provide a basin-wide overview of the status and the long-term trends of surface and ground water quality (after ICPDR, 2009, quoted by Sommerwerk N. et al., 2010). The TNMN data are checked via an analytical quality control program by a network of 69 national laboratories quarterly and the results are published annually (after 'QualcoDanube', VITUKI, 2009, quoted by Sommerwerk N. et al., 2010).

The monitoring efforts through the TNMN have been supplemented by 'Danube expeditions': two Joint Danube Surveys (JDS 1 in 2001 and JDS 2 in 2007) were earned out by multidisciplinary teams of scientific experts. These international expert teams collected hydromorphologic, physico-chemical, and biological data along the entire Danube main stem, as well as along selected tributaries, in a standardized way. In total, 280 environmental parameters were evaluated. Despite limitations owing to the snapshot character, the results of both JDS provide a useful scientific basis for the further improvement of DRB management strategies, and concurrently stimulate the dialogue with different stakeholder groups. Furthermore, the surveys provided the opportunity to check the comparability of the nationally applied WFD-compliant sampling and assessment methods, as well as to train field and laboratory staff.

The JDS are supported by the DRB governments, private and public-run laboratories, private companies, and local authorities and NGOs. The 'Danube expeditions' received major attention by the media and therefore helped to enhance public awareness about the multiple threats in the DRB (www.icpdr.org/jds/). It is planned to repeat the JDS at six-year intervals to detect long-term trends, at a high spatial resolution, and to assess the success of the DRB management strategies.

A comparative and consistent water quality classification and status evaluation is a legally binding requirement of the WFD. At the European and DRB level, this task of benchmarking is subsumed as 'intercalibration' (European Commission, 2005). The purpose of the intercalibration exercise is not to harmonize assessment systems, but their results. The exercise aims to ensure that good ecological status represents the same level of ecological quality throughout Europe. For large and lowland rivers, near-natural reference sites are absent; therefore, intercalibration approaches for impacted conditions were developed (after Heiskanen et al., 2004; Birk and Hering, 2009, quoted by Sommerwerk N. et al., 2010). Owing to data gaps, and because national WFD-compliant assessment methods were not developed to a sufficient extent, not all biological quality elements in all water categories have been intercalibrated within the first phase of the intercalibration exercise between 2005 and

2007. The exercise should be finalised by the end of the second phase (2008-2011). Moreover, the assessment of the ecological status of large rivers, such as the Danube, has been recognized as a particular challenge, and is dealt with by specific working groups at the DRB and the European level (after ICPDR, 2009, quoted by Sommerwerk N. et al., 2010).

Proactive management options for nutrient reduction

The model MONERIS (Modeling Nutrient Emissions into River Systems) was used to quantify point and diffuse source emissions for seven emission pathways into surface waters as well as in-stream retention processes (after Venohr et al., 2010, quoted by Sommerwerk N. et al., 2010). In addition, management options are implemented in the model that can be evaluated according to their potential to reduce nutrient emissions (after Behrendt et al., 2002; Schreiber et al., 2005, quoted by Sommerwerk N. et al., 2010). Based on this model, a total of 650 kt (49% agricultural sources) of nitrogen (N) and 53.5 kt (62% urban sources) of phosphorus (P) are emitted into the DRB annually (2005 is used as a reference year); whereas geogenic background emissions only contribute ~7% for N and 12% for P to the current loads. A major management goal for the DRB is to reduce the nutrient load to the level observed in the 1960s (MoU ICPDR-ICPBS, 2001). This requires a 40% and 20% reduction for N and P loads, respectively. Of all the suggested measures, establishing efficient WWTPs has the greatest N-reduction potential (-5%). The reduction of atmospheric deposition of NOx (-4%), altered N-surplus (-2%) and reduced soils loss (~1%) would also further reduce N emissions.

In all DRB countries, except Germany, Austria, Romania, and Slovenia, agricultural land use is predicted to increase until the year 2015. As a consequence, N emissions will most probably increase, which could counteract the reduction effects accomplished through other measures. Phosphate emission in the DRB via household detergents is also significant. Up to now, only Germany and Austria have imposed bans on phosphate in laundry detergents. However, this ban does not apply to dishwasher detergents, and these remain an emerging pollution pathway. Nevertheless, the reduction potential of a P ban in laundry detergents amounts to 14% and 21.2% in the Middle and Lower Danube.

Measures to prevent soil loss from arable land could further reduce phosphorus emissions considerably (up to 14% reduction when applied to all arable land). This is an important measure in the Upper Danube where other options are less effective. In combination, all measures can reduce N and P by 8 and 40%, respectively. However, for N, the management objective, as stated in the DRBM Plan, cannot be achieved by 2015 (after ICPDR, 2009, quoted by Sommerwerk N. et al., 2010).

Proactive management of protected areas

Within the DRB, 1071 freshwater protected areas (>500 ha) have been identified (after ICPDR, 2009, quoted by Sommerwerk N. et al., 2010). However, it is difficult to estimate the total area of protection sites within the DRB because various protection categories spatially overlap. For example, parts of the Danube Floodplain National Park east of Vienna (Austria) are concurrently designated as a NATURA2000 site, Ramsar area, UNESCO Biosphere Reserve, National Park, Nature Reserve, IBA (Important Bird Area) and Protected Landscape. Moreover, there is variation throughout the DRB countries whether aquatic ecosystems are the focus of protection, and categories like 'National Park' and 'Nature Reserve' are often not in accordance with the international categories of the IUCN (after Dudley, 2008, quoted by Sommerwerk N. et al., 2010). The different uses and protection categories of freshwater reserves can be attributed to the biogeographic setting, the uneven economic development of the DRB, and different stressors that act in the different regions. Although water abstraction for irrigation and chemical pollution are major stressors in SE Europe, hydropower generation, flood protection and navigation (i.e. hydromorphologic alterations) dominate in Central and Western Europe. Protected areas that are managed by an administrative authority usually belong to the highest conservation category. The Accessory Publication (Part A) lists these protected areas along the Danube River and its major tributaries.

The NATURA2000 concept constitutes the first uniform definition of habitat types to be protected in Europe. Special Protection Areas (SPAs) under the Birds Directive (Directive 2009/1471EC) as well as the protection of threatened (Red List) species protected by the Bern Convention are integrated into the NATURA 2000 network. Along the main stem of the Danube River, 117 NATURA2000 sites, ranging from 30 ha to ~600.000 ha, have been designated for the protection of habitats and species (European Environment Agency, DG ENV E2). This number will most likely grow when non-EU Member States, after accession, designate their NATURA2000 sites. The standardized NATURA2000 rules allow EU citizens to have actions that might be destructive to the environment assessed via the European Commission, mostly independent of local or governmental interests. However, the implementation and adjustment of the NATURA2000 network is a long-term endeavour. Criticism has been made with regard to the: (i) doubtful representativeness of the nominated sites; (ii) the often small area coverage of the sites; (iii) the insufficient update of the lists of protected species and habitats, and (iv) the spatial isolation of the individual sites.

The NATURA2000, as well as other protection measures such as the Ramsar Convention and the WFD, should not be regarded as the end points of the EU conservation policy (after Maiorano et al., 2007, quoted by Sommerwerk N. et al., 2010). There is urgent need to simplify and properly harmonize existing protection concepts and directives, as well as to incorporate them into a general nature conservation strategy. Additionally, advanced reserve network designs, such as the concept of ‘Key Biodiversity Areas’ (KBAs), are currently under development (after Langhammer et al., 2007; www.freshwaterbiodiversity.eu, quoted by Sommerwerk N. et al., 2010). They are envisaged to allow for a more effective protection of species and prioritization of sites for conservation. However, all protection categories outlined above focus on the preservation of the environmental *status quo* and consider the structure rather than the function of ecosystems as the main conservation target.

Currently, the remaining ecologically-valuable river sections of the Danube are at high risk because of large-scale navigation and flood management plans. Therefore, in 2007 the representatives of the large protection areas within eight Danubian countries launched the initiative for a Danube River Network of Protected Areas (‘Danubeparks’; funded by the EU SE Europe Transnational Cooperation Program, www.danubeparks.org). The main goals of this initiative are to: (i) exchange experiences in river restoration and invasive species control; (ii) propose management strategies for sustainable sediment balances, nutrient control, inland navigation and hydromorphologic integrity; (iii) conserve flagship species such as sturgeons and the white-tailed eagle; (iv) act as an observer within the ICPDR and to advocate for large protected areas as part of basin-wide management strategies; (v) promote the implementation of the NATURA2000 concept and of transnational monitoring programs; (vi) implement a basin-wide public relation program for nature conservation, and (vii) stimulate eco-tourism.

Reactive management strategies: restoration

Nature restoration is a thriving enterprise worldwide. This is also true in the DRB. Some case studies are outlined in the Accessory Publication, Part B. In the Upper Danube Basin (Germany, Austria), channel widening, re-connection of side-arms, shoreline restoration, and re-establishing the continuum for migratory fish and benthos are the main activities (e.g. near Ingolstadt, Germany; in the Wachau valley, Austria). In the Middle Danube, restoration projects mostly focus on the re-connection of former side-arms. In the Lower Danube, large sketches have been embanked and restoration projects focus on the integration of former floodplains and wetlands into the river flow regime (e.g. Bulgaria opening of polders in the Danube Delta, Romania).

River restoration projects along the Danube are mostly designed and implemented locally. Usually, national river engineering administrations constitute the highest level of planning. Moreover, cultural diversity and political and language barriers hinder the exchange of experiences regarding the design and implementation of river restoration strategies. Proper monitoring (i.e. assessing success) is mostly lacking. The Danube River Network of Protected Areas aims to fill these gaps and to serve as an adequate future information platform (www.danubeparks.org).

The ICPDR initiated a spatially-explicit prioritization approach for restoration, with a focus on fish species migrating long and medium distances in the DRB. Barrier-free fish migration along key migration routes is envisaged by 2015 (ICPDR 2009). Barriers along the main stem and close to the mouth of major tributaries need to be re-opened first for achieving this high priority goal.

Challenges and recommendations for the sustainable development of the Danube River Basin

'Sustainable management' of ecosystems is a buzzword that is highly popular among and scientists. However, to properly define this concept and to implement it into a river basin management plan remains a major challenge that requires tight feedbacks between science and application (after Bloesch, 2005; Eberhard et al., 2009, quoted by Sommerwerk N. et al., 2010). Therefore, the European Union, along with national governments, has invested considerable financial resources in supporting the scientific community in the DRB during the past decades. However, the knowledge gained through supported projects is not yet efficiently implemented into management programs and legislative tools (after Kramer and Schneider, 2010, quoted by Sommerwerk N. et al., 2010). The science-policy integration is often hindered by inadequate communication and the lack of access of adequate scientific results. Therefore, the 'portal for science and technology transfer to policy making and implementation of integrated water resources management' was launched in 2007 as part of the Water Information System for Europe (WISE RTD web portal, www.wise-rtd.info). Projects that are funded via the Seventh Framework Program of the European Community have to allocate a certain amount of the budget to involve 'communication with non-academic partners'. These dissemination efforts are expected to be part of the project evaluation (after Holmes and Scott, 2010 quoted by Sommerwerk N. et al., 2010). Despite the existence of these web portals and communication obligations, the transfer of scientific results into practice remains suboptimal (after Kramer and Schneider, 2010, quoted by Sommerwerk N. et al., 2010). It is therefore crucial that scientific experts actively participate and expose themselves in the public political discussion; for example, as members of the local and regional parliament. Unfortunately, scientific career-reviewing schemes rarely give credit to efforts for the integration of knowledge to fulfill policy objectives (after Quevauviller, 2006, quoted by Sommerwerk N. et al., 2010). In addition, the scientific community needs to come up with a clear concept of environmental services that can be integrated into management strategies. If this issue stays under dispute within the community, its persuasive power is weakened.

The identification of research needs and the setting of research agendas have to be an ongoing process and should not only start when an urgent problem emerges (after Holmes and Scott, 2010, quoted by Sommerwerk N. et al., 2010). Thus, effective science-policy integration requires joint framing and planning of fundamental and applied research, the presence of policy makers and stakeholders on research steering boards, and an agreement on clear environmental targets. What we urgently need are quantitative tools that allow us to predict the effects of management options under rapidly changing environmental and political conditions. In addition, we need to develop spatially-explicit priorities for conservation and restoration. Further, synergies among the presently competing targets such as navigation, biodiversity conservation, and flood control need to be established. In this respect, the ecosystem service concept might be very promising for the management of ecosystems that are under multiple uses.

In Europe, but also globally, the establishment of catchments commissions for transboundary rivers is a major step forward in integrating science-policy activities. For example, the ICPDR, with its seven technical expert groups and network of observers, is an important platform for dialogue and debate. The members of the secretariat have a scientific background, and thus function as ‘translators’ of research outcomes into management practice. Moreover, the ICPDR initiates programs like the JDS, serves as a member in the advisory board for several initiatives such as the WISE-RTD portal, and presents the DRBM Plan on scientific conferences. A special website has also been launched that actively involves the public in the preparation of the DRBM Plan (www.icpdr.org/participate). This more holistic approach allowed for the recognition of cause-effect chains and the formulation of measures to properly address them.

Despite progress, many obstacles undermine the implementation of the DRBM Plan. The distinct west-east (upstream-downstream) gradient matters with regard to economic wealth, and many large projects funded through international programs (e.g. EU-Phare, World Bank) did not meet their goals and were unsuitable for the long-term capacity building within the DRB. For example, installing modem chemical laboratories is useless if the necessary experts are not yet available. Hence, there is a need for step-by-step procedures that progressively introduce new skills and technologies in this region (after Harremoës, 2002, quoted by Sommerwerk N. et al., 2010).

Bureaucracy, corruption, and politicians ignoring the current best science can hinder the implementation of effective management strategies. This is particularly the case in the downstream DRB countries. For example, ongoing poaching of endangered sturgeons in the Danube Delta undermines the implementation of sturgeon protection strategies and CITES regulation. Although Romania banned commercial fishing and the trade of wild sturgeon products for a 10-year period, the enforcement and therefore the efficacy of this ban, is doubtful.

The lack of political willingness at the national level can undermine the implementation of the WFD. A stronger involvement of the public and of the stakeholders, as required by the WFD and the Aarhus Convention, may support the implementation of management practices. However, participatory processes to finding agreed solutions need to be taught are laborious, time-consuming, and slow-particularly when stakeholders are involved.

A few decades ago, the construction of large dams at the Iron Gate and Gabčikovo, as well as the memorable occupation of the Hainburg floodplains in Austria, were subjects of great public debates. Present ‘hot spots’ of controversy are large-scale river regulation projects for navigation and flood control. A major challenge is to produce sound environmental impact assessments based on published and ‘grey literature’ data, *in situ* investigations, a good monitoring strategy, and optimized measures of impact mitigation. In this respect, the Directives on Environmental Impact Assessment (EIA) and Strategic Environmental Assessment (SEA) are starting to be properly applied in the Lower DRB. However, the great difficulties to implement western standards of EIA is demonstrated by the ongoing discussions about the ISPA 1 and 2 navigation projects (Instrument for Structural Policies for Pre-Accession, TEN-T Program) in the Green Corridor.

Open discussions and the utilization of innovative strategies may lead to a paradigm change that yields acceptable solutions to otherwise conflicting groups. For example, in recent restoration projects along the Danube River east of Vienna, navigation maintenance work was balanced with structural measures for improving hydrologic and geomorphic conditions (after Reckendorfer et al., 2005, quoted by Sommerwerk N. et al., 2010). Moreover, the ecosystem services provided by near-natural and restored ecosystems are increasingly taken into consideration in management strategies (after WWF 1995; Barbier et al., 1997; Schuyt, 2005;

Kettunen and ten Brink, 2006, quoted by Sommerwerk N. et al., 2010). Croatia, for example doubled the size of flood retention areas based on the economic use and non-use values of these floodplains (after Brundic et al., 2001, quoted by Sommerwerk N. et al., 2010).

A major difficulty in the implementation of the DRBM Plan is the harmonization of legal aspects, as well as the improvements of scientific concepts and methods to investigate large rivers. Most DRB counties have developed their own national standards, and ISO-standards can only provide a general guideline. Hence, method harmonization and intercalibration is an important issue of the ICPDR (after European Commission 2000; Birk and Schmedtje, 2005, quoted by Sommerwerk N. et al., 2010). Furthermore, mapping of the hydrogemorphologic conditions according to CEN-Standards provides a powerful tool for decision making (after Schwarz, 2007, quoted by Sommerwerk N. et al., 2010).

In summary, the DRB is in a stale of fast political and environmental transition. The political and cultural diversity within the DRB can either be considered as an obstacle or as an asset to develop novel and innovative management strategies. The EU WFD supports the protection and restoration of the DRB; however, it is a time-consuming process that requires continuous support from responsible scientists and politicians to foster public awareness and to search for sustainable solutions.

MATERIALS AND METHODS WITHIN PHASE'S ACTIVITIES

To accomplish this phase *Preparation of the Danube River's Revitalization of the finalized proposed projects for the assessment with the selection at least two projects per every standard criterion* the following activities were achieved through different approaches:

Activity 1.1. Inventory of finalized projects for Danube River's Revitalization.

This first activity consists in the assessment of the finalized proposed restoration projects.

Materials: For this purpose the documentation was made from various sources of information:

- Scientific literature - books, articles and other scientific publications (e.g. Binder W., (2008), *River restoration: an European overview on rivers in urban areas*. In ECRR Conference on River Restoration; Buijse A. D. et al., (2002), *Restoration strategies for river floodplains along large lowland rivers in Europe,* In Freshwater Biology Journal; Drost H.J. et al., (2002), *Research for ecological restoration in the Dunavat-Dranov region, Danube Delta;* Holubova K. et al., (2003), *Middle Danube tributaries: constraints and opportunities in lowland,* In Lowland River Rehabilitation "An international conference addressing the opportunities and constraints, costs and benefits to rehabilitate natural dynamics, landscapes and biodiversity in large regulated lowlands rivers");
- Official Web sites of natural parks along the Danube bodies involved and intenational (ECRR, WWF etc.).

Projects presentation took into account the following selection criterion:

- the scientific importance of the project;
- relevance of the thematic area in which the proposed theme become employed, in relation to the dynamics of international scientific research;
- contribution to scientific knowledge development;
- promoted/strengthened research directions in Danube River's Morphology and Revitalization.

Activity 1.1.1. Logistics study regarding the inventory methods and means for Danube River's Revitalization projects.

Methods: In this activity we made an inventory of the methods and means that will be applied in the next phase of the project *Comprehensive Danube River's Revitalization Assessment and preparation of the Best Practices Danube River's Revitalization Manual,* based on the previous DDNI projects experience*: Integrated Management of European Wetlands (IMEW), Master Plan for Master Plan - support for sustainable development in DDBR Tulcea county/ Romania Logical Framework Analyse (LFA), Room for the River in Cat's Bend, Romania, as fallows:*

- Interactive planning Sketch Match;
- Focus groups and semi-structured interviews;
- The tree problems.

Activity 1.1.2. Classification of Danube River's Revitalization Project on subclasses.

Methods: Starting from *The Los Angeles River Revitalization Master Plan*[1] developed by City of Los Angeles department of public works were taken and adapted several standard criterions of revitalization for Danube River, representing the base for the following 4 criterion subclasses:

- Danube River's restoration and rehabilitation through Lateral Connectivity;
- Danube River's restoration and rehabilitation through Longitudinal Continuity;
- Capture Community Opportunities;
- Create Value.

Danube River's restoration and rehabilitation through Lateral Connectivity

During the last decades, the perception of river-floodplain systems has been significantly improved by the application of new theoretical concepts (after Ward et al., 2001, quoted by Buijse A. D. et al., 2002). The 'river continuum concept'

[1] www.lariverrmp.org

addresses the longitudinal linkages within rivers (after Vannote et al., 1980, quoted by Buijse A. D. et al., 2002), while the 'flood pulse concept' integrates the lateral river-floodplain connections in both tropical (after Junk, Bayley & Sparks, 1989, quoted by Buijse A. D. et al., 2002) and temperate climates (after Bayley, 1991; Junk, 1999, quoted by Buijse A. D. et al., 2002).

In most riverine systems, hydrological connectivity between the Danube River and its floodplain is restricted to groundwater pathways; geomorphological dynamics are mostly absent.

This second principle, lateral connectivity, focuses on the goals of developing continuous. This is linked to an overall network of channels connections that extend the River's influence into adjacent neighborhood and provide ways for water circulation in/out for wetlands. Further, the Lateral Connectivity system develops new linkages would be created that strengthen the connectivity between riparian systems along the Danube.

Goals of Lateral Connectivity consist in:

- create a continuous ecological corridor River Greenway, adjacent to the Danube River consisting of the extension wetlands into Neighborhood;

- connect Neighborhood to the Danube River.

Danube River's restoration and rehabilitation through Longitudinal Continuity

As a very long-term goal, its ecological and hydrological functioning can be restored through creation of a continuous riparian habitat corridor within hydro network of arms and channels and through removal of concrete walls where feasible. While completely restoring the Danube Valley to a naturalized conditions is not likely feasible, the restoration projects address to flood control requirements and river channel could be naturalized in significant areas.

Three goals complement the efforts to restore river functioning ecosystems:

- *enhance flood storage* - focuses on off- channel storage of peak floods flows in order to reduce flow velocities, which is a necessary precondition for ecosystem restoration;

- *enhance water quality* - seeks to improve the quality of water within implementation of a comprehensive, landscape-based system for filtering;
- *restore the ecosystems functions* - aims to restore the natural ecosystems affected by human activity and restoration of these ecosystems function.

Capture Community Opportunities

In the past, communities have turned their back on the River, viewing it as an unsafe, unpleasant place that primarily functions to transport flow and to form a waterway. Constant danger of floods and the desire to obtain land for urban development and economic activities insured against flooding works have led to extensive damming and draining eliminating large areas of floodplains affecting natural ecosystems. These works had negative consequences for local communities near the river who have lost identity and traditional occupations.

By restoring lateral connectivity will be created new opportunities for local riparian communities.

The study will identify these opportunities, how engaging residents in the community planning process and how:

- engage residents in the community planning process and consensus building;
- provide opportunities for educational and public facilities;
- cultural heritage of the river and foster civic pride.

Create Value

Core elements of this principle include the goal of improving the quality of life by providing new opportunities for traditional economic activities and jobs. River Revitalization can introduce a broad range of benefits that will enhance Danube Valley livability and result in greater economic prosperity. Goals encompass:

- improve the quality of life;
- increase employment;

- create an adequate territorial planning emphasis on protecting natural and cultural heritage, biological diversity and land use of renewable natural resources directly benefit of local communities.

The above mentioned four criterion subclasses were related to the FORECAST project (**F**acilitating the application of **O**utput from **RE**search and **CA**se **ST**udies on Ecological Responses to hydro-morphological degradation and rehabilitation) preliminary restoration and revitalization measures (Figure 2), in order to be analyzed in the next phase *Comprehensive Danube River's Revitalization Assessment and preparation of the Best Practices Danube River's Revitalization Manual*. These measures are temporary classified according to the Environment Agency of England and Wales and River Basins Management Plans of the countries represented in the project.

Preliminary classification of measures after FORECAST project:

- to improve water flow quantity;
- to improve sediment flow quantity;
- to improve flow dynamics;
- to improve longitudinal connectivity;
- to improve river bed depth and width variation;
- to improve in-channel structure and substrate;
- to improve lateral connectivity;
- to improve riparian zones;
- to improve floodplains.

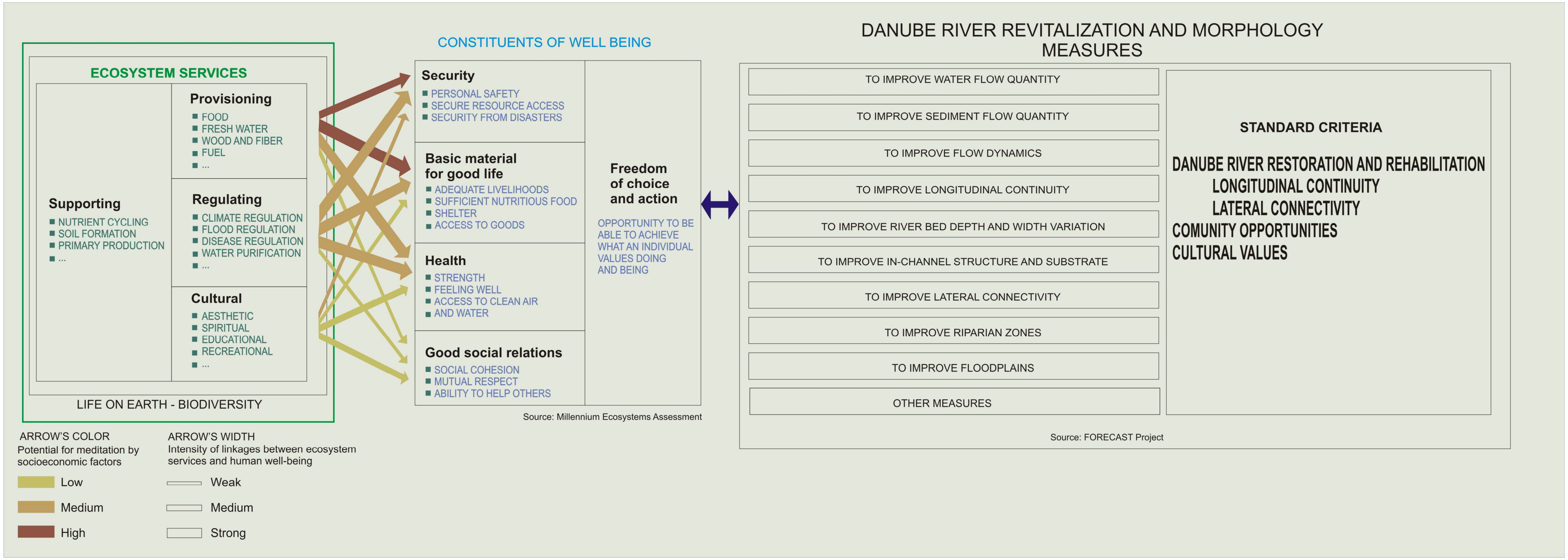

Fig. 2 – Know –How approach regarding the relation between ecosystem services and functions

Activity 1.2. **A public debate about the Danube River's Revitalization Projects Assessment.**

DDNI Tulcea has the logistical capacity to organize a symposium (public debate). This activity will be accomplished in the next phase and its aim will be to select two projects for each subclasses of Danube revitalization and to formulate strategic guidelines for based on their implementation results.

RESULTS OF THIS PHASE

1.1. INVENTORY OF FINALIZED PROJECTS FOR DANUBE RIVER'S REVITALIZATION

Project name:

1. **The Danube restoration project between Neuburg und Ingolstadt (Germany)**

Institution:

Aueninstitut-Neuburg, Landratsamt Neuburg-Schrobenhausen

Project summary:

The study area is the Danube River between Neuburg and Ingolstadt. Along the study area since the 19th century there were a lot of changes regarding the river course. In the 1970s two additional hydropower station (Bergheim in the west and Ingolstadt in the east) were built. Due to these changes occurred in the past, today typical floodplain habitats are highly endangered. In the last 150 years 75% of the Bavarian floodplain areas were lost due to human activities (after Margraf, 2004, quoted by Stammel, 2008). In the study area, however, 2100 ha of riparian forest and riparian habitats have survived as relicts of the former floodplain. (Stammel, 2008)

The objective of the project is to restore the key hydrological and morphological dynamics which are the preconditions for the conservation of typical floodplain habitats and species (after Schiemer, 1999, quoted by Stammel, 2008). The floodplain should be reconnected to the Danube water gradually by stepwise measures. If one is able to use water as an adjusting screw, many other related features (e.g. vegetation) will adjust themselves after a certain period (after Cyffka, 2006, quoted by Stammel, 2008). Therefore, in order to restore the water and soil dynamics in the floodplain, the implementation of three measures is planned. (Stammel, 2008)

Situation before restoration project:

• No river continuity;

• No water and soil dynamics in the floodplain, no connection between river and floodplain (except from flooding > 1.300 m3/s);

• Partly high groundwater level;

• Change of vegetation from typical riparian and floodplain species to terrestrial or wetland species;

• Lost of dynamic ruderal habitats (ox-bows, gravel banks, undercut slopes).

Idea of the project:

Hydrological process is key process for morphological dynamics and water dynamics.

Aims of the project:

- Bring back dynamics to the floodplain;
- Reconnect floodplain and river.

Results of the project:

The subproject: Bypass Bergheim barrage

- permanent flow of 0.5-5 m3/s;
- total length 9 km;
- new water course or temporary water bodies.

The subproject: ecological flooding

- runoff up to 30 m3/s during peak discharge of the Danube (600-1000 m3/s);
- 2 or 3 times a year, duration 5-10 days;
- main flowing of water is along the bypass, return at different sites;
- man-controlled.

The subproject: temporary drainage

- new drainage channel in the water storage area of Ingolstadt;
- two locks of the return courses of the new river, sluice in the dike;
- man-controlled, during low water level of the Danube.

Conclusions of the project:

The subproject: Bypass Bergheim barrage

- river continuity;
- hydromorphological dynamics;
- new riparian and aquatic habitats;
- improved groundwater dynamics.

The subproject: ecological flooding

- more frequent floods adjusted to the Danube;
- improved groundwater dynamics;
- restoration of floodplain habitat relicts;
- development of new floodplain habitats.

The subproject: temporary drainage

- temporary drawdown of permanent high groundwater level;
- the „adequate“ water level is part of the research program;
- restoration of floodplain habitats instead of wetland habitats.

Project name:

2. **Bulgarian Wetland Restoration and Pollution Reduction Project (RIVER ENGINEERING) (Bulgaria)**

Institution:

Bulgarian Ministry of Environment and Water under a WB Financing.

Project summary:

MWH carried out the river engineering project for the restoration of Belene Island and the Kalimok/Brushlen wetlands on the Danube River for the Bulgarian Ministry of Environment and Water under a WB Financing.

The Bulgarian Wetlands Restoration and Pollution Reduction Project is the first of its kind under the umbrella of the GEF Black Sea/Danube Strategic Partnership - Nutrient Reduction Investment Fund, a program which intends to help riparian countries undertake investments to control or mitigate nutrient inflow to the Black Sea. The Wetlands Restoration and Pollution Reduction Project is consistent with the Strategic Action Plan for the protection and rehabilitation of the Black Sea (BSSAP) and the Black Sea/ Danube Strategic Partnership. The BSSAP, formulated with the assistance of GEF, had identified nutrient discharge as the most serious problem facing the Black Sea. The Government of Bulgaria requested assistance from the GEF/World Bank for undertaking an innovative approach to wetland/floodplain restoration which linked land use change with sustainable use and economic development.

In October 2002 the Ministry of Environment and Water launched the implementation of activities under the Wetlands Restoration and Pollution Reduction Project being a pilot project for Bulgaria and the Danube River downstream.

The project will assist the Government of Bulgaria in:

• restoration of critical priority wetlands in the Danube River basin and piloting the use of riparian wetlands as nutrient traps;

• establishment of comprehensive monitoring systems for water quality and ecosystem health;

• supporting protected areas management planning in the Persina Nature Park and Kalimok/Brushlen Protected Sites;

• strengthening capacity to protect and manage biodiversity and natural resources;

• building public awareness of sustainable natural resources management and biodiversity conservation;

• promoting and supporting entrepreneurial and agricultural activities within the project region which ensure the sustainability of natural resources and are compatible with biodiversity objectives.

The project assisted Bulgaria in meeting its international commitments in relation to the Strategic Partnership for reduction of nutrient pollution in the Danube and the Black Sea basins and the relevant requirements of the Convention for Protection of the Danube, the Convention for Protection of the Black Sea etc. All these activities are carried out in close cooperation with the local communities (Nikopol, Belene, Svishtov.Tutrakan, Slivo Pole), the Belene Island prison administration, RIEWs (Pleven, Veliko Tarnovo, Ruse), the Executive Environmental Agency, state forestry boards in Nikopol, Svishtov, Tutrakan and Ruse, scientific and academic institutions, non-governmental organizations etc.

The project completion date:

The project completion date was December 15, 2008.

The project funds:

The project was funded by a Global Environmental Facility Trust Fund Grant through the World Bank amounting to USD 7.5 million, Bulgarian government and local municipalities co-financing of USD 3.05 million and other donors (The European Union PHARE Program and the Austrian Government) at the amount of USD 2.73 million.

Aims of the project:

The project aim is to restore the former conditions of the wetlands to a degree, which is not in conflict with other private or public interests (e.g. flooding of private or State lands), and it is possible under the current natural conditions (e.g. flooding levels in the Danube).

The global environmental objective of the project is to create a model for reducing trans-boundary nutrient loads in the Danube and Black Sea basins and to preserve biodiversity in the protected sites through:

• restoration of wetlands and management plans for protected sites;

• support to the local people in adopting environmentally friendly economic activities.

The long term objective of the Project is the adoption of practices for sustainable management of the natural resources by the local communities and authorities on the territory of Persina Nature Park and Kalimok/Brushlen Protected Site. The project demonstrates how the environmentally friendly activities for the development of an agricultural area can improve the local economy and business.

Persina Nature Park (PNP) and Kalimok/Brushlen Protected Site (KBPS) were selected as project sites due to the high value of their biodiversity, the wetland capacity to extract biogenic pollutants and their role for flood prevention. Besides both of the territories are part of the initiative "The Danube River Downstream - a Green Corridor", which started in June 2000, with the objective to structure a network of completely functioning wetlands along the Danube River in Romania, Bulgaria, Moldova and Ukraine.

Project implementation:

This project is implemented in the framework of the Strategic Partnership for Nutrient Reduction Strategy for the Danube and Black Sea Basins The objective of the strategic partnership is to assist the countries to invest in ensuring control or reduction of nutrient flux into the Black Sea water.

The scope of works:

The scope of works comprises carrying out a feasibility study and detailed technical designs, inclusive of cost estimates, for the necessary infrastructure improvements required for the proposed wetland restoration scenario. This included piled inlet/outlet sluice structures, rehabilitation of existing dikes and channels and new drainage canals.

> Conduct additional necessary surveys

> Carry out a technical feasibility of the proposed restoration alternatives

> Elaborate detailed technical engineering design for the necessary infrastructure improvements, including new canals, structures and rehabilitation of existing facilities, to ensure restoration and sustainable management of wetlands under the current hydrological regime in the Danube river.

> Carry out detailed cost estimates for all infrastructure construction and improvement.

> Prepare bid documents required for tendering as per World Bank standard documents for the construction of the required infrastructure components

> Develop an operational and maintenance manual to operate and maintain the facilities in a sustainable manner

The final design solution for each site needed to ensure that the restoration and sustainable management of the wetlands could be met under the current hydrological regime in the Danube River. These improvements should aim to maximise the water flow through the system in order to optimize nutrient trapping, bio-diversity restoration, maximise fish production and create opportunities for fisheries development, and minimise sedimentation.

Results of the project:

The most important and innovative activity of the project is the physical restoration of the wetlands in the two protected areas. In the course of the implementation of this component activities the project has restored 4 035 ha of former wetlands on two specific sites – Belene Island (2 280 ha) within the Persina Nature Park and Kalimok/Brushlen (1 755 ha) within the Kalimok/Brushlen Protected Site – in order to demonstrate the use of riparian wetlands as nutrient traps.

In order to achieve efficient restoration of the wetlands it is necessary to enable the Danube River water flow into the previous marsh territories. To provide for this some engineering facilities are built, including sluices, channels, dykes to protect the adjacent land, as well as access roads. Thus an option for controlled flooding, optimized trapping of nutrient elements, and restoration of biodiversity and fish populations, living in these water basins will be ensured. All that will allow for sustainability of the wetlands ecosystems.

The construction works for building the sluices, channels, inner protective dike, parallel drainage channel, pump station and roads for access to Belene Island took about a year and a half. The works are fully completed and the first flooding was successfully implemented in April 2008. The results from the flooding are very satisfactory and give us confidence that the restoration objectives are feasible.

Certainly, for the complete restoration of the eco-system a longer period of time is necessary. The other Danube countries experience shows that it would take about ten years.

The construction works for the restoration facilities in Kalimok marshes are also completed.

In Persina Nature Park the marshes in the eastern part of Belene Island are restored and in Kalimok/ Brushlen Protected Site – only the territory of the previous marsh Kalimok, where the land is state owned. No private owned territories on the two sites were flooded. Nevertheless in order to support the transition to new agricultural practices, providing sustainable economic development in the region a special farmer transition fund was established.

The environmental effect of the wetlands restoration would be observed through monitoring on water, birds, fish, mammals, reptiles and vegetation. The baseline data on biodiversity is collected within the project framework. This data will be compared with the data collected after a succession of floodings of the restored territories. This would allow for controlling the water quality and the regime for maintaining the wetlands in future.

Project name:

3. **Extension of the existing Belene Islands Complex Ramsar Site Bulgaria**

Project summary:

Belene Islands Complex is designated as a reserve, natural monument, and natural park. A group of one big (Belene) and nine smaller islands located along 16km of the Danube River, the site is a particularly good representative example of a natural riverine wetland complex in the Danube River catchment.

The site includes the biggest Bulgarian Danube island, Belene, with the three freshwater marshes on its territory, surrounded by old riverine willow forests, as well as the nearby islands Milka and Kitka (Ljuta), which are entirely covered by riverine forests. The islands are located between km 576 and 560 of the Danube River, north-east of the town of Belene and 18 km west of the town of Svishtov. The prevailing habitat is natural riverine forest mainly of willow Salix sp. and White Poplar Populus alba, on the island of Milka – White Elm Ulmus laevis too. Their formation is directly related to the river's water regime. The high waters do not allow the complete development of the spring vegetation. The water withdrawal coincides with the high summer temperatures, as a result of which lush summer vegetation covers the island. The tree – shrub vegetation has poorer composition compared with that on the riverbank of the Danube and is dominated by White Willow Salix alba and Blackberry Rubus caesius. The three marshes on the Belene island (Peschina, Murtvo and Djuleva Bara) are connected by a canal that flows into the Danube. In high spring waters the wetlands are fed by fresh water coming through the open sluice of the canal. Typical marsh associations develop in the marshes - Nuphar lutea and Potamogeton natans in the deeper sections, Nymphoides peltata, Hydroharis morsus-ranae and Trapa natans in the shallower ones. The marshes are overgrown to a different extend with Phragmites australis, Sparganum ramosum, Alisma plantago-aquatica etc. The formation of Azola filiculoides is quite typical for these marshes. Part of the territory of Belene island is occupied by meadows. The grass associations are represented by several plant communities that often merge, dominated by Cynodon dactylon, Scirpus michelianus, etc. In the eastern and western parts of the islands sand strips, usually without vegetation, are being formed.

The islands once had a significant role as a nursery for about 20 fish species, and efforts are being made to reinstate their importance with a planned restoration project.

Threats:

The area is very sensitive to drainage, because it is highly dependent on the flooding, which maintains the marshes, riverine forests and all the various tree associations. At present the area is drained for the maintenance of meadows and arable land, as well as for forestry activities. In some years the marshes dry up completely. Processes and species dependent on temporary inundation and fish occurrence on Persina Island are extinct. The unique forests have been partly destroyed by cutting and replanting with non-native species. The western part of Persina Island is urbanized, where a prison is situated. Urgent measures are needed for the restoration of the natural water balance on the Persina Island. During the recent years a restoration project started on the island, but the type and scope of the restoration measures are stils not agreed. The shipping on the Danube River influences the water quality of the river. Deepening the bottom of the Danube, planned by the Government with EU funds, will cause in this particular part of the river further disturbance of water regime and deterioration of the wetland habitats in the Belene Island Complex. The planned construction of the Belene Nuclear Power Station south of the Belene complex by the Government will have significant impact on the water characteristics and parameters, which will change the species composition in the area and the food base for majority of the water birds.

Legal protection:

The land territory of Belene Island Complex is situated in “Persina” Nature Park, designated in the year 2000. Two reserves – the islands “Milka” and “Kitka” are established in the area respectively in 1956 and 1981 to protect the unique riverine forests. The “Persina marshes” Maintained reserve with a buffer zone, as well as the “Persina iztok” Protected Area were designated in 1981 to protect the representative wetlands, with typical habitats and breeding grounds for terns, ducks and geese. In 1998 the Persina Island was appointed as CORINE Site because of its European value for habitats, rare and threatened plant and animal species, including birds.

Whole the area of Belene Island complex was designated as Wetland of International Importance under The Ramsar Conventionin 2003. In 1989 the area was designated as Important Bird Area by BirdLife International. The proposed SPA borders a proposed Special Protection Area in Romania.

Project opportunity:

Kaikusha marshes are a protected area included in a nature park at the border with Romania, formerly connected to the Danube River. Due to the interruption of this connection and the existence of a drainage system, the wetland has been drying up.

Project objectives:

The main objective of the project is the restoration of the water regime through construction works to rehabilitate the wetland biodiversity. After completion, it would be used as a model to encourage wetland sustainable use practices through meetings with stakeholders, local community training and dissemination of educational materials.

A proposal for the extension of the existing Belene Islands Complex Ramsar Site to include Kaikusha would be drafted at the end of the project.

Project name:

4. The LIFE Project "Upper Drava-river valley" Austria

Project period: 1999 – 2003

Beneficiary: Water Management Authority of Carinthia

Partners: Federal Ministry of Agriculture, Forestry, Environment and Water Management, Nature Conservation Authority of Carinthia, WWF Austria

Budget: 6,3 Mio Euro

Life contribution: 26%

Project summary:

The upper Drava in Carinthia in Austria is a typical Alpine river which hosts the last remnants of inner alpine floodplain forest associations and endangered species populations such as the Danube Salmon (*Hucho hucho*). The alder-ash floodplain forests are the best preserved and largest ones in the entire Alps. It is one of Austria's largest rivers which have being preserved as a free-flowing river on over 60 km without any dams.

Situation before restoration:

The upper Drava in Carinthia, once a highly braided river with many side arms and gravel banks, has met the same fate as so many other Alpine rivers in the 20th century: the river bed was canalized, bends were straightened out and branches cut off from the main stream, dams built and farming in the floodplain area intensified. This has brought an enormous loss and degradation of the natural freshwater habitats including alluvial forests and a decline of species populations including the Danube salmon (*Hucho hucho*) and the crayfish (*Austropotamobius pallipes*). Major problems, including the deterioration of natural flood retention capacity leading to great risk of flooding for the whole area as well as deepening of the river bed (e.g. deepening of 2 cm per year) which caused a fall in groundwater tables, have forced a fundamental reassessment of Carinthia´s approach to river management. Starting in the early 1990s, the Water Management Authority of Carinthia has started restoring the river to a semi-natural state again. New efforts were made to preserve and improve what was left of the rich natural environment and have to date culminated in one of the largest river restoration projects in Europe.

Situation after restoration:

The main objective of the LIFE project was to maintain and improve natural flood protection and the river dynamic processes and therefore to improve natural habitats and typical species populations. This was achieved through restoring three ecological “core zones” by river bed widening and reconnection of the former side-arm system with the main river of over 7 km of its length. An additional focus lay in the restoration of the natural floodplain forests, the protection of endangered species and the creation of a combined biotope system along the whole river valley.

Project results:

• Better flood prevention: On 200 hectares natural flood retention capacity improved by 10 million cubic meters.

• Reduced flow velocity: The speed of the flood wave slowed down by more than one hour.

• River bed deepening stopped or even rose.

• More space: 50-70 ha more natural river habitats as river islands, gravel banks, steep banks for engendered species such as Danube Salmon, Common Sandpiper and Kingfisher created.

• Fish population doubled such as the grayling.

Project name:

5. The LIFE Project „Wild river landscape of the Tyrolean Lech" Austria

Project period: 2001 – 2006

Beneficiary: Environmental Protection Authority of Tyrol

Partners: Federal Ministry of Agriculture, Forestry, Environment and Water Management, WWF Austria

Budget: 7,8 Mio Euro

Life contribution: 50%

Project summary:

The Lech in northern Tyrol is characterised by huge gravel banks and broad areas of lowland riparian forest. It is the last major river in the northern Alps that is in a semi-natural state. For over 60 km, the highly braided river occupies a gravel bed that in parts is up to 100 m wide. The course of the river is constantly changing due to erosion and deposition.

Situation before restoration:

In the past, however, flood disaster and increasing pressure from human activities have led to river regulation measures which in certain sections have severely narrowed the riverbed. The construction of debris dams across small tributaries and growing exploitation of gravel from the river bed have also contributed to river bed deepening and the lowering of the groundwater tables. Particular the diminished river dynamics have caused a decline of endangered species characteristic for gravel banks including the German tamarisk (*Myricaria germanica*), the pink-winged grasshopper (*Bryodema tuberculata*) and the little ringed plover (*Charadrius dubius*).

Situation after restoration:

The main objective of the LIFE project is to restore characteristic habitats of the Lech River by widening the riverbed of over 6 km of its length. In the widened sections about 35 ha of new gravel banks are going to be created which increases endangered species populations. At the same time the supply of gravel to the main river channel is being increased by gradually removing the debris dams in the tributaries. This would mean using the ecological approach for stopping further deepening or even raising of the riverbed. The project is being accompanied by species protection as well as visitor management measures.

Project name:

6. Monitoring results of revitalization measures on an urban lowland River (Liesingbach, Vienna, Austria)

Institution:

ARGE Okologie, Technisches Buro fur Okologie, Wien, Austria

Project summary:

The Liesingbach, flowing through the south of Vienna, Austria, is an urban stream that has been designated as a heavily modified body mainly because the river was canalized, its bed was hard and the water quality poor due to considerable wastewater discharge. A study in 1999 before the restoration confirmed the poor ecological status in terms of hydromorphology, aquatic biocoenosis, riparian vegetation and water related terrestrial fauna. Until 2005, a 5.5 Km long reach close to the south-eastern city limit was revitalized with the intention to induce an ecological development by improving the hydromorphological conditions. However, the creation of a typical lowland river morphology was limited due to the difficulties in acquiring adjoining premises. The implementation of the European Water Framework Directive into national legislation gave rise to an interdisciplinary assessment of realistic development objectives for an urban river like the Liesingbach. Consecutively, the Liesingbach was classified as a heavily modified water body.

Aim of the project:

To improve the ecological status of the river, it was decided to reduce the immissions significantly. The discharge of sulphureous hot spring wastewater was stopped and also a small municipal sewage plant was shut down while its wastewater was redirected to Vienna's main clarification plant. For this, a new main sewer had to build following the river course. (Panek, 2008)

Situation before restoration project:

The hydro-morphological status in 1999 showed adverse and unnatural conditions (structural status class IV). Beside interrupted passability for sediment and fish, the hard construction caused several deficits such as a straightened river course without bed sediments, lacking variability in width and depth as well as missing riparian vegetation. (Panek, 2008)

Situation after restoration project:

Gravel discharge is observed in places because sediment dynamics within the revitalized river stretch were initialized. This indicates, that the re-establishment of the natural passage of sediment is quite essential to achieve a sustained revitalization success. (Panek, 2008)

Results of the project:

The ecological monitoring commenced at the end of the year 2004 and ended in 2007. Investigated parameters were river morphology, sediment composition, vegetation ecology, dragonflies, carbides, ciliates, macrozoobenthos and fish. This showed that the morphological setting has dramatically improved resulting in an increased variability in water depth, channel width and bank design. Wet and damp sites with typical plant species developed. (Panek, 2008)

Conclusion of the project:

The results indicate that even in an urban surrounding with significant spatial restrictions a revitalization can be successful. Three years after completion of the reconstruction works, the biocoenotic development is still in progress. (Panek, 2008)

Project name:

7. River Wien restoration project: improvement of the ecological condition of a heavily modified river in a urban environment (Austria)

Intitution:

Department of Freshwater Ecology, University of Vienna, Austria

Project summary:

The Wien River has its source in the Vienna Woods, to the west of Vienna, Austria, at 620 m ASL. With a length of 32 Km and a catchments area of 230 sqKm, it is, beside the River Danube, the most important river passing through the city of Vienna. The catchments area mainly consists of flysch with a very low pore volume and a low water retention capacity. Rainfall therefore leads to high surface runoff and an immediate and strong rise of the discharge of the Wien River. For flood protection, the river was placed in a deep channel in the late 19th century and the river bottom was sealed with paving stones and concrete.

After a careful planning and extensive model experiments, transverse ground sills and large stones were anchored in or on top of the sealed channel. The ground sills were designed to protect against the avulsion of the gravel and should help to maintain the subsequent pools. The whole stretch was covered with gravel of different sizes and finer sediment was used to loosely fill the interstices. Along the left bank a maintaining path was constructed, the right bank was composed of small grassland and riparian vegetation mainly consisting of willows. (Keckeis, 2008)

Aims of the project:

In both river sections, measures were undertaken to increase aquatic habitat area, habitat heterogeneity and connectivity. According to the habitat heterogeneity theory (after Ricklefs and Schluter, 1994, quoted by Keckeis, 2008) and several concepts of river ecosystems (after Vannotte, 1980; Amoros and Roux, 1998; review in Ward, 2002; quoted by Keckeis, 2008) this should improve ecosystem function and therefore boost species diversity. (Keckeis, 2008)

Results of the project:

At the end of the first year, the number of taxa and their relative abundance were not different from that after three years. This indicates that the colonization process was completed (a stable assemblage established) after about one year. Although, the control reach was dominated by chironomids rather than by oligochetes, compared to the test reach back in 2003/04, the number of taxa and the diversity were similar in both stretches. (Keckeis, 2008)

Both restored areas were colonized almost immediately after the completion of the restoration measures. In both reaches, species number increased markedly shortly after the implementation and a further increase with time indicates the establishment of a new populations. This is also expressed in the high abundance of a large portion of observed species, demonstrating the development of self-sustaining populations. (Keckeis, 2008)

Project name:

8. **LIFE Nature Project Wachau of dry grasslands and Danube nase (Austria)**

The project objectives:

- Structuring the main current of the Danube with gravel embankments and islands.
- Linking old tributaries to the Danube.
- Maintenance and management of dry grasslands and grassy slopes.
- Improvement of semi-natural forests.
- Creation of a nature protection coordination body.

Situation before/after human impact

The Danube has an alpine character in that region, with coarse gravel as bed sediment. Mean water flow velocity is 1.5 to 2.0 m/s, mean water discharge is 1950 m^3/s. Due to regulation works in the 20th century the river banks are fixed by embankments, and side arms are cut-off by rocky dams.

Project results:

- *Dry grassland describes the sparse, low-lying vegetation which is suited to barren and dry conditions.*

In the LIFE Nature Project these particular habitats are maintained by re moving bushes and mowing grass cover. Grazing with Waldschaf sheep prevents open spaces from becoming overgrown. The focal areas for dry grassland management are in the communities of Dürnstein, Rossatz-Arnsdorf, Spitz and Weissenkirchen. The Arbeitskreis Wachau group cleared and recreated over 50 hectares of overgrown dry grassland and meadow. Recurrent land management procedures were carried out on a further 100 acres.

- *The higher reaches of the slopes which lead down to the Danube are predominantly forested and are of special significance as protection and recreational forests.*

The LIFE Nature project, in collaboration with the municipality of Mautern, has taken the semi-natural forest around the Ferdinand-Warte look-out point near Unterbergern out of utilisation. Forest protection areas covering almost 160 hectares have been established, in collaboration with the Rossatz agricultural association and the communities in Rossatz-Arnsdorf and Spitz. These untreated areas form the habitat for many endangered bird species such as the black stork, white-backed woodpecker, red-breasted flycatcher and many more. Old and deadwood are necessary for the survival of endangered beetles such as the Great Capricorn beetle and the stag beetle.

- *The new gravel islands enhance the landscape and the Danube as a natural habitat.*

The LIFE project and via donau have developed a gravel concept with ecologists in which future gravel structures are predetermined. This will be the template for ecological gravel management in the Wachau valley until 2020. The dredged gravel is turned into new gravel embankments and islands away from the shipping channel. Gravel structures are planned for 13 sites between Melk and Mautern. The new islands create shallow water zones, protected from the pounding of waves, which are used by migratory fish species as places to spawn. The fry have a greater chance of survival in these shallow spots behind the islands. Via donau has already created 25 island and embankment structures with over 500,000 m³ of gravel at Aggsbach Markt, Willendorf, Schwallenbach, Arnsdorf, Wösendorf, Rossatz and Dürnstein.

The newly created gravel islands enhance the natural landscape. They provide spawn sites, nurseries for juvenile fish and habitats for birds which nest in gravel. Gravel embankments close to towns and communities are popular local recreation areas.

- *The LIFE Nature project has linked dry old tributaries to the Danube once again and created refuges for fish fauna.*

The LIFE Nature project has reconnected three of the truncated remains of old distributaries in Aggsbach Dorf, Grimsing and Rührsdorf-Rossatz with the Danube to ensure that these water biotopes are, as far as possible, provided with a permanent supply of Danube water. The new channels were, for the most part, dredged a metre deeper than regular low-level water (= Kienstock gauge 177 cm). This resulted in the creation of a further 6km of refuge space for fish in the Danube. Other river inhabitants such as the kingfisher, common sandpiper, amphibians and dragonflies have also profited from the improvements to the ecological situation.

Decades ago the migratory Danube nase was a prevalent fish species in the Wachau. The Danube nase population numbered well over 100, 000 in the free flowing course of the river. Numbers of nase have declined drastically. A fish survey, carried out as part of the LIFE project “Danube salmon habitat”, revealed that nase numbers in the year 2002 were between 3000 and 7000.

The distributaries and gravel islands provide new breeding grounds for nase. Fish experts have confirmed the presence of large numbers of juvenile nase in the last few years. This increase in nase numbers is only possible thanks to shallow water zones, created by via donau as part of the LIFE project, which protect the fish from the pounding of waves. The new Danube distributaries have become attractive areas of unspoiled nature where visitors can rediscover and experience the beauty of the river landscape.

- *In the Aggsbach Dorf old tributary project the remains of silted watercourses were dredged and linked under the current to the Danube.*

The new tributary has been supplied with Danube water all year round since it was opened in the spring of 2007.

The channel is dredged so deep that it supplies water even in dry periods. In collaboration with the Lower Austrian State Fisheries Association two additional deep channels (two metres below low-level water) were created.

Just less than 80,000 m3 of fine material and gravel was transported to the adjoining loose-rock dump at the Danube dam and heaped to form flat embankments. In order to ensure the passability of the Danube cycle way, it was necessary to build a bridge over the inflow opening.

The new channel, which rejoins the watercourse downstream, provides primarily migratory fish species with spawning grounds, winter habitats and rest areas. Endangered Danube fish such as the zope, asp, pike and nerfling find suitable breeding, feeding and resting grounds. Numerous fish species have settled again in the old tributary since spring 2007. Fish ecologists have meanwhile identified 22 different breeds of fish, some of which are also breeding in the new watercourse.

The project was implemented in collaboration with the market towns of Schönbühel-Aggsbach, the Walpersdorf estate management (permitted authority), via donau and the Austrian Fisheries Association founded in 1880.

- *The Grimsing tributary is developing once again into one of the most prolific bodies of water for fish in the Wachau valley.*

In October 2006 the building work began, and in April 2007 the new, 2km long tributary system was linked with the Danube. A total of 300,000 m³ of fine sediment and gravel was dredged. With the opening of the Danube loose-rock dump, a 200 m wide inflow area and a 5 hectare island in the Danube have been created. The new channel was deepened to that ensure that water passes through, even when water levels are low. In mean flow conditions in the Danube, approximately 50 m³/s flow through the distributary.

- *The ambitious network project in Rührsdorf-Rossatz has recreated over 4km of river habitat.*

The Venedig and Pritzenau tributaries are linked to the Danube by two inflow openings. The pools are fed by the Pritzenau tributary or are linked directly to the main current of the Danube. The distributaries were dug deep to ensure that water flows along them even during longer dry periods. Via donau used the excavated fine material and gravel to cover the drab loose-rock dump on the banks of the Danube. This has created over 1km of new, attractive flat embankment. From now on the Danube will be responsible for shaping the ultimate physical form of the distributary system.

LIFE has created a natural paradise here for people and animals. The new watercourse system provides numerous species of fish protection from the pounding of waves to spawn, settle for the winter and rest. Endangered Danube fish such as the Danube salmon, Danube roach, striped ruffe, streber, Danube streber nase have re-established new habitats here.

Project name:

9. Lobau (Austria): reconnection of floodplains

Situation before/after human impact

The floodplain area “Lobau” is situated along the left bank of the Danube River at the eastern border of the city of Vienna (Rkm 1924-1907). During the 19th century, this former braided-anabranching floodplain complex was disconnected from the main channel by the construction of lateral embankments and a flood protection dyke. Land use change has led to a 74% decrease in surface water area and has dramatically altered habitat composition and related ecosystem functions.

Restoration project

Lobau floodplains have been reconnected to an artificial flood relief channel of the Danube since 2001 (flow input: up to 1.5 m^3/s during the vegetation period, mean discharge during 2001-2008: 0.25 m^3/s).

Situation after restoration

The improved connectivity between water bodies at higher mean water levels in the floodplain has decreased the risk of massive eutrophication events, improved the water levels in small oxbows and some semi-aquatic areas, and conserved the existing species diversity in aquatic habitats (after e.g. Bondar-Kunze et al., 2009, Funk et al., 2009, Sommerwerk N. et al., 2010).

Lessons learnt

Increased connectivity has led to more diversified aquatic and semi-aquatic habitats and more intense biogeochemca1 cycling. However, due its vicinity to Vienna, societal demands, like flood protection, drinking water supply (20% of the drinking water for Vienna), and recreation (~650.000 visitors per year-census 2006) challenge floodplain management of the Lobau. A multi-criteria decision support system that integrates ecological and societal demands has been developed in order to identify future measures able to serve multiple uses and rehabilitate the hydrological connectivity in certain parts of the floodplain area (after Hein et al., 2006b, Sommerwerk N. et al., 2010).

Project name:

10. National Park Donau – Auen (Austria): side arm restoration and river bank restoration

Situation before/after human impact:

The Danube has an alpine character in that region, with coarse gravel as bed sediment. Mean water flow velocity is 1.5 to 2.0 m/s, mean water discharge is 1950 m^3/s. Due to regulation works in the 20th century the river banks are fixed by embankments, and side arms are cut-off by rocky dams.

Restoration project:

To enhance riverine – morphodynamics, several sidearms have been reconnected since 1995 (Rkm 1905.0-1906.5; 1905.2-1902.0; 1910.1-1906.5) and since 2005 river embankments and grayness have been removed from 2.85 kilometres (Danube Rkm 1885.75-1882.9) and from 1.2 km (Danube Rkm 1883.1-1881.9). The long-term goal of the project is to come as close as possible to the pre-regulation status of this Danube section. Implementation is by the Austrian Waterway Agency (via donau) and Danube Floodplain National Park subsidized by the EU LIFE-Programme.

Situation after restoration:

Reconnected side arms show considerable erosion of lateral fine sediment layers and meandering is starting to take place. However, morphodynamics are not yet sufficient for adequate bedload gravel transportation. Sidearms have not increased water depth by incision. Along the Danube natural river banks were restored within half a year with lateral erosion rates of up to 10 m, though the erosion rate is currently declining.

Lesson learnt:

Revitalisation of floodplains, flood control and inland navigation are compatible, when win-win situations are created. In these cases it is even possible to obtain or to proactively protect riverine landscapes with steep river banks several meters high, to have gravel relocation rates that allow for the formation of gravel banks and to have river banks structured with large woody debris.

Project name:

11. Morava River (Slovakia and Austria): reconnection of meanders

Situation before/after human impact

Originally a meandering river, more than 90 % of the river course faced intensive river regulation during the 20th century, like dike construction, canalization, and elimination of all major meanders.

Project summary:

Within the project GEF-Biodiversity four cut-off meanders were partly reconnected to the river between 1993 and 1995 (Morava-Rkm 12, 19, 65). The aim was to increase the flow dynamics in the former anabranches. The bypass-canals stayed fully active, water inflow to the re-opened meanders was limited by rock dams.

Situation after restoration

The expected washout of settled sediments did not occur, and the opened meanders suffered severe sedimentation after restoration. The morphology and the sediment layer did not develop towards an active meander. Biotic response showed an increase of fish taxa; mainly additional rheophylic species. Invertebrate and plant communities shifted towards the riverine set of species, but could not be considered equivalent to those observed in active meanders.

Another type of meander re-opening was tried on the Austrian side of Morava River at river-km 18, where the meander was reconnected at the downstream part to the river which leads to severe sedimentation in the outflow area of the meander.

Lessons learnt

The results provide evidence that reconnected meanders might be unsustainable if a parallel shortcutting is not blocked. It is one of the only projects where full meander bends of lowland rivers have been reconnected and the resulting hydromorphologic changes were well-documented (Phare Project Report 1999).

Project name:

12. LIFE05NAT/SK/000112 „Restoration of the Wetlands of Zahorie Lowland“ (WETREST) Slovakia

Project period: 01/02/2005 to 31/12/2008

Beneficiary: State Nature Conservancy of Slovak Republic

Partners: Slovak Water Management Enterprise, Department Bratislava
BROZ — Regional Association for Nature Conservation and Sustainable Development

Total project budget: €624,000

EU financial contribution: €312,000 (50%)

Financial contribution of beneficiary and Partners: €312,000 (50%)

Project summary:

In Slovakia the wetlands are among the most seriously threatened natural ecosystems. Wetlands represent rather unique habitats for many plant and animal species, and they are considered important both for the biodiversity conservation and stabilization of the water regime of the landscape. Important function of the wetlands is retention of the water coming from the rain and snow. This water is being naturally slowly released from the wetlands by out-flow and evaporation. In this way the undisturbed, well functioning wetlands contribute to the reduction of the extreme climate phenomena like droughts, floods or storms.

The wetlands also represent important natural resources for the local economies – especially for the timber production, hunting and fisheries.

In the last century, especially during its second half, the total area of wetlands in Slovakia has been dramatically reduced and the vast majority of remaining natural and semi-natural wetlands have been seriously threatened by human interventions. The most significant have been the changes in their natural water regime, caused by the extensive regulations, drainage, peat extraction and land reclamation schemes. The wetlands have been drained mainly in the lowlands. The main purpose of the reclamation schemes was to gain more arable land for the agriculture. However, the wetlands were drained also in the forest areas, as a part of so-called “intensification” of the forest management. Many wetlands have been completely destroyed during this period, and many others have been seriously deteriorated.

The project area consists of eight wetlands – Sites of Community Importance that are located in the area between the district cities of Malacky and Senica (west Slovakia). Four of them – Rudava, Orlovské vŕšky, Mešterova lúka and Kotlina – are situated within Zahorie Military District. Rudava is also designated as an internationally important wetland (Ramsar site) according to the Ramsar Convention.

In Zahorie Lowland (western Slovakia) almost all important wetlands have been drained. Following the drainage of wetlands, the landscape has been dried up in the whole region. One of the most serious consequences was the dramatic increase of the forest fires.

These changes have lead to the dramatic decline of the biodiversity and reduction of the retention capacity of the areas concerned. Many species, that were once common (such as amphibians or storks) became rare, some of them even locally extinct.

Aims of the project:

The project is focused on the restoration of the most valuable remaining wetlands at the territory of Zahorie Lowland, which is one of the most important regions in Slovakia not only for wetlands, but also for the biodiversity in general.

The main project objective is to restore the original water conditions and to reach the favourable conservation status of the forest and wetland habitats at 8 project localities - proposed Sites of Community Interest. During the project period specific restoration and management measures are being implemented at individual project sites, including the restoration of water regime, improvement of the habitat conditions for most threatened plant and animal species, construction of fish by-pass at Rudava River near Veľké Leváre community to restore this important fish migration route, and restoration of species-rich lowland meadows along the rivers' floodplain.

For each project site the Management Plan, and if needed, also the Restoration Project shall be elaborated. Other project actions are focusing on increasing of public awareness about the wetlands conservation and restoration, especially in Zahorie region, including installation of signposts at the project sites, presentation of the project in media, publishing of information and educational materials, public presentations, meetings, workshops and excursions. Important part of the project is also the capacity building of the implementing organisations.

Project objectives:

The project shall contribute to the development of NATURA 2000 network through the conservation, restoration and enhancement of important wetland habitats and species at the territory of Zahorie Lowland.

The specific project objectives are:

- improving the overall habitat conditions at eight proposed Sites of Community Importance (pSCI) - wetlands degraded in the past by the drainage schemes and other human interventions.
- reaching and maintaining favorable conservation status of the habitats and species targeted at the national and European level that occur here. Several of these species have its only localities or it's most important populations in Slovakia located here, in Zahorie.
- raising public awareness about the wetland restoration / conservation issues.

Project actions:

Most of the project actions are focused on the improvement of water conditions and reaching the favorable conservation status of the habitats and species targeted at 8 proposed Sites of Community Importance (pSCI). For this purpose on each of project localities different revitalization and management measures take place.

Project implementation:

During the project duration (2005 - 2008) following activities were implemented:

- elaboration and implementation of Management Plans and Restoration Projects for 8 proposed Sites of Community Importance (degraded wetlands) at the territory of Zahorie Lowland;

- harmonization of Forest management plans with the needs of Nature conservation ;
- implementation of specific restoration and management measures at each of 8 project sites – improvement of water regime (backfilling of drainage ditches, small streams restoration), improvement of habitat conditions of most threatened plant and animal species;
- construction of the fish by-pass at Rudava River close to Velke Levare to restore the traditional fish-migration route;
- restoration of species-rich lowland meadows along Rudava River;
- institutional strengthening of project partners, including education and training of key personnel ;
- public awareness campaign on the importance of the wetlands and their conservation and restoration, including production of information and educational materials about the project.

Project name:

13. Krapje Djol (Croatia): reflooding of oxbow

Situation before/after human impact:

The spoonbill colony Krapje Dol is the heart of the Nature Park Lonjsko Polje. In 1963 the oxbows became the first Ornithological Reserve of Croatia. In 1988,180 pairs of spoonbills and 210 pairs of herons nested there. During the implementation of the UN-World Bank SAVA 200 program the site suffered as its surroundings were drained in a polder, large flooded pastures were transferred to arable land and herbicides delivered by airplane directly over the colony. A ditch drained the water from the oxbow and the site dried out in 1989 (after Dezelic and Scheider-Jacoby, 1999, Sommerwerk N. et al., 2010).

Restoration project:

Two Important steps led to the recovery of the site. In 1989, a rehabilitation project was planned by the Croatian Institute for Nature Protection and EuroNatur to restore the water Level in the oxbow. Moreover, a pipe is built to re-flood the area. It is in use when the water level in the Sava is above 620 cm. Funding was provided by the Zoological Society Frankfurt.

Situation after restoration:

In 1991, the first spoonbills returned. In 2004, the colony has reached 80 pairs of spoonbills and 370 herons. In 1997 the plant Stratiotes aloides was spotted again in Krapje Dol.

Lessons learnt:

Flooding without a pump and depending on the natural water regime of the Sava was the best solution. Water quality improves after the first flood wave.

Today, the site is once again one of the key attractions of the Nature Park Lonjsko Polje and the mixed heron and spoonbill colony Krapje Dol offers a great insight in the biodiversity of alluvial wetlands.

Project name:

14. Camenca river restoration (Moldova) – Lessons learned for river restoration in the eastern part of the Danube River Basin

Institution:

Center for Strategic Environmental Studies “ECOS”, Moldova

Project summary:

The Camenca River represents a heavily modified watercourse. The channel constructed in the 70s dried the wetlands from the lower part of the river and reduced the river discharge into the Prut river. The channel length is shorter with 7 Km than the natural course (50-60 Km length). Dried lands were used for agriculture purposes, and the surface covered by water was reduced up to 90 %. (Drumea, 2008)

Aim of the project:

• restoration of the former wetland areas of the Camenca river basin to sustain the ecosystems of the protected area “Padurea Domneasca”;

• development of the Action Plan and monitoring programs on the state of the protected area;

• involvement of public organizations and NGO community in nature restoration activities in small rives basins in order to mitigate negative consequences of deterioration of small rivers in the past;

• improvement of water quality and hydrological regime in the Camenca river basin. (Drumea, 2008)

Results of the project:

Hydrological regime was restored after opening the channel gates.

Around 50 Km of the lower part of Camenca river bed were restored and water returned to the wetland areas.

It has been estimated that around 60 ha from the 125 existing ha of wetlands are now permanently flooded. River meanders were restored and a water storage in the floodplain was increased. (Drumea, 2008)

Project name:

15. Ecological Restoration in the Danube Delta Biosphere Reserve (Romania) – Babina and Cernovca islands

Institution:

Danube Delta National Institute for Research and Development Tulcea

Danube Delta Biosphere Reserve Authority

WWF Auen Institut

Project period: 1994-1996

The rehabilitation of Babina was initiated in April 1994 with the dam openings and the reconnection to the flood regime of the Danube.

In spring 1996, the circular dam of Cernovca island was also opened in two places and gave way to the reestablishment of natural and near-natural conditions.

Project summary:

The study areas are the islands of Babina and Cernovca situated in the north-east of the Danube Delta. The reason for dyking and drainage on the islands was the intention to transform swampland into arable soil. All typical and traditional forms of land use, including fishing and reed harvesting, were eliminated. Before they were dyked, both islands had a water network which regulated their hydrological balance. Due to embankments the vegetation of the islands was submitted to dramatic alterations. There was, in particular, a distinct shift towards dryness. The dyking implied also the loss of the habitats function as a natural reproduction area for fish and as an essential source of food and living.

The objective of the project was to reconnect the islands to the hydrological regime of the Danube. Studies were done to evaluate a number of points including the habitat conditions in the dyked areas, their ecological evaluation and the reestablishment of a near-natural hydrological regime.

Rehabilitation clearly was the best solution for the two islands, both from an ecological and an economical point of view.

Idea of the project:

Hydrological process is key process for:

• morphological dynamics and

• water dynamics.

Project objectives:

• rehabilitation of the wetlands with their varied habitats and functions;

• reestablishment and conservation of biodiversity;

• reestablishment of natural, renewable resources for the sake of the local population;

Situation before restoration project:

• Water circulation was almost non-existent;

• The alteration of the hydrological regime implied an alteration of both the biochemical processes occurring in the soils and their intensity while substituting some of the system's functions;

• Partly high groundwater level;

• Change of vegetation from typical wetlands species to terrestrial, tolerant of dry and moderately dry conditions;

• Lost of natural reproduction area for fish, birds and animals as an essential source of food and living space.

Situation after restoration:

• the reestablishment of the hydrological regime also implies the reestablishment of the area's ecological functions;

• after Babina reconnection to the Danube flood regime, the island took up its former function as a water reservoir, so that 35 million m^3 may be retained at high water levels and 5 million m^3 at low water levels;

- the periodical alternation of flooding and drying-out as well as the flood duration and height create a varied mosaic of different aquatic, amphibian and terrestrial habitats;
- in the course of the second year the majority of aquatic and swampland plant communities which usually only appear in untouched Delta areas, could already be found;
- the area has been regained as a habitat and reproduction ground for fish and as a breeding, resting and feeding place for water and wading birds;
- the area also plays an essential role as a habitat for mammals and a highly varied arthropod fauna;
- after the flooding, the biogeochemical processes, completed by the soils in the polder's ecosystem, changed;
- immediately after the opening, the Cernovca island took up again its ecological function as a reproduction ground for fish and as a habitat for water and wading birds;
- after a mostly near-natural reestablishment of the hydrological regime all other ecological factors were reestablished and the natural floodplain resources could again redevelop.

Project name:

16. Research for ecological restoration in the Dunavat-Dranov region, Danube Delta (Romania)

Institutions:

Institute for Inland Water Management and Waste Water Treatment RIZA

Danube Delta National Institute for Research and Development

Project summary:

Within the Danube Delta in Romania large, natural areas have in the past been reclaimed to be used for forestry, agriculture and fisheries. Since the political revolution of 1989, a change has occurred in the management objectives for large parts of the Danube Delta and some of these reclaimed areas have been selected for ecological restoration. This report deals with ecological restoration in the Dunavat,/Dranov region, in the southern part of the Danube Delta. In this region there are several former fish-ponds of large size (> 1000 ha), with potentially high natural value. The aquatic ecosystem of one of these former fish-ponds, namely Holbina II, was observed to change during the mid-nineties from a highly diverse mesotrophic state to one of turbidity with low natural value. The objective of this report is to summarize all research related to the ecological restoration of these fish-ponds, in particular Holbina II, conducted over the past decade. Based on this review, some recommendations have been formulated. Holbina II is, in common with the other fish-ponds, surrounded by a dike and almost isolated from Danube river water. There are only a few culverts and in some years there have been breaches in the dike. Previous studies had suggested that it was this isolated character of the fish-pond which was mainly responsible for its observed eutrophication. However, the water of the Danube River has high levels of nutrients and allowing this water to enter the restoration area untreated was expected to enhance eutrophication. It was hypothesized that reed beds might act as natural filters, reducing levels of nutrients. The idea was thus to restore and maintain mesotrophic conditions within Holbina II by flushing the basin with such filtered water. Several hydrological and ecological studies were implemented in order to find out whether such measures were feasible. The main result to emerge was that reed beds proved during summer to be a source of phosphate, the most important nutrient. This was contrary to the hypothesis.

Another important finding was that the aquatic ecosystem in Holbina II had spontaneously reverted to a clear water state in 2002. Given the prevailing concentrations of phosphate, both clear and turbid states are possible. The ecosystem is inherently unstable and may switch from the clear water state to the turbid water state, and then back again. For the ecosystem in Holbina II there are two possible ecological target states consistent with the management objectives. In the short term, it is recommended that the current 'clear water' state be retained as the ecological target. The alternative ecosystem state that might be advocated, the 'black-water' state, would require for its realization measures implying important regional consequences. These consequences need to be weighed in political debate against the benefits of restoring habitat for rare organisms. Given that the ecosystem state of Holbina II was recently favorable from a biodiversity point of view, given the inherent instability of the ecosystem, and given current uncertainties concerning the effects of hydraulic works for ecological restoration, it is recommended that the authorities implement no immediate ecological restoration measures unless these measures can be accompanied by systematic study. (Drost, 2002)

Aims of the project:

Given the objectives of the Biosphere Reserve, there are two ecological target states relevant for Holbina II. The first possible target is the 'black-water' or 'reference' ecosystem state. This is a state similar to its historical condition, or as it is found elsewhere in the Delta. Originally, Holbina II was a low-basin, peat-reed marsh situated on the periphery of river branches, with little open water (after Rijsdorp et al., 1995, quoted by Drost, 2002). This state is characterized by low connectivity, the regular occurrence of anoxic conditions in summer, organic soils, a high abundance of the C. demersum or the Nitellopsis obtuse community and the presence of rare fish species (black fish, after Oosterberg et al., 2000, quoted by Drost, 2002). The water is usually clear but has long residence times. It will be referred to as the 'black-water state' (where water is of lake type 3 in the typology of Oosterberg et al. 2000, quoted by Drost, 2002).

The second possible target might be a clear water ecosystem, with lower residence times and high biodiversity in flora and fauna (lake type 2 in the typology of Oosterberg et al. 2000) representing more common species than those organisms found in the first target state. This latter will be referred to as the 'clear water' state, characterized by clay soils, a high abundance of the Potamogeton pectinatus or the P. trichoides community, with eurytopic fish. Under natural conditions, these states co-occur, with 'clearwater' areas near the river, generally in the larger lakes, and 'black-water' conditions in the periphery, usually in smaller lakes. Also within Holbina II, there were gradients from areas with 'clear-water' characteristics to areas that are more isolated, having a 'black-water' character (after Buijse et al., 1997, Bos, 2002, quoted by Drost, 2002). In Drost et al. (1996) a strategy is outlined for the establishment of a self-regulating wetland in the Dunavat,/Dranov region, with decreasing riverine influence in isolated parts. This strategy involves integration of the separate fishponds to form one unit and results in a combination of targets 1 and 2. Other possible ecological target states, such as one characterized by turbid-water, are not in line with the management objectives and will not be considered here. (Drost, 2002)

Situation before restoration:

The fish-ponds in the Dunavat,/Dranov region in the Danube Delta were constructed in the 1970s.This involved the creation of large, isolated basins surrounded by ring-dikes and separated from each other by major canals. Fish-farm construction also involved the dredging of additional smaller canals within the basins and the construction of pumping stations and culverts with shut-off valves for water exchange with the surrounding canals. Holbina II is one of the four major fish basins in the Dunavat,/Dranov region. The other basins are Holbina I, Dunavat, I and Dunavat, II. Holbina II and Dunavat, II are further subdivided into sub-basins using minor dikes. Inside Holbina II, the peat soil has locally been removed by burning. The exploitation of the fish-ponds involved cyclic water level management, including a complete draw-down once in every three years. The energy required for pumping the water out of the basins was supplied to the pumping stations by a high tension electrical power-line carried on pylons. Water levels were manipulated to improve the efficiency of harvesting and feeding conditions for the fish. In addition, the ponds were stocked with fingerlings and reed regeneration was stimulated by burning and cutting. Emerging reed serves as food for some species of commercially exploited fish. Harvest levels of fish have reached the order of 200-400 kg.ha-1 under these conditions. However, this type of management is no longer in use because the required electricity is too expensive. Besides, the necessary infrastructure has largely been destroyed. Since the political revolution in 1989, the policy for the area has changed from being one of exploitation of the fish-ponds to that of ecological restoration. The basin of Holbina II was already taken out of production in 1989. In that year, the dikes had been opened and these were not repaired until 1996. By 1995 Dunavat, II1+2 had also been withdrawn from use. The basins Dunavat, I, II3 &4 continued to be used as a fish farm, at least until the middle of the nineties (after Drost et al., 1996, quoted by Drost, 2002).

Situation before restoration:

Although the major vegetation structures remained very constant, aquatic vegetation underwent a drastic change. Large fields of submerged Myriophyllum spicatum / Potamogeton spp. vegetation, associated with transparent water and observed in Holbina II-north in 1994 and 1995 (after Rijsdorp et al., 1995, Buijse et al., 1997, quoted by Drost, 2002), gradually disappeared in these places over 1996 and 1997. By 1998, all M. spicatum had disappeared. What was left was turbid open water, coloured green by suspended algae. The dominance of aquatic vegetation, associated with transparent water, persisted within Holbina II only in the “dead ends” of drowned canals in dense reed beds. These stands consisted exclusively of Ceratophyllum demersum. In September 2002 the aquatic vegetation was again found to be dominated by macrophytes: plant species characteristic of nutrient-rich waters, such as C. demersum and Valisneria spiralis (Bos, 2002). In 2002, Myriophyllum verticilatum and P. pectinatus were also encountered frequently. Both the deeper open waters and the canals featured this clear water situation, with an associated high diversity in bird species. Fish farming and its cyclic water level management continued in the basins of Dunavat II1+2 and Holbina I up until the year 2000. Conspicuous in these basins were the transparent water systems with fields of Myriophyllum / Potamogeton in the first years after a reflooding. Extremely rich vegetation was, for example, present in Dunavat II1 in spring and summer 1996, and in Holbina I in August 1997, immediately after re-flooding. The aquatic vegetation was rather diverse in this first season of development.Various species of Potamogeton were present, together with Najas marina and M. spicatum. A few years later, aquatic vegetation was found to be disappearing and the transparent water tended towards turbid conditions. (Drost, 2002)

1.1.1. Logistics study regarding the evaluation methods and means for Danube River's Revitalization projects

The evaluation methods and means used in the project are complementary and therefore should be presented as a coherent whole. The methods are briefly described and explained below.

<u>SketchMatch (SM) method</u>

An interactive planning method, developed by the Government Service for Land and Water Management in the Netherlands.

The sketch match is a method that is used to identify and visualise potential development paths and so facilitate the decision-making process for managers, policymakers and local stakeholders.

It is an intensive process that organisations and other interested parties can use in their own development areas.

The SketchMatch is a workshop method and works as a ‘creative pressure cooker’. During a minimum of 1 to a maximum of 3 days, a group of stakeholders involved in projects described above come together to analyze, define and find out the best practices regarding Danube River Revitalisation.

The strength of this method is that these analyses are done collectively.

A SketchMatch is facilitated by a process supervisor and one or more project’s evaluation specialists, who visualize the status of the projects, problems and solutions by sketching them out on maps. Various disciplines come together in a SketchMatch: spatial design, GIS, ecology, hydrology, hydraulics, cost estimation etc., depending on the nature of the project and issues involved.

Organising a sketch match involves a substantial investment. The working hours that specialists would usually spend on a project over the course of a longer time period are now condensed into a few days. Experience has shown that this accelerates the planning process immediately. It energises the client and the residents of the area and gives them a sense of community and shared responsibility. A sketch match can create the momentum a project needs to really take off, or the impetus required to overcome a deadlock.

However, to have this effect a sketch match must meet a number of conditions regarding:

a) Definition

The definition must clearly identify the parameters of the problem(s) to be addressed. In other words: The assignment or problem must be clearly defined.

b) Drafting and visualising

A sketch match is only useful if design and visualisation will genuinely be of help in identifying potential new development paths and solutions for the issues that need to be addressed. A sketch match can prove to be useful at any stage of the planning and implementation process, as long as choices need to be made concerning spatial planning in a well defined specific area.

c) Results

Drafts must always be produced; calculations are optional. Whenever there are doubts about the financial and economical feasibility of a project the costs of different solutions can be calculated immediately. The result of a Sketch Match is a spatial design, in the form of a manual, guideline, map, book, visual story, model, or whatever form suits the project best.

Focus groups and semi-structured interviews.

There will be organized within each category of subgroups defined by basic principles of revitalization focus groups. Two researchers must attend every focus group. Making a larger number of groups allows drafting of behavioral trends for categories of subjects interviewed.

a) Not all Focus groups are the same. The interviews will not be exactly the same in each location. It is very important that the results from different locations are comparable, and the most important thing is to ensure that, however Focus groups are arranged.

b) *The number of partcipants at Focus group.* In terms of numbers, the ideal number is 5-7 participants. Participants in the discussion will have time to make their views known about Danube River ecological restoration.

c) *The Focus groups structures (homogeneous or heterogeneous groups).* An important decision is whether to mix people up in group's interviews, or have organized separate groups on the criterion of gender, age. Heterogeneous groups are useful for hearing differences of opinion, and understanding how conflicts are negotiated and resolved. However, where there are power differentials between groups, some people may be afraid to say what they really think.

d) Duration of a interview group. Duration of a interview group shall be determined according to what should be investigated, and the needs of individuals / institutions concerned.

e) Instruments used in the Focus groups. In order to make best use analysis, the investigator shall have different work techniques with applicability to Focus groups.

Such tools are:

- "*time line chart*" - a graph versus time, which includes horizontal months / years, days of the week / month etc. and vertically the seasonal variations of socio-economic system components.
- "*mapping*" - which involves that the subjects making a systematic maps of the various aspects covered in the study. In case of refusal, the layout map will be made by group moderator following the guidelines of the participants.
- "*games*"
  In addition to these basic techniques will be group discussions to understand the thinking of people, how they respond to problems identified. It will follow the existence of conflicts and consensus, how to resolve conflicts. Before the end of the discussion will arrange meetings with some participants for semi-structured individual interviews.

f) The location should be chosen related to the selected projects for the evaluation of the Danube River revitalization.

<u>Semi-Structured Interviews</u>

The purpose of these interviews is to deepen some interesting issues that arise during the focus groups.

a) *Recruiting people.* The ideal place for the selection of subjects for individual interviews is during the group interview in order to analyze certain aspects relevant to the discussion group.

b) Location is as important as focus groups. It may use the interviewee for a walk outside to stimulate him to answer questions.

c) Recording the interview. The researcher's interviews/observations will be recording on tape or noted in reseracher's notes book after the free decision of the subjects and transcribed and processed for analysis. The interviews will be carried from the interview guide that explains the main criteria and sub-criteria to be addressed throughout the interview.

d) *Questions.* These will vary from one interviewee to another, depending on the person being discussed and the problems of group interview. Use your local knowledge to modify and add to this list.

Begin the conversation by asking your interviewee a few things about themselves. Anyway you need to know something about the person for the information gained in the interview to be useful.

A general point is to be over prepared rather than under prepared. It doesn't matter if you do not get around to asking all of the questions. Individual interviews should be preceded by pilot interviews. It is necessary to record the information provided by the interviewee and how the interview went, because the methodology can be improved further. This is done by keeping a permanent contact with the coordinator, and that results are comparable between different areas of study.

Progressive development of tree problems for the projects for Danube River's Revitalization

In time, favorability and restrictiveness factors have played an important role in changing by damage or loss of geographical landscape components in the Danube River (abiotic, biotic, factors arising from local connection with the natural life, ethnic identity elements or religious life). Information about existing problems came from a variety of sources including semi-structured interviews, ethnographic agenda, local media and specialized literature.

Problem analysis was conducted to create the conceptual model of human intervention in the geographic landscape of the Danube River, starting from identifying key factors that have a modifier role and their effect as shown in the problem tree. Tree problems show the problems in a hierarchical order. First will be identified causes and effects, then they will be summed and placed in a wider range, then building the tree as follows:

- what are the causes are at the bottom of the tree;
- what are the effects are at the top of the tree.

1.1.2. Classification of Danube River's Revitalization Project on subclasses

Starting from the projects inventory and the 4 subclasses presented in the chapter **Materials and methods** we can conclude that these projects could be classified according to the standard criterion (Table 1).

No. Crt.	Project name	Subclasses
1	The Danube restoration project between Neuburg und Ingolstadt (Germany)	River restoration Capture Community Opportunities
2	Bulgarian Wetland Restoration and Pollution Reduction Project (RIVER ENGINEERING) (Bulgaria)	River restoration
3	Extension of the existing Belene Islands Complex Ramsar Site Bulgaria	Create Value
4	The LIFE Project "Upper Drava-river valley" Austria	River restoration Create Value
5	The LIFE Project „Wild river landscape of the Tyrolean Lech" Austria	River restoration Create Value
6	Monitoring results of revitalization measures on an urban lowland River (Liesingbach, Vienna, Austria)	Capture Community Opportunities
7	River Wien restoration project: improvement of the ecological condition of a heavily modified river in a urban environment (Austria)	Capture Community Opportunities
8	LIFE Nature Project Wachau of dry grasslands and Danube nase (Austria)	River restoration
9	Lobau (Austria): reconnection of floodplains	River restoration
10	National Park Donau – Auen (Austria): side arm restoration and river bank restoration	River restoration
11	Morava River (Slovakia and Austria): reconnection of meanders	River restoration
12	LIFE05NAT/SK/000112 „Restoration of the Wetlands of Zahorie Lowland" (WETREST) Slovakia	Create Value
13	Krapje Djol (Croatia): reflooding of oxbow	River restoration
14	Camenca river restoration (Moldova) – Lessons learned for river restoration in the eastern part of the Danube River Basin	River restoration

15	Ecological Restoration in the Danube Delta Biosphere Reserve (Romania) – Babina and Cernovca islands	Capture Community Opportunities River restoration
16	Research for ecological restoration in the Dunavat-Dranov region, Danube Delta (Romania)	Capture Community Opportunities River restoration

Table 1 – Link between projects and the 4 clases of revitalization

1.2. A PUBLIC DEBATE ABOUT THE DANUBE RIVER'S REVITALIZATION PROJECTS ASSESSMENT

This activity will be accomplished in the next phase and its aim will be to select two projects for each subclasses of Danube revitalization and to formulate strategic guidelines for based on their implementation results.

CONCLUSIONS

Along the Danube River, there are planned a lot of restoration and revitalization project, but in this moment is a lack of ecological restoration projects-information data base and on Lateral Connectivity and Longitudinal Continuity finalized projects for this river.

However, restoration ecology is still in its infancy and the literature pertinent to river restoration is rather fragmented.

(Semi-) aquatic components of floodplains, including secondary channels, disconnected and temporary waters as well as marshes, have received little attention, despite their significant contribution to biological diversity.

Many revitalization projects were planned or realized without prior knowledge of their potential for success or failure, although, these projects greatly contributed to our present understanding of river-floodplain systems.

River revitalization benefits from a consideration of river ecosystem concepts in quantitative terms, comparison with reference conditions, historical or others, and the establishment of interdisciplinary partnerships.

Despite the benefits of ecological concepts for understanding large rivers, like Danube River, more multidisciplinary empirical studies are needed to asses the ecological state of river-floodplain systems, so as to facilitate restoration planning and challenge existing conceptual constructs.

Information on habitat diversity, biological production and the source and flow of energy is especially important.

Other important issues that need to be resolved include the questions of whether hydro- and morpho-dynamics should be increased or decreased, and to what extent floodplain succession can be reset by integrating conflicting interests of ecological needs, safety and navigation.

From the inventory of projects regarding Danube River revitalization can be seen that certain projects are at the interference of several fundamental principles of revitalization.

Majority of research studies are on Water Directive Framework thematic, Flood Risk Management Directive and Natura 2000.

From the total number of 16 projects identified, 10 of them are on river restoration, especially in Austria and in the Danube Delta area.

The projects done in order to create socio-economical values are those for tourism.

The Danube River restoration must focus on the dynamic interplay among the main channel, the floodplain, and the tributaries.

Successful Danube River and wetland restoration demands an interdisciplinary approach in order to understand how the Danube River and Danube floodplain system function.

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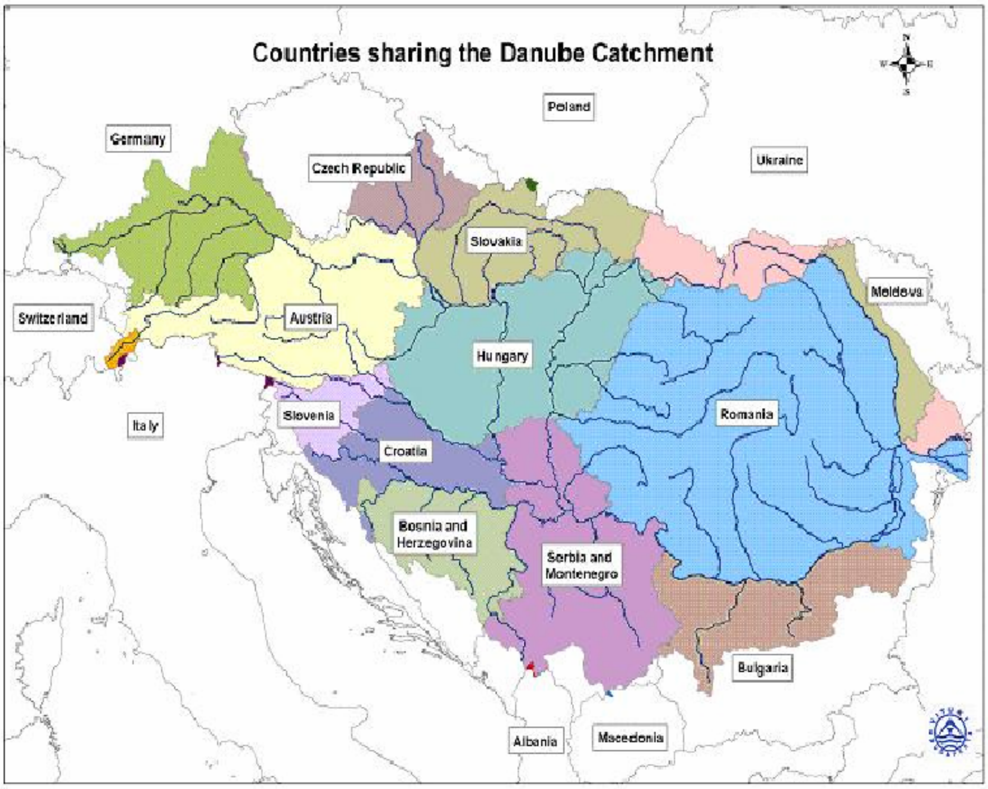
DANUBE RIVER'S MORPHOLOGY AND REVITALIZATION

TO THE SERVICE CONTRACT - STUDIES DEVELOPMENT NO. 414 / 2010

- REPORT -

Phase 2 – Comprehensive Danube River's Revitalization Assessment and preparation of the Best Practices Danube River's Revitalization Manual



***BENEFICIARY*:**

Danube Delta Biosphere Reserve Authority Tulcea

- December 2010 -

SOUTH EAST EUROPE
Transnational Cooperation Programme

DANUBEPARKS
network of protected areas

Programme co-funded by the EUROPEAN UNION

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DANUBE RIVER'S MORPHOLOGY AND REVITALIZATION

PROGRAMME NAME:

TRANSNATIONAL COOPERATION PROGRAMME FOR SOUTH-EAST EUROPE 2007-2013

PROJECT NAME:

DANUBEPARKS - DANUBE RIVER NETWORK OF PROTECTED AREAS - DEVELOPMENT AND IMPLEMENT THE TRANSNATIONAL STRATEGIES FOR CONSERVATION OF DANUBE NATURAL HERITAGE

- REPORT –

Phase 2 - Comprehensive Danube River's Revitalization Assessment and preparation of the Best Practices Danube River's Revitalization Manual

BENEFICIARY **:**

DANUBE DELTA BIOSPHERE RESERVE AUTHORITY TULCEA

PERFORMER:

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- DECEMBER 2010 -

TULCEA

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- JENICA HANGANU – ecological restoration
- VASILE OTEL – biodiversity

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Phase 2 - Comprehensive Danube River's Revitalization Assessment and preparation of the Best Practices Danube River's Revitalization Manual.

Introduction

As a very long-term goal, its ecological and hydrological functioning can be restored through creation of a continuous riparian habitat corridor within hydro network of arms and channels and through removal of concrete walls where feasible. While completely restoring the Danube Valley to a naturalized conditions is not likely feasible, the restoration projects address to flood control requirements and river channel could be naturalized in significant areas.

Three goals complement the efforts to restore river functioning ecosystems:

- *enhance flood storage* - focuses on off- channel storage of peak floods flows in order to reduce flow velocities, which is a necessary precondition for ecosystem restoration;
- *enhance water quality* - seeks to improve the quality of water within implementation of a comprehensive, landscape-based system for filtering;
- *restore the ecosystems functions* - aims to restore the natural ecosystems affected by human activity and restoration of these ecosystems function.

Materials and Methods

To accomplish this phase *Comprehensive Danube River's Revitalization Assessment and preparation of the Best Practices Danube River's Revitalization Manual* the following activities were achieved through different approaches:

Within this activity the documentation was made from various sources of information:

- Scientific literature - books, articles and other scientific publications (e.g. Binder W., (2008), *River restoration: an European overview on rivers in urban areas*. In ECRR Conference on River Restoration; Buijse A. D. et al., (2002), *Restoration strategies for river floodplains along large lowland rivers in Europe,* In Freshwater Biology Journal; Drost H.J. et al., (2002), *Research for ecological restoration in the Dunavat-Dranov region, Danube Delta;* Holubova K. et al., (2003), *Middle Danube tributaries: constraints and opportunities in lowland,* In Lowland River Rehabilitation "An international conference addressing the opportunities and constraints, costs and benefits to rehabilitate natural dynamics, landscapes and biodiversity in large regulated lowlands rivers");
- Official Web sites of natural parks along the Danube bodies involved and intenational (ECRR, WWF etc.)

- FORECASTER project (http://forecaster.deltares.nl/index.php?title=Main_Page)

In this activity was developed a conceptual framework and a matrix of criteria for restoration projects assessments.

RESULTS OF THIS PHASE

Activity 2.1. Conceptual Framework and Danube River's Revitalization Analysis Methods

Background & definitions

There had been developed and applied at the Danube hydrographical basin scale, especially in the second part of the XX century, a lot of management plans and policies which were grounded exclusively on neoclassical economy principles. These principles had a large class of economical and social objectives from which some were identified as driven forces for Lower Danube wetlands System structural and functional changes, such as:

1. economical objective translated as arable surface extension and increase agricultural production;
2. urban and industrial development;
3. Danube River and its main tributaries hydro-electrical potential capitalization and protection against floods;
4. to counteract the drought effects toward agriculture crops;
5. to maintain and develop the navigation conditions and infrastructure.

Achieving these strategic and political objectives required the development and implementation of management plans and programs, each consisting of a wide range of human activities and that means to exercise pressure on the Lower Danube Floodplain.

As is well known, the productivity and stability of ecosystems depends directly on their viability, to provide physical support for the use of natural resources and to provide socio-economic system services. Analysis of ecosystems as dynamic systems, nonlinear and as production units consists in lengthy processes of which variability and diversity are essential for unit stability and productivity. This analysis does not overlook the social and economic implications, taking into account the relationship between Natural Assets of the unit and the existing Socio-Economic System, following the same principles.

For a coherent understanding and interpretation due to the spatio-temporal dynamics of interactions complexity between human population and environment it is needed to tackle by a theoretical transdisciplinary integrating model framework that allows changes, transformations, trends and adjustments identification/ understanding in the system.

This first activity consists in the assessment of hydro-morphology concepts within Danube River basin.

Conceptual framework presentation took into account the following river connectivity categories:

- Lateral connectivity;
- Longitudinal connectivity;
- Vertical connectivity;
- Temporal connectivity

All these connectivity types describe the river ecosystem in the same space and time as it can be seen and explained in the **Figure 1**:

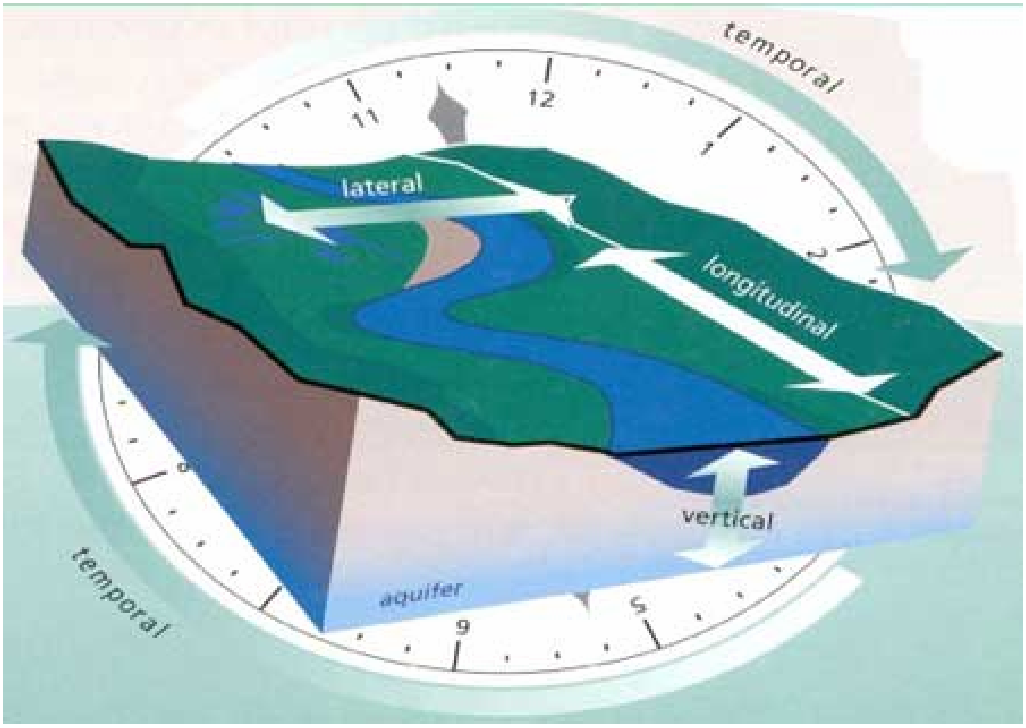


Figure 1 - Connectivity types sketch in a river ecosystem

(http://www.battleriverwatershed.ca/gfx/old-images/connectivity.jpg)

- ***Lateral connectivity*** refers to the periodic inundation of the floodplain and the resulting exchange of water, sediment, organic matter, nutrients, and organisms. Lateral connectivity becomes especially important in large rivers with broad floodplains. *(Benke, A.C., 2001*)

To discuss about the lateral connectivity it is good to have some question at the beginning and to try to find some answers as an understanding way of the concept.

Is *the river able to connect with its floodplain (during floods etc.)?*

In a natural status the river keep connection with its floodplain especially in floods time, invading places with its water, new sediments and all its influence. Former streams become active, small pools are filled up with fresh water; parts of the ground are covered by new sediments.

Is *there a connection between the aquatic and terrestrial (upland) environments?*

In main cases there is a connection between the aquatic and terrestrial environments by the simple fact that they lay side by side and the water through the capillarity of the soil ensures a certain degree of moisture that influence the presence of specific vegetation and animals.

Is *there a healthy riparian area?*

Riparian area is the interface between land and a river or stream. A healthy ecosystem is an ecosystem in which structure and functions allow the maintenance of biodiversity, biotic integrity and ecological processes over time. The lateral connectivity is a premise of a healthy riparian biome.

- ***Longitudinal connectivity*** refers to the pathways along the entire length of a stream. As the physical gradient changes from source to mouth, chemical systems and biological communities shift and change in response. The River Continuum Concept (RCC) can be applied to this linear cycling of nutrients, continuum of habitats, influx of organic materials, and dissipation of energy. (Watershed Assessment Tool: Connectivity Concepts – Minnesota Department of Natural Resources)

For example:

- A headwater woodland stream has steep gradient with riffles, rapids and falls;
- Sunlight is limited by overhanging trees, so photosynthesis is limited;
- Energy comes instead from leaves and woody material falling into the stream;
- Aquatic insects break down and digest the terrestrial organic matter;
- Water is cooled by springs and often supports trout.

In the mid-reaches

- the gradient decreases and there are fewer rapids and falls;
- the stream is wider; sunlight reaches the water allowing growth of aquatic plants;
- insects feed on algae and living plants;
- proportion of groundwater to runoff is lower so stream temperatures are warmer;
- the larger stream supports a greater diversity of invertebrates and fish.

The river grows and the gradient lessens with few riffles and rapids

- Terrestrial organic matter is insignificant in comparison to the volume of water;
- Energy is supplied by dissolved organic material from upstream reaches;
- Drifting phytoplankton and zooplankton contribute to the food base as do organic matter from the floodplain during flood pulses;
- Increasing turbidity reduces sunlight to the streambed causing a reduction in rooted aquatic plants;
- Backwaters may exist where turbidity has settled and aquatic plants are abundant;
- Fish species are omnivores and plankton feeders such as carp, buffalo, suckers, and paddlefish;
- Sight feeders are limited due to the turbidity (MN DNR, Healthy Rivers).

To discuss about the longitudinal connectivity it is good to have some question at the beginning and to try to find some answers as an understanding way of the concept.

How *connected is the river along its length?*

The longitudinal connectivity implies that stream (in our case river) should have a continuously path from the spring to its mouth. This is the natural case.

Is *it broken up by dams, weirs or natural obstacles?*

This longitudinal continuity could be often tainted by natural and artificial causes. The main artificial causes are: dams for different purposes (water stocking, producing energy etc.). Natural causes are more rare and usually are accidentally (weirs created by thunderstorms by getting down the trees) and not accidentally weirs created by beavers.

➢ ***Vertical connectivity i***s represented by the connection between the atmosphere and groundwater. The ability of water to cycle through soil, river, and air as liquid, vapor, or ice is important in storing and replenishing water **(Figure 2).** This exchange is usually visualized as unidirectional–precipitation falling onto land and then flowing over land or percolating through the ground to the stream. An equally important transfer of water occurs from the streambed itself to surrounding aquifers. Groundwater can contribute to flows in the river at certain times in the year and at certain locations on the same stream. Streams may either gain or lose water to the surrounding aquifer depending on their relative elevations. Lowering the water table through groundwater withdrawals may change this dynamic exchange in unanticipated ways (Stream Corridor, FISRWG).

The slow movement of water through sediments to the river produces several ecological benefits (Minnesota Department of Natural Resources):

- The water is filtered of many impurities.
- It usually picks up dissolved minerals.
- The water is cooled.
- The water is metered out slowly over time.

This is particularly important in smaller, cooler streams for the maintenance of critical habitat for fish, wildlife and invertebrate species.

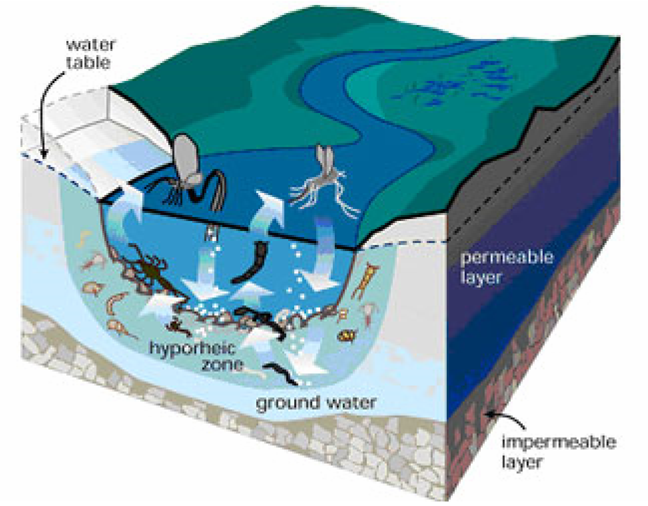


Figure 2 – Vertical connectivity sketch in a river ecosystem *(Stream Corridor, FISRWG)*

➢ ***Temporal connectivity*** *c*onsists in continuous physical, chemical, and biological interactions over time, according to a rather predictable pattern. These patterns and continuity are important to the functioning of the ecosystem. Over time, sediment shifts, meanders form, bends erode, oxbows break off from the main channel, channels shift and braid. A stream rises and falls according to seasonal patterns, depending on rain and snowmelt. Throughout most of Minnesota, free-flowing rivers experience high water in spring, falling flows in summer, moderate flows in fall, and base flows in winter. The watershed has adjusted to these normal fluctuations, and many organisms have evolved to depend on them (MN DNR, Healthy Rivers).

The importance of the connectivity

Connectivity is important because it ensures natural river processes continue to occur (channel maintenance, floodplain evolution).

It is also important because isolated (fragmented) habitats, whether aquatic or terrestrial, have fewer species (biodiversity), and it is difficult for species to re-colonize isolated habitats.

Connectivity also ensures there is a flow of energy and nutrients between and within aquatic and terrestrial (land) environments. For example, in the fall, leaves are washed into the river and provide important food for aquatic insects.

The connectivity of the river ensures also the ecosystems services. The ecosystem services are as follows (by the Millenium Ecosystem Assessment classification):

- *Provisioning* services, the products obtained from ecosystems, including, for example, genetic resources, food and fiber, and fresh water.

- *Regulating* services, the benefits obtained from the regulation of ecosystem processes, including, for example, the regulation of climate, water, and some human diseases.

- *Supporting* services, that are necessary for the production of all other ecosystem services. Some examples include biomass production, production of atmospheric oxygen, soil formation and retention, nutrient cycling, water cycling, and provisioning of habitat.

- *Cultural services*, the non-material benefits people obtain from ecosystems through spiritual enrichment, cognitive development, reflection, recreation, and aesthetic experience as well as knowledge systems, social relations, and aesthetic values.

Connectivity is crucial in the context of restoration. Many reach-scale restoration projects have been unsuccessful because they were conceived and implemented in isolation from the larger catchment context (Frissell and Nawa 1992, Muhar 1996, Wohl et al. 2005 cited by Mathias Kondolf et all). For example, instream structures used in some restoration projects have not been recolonized because of a limited pool of potential colonizers in nearby intact sites or because of barriers to dispersal of the colonizers (Bond and Lake 2003). Alternatively, the structure may be overwhelmed by sediment derived from upstream sources and carried downstream through the drainage network (Iversen et al. 1991). (http://www.ecologyandsociety.org/vol11/iss2/art5/)

Logical Framework Analyse for Danube River Morphology and Restoration

Restoration framework

The following steps were established for each restoration project to be fallowed, in order to have a good perception of the assessment:

Step 1 – Identifying Problems and Opportunities

The problem, or perceived degradation of ecosystem properties and reduction in related resources, must first be clearly stated. The first place to consider restoration and uncertainty is in the selection of planning objectives. Planning objectives give a rational focus to the planning process. Optimal objectives for restoration projects will reflect a watershed, or other ecosystem perspective.

- **Step 2 – Inventory and Forecast**
- **Step 3 - Ecological Restoration Plan Formulation - Management measures**

  - System Context
  - Conceptual and Empirical Models
  - Landscape Variables identified through several indicators as:

a) *the land segregation indicator* that measures the aquatic and agriculture availability related to the total number of people, being the expression of the above mathematical formula Ils=AG/P-A/P, where Ils is the land segregation indicator, the AG is the agricultural land use, P is the local population within the restored area and A is the aquatic area. The knowledge of this indicators has triple role: as mark for quantifying the agriculture an and aquatic potential, unit measure for the correlation degree between these land categories, support for the decision processes and stakeholders in terms of applying legislative measures in the restores areas;

b) the environmental indicator is given by the ration between the wooded area and the agriculture and artificial land;

c) the agriculture productivity indicator represents the ration between an output (effect) and input (effort), expressing the efficiency in using the production factors.

  - Implications for Plan Formulation
  - Uncertainties Associated with the Models used for Management which must respond to following questions:

Will there be adequate ecological corridors?

How will restoration for a species affect the community?

Is the site large enough?

How will the project's resistance and resilience change over time? Is this acceptable?

What are the likely landscape changes over time? How will they affect the site?

Does the design invite invasive species?

How will the community affect the species of interest?

What else could go wrong?

- **Step 4 – Evaluation of Project Solutions**
- **Step 5 – Comparation of Alternatives**
- **Step 6 – Ecological Restoration Plan Selection**

Criteria and General Model for Ecosystem Performance

The general model for ecosystem performance **(Figure 3)** provides the general direction with respect to structure and function that the ecosystem is expected to take on its trajectory toward meeting the project goal. Under a restoration scenario, the goal is to move the system from a degraded condition to one that is less degraded and more desirable. For management purposes, it is assumed that there is a positive relationship between the structure and function of an ecosystem. The natural structure of an system, habitat, or community has a corresponding functional condition, and to the extent that this is predictable, this information may be used to construct the ecosystem performance model

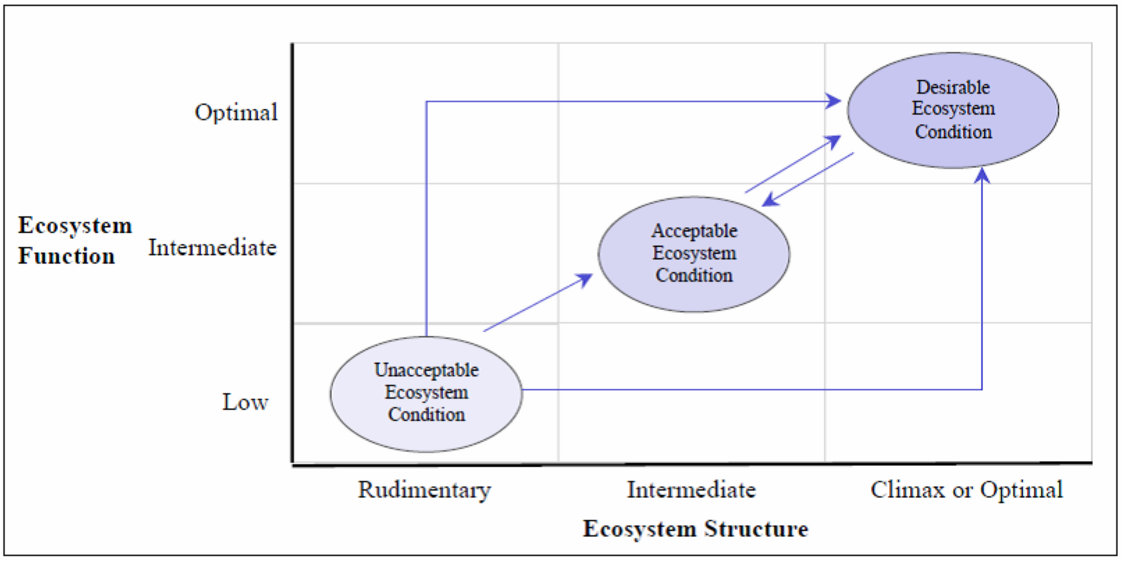


Figure 3 - General model of ecosystem performance. An ecosystem or habitat that is in rudimentary condition with low functioning develops into a system with optimal structure and functioning. Development can take several pathways, and can oscillate between system states (Thom R.M, 2004).

Figure 3 also indicates that a system may oscillate between states. This can be caused by stochastic processes such as human or natural disturbances, as well as stochastic climate related forcing. This dynamic may be more pronounced in some system types than in others. It is important to recognize that the system can move between different structural and functional states and still maintain its long-term integrity. Finally, and not explicit in Figure 3, is the fact that stability regimes are rarely ecosystem-wide, but are limited to some fraction of the ecosystem.

This implies that if enough of an ecosystem is restored, sites within that system should support desirable resources.

If stressors are removed, the natural recovery *(passive restoration)* of ecosystems will tend to take place regardless of human intervention, but this may take a very long time— decades or centuries. *Active restoration* essentially means that humans act beyond stress removal to reduce the period of time required to improve ecosystem conditions, through a combination of physical intervention and natural recovery. At the desirable ecosystem condition, the system is fully functional, has an optimal structure, is resilient to disturbances, and is self-maintaining. However, the definition of "optimal" must be made with care and with relevance to the system under investigation. In the case presented here, it is assumed that optimal conditions are met with a natural climax community that, because of its persistence, is resistant and maintains itself through the ability to buffer changes. The term "optimal" implies a human value, and the optimal state represents what humans (i.e., restoration planners) view as the "best" condition for the system.

Activity 2.2. Analysis Functional Multicriterial Model

Within this activity was developed a matrix of multicriterial indicators grouped on 4 main assessment criteria as follows: **Stakeholder success, Ecological success, Learning success, River system. E**ach indicator must receive a value between 1 and 5 corresponding to success level achieved by each restoration project: value 1 represents the most unsuccessful result and value 5 is given to the most successful result.

Stakeholder success reflects human satisfaction with restoration outcome, whereas learning success reflects advances in scientific knowledge and management practices that will benefit future restoration action.

Ecological success

1. Guiding image exists evaluation standards should follow the principles below:

1. Ecological integrity. Because of strong interference from human activities, it is not possible to restore urban water ecosystems to the pristine state. Ecological restoration should be based on achieving the greatest natural state for the specific region, in reference to its natural state, with the relative ecological integrity as the target. The health of the ecosystem may not be the original ecosystem, but it must be a relatively complete ecosystem.

2. Management categories. In this paper, the evaluation standard is divided into 3 levels ‘‘healthy, critical state, unhealthy’’.

3. Objective integrity. Danube River Valley is a complex of ecosystems, and should meet the flood control objectives, landscape function, and achieve a harmonious water–human relationship.

4. Spatial distribution. Within the context of integrated river basin ecosystem theory, the evaluation of the ecological restoration sites should consider the characteristics of the different spatial components and the differences of environmental problems in each area, including differences between upstream and downstream locations and different ecosystem service function.

2. Ecological improvement. Ecologically successful restoration will induce measurable changes in physicochemical and biological components of the target river or stream that move towards the agreed upon guiding image.

3. Self sustaining

The ecosystem is self-sustaining. It has the potential to persist indefinitely under existing environmental conditions. Aspects of its biodiversity, structure and functioning will change as part of normal ecosystem development, and may fluctuate in response to normal periodic stress and occasional disturbance events of greater consequence. As in any intact ecosystem, the species composition and other attributes of a restored ecosystem may evolve as environmental conditions change.

Ecologically successful river restoration creates hydrological, geomorphologic and ecological conditions that allow the restored river to be a resilient self-sustainable system, one that has the capacity for recovery from rapid change and stress (Holling 1973; Walker *et al* . 2002, cited by Palmer, 2005). Natural river ecosystems are both self-sustaining and dynamic, with large variability resulting from natural disturbances.

4. No lasting harm is done

In the last century, Aldo Leopold (1948) , cited by Palmer, 2005, stated that the first 'rule' of restoration should be to do no harm. Restoration is an intervention that causes impacts to the system, which may be extreme (e.g. channel reconfigurations). Even in such situations, an ecologically successful restoration minimizes the long-term impacts to the river. For example, a channel modification project should minimize loss of native vegetation during in river reconstruction activity, and should avoid the fish-spawning season for construction work. Indeed, removal of any native riparian vegetation should be avoided unless absolutely necessary. Additionally, restoration should be planned so that it does not degrade other restoration activities being carried out in the vicinity (e.g. by leading to permanent increases in the downstream transport of sediments that are outside the historical range of sediment flux).

5. Ecological assessment is completed- pre and post project assessment is conducted and the information made available

Ecological success in a restoration project cannot be declared in the absence of clear project objectives from the start and subsequent evaluation of their achievement (Dahm *et al* . 1995). Both positive and negative outcomes of projects must be shared regionally, nationally and internationally (Nienhuis & Gulati 2002, cited by Palmer, 2005).

Learning success

The circumstances that we seek to address are often very challenging. The areas of degraded land now present in various parts of the world are large. Some systems are severely degraded and will be costly to repair. Further, people are still using many of these degraded systems and many of these people are poor. We may not succeed in fully eradicating the causes of degradation in these circumstances but there is sufficient evidence from a variety of case studies for us to be optimistic. This evidence makes it clear that ecological restoration will be a key element not only of conservation but also for sustainable development worldwide.

River system it is about the river connectivity (lateral, longitudinal & temporal).

Further more, the assessment criteria matrix developed in this activity was applied as an example (for Babina and Cernovca well known restoration projects) to illustrate its benefits **(Table 1).**

The next steps will focus on applying this matrix to each project identified within DanubeParks project, as shown in **Table 2**.

Assessemnt Criteria		Project Identification Number (ID) and values															
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**
Stakeholder success	Aesthetics	*5*	*5*	*5*	*4*	*3*	*2*	*3*	*4*	*4*	*5*	*4*	*3*	*5*	*4*	*5*	*4*
	Economic benefits	-	*3*	*3*	-	-	*4*	-	*4*	-	*5*	-	-	-	-	*4*	*4*
	Tourism and recreation	*3*	*5*	*5*	*3*	*3*	-	-	*4*	*4*	*5*	-	*4*	*5*	-	*3*	*5*
	Education	*5*	*4*	*4*	*3*	*4*	-	-	*4*	*4*	*4*	-	*5*	*4*	*4*	*5*	*3*
	Traditional activities renew	-	*3*	*3*	-	-	-	-	*4*	-	-	-	-	-	-	*5*	*5*
	Health	-	*3*	*3*	-	-	*5*	-	-	-	-	-	-	-	-	*3*	*2*
	Governance	*4*	*4*	*4*	*4*	*3*	*4*	*3*	*3*	-	*5*	*2*	*5*	*4*	*2*	*5*	*5*
	Security – Flood risk management	-	*3*	*3*	-	*4*	-	-	-	-	*5*	*2*	-	-	-	*3*	-
Ecological success	Guiding image exists	-	*5*	*5*	-	*3*	*3*	-	*4*	*4*	*5*	*2*	*4*	*4*	*4*	*5*	*5*
	Ecological improvements	-	*5*	*5*	-	*3*	*3*	*3*	*5*	*4*	*4*	*2*	*4*	*4*	*4*	*5*	*4*
	Self sustaining	-	*5*	*5*	-	-	-	*5*	*5*	*4*	*4*	*1*	*4*	*4*	*3*	*5*	*4*
	No lasting harm done	*4*	*4*	*4*	*4*	*1*	*1*	*4*	*3*	*4*	*5*	*1*	*4*	*2*	*4*	*5*	*4*
	Assessment completed	*5*	*3*	*3*	*4*	*4*	*5*	*4*	*4*	*4*	*5*	*4*	*4*	*3*	*4*	*5*	*5*
Learning success	Scientific contribution	*4*	*4*	*4*	*3*	-	*2*	*3*	*3*	*4*	*4*	*3*	*3*	*3*	*3*	*5*	*5*
	Management experience	*4*	*4*	*4*	*4*	-	*3*	-	*5*	*4*	*4*	*2*	*5*	*4*	*3*	*5*	*5*
	Improve methods	*5*	*3*	*3*	*4*	-	*1*	*2*	*3*	*4*	*3*	*2*	*4*	*3*	*2*	*4*	*4*
River system	Lateral connectivity	*5*	*3*	*3*	*4*	*3*	-	-	*4*	*5*	*5*	*2*	*4*	*3*	*3*	*5*	*3*
	Longitudinal connectivity	-	-	-	-	-	-	-	-	-	*4*	*2*	-	*2*	-	-	-
	Temporal connectivity	-	*5*	*5*	-	*3*	-	*3*	*4*	*4*	*4*	*1*	*4*	*2*	*3*	*4*	*4*
T O T A L (max. 95 p.)		**44**	**71**	**71**	**37**	**34**	**33**	**30**	**63**	**53**	**76**	**30**	**57**	**52**	**43**	**81**	**71**

Table 1 – Assessemnt criteria Matrix (the "-"means lack of information**)**

Project Identification Number	Project name
1	The Danube restoration project between Neuburg und Ingolstadt (Germany)
2	Bulgarian Wetland Restoration and Pollution Reduction Project (RIVER ENGINEERING) (Bulgaria)
3	Extension of the existing Belene Islands Complex Ramsar Site Bulgaria
4	The LIFE Project “Upper Drava-river valley” Austria
5	The LIFE Project „Wild river landscape of the Tyrolean Lech” Austria
6	Monitoring results of revitalization measures on an urban lowland River (Liesingbach, Vienna, Austria)
7	River Wien restoration project: improvement of the ecological condition of a heavily modified river in a urban environment (Austria)
8	LIFE Nature Project Wachau of dry grasslands and Danube nase (Austria)
9	Lobau (Austria): reconnection of floodplains
10	National Park Donau – Auen (Austria): side arm restoration and river bank restoration
11	Morava River (Slovakia and Austria): reconnection of meanders
12	LIFE05NAT/SK/000112 „Restoration of the Wetlands of Zahorie Lowland“ **(**WETREST) Slovakia
13	Krapje Djol (Croatia): reflooding of oxbow
14	Camenca river restoration (Moldova) – Lessons learned for river restoration in the eastern part of the Danube River Basin
15	Ecological Restoration in the Danube Delta Biosphere Reserve (Romania) – Babina and Cernovca Islets
16	Research for ecological restoration in the Dunavat-Dranov region, Danube Delta (Romania)

Table 2– List of revitalisation projects identified within Danube Parks

Activity 2.3. Aggregate indicators to economic and ecological evaluation.

In the following chapter there will be presented the completed questionnaires for several restoration sites (as examples) from Romania. The first study case will be Babina islet an abandoned agriculture polder.

2.3.1. Factsheet (Babina Islet):

		Description
Author	Mircea STARAS	Person who collected the information
Date	16/04/2009	Date in format: dd/mm/yyyy
Country	Romania	Country of the project
River name	Danube	Name of the river
Park/Site name	DDBR / Babina	Site where the project is located
River Typology		
Latitude	45.424763 N	Latitude and longitude in decimal notation (no minutes and seconds)
Longitude	29.411763 E	
Altitude	3	Class according to Table 3
Catchments area	4	Class according to Table 3
Geology	3	Class according to Table 3
River type name	Danube Delta	River type name and code according to national classification
National code	RO15(former RO22)	
Project name	BABINA	Name of the project
Pressures		
Goup	4 Morphological changes	Type, according to Table 4

Type	4.6 Embankments	
Description	Drained wetland for agriculture use (rice)	Particular description
Measures		
Group	7 Improving the lateral connectivity	Group according to Table 5
Measure	7.2 Set back embankments, levees or dykes	According to Table 5
Description	Dyke breaches	Particular description
Project size	2100 (Units: Ha)	Area covered by the project
Approximate cost	840.000 (Units: Euro)	Approximate cost of the project
Synergy	Nutrients retention, wild life habitat	Combination of the project with other functions (e.g. flood protection, navigation)
Status	Finalized	Planned, in progress or finished
Period of realization	1994	Approximate dates
Evaluation	YES	Yes or No
Implemented by	Danube Delta National Institute for Research and Development (DDNI)	Name of organization who implemented the works

(from *Forecaster* project)

2.3.2. Background information (Babina Islet):

In the last decades of the 20th century, the Danube Delta has suffered due to anthropogenic interventions which led to dramatic changes in some areas. These interventions were the impoundment of large areas in order to use them for agriculture, fishery and forestry intensive, which led to dramatic alterations or changes in water balance. This took effect also onto natural processes as much as on ecological balance as well as the ecological specific functions of wetlands and led to alteration or even more specific loss of wetland habitats. When work were halted in 1990 impounded areas occupied an area of 97,408 ha (22%) of total area of 482,592 ha. Studies for the rehabilitation / re-vegetation were started immediately after the Danube Delta was declared as a Biosphere Reservation in 1990.

The objective of ecological reconstruction / rehabilitation is to restore natural hydrological, biogeochemical and ecological functions, to ensure the redevelopment of ecosystems and their functions and by this specific area to determine recurrence habitats and their associated biodiversity. Moreover, the re-development of natural resources will ensure access of the local population to their traditional exploitation of the resources.

Given that the Danube Delta ecosystems depend on the dynamics of river water Danube, hydrological regime restoration proves to be the most important factor to consider in the ecological reconstruction. If dammed and drained for agricultural areas are not used for the purposes for which they were created, reconnecting the flood regime of the Danube is the first step to be taken and an essential condition for re-vegetation. Such a measure does not restore the original conditions of time before impoundment, considering that it implies complete removal of dams and this is impossible because of extreme cost, to open dykes in locations that provide a hydrological and ecological efficiency reconnecting to the river dynamics could be measured leading to an improvement in conditions for environment.

After the political changes in Romania in the early 90's, the first project was Babina area from the Danube Delta Biosphere Reservation in New Optics was proposed, by switching from an intensive use, unspecified area in a state close to that nature. Thus, in spring 1994, Babina abandoned agricultural land, located in north-eastern Danube Delta has been reconnected to the natural regime of flooding of the Danube. It has also been developed and implemented a monitoring program to find out the answers to major questions raised by the recovery process and to check ecological success of reconstruction of undertaken work. This allowed the tracking of the evolution trends of the area, evaluating the efficiency of work performed and if necessary, propose additional measures. First results on resumption of hydrological, biogeochemical and ecological functions were published in 1997 in a comprehensive report prepared in cooperation between the Danube Delta National Institute-Tulcea and Institute for Research and Ecology of the Meadows – WWF Germany (recently integrated into the Institute for Water and river basin management in University of Karlsruhe).

Monitoring activities carried out on more than 10 years have shown a fast development of the area, the hydrological regime with alternation with long periods of high and low water levels, proved to be a key factor for re-vegetation. The conditions differ from natural flooding. Before embankment, in their natural state flooding was at a large scale over the levees to shore island. In the current situation flooding that occurs mostly in the dyke breaches made in border dykes. With all these constraints ecosystem efficiency was restored by opening the dykes, bringing dynamics of the river and reconnection. These works have provided a redevelopment of a specific biodiversity resources and the Danube Delta biodiversity. The project implementation leaded in a change of mentality regarding the wetlands management, allowing restoration of degraded areas and other man-made areas, both in the Danube Delta, as well as in its floodplain.

2.3.3. Extra information (Babina Islet):

Links to other sources of information online, and/or extra files (pdf, jpeg, etc) containing more detailed information about the project.

file name or link	*Description*
Babina_Report.pdf	Evolution of Babina polder after restoration works
http://www.indd.tim.ro/	Link with DDNI web site

Table 3: River typology, System A WFD (2000)

Indicator	Classes	
1	Ecoregion	
	1	Based on latitude and longitude and
		(according to classification in Map A, WFD ,Annex XI)
2	Altitude	
	1	high: > 800 m
	2	mid-altitude: 200 - 800 m
	3	lowland: < 200 m

3 Catchment area size:	
1	small: 10 - 100 km2
2	medium: > 100 - 1000 km2
3	large: > 1000 - 10000 km2
4	very large: > 10000 km2
4 Geology	
1	Calcareous
2	Siliceous
3	organic

(from *Forecaster* project)

	Pressure Groups		List of pressures type
1	Water abstractions:	1.1	Surface water abstraction
		1.2	Growndwater abstraction
2	Flow regulations	2.1	Discharge diversions and returns
		2.2	Interbasin flow transfers
		2.3	Hydrological regime modification: can be timing or quantity
		2.4	Hydropeaking
		2.5	Reservoir flushing
		2.6	Sediment discharge from dredging
3	River fragmentation	3.1	Artificial barriers upstream from the site
		3.2	Artificial barriers downstream from the site
		3.3	Colinear connected reservoir
4	Morphological alterations:	4.1	Impoundement
		4.2	Channelisation / Cross section alteration
		4.3	Alteration of riparian vegetation
		4.4	Alteration of instream habitat

		4.6	Embankments, levees or dikes
		4.7	Sedimentation
		4.8	Sand and gravel extraction
		4.9	Loss of vertical connectivity
5	Other pressures:	7.1	Other pressures

Table 4 – List of pressure groups and types (from *Forecaster* project)

Nr. crt.	Measure Groups		List of measure types
1	to improve water flow quantity	1.1	Reduce surface water abstraction without return
		1.2	Reduce surface water abstraction with return (e.g. cooling water)
		1.3	Improve water retention (catchment, basin, capillaries)
		1.4	Reduce groundwater extraction
		1.5	Improve/Create Water storage
		1.6	Increase minimum flows
		1.7	Water diversion and transfer
		1.8	Recycle used water
		1.9	Reduce water consumption
2	to improve sediment flow quantity	2.1	Add/feed sediment
		2.2	Reduce undesired sediment input
		2.3	Prevent sediment accumulation in reservoirs
		2.4	Reduce erosion
		2.5	Improve continuity of sediment transport
		2.6	Manage dams for sediment flow
		2.7	Trap sediments
3	to improve flow dynamics (both water and sediment)	3.1	Ensure minimum flows
		3.2	Establish environmental flows / naturalise flow regimes

		3.3	Modify hydropeaking
		3.4	Increase flood frequency and duration in riparian zones or floodplains
		3.5	Reduce anthropogenic flow peaks (e.g drainage, urban run-off)
		3.6	Favour morphogenic flows
		3.7	Shorten the length of impounded reaches
		3.8	to link flood reduction with ecological restoration ('ecoflood')
		3.9	to manage aquatic vegetation
4	to improve longitudinal connectivity/continuity	4.1	Remove barrier (e.g weir, dam)
		4.2	Install fish pass/bypass/side channel for upstream migration
		4.3	Facilitate downstream migration
		4.4	Modify culverts, syphons, piped streams (e.g. daylighting)
		4.5	Manage sluice and weir operation for fish migration
		4.6	Fish-friendly turbines and pumping stations
5	to improve river bed depth and width variation	5.1	Remeander water courses
		5.2	Widen water courses
		5.3	Shallow (i.e. opposite to deepen) water courses
		5.4	Allow/increase lateral channel migration or river mobility
		5.5	Narrow water courses
		5.6	Create low flow channels in over-sized channels
6	to improve in-channel structure and substrate	6.1	Initiate natural channel dynamics to promote natural regeneration
		6.2	Remove sediments (e.g. eutrophic, polluted, fine)
		6.3	Modify aquatic vegetation ('weed') maintenance
		6.4	Introduce large wood
		6.5	Add sediments (gravel, sand)
		6.6	Remove bank fixation
		6.7	Recreate gravel bar and riffles
		6.8	Remove or modify in-channel hydraulic structures (e.g. groynes, deflectors)
		6.9	Reduce impact of dredging
7	to improve lateral connectivity	7.1	Lower river banks or floodplains to enlarge inundation and flooding

		7.2	Set back embankments, levees or dykes
		7.3	Reconnect backwaters (oxbows, side channels) and wetlands
		7.4	Remove hard engineering structures that impede laterel connectivity
8	to improve riparian zones	8.1	Adjust land use (e.g. buffer strips) to develop riparian vegetation
		8.2	Revegetate riparian zones
		8.3	Remove bank fixation
		8.4	Remove non-native substratum
		8.5	Adjust land use (e.g. buffer strips) to reduce nutrient, sediment input or shore erosion
		8.6	Develop riparian forest
9	to improve floodplains/off-channel habitats	9.1	Reconnect backwaters (oxbows, side channels) and wetlands
		9.2	Restore wetlands
		9.3	Retain floodwater (e.g. through local sluice management)
		9.4	Improve backwaters (e.g. morphology, vegetation)
		9.5	Set back embankments, levees or dykes
		9.6	Lower river banks or floodplains to enlarge inundation and flooding
		9.7	Construct semi-natural/articificial wetlands or aquatic habitats
10	Other aims to improve hydrological or morphological conditions	10	Reduce surface water abstraction without return

Table5 – List of measures groups and types (from *Forecaster* project)

The second project that was successful and it is taken as a case study is the Cernovca Islet

2.3.4. Factsheet (Cernovca Islet):

		Description
Author	Marian TUDOR	Person who collected the information
Date	16/04/2009	Date in format: dd/mm/yyyy
Country	Romania	Country of the project
River name	Danube	Name of the river
Park/Site name	DDBR / Babina	Site where the project is located
River Typology		
Latitude	45.402668 N	Latitude and longitude in decimal notation (no minutes and seconds)
Longitude	29.495029 E	
Altitude	3	Class according to Table 3
Catchments area	4	Class according to Table 3
Geology	3	Class according to Table 3
River type name	Danube Delta	River type name and code according to national classification
National code	RO15 (former RO22)	
Project name	CERNOVCA	Name of the project
Pressures		
Type	4 Morphological changes	Type, according to Table 5
SubType	4.6 Embankments	
Description	Drained wetland for agriculture use (rice)	Particular description

Measures

Group	7 Improve the lateral connectivity			Group according to Tabel 5
Measure	7.2 Set back embankments, levees or dykes			According to Tabel 5
Description	Dyke breaches			Particular description
Project size	1580	Units	Ha	Area covered by the project
Approximate cost	10000 – 100000	Units	Euro	Approximate cost of the project
Synergy	Nutrients retention, wild life habitat			Combination of the project with other functions (e.g. flood protection, navigation)
Status	Finalized			Planned, in progress or finished
Period of realization	1996			Approximate dates
Evaluation	YES			Yes or No
Implemented by	Danube Delta National Institute for Research and Development (DDNI)			Name of organization who implemented the works

(from *Forecaster* project)

2.3.5. Cernovca background Information:

The first attempt of large-scale farming in the Delta dates back about 100 years (1895) and concerns an area situated between km 82 and 88 on the St. Georghe branch, the so-called 'Garden of the Dutch'. ANTIPA (1907, 1911) considers the more holistic problems of agricultural use in the inundation area on the lower Danube and the Delta (see also BOTNARIUC 1960). He points out that farming in the Delta "has on the one hand to be founded on a most precise knowledge of the physical and biologic conditions of these areas, i.e. the climate, the soil nature, hydrographical conditions, fauna and flora and that on the other hand any general and specific economical conditions have to be considered" (ANTIPA, 1911, p. 387). An analysis of the Danube Delta's ecological conditions leads to the conclusion, that farming is only possible on the embankments (grinduri) and the higher situated flood channels. (***, 1997)

The first embankment of a 3400 ha area was carried out from 1938-1940 on Tataru island situated upstream of Babina and Cernovca in the Chilia-branch (RuDESCU et al. 1965). In 1983, the Programme for the remodeling and integral use of the natural resources in the Danube Delta' (decree Nr. 92/1983) planned the embankment of Babina, Cernovca and other areas for agricultural use. (***, 1997)

Cernovca had been reserved for rice-growing although the soil analysis showed that the island consisted mainly of agriculturally unusable marshland. Moreover, the soil salinization in the western part of the islet, caused by a high evaporation rate, had not been taken into account (see also ANTIPA 1 91 1) This was likely because under natural conditions, and thanks to periodical inundations, there seemed to be a balance that prevented salinization. Other information pointing out the high soil salinization and the formation of solonchak-soils as a consequence of four decades of embankment and drainages in Ukraine, on the left Chilia - branch bank, had as well been ignored. (***, 1997)

The dykes for Babina were initiated in 1985 and in 1987 for Cernovca. As a consequence of these measures the islands were cut off from the inundation regime of the Danube. The dams surrounding the islands are situated at a distance of about 75 -1 00 m from their bank and are about 2.05-3.79 m over Black Sea level (this included freeboard to prevent inundation). The material needed for the construction of the dams was excavated along the dam, so that outside the dam a circular channel was formed. For Cernovca, this dam is partly situated inside (***, 1997)

In order to lower the groundwater level, a network of main and secondary channels as well as pumping stations was constructed. In Babina polder, leveling works were realized and the reed rhizomes were removed by means of mechanical measures. Therefore, the ground was ploughed 28-30 cm deep. (***, 1997).

These measures radically altered the relief of the islets which had formerly been shaped by the Danube. Although on Babina the changes were completed. On Cernovca the measures were not brought to an end. On Cernovca only the western part was ploughed which is evident in the vegetation distribution in the furrows with small elevation differences. (***, 1997)

From an ecological point of view, cutting off the islands from the Danube flood regime meant elimination of a major factor and caused dramatic alterations as regards the water balance. Leveling and canalization destroyed major parts of the islands characteristic water network of small watercourses and flood channels. Air photographies show that it is true for almost all Cernovca Islet; the former streams have been preserved. On Cernovca, however, the structures of the former flood channels and smaller watercourses are more distinctly visible. Only groundwater fluctuations of -0.80 to 1.7 3 m below Black Sea level in Cernovca polder implied a slight dynamics. Within the drainage ditch and channel network of the polder, the water circulation was almost non-existent. (***, 1997)

2.3.6 Extra information ((Cernovca Islet):

Links to other sources of information online, and/or extra files (pdf, jpeg, etc) containing more detailed information about the project.

file name or link	*Description*
Hard copy	Ecological restoration in the Danube Delta Biosphere Reserve / Romania
http://www.indd.tim.ro/	Link with DDNI web site

2.3.7. Ecological reconstruction implementation results (from the study cases)

2.3.7.1 For Babina Islet (***, 2008)

The restoration of Babina Island was a significant step forward towards a sustainable development of this area. Both the redevelopment of the natural habitats and its biodiversity and the use of resources that are bound to traditional management methods stayed abreast of changes. After the political reversal in Romania, Babina Islet was the first project in the Danube Delta where new paths were stroke, away from an intensive, site-unspecific use back to near-natural structures, exemplar for nature r conservation with an for man. It caused a change of mind and offered new incentives to restore further flood prone areas that had been altered by man, in the Danube Delta but also beyond.

The monitoring conducted over 10 years accounts for a relatively rapid development of the area, the hydrological regime with its fluctuating floods and dry periods representing the key factor for restoration. Flood conditions do, however, differ from the natural flood situation. Before the construction of the dykes, i.e. under natural conditions, it occurred with a large-scale over-flooding of the islet. In the case of the dyked Babina Islet it merely occurs in the area of the dam openings (STARAS 2001).

Despite of these constraints the efficiency of the ecosystem has been reestablished by an opening of the dyke in specific hydraulically and ecologically effective spots and the reconnection to the river dynamics. This ensured a redevelopment of the site-specific biodiversity and the resources.

The monitoring of the hydrological regime in close relation with morpho-hydrological changes revealed the alterations in the artificial canals.

The reestablishment of the flood regime induced a process of rehabilitation of the plankton fauna comparable to permanent eutrophic waters with a significant increase in the species number. This proves that the water quality has gradually changed in towards the positive approaching natural conditions that are specific of clear water habitats where R, the development of aquatic vegetation sustains a rich and abundant zooplankton community i.e. an excellent food source for fish.

A specimen and species-abundant fauna of macro-zoo-benthos populate stagnating waters, permanent and macrophyte-rich. The composition according to nutrition types confirms a well-operating interplay between macrophytes, macro-zoo-benthos and fish. If the present hydrological conditions are maintained, there will be no significant changes or infringements of the zoo-benthos fauna in the short or medium term. In the long run, however, the insufficient water exchange in the water system of Babina will have indirect, negative effects on the macro-zoo-benthos.

The reconnection to the Danube River and the sc linking up to the neighboring ecosystems allowed the islet to take up again its function as habitat and spawning ground for fish. The studies conducted, prove that the redeveloped aquatic habitats play an important ecological role for reproduction and nutrition of fish.

Especially phytophilous species and species spawning on mollusks have been reestablished on Babina after the islet's reconnection to the flood regime of the Danube River.

The species occurring in the Babina area are characteristic eutrophic species of the Danube catchments area that occur both in running and in stagnating waters. Other limnophilous species, characteristic of stagnating waters do occur as well, the latter being predominant in the Babina Islet area.

The studies on diversity and structure of the fish populations show a characteristic ichthyofauna of eutrophic waters. This is because the area offers the respective habitats for their natural reproduction, adequate feeding and raising grounds for juvenile and adult fish. Diversity and structure of the fish communities vary from one habitat to another with the result that they may be considered as indicators for the ecological condition of the respective areas.

The development and stabilization of the fish populations involve the use offish resources and their socio-economic significance for the local populations. Ecological restoration can be considered as an economic alternative for the management of embanked and unprofitable or abandoned polders.

The reconnection to the dynamics of the Danube River and the redevelopment of a mosaic. of stagnant and running waters within the island led in their turn to a rapid redevelopment of the aquatic vegetation and its communities. This is why already during the second year after the flooding a major part of the aquatic vegetation occurred in the area of the island. From 1998 their stands increased so that the plant communities became relatively stable. With a few fluctuation caused by the hydrological regime of the Danube the communities became distinctly apparent and comparable to natural areas in the Delta.

2.3.7.2. For Cernovca Islet (***, 1997)

A monitoring programme was established to document the developments that occurred after the reconnection of the islets to the Danube's flood regime and to verify the success of the rehabilitation measures. A study comparing the data obtained before and after the dyke constructions should provide the opportunity to show developments and evaluate the measures. The monitoring programme comprises studies focused on both terrestrial and aquatic investigation spots.

The monitoring considers soils, vegetation and fauna with regard to **area-specific biodiversity** arising from changed ecological conditions implied by the reconnection to the flood regime of the Danube. After the dyke openings, the areas were analyzed with regard to the reestablishment of the ecological functions of these floodplains influenced by the river dynamics. The redevelopment of natural, area specific resources has been considered as well.

For the areas, the reestablishment of the hydrological regime and of the hydrological functions also meant a restoration of the following ecological functions:

• habitat for plants and animals, in particular,

• habitat and reproduction area for fish,

• habitat for water and wading birds,

• biodiversity reservoir providing,

• the guarantee of genetic resources

- biocorridor / genetic exchange,
- bioproduction,

• nutrient accumulation and turnover/nutrient cycling:

- sediment and pollutant retention,
- filter for the Black Sea.

The reestablishment of the ecological functions also implies the redevelopment of area-specific resources and the local population's traditional economical occupations: fishing, hunting, reed harvesting, pasturing, recreation etc.

The significant floodplain specific diversity maintained in the distinct habitats of the islands also represents a considerable genetic potential that would have been lost in the long run if the areas remained embanked. After the flooding, the biogeochemical processes, completed by the soils in the polder's ecosystem, changed. Vegetation, particularly the broad leaf, rapidly regenerating reed, show a high bio-production and play an essential role for nutriment accumulation, sediment and pollutant retention and as a filter for the Black Sea.

The rehabilitation of Cernovca was initiated with two openings in the surrounding dyke (April 1996). Its hydrological function as a water reservoir is reflected by a water retention volume of 28 million m3 water. On Cernovca, the reconnection to the water fluctuations of the Danube was the initiating element of the rehabilitation process. Immediately after the opening, the island took up again its ecological function as a reproduction ground for fish and as a habitat for water and wading birds. The limnological investigations prove the existence and development of zoo-benthos as nutrition for fish, although no distinct development tendencies could be observed up to now.

The waters of Cernovca indicate a considerably higher electrical conductivity than those of Babina, which is an indirect salt indicator.

After a mostly near-natural reestablishment of the hydrological regime, all other ecological factors were reestablished and the natural floodplain resources could again redevelop. The analysis of both the hydraulically ecological measures and the monitoring activities carried out up to now will be used to show whether additional measures (further dyke openings) are necessary.

The traditional use of the natural, regenerating resources may occur as a function of the rehabilitation of water levels. After a stabilization of the conditions, economical use of the fishing grounds, the pastures in the western parts of both islands and an ecologically sound reed use can occur. The development of the game stands still requires further investigation.

CONCLUSIONS AND RECOMMENDATIONS

From the information mentioned above, the following conclusions could be highlighted:

I. Healthy, self-sustaining river systems provide important ecological and social goods and services upon which human life depends (Postel & Richter 2003 cited by Palmer, 2005). Concern over sustaining these services has stimulated major restoration efforts. Indeed, river and stream restoration has become a world-wide phenomenon as well as a booming enterprise (NRC 1996; Holmes 1998; Henry, Amoros & Roset 2002; Ormerod 2003 cited by Palmer, 2005). Billions of dollars are being spent on stream and river restoration in the USA alone (Palmer *et al*. 2003; Malakoff 2004 cited by Palmer, 2005).

Although there is growing consensus about the importance of river restoration, agreement on what constitutes a successful restoration project continues to be lacking.

Given the rapid rate of global degradation of freshwaters (Gleick 2003 cited by Palmer, 2005), it is time to agree on what constitutes successful river and stream restoration.

There are <u>five criteria</u> for measuring success, hereafter referred to as the standards for ecologically successful river restoration. We chose a forum to propose these in order to elicit broad input from the community, including critiques and suggestions for expanding or revising what we propose.

a) The design of an ecological river restoration project should be based on a specified guiding image of a more dynamic, healthy river that could exist at the site.

b) The river's ecological condition must be measurably improved.

c) The river system must be more self-sustaining and resilient to external perturbations so that only minimal follow-up maintenance is needed.

d) During the construction phase, no lasting harm should be inflicted on the ecosystem.

e) Both pre- and post-assessment must be completed and data made publicly available.

Once a general agreement on reasonable success criteria has been reached, indicators to evaluate ecologically successful restoration must be identified based on questionnaires.

The success of a restoration project could be evaluated in many different ways, but is needed to have answers to this questions:

- Was the project accomplished cost-effectively?
- Were the stakeholders satisfied with the outcome?
- Was the final product aesthetically pleasing?
- Did the project protect important infrastructure near the river?
- Did the project result in increased recreational opportunities and community education about rivers?
- Did the project advance the state of restoration science?

However, for the following reasons, we argue that projects initiated in whole or in part to restore a river or stream must also be judged on whether the restoration is an ecological success.

Many projects are funded and implemented in the name of restoration, with the implication that improving environmental conditions is the primary aim.

Protecting infrastructure and creating parks are important activities but do not constitute ecological restoration and many in fact actually degrade nearby waterways.

For example, riverfront revitalization projects may be successful in increasing economic and social activity near a river but can constrain natural processes of the river and floodplain (Johansson & Nilsson 2002 cited by Palmer, 2005).

Similarly, channel reconfiguration from a braided to single-thread morphology may be aesthetically pleasing but inappropriate for local geomorphic conditions (Kondolf, Smeltzer & Railsback 2001 cited by Palmer, 2005). Thus, projects labeled restoration successes should not be assumed to be ecological successes. While other objectives have value in their own right, river restoration connotes 'ecological' and should be distinguished from other types of improvement.

In the ideal situation, projects that satisfy stakeholder needs and advance the science and practice of river restoration (learning success) could also be ecological successes **(Figure 4).**

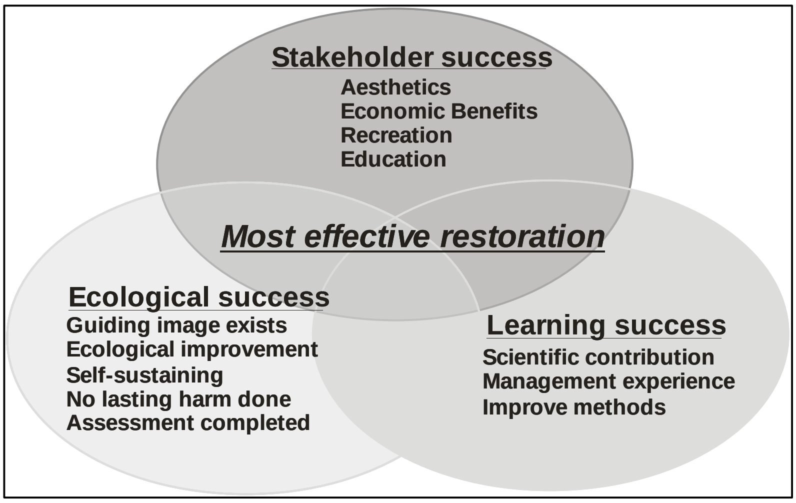


Figure 4 - The most effective river restoration projects lie at the intersection of the three primary axes of success. The assessment focuses on the five attributes of ecological success, but recognizes that overall restoration success has these additional axes.

Progress in the science and practice of river restoration has been hampered by the lack of agreed upon criteria for judging ecological success. Without well-accepted criteria that are ultimately supported by funding and implementing agencies, there is little incentive for practitioners to assess and report restoration outcomes. At present, information on most restoration efforts is largely inaccessible and, despite pleas to report long-term responses (Zedler 2000; Hansen 2001 cited by Palmer, 2005), most projects are never monitored post-restoration (NRC 1992 cited by Palmer, 2005). Our interest here is not which monitoring methods are employed, but rather which criteria are used to determine if a project is a success or failure ecologically. Bradshaw (1993), Hobbs & Norton (1996), Hobbs & Harris (2001), Lake (2001) and many others have long argued that restoration evaluation is crucial to the future of ecological restoration. This begs the question of evaluation with respect to what? What criteria can be brought to bear in evaluating success? While the objectives of ecosystem restoration are ultimately a social decision; if they are to include ecological improvement then we argue that the following criteria must be met.

II. For the future the next steps to be accomplished in order to extract the best practices it will be necessary to adopt the following analyzing procedure of the revitalization projects:

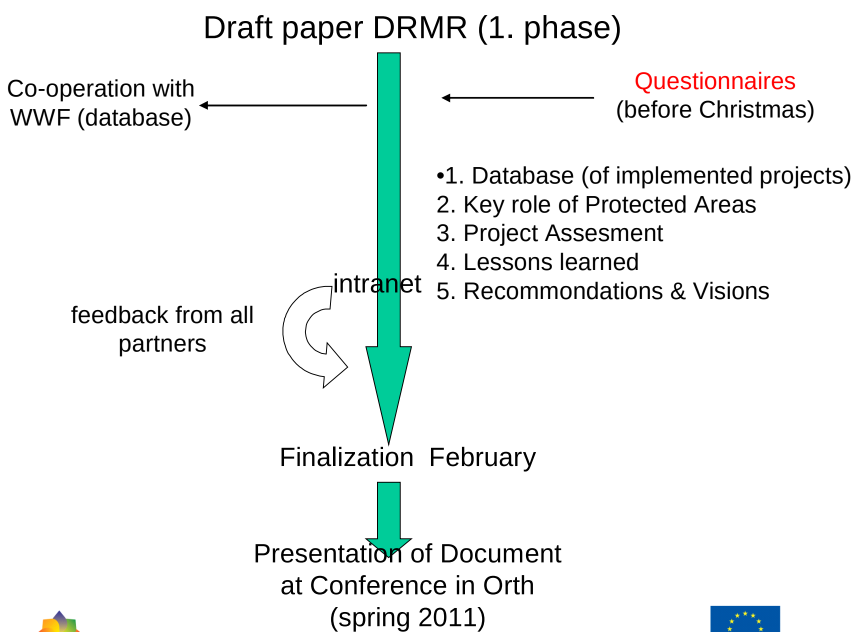
i) screening (environment and cost estimation)

ii) management programme – basic requirements & eco-investments

iii) audit action plan

iv) monitoring and re-certificate

All this procedures will be implemented taking into account the following work sketch:



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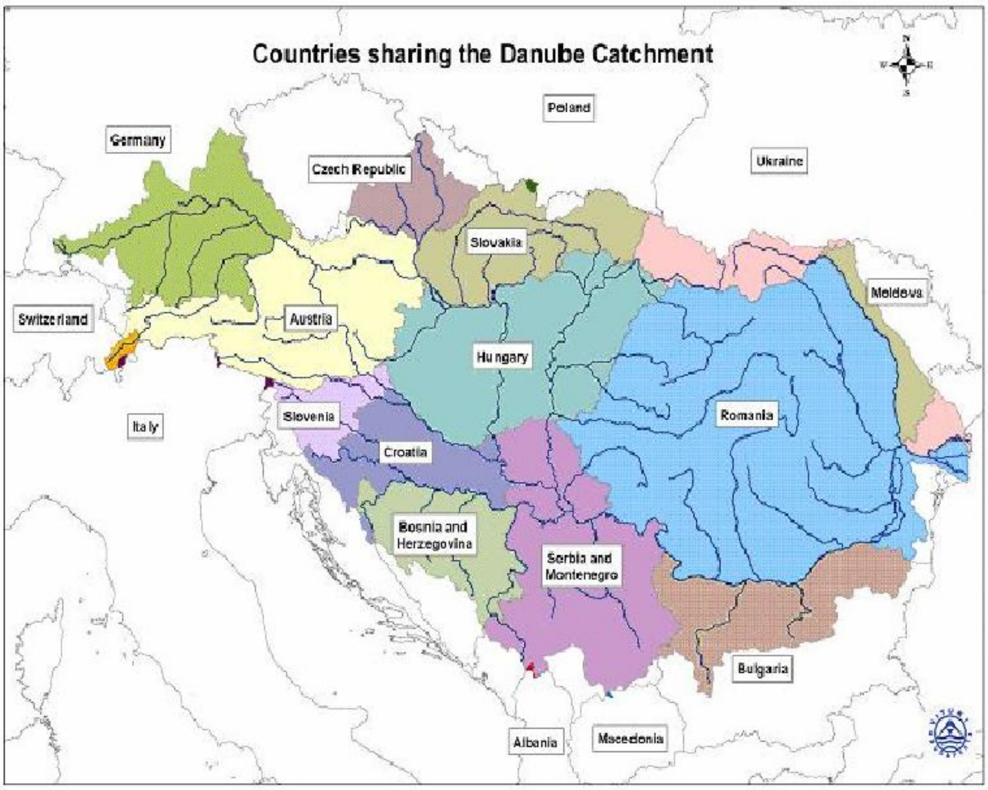
DANUBE RIVER'S MORPHOLOGY AND REVITALIZATION

TO THE SERVICE CONTRACT - STUDIES DEVELOPMENT NO. 414 / 2010

- REPORT -

Phase 3 – Preparing the guide for the Danube area



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PROGRAMME NAME:

TRANSNATIONAL COOPERATION PROGRAMME FOR SOUTH-EAST EUROPE 2007-2013

PROJECT NAME:

DANUBEPARKS - DANUBEPARKS - DANUBE RIVER NETWORK OF PROTECTED AREAS - DEVELOPMENT AND IMPLEMENT THE TRANSNATIONAL STRATEGIES FOR CONSERVATION OF DANUBE NATURAL HERITAGE

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Phase 3 – Preparing the guide for the Danube area

BENEFICIARY :

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I. INTRODUCTION

Rivers have always been with huge interest for life's existence and development. The ecosystems created in the proximity of rivers are very complex including a large number of species of plants and animals that are interact. All these inter-relations are into a stable equilibrium. The intervention of human society on rivers has determined the instability of this equilibrium shifting towards the extreme limits. Rivers are an important component of the European landscape and of great significance for biodiversity.

In this sense we can recall some of the "interventions" that has determined the instability of the equilibrium: over-exploitation of the riparian resources (biotic and abiotic), planning the river course (damaging them by embankment, course changing etc.), establishment of the human settlements in lower floodplain.

The Danube River has suffered alteration processes of the ecological balance in order to development of the human society. From the existing studies it comes to the conclusion that in the alteration process of the Danube have been destroyed dominating natural systems and have created industrial structures with economical purpose (navigation, hydro-energy, agriculture, ports etc.) that is damaging the Danube river, because of losing the floodplains and morphological structures.

Danube River regarded like an entire system raised the idea of making some zones with potential for local revitalization with an entire system effect (Figure 1).

Transformations of these ecosystems in the floodplains into terrestrial ecosystems have reduced their functions (ecological, economical, recreational, esthetical and educational) to a single one – economical.

The river restoration projects preconditions are ecological functions. This means that rivers are dynamic systems. They are formed by the natural characteristics of the drainage basin like climate, geology, tectonic, vegetation and land use. The discharge depending from precipitation is fluctuating. The power of running water and the amount of transported solids influence the morphological process and the geometry of the river channel. This includes bank erosion and sedimentation, natural restoration of riffle and pool and migration of the riverbed within the flood plain.

The geometric features of the river channel e.g. plant form, longitudinal and cross sections as well the substrate in the river channel are depending from the conditions in the watershed area. River and floodplain are an unit. (Binder, 2008)

The part presented above forms the abiotical part of a river system. The biotic part molds the abiotic part. The vegetation along the river and in the flood plain is in natural succession, its zonation spans from pioneer vegetation to alluvial woodland. The morphological structure housing a mosaic of biotopes for animals and plants. This explains why natural river systems offer such a wide range of habitats and why they are today in most European countries protected by Natura2000. Their reference status is equal to the high ecological status of the Water Frame Directive (WFD). (Binder, 2008)

The management of international water resources and large transboundary rivers is a challenging task because of the administrative and socio-cultural differences within the catchments, the heterogeneity of the encompassing landscapes, the multiple and often competing water uses, and, not least, the difficulty of enforcing international laws at regional and local levels.

Moreover, managing landscapes as complex as large river-floodplain networks requires a comprehensive understanding of the underlying ecological structure-function relationships at various spatiotemporal scales. Hence, tailor-made water management strategies need to be properly selected, designed, and implemented based on sound ecological principles, the best available scientific knowledge, and stakeholder participation (after Uitto and Duda, 2002; Dudgeon et al.,2006; Hein et al., 2006; Quevauviller, 2010, quoted by Sommerwerk N. et al., 2010).

The Danube River Basin (DRB) is the most international river in the world, characterized by exceptionally diverse ecological, historical, and socioeconomic properties. Its unique biodiversity and high ecological potential make the DRB one of the Earth's 200 most valuable ecoregions (after Olson and Dinerstein, 1998, quoted by Sommerwerk N. et al., 2010). At the same time, the DRB is listed among the world's top 10 rivers at risk (after Wong et al. 2007, quoted by Sommerwerk N. et al., 2010).

I.1 Synergies between revitalization and ecological restoration

to restore - tranzitive verb. (paintings, architectural monuments, etc.) A return to baseline, to put back into a former or original state [Sil. -Sit-u-] / <fr. restaurer, lat. restaurare
to revitalize - transitive verb - to give new life or vigor to (< fr. revitaliser)

Anthropic degradation of aquatic ecosystems, whether we refer to rivers, streams, lakes or coastal areas, deltas, is an omnipresent reality with major implications for centuries, if we refer to the Danube basin. Ecosystems are affected by morphological, chemical, hydrological or biological changes, all creating pressure on the structure and functions of ecosystems. Human impact on ecosystems is the main theme of numerous studies on the degree of anthropic degradation and many monitoring and evaluation indicators have been developed, to diagnose the state of ecosystems. In response to anthropic pressures that led to the degradation of ecosystems, have been tried measures of reconstruction / rehabilitation or ecological restoration. Most often, ecological restoration is described as successful when communities began to recover, and the pressure was reduced or even eliminated. However, the simple approach of removing the effects of environmental degradation is not expected to be achieved and biotic components will continue to be in poor condition. Measures to restore at small spatial scales - local, will not meet the requirements for restoration of river basin with degraded ecosystems what is essential to structuring of the restoration work at space level. Also, if monitoring activities are carried out only in the short term, there will be insufficient to quantify on long-term the environmental restoration requirements to functional and structural level. Not the least, the knowledge about recovery potential of the basin is unknown.

Ecological restoration is a discipline that has developed over 20 years, covering various topics with applications on habitat, species.

The necessity of enhanced measures for ecological restoration is an inevitable consequence of ecosystem degradation at functional and structural level. Human population growth, technological and cultural development, simultaneous with natural resources absorbing, lead to increased degradation of ecosystems.

Revitalization as defined in Los Angeles River Master Plan is a concept that accountre both measures of ecological restoration, rehabilitation and ecological reconstruction and development opportunities for local communities in the context of sustainability.

If rebuilding of longitudinal continuity, lateral connectivityand the temporal one is subject to revitalization or ecological restoration (Figure 1), the development of of local communities opportunities and cultural values will be treated by the concept of amelioration/ improvement (english mitigation).

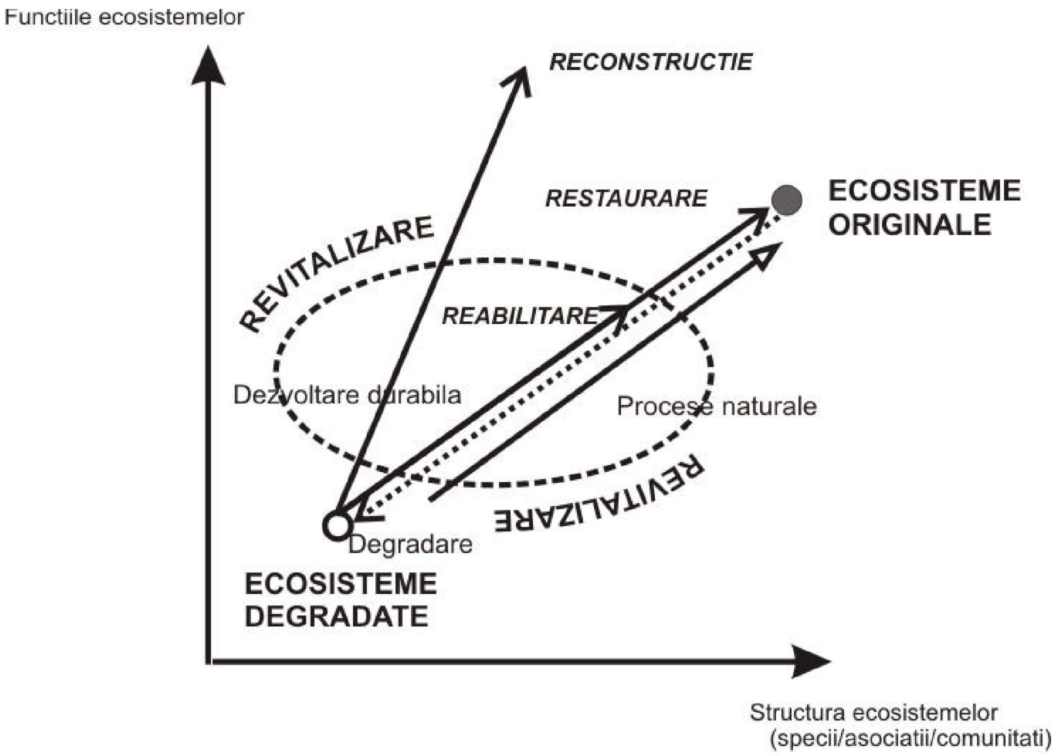


Figure 1 – Synergy Revitalization - Ecological Restoration Scheme (Perrow R.M, Davy A.J., 2002)

Natural resources managers must ensure a balance between legal, social, economic, biological problems, but also through adaptive management and spatial planning and of socio-ecological complex, will create strategies to achieve environmental objectives. Environmental objectives can vary from single species protection and management to a complex management of communities and ecosystems. Social objectives are intended to perpetuate or restore endangered species or manage or expand commercial, sport, or use, directly or indirectly to meet the needs of a changing society. The legal system requires quantitative and qualitative assessment of these issues, based on:

- Analytical models;
- Analysis of species-habitat relationship.;
- Population sustainability assessment and risk assessments.
- Support the framework for decision-makers
- Summary of available knowledge
- Mega Database
- Technical support for watershed planning and recovery of species
- To facilitate scientific discussion and networking
- Develop and implement tools to support planning
- Technical Consultation on biological and ecological aspects

Our approach is to structure and develop a guide for the revitalization of the works in the context of restoration / ecological reconstruction.

From the very beginning we must note that these works are defined on the one hand by the spatial dimension and on the other hand we are dealing with a complex thematic area.

Trying to define the spatial dimension we must look the whole body as an organism or a molecular structure whose cells interact on different scales.

Thus we have defined three levels of extension to which we refer to:

- Local level
- Regional level
- The river basin level.

I.2 The approach framework of the Danube in the European context - the Danube Strategy & ESPON Programme 2013

Danube Strategy. EU Strategy for the Danube Region is a model of regional cooperation at european level - inspired by the EU Strategy for Baltic Sea Region, approved by the European Council in october 2009 - which implements a new concept of territorial cohesion in the Treaty of Lisbon.

The strategy is a platform to facilitate partnerships, both among local and regional authorities and between authorities, private and NGO sector by generating projects for the development of the Danube region.

Danube Basin region is a functional area defined by the Danube river basin. Cooperation bodies such as the Danube Commission and the International Commission for the Protection of the Danube address specific issues. Strategy extends this approach to target priorities in an integrated way. In terms of geography, this strategy concerns mainly but not exclusively: Germany (Baden-Wurttemberg and Bavaria), Austria, Slovak Republic, Czech Republic, Hungary, Slovenia, Romania and Bulgaria in the EU and Croatia, Serbia, Bosnia and Herzegovina, Montenegro, Moldova and Ukraine (areas located along the Danube), outside the Union. The strategy remains open to other partners in the region. Since the Danube flows into the Black Sea, the strategy should be consequent with the perspectives of the Black Sea. With over 100 million people and one fifth of the EU area, this area is vital for Europe.

River basin that crosses most countries in the world is now largely an area of the European Union.

There is a need to connect people, ideas and needs in this region. The transport interconnections gave to be upgraded and information access improved. Energy can be cheaper and safer because of better connections and alternative sources. Development can be balanced with environmental protection in a sustainable development approach, according with the community acquis, as it is applicable. Collaboration is needed to minimize risks and disasters such as floods, droughts and industrial accidents. Capitalizing the considerable research and innovation perspective, this region may be in the forefront of commerce and entrepreneurial activity in the EU. The gaps in education and employment can be overcome. This can become a safe area, where conflicts, marginalization and crime are properly approached.

Until 2020, all citizens of this region should enjoy better prospects of higher education, labor employment and prosperity in areas where they live. The strategy should make this region a region that truly belongs to the 21st century, secure and confident in their own forces and one of the most attractive in Europe.

To achieve this objective, the European Council asked the Commission to develop this strategy. This comes after the EU strategy for Baltic Sea region, which is now implemented, was very well received. Demand on the Danube, based on experience with the Baltic Sea region, emphasizes an integrated approach to sustainable development. Synergies and compromises must be identified, for example, development of new environmental technologies, working towards a better alignment of policies and better funding to improve the practical impact and overcome the problems posed by fragmentation.

Objectives will apply to Member States, third countries will be encouraged to work towards achieving them in the light of their specific conditions. The objectives will be monitored closely in the context of reporting by the Commission. They are:

- Providing and supporting the economic development, social and cultural development of countries and regions in the catchment area of the Danube, in compliance with environmental regulations
- To reduce downshift between poor and the richer regions, according to EU cohesion policy;
- Efficient use of European funds and attracting new funds for the Danube Region.

Areas covered by the strategy are:

- connectivity (sustainable transport, energy networks, tourism and culture)
- environment, water resources and risk management;
- economic prosperity and social development (education, research, rural development, competitiveness, internal market);
- improving system of governance (institutional capacity and internal security).

Proposals occur after extensive consultations with stakeholders.

Governments, including those of third countries were involved through „the National Points of Contact". It was mobilized the expertise of relevant Commission services and European Investment Bank and other regional bodies (eg Regional Cooperation Council). Stakeholders were consulted online and in five major conferences. The main message was: (a) the initiative to strengthen regional integration in the EU is welcomed, (2) Member States and third countries (including the candidate and potential candidate countries) is committed to the highest political level, (3) The Commission has a key role in facilitating the process (4) existing resources can be better used for the objectives of Strategy and (5) The strategy must provide visible improvements, concrete for the region and its inhabitants.

Challenges: historically speaking, the Danube region was particularly affected by the turbulent events, with many conflicts, population movements and democratic regimes. However, the Iron Curtain and EU enlargement give the opportunity for a better future. This means that major challenges must be addressed, in particular:

Mobility: The Danube River is itself an important TEN-T corridor. However, is used much below its existing capacity. Because inland waterways has important environmental and efficiency benefits, its potential should be exploited in a sustainable manner. They are particularly necessary greater intermodality, better interconnection with other river basins, and the modernization and expansion of infrastructure in transport such as inland ports.

Energy: prices are relatively high in this region. Fragmented markets causes higher costs and reduced competition. Reliance on too few suppliers increased external vulnerability, as proof, the frequent crises in the winter. A greater diversity of supply through interconnections and authentic regional markets will improve energy security. A better efficiency, including energy saving and renewable supplementation is crucial.

Environment: Danube region is an important river basin and an international ecological corridor. This requires a regional approach of nature conservation, planning and hydraulic works. Pollution does not respect national boundaries. Major problems such as untreated sewage and runoff of fertilizers and soil, pollute heavily the river. Environmental impacts of transport, tourism construction or new facilities for energy production should also be taken into account.

Hazards: Floods, drought and large-scale industrial pollution are all too frequent. Prevention, preparedness and effective response requires a high degree of cooperation and information exchange.

Society and economy: the region has important differences (downshift) . Here are some of the most successful regions, but also of the poorest in the EU. In particular, the contacts and cooperation are missing, both financial and institutional. The industry does not sufficiently exploit the international dimension of marketing, innovation and research. Percentage of people with higher education in the Danube region is lower than the EU-27 average, with one important difference, present in this domain The best often leave the area.

Security, serious infraction and organized crime: there are still major problems. Human trafficking and contraband are special problems in several countries. Corruption undermines public confidence and prevent the development.

The best way is to approach these challenges together, identifying priorities, consensus and implement actions. For example, developers and conservationists must find innovative solutions to solve the most difficult issues together, to benefit the whole region.

Action Plan. An integrated response is the essence of strategy. Emphasis is placed on: better connections and more intelligent for mobility, trade and energy; action in environment management and risk management, security cooperation. There is a benefit of cooperation in innovation, tourism, information society, the institutional capacity of marginalized communities. There is a benefit resulting from the collaboration in innovation, tourism, information society, the institutional capacity and of marginalized communities.

The strategy proposes an Action Plan, which require a strong commitment from the states and stakeholders.

The projects presented in the Strategy are examples that will be promoted. Their role is illustrative, not prioritization. The main problems are grouped into four pillars. Each of them contains the priority areas, specific areas of action. They are:

(1) Interconnection Danube region

• To improve mobility and multimodality

(a) Inland waterways

(b) Road links, rail and air

• To encourage more sustainable energy

• To promote culture and tourism, direct contacts between people

Good connections are essential for the Danube region, whether internal or with other parts of Europe or the world. No area should be left out of these connections. Transport and energy infrastructures have large gaps and deficiencies due to insufficient capacity or quality or poor maintenance. Better connections between people are also needed, particularly through culture and tourism.

For some specific improvements require planning, funding and coordinated implementation. Market failures, due to external effects are very evident in the lack of transboundary investment. Major projects have to be identified and implemented in a sustainable and efficient way, with costs and benefits shared. The higher number of users, the investments are more efficient, with economies of scale.

The main issues

Environment in the Danube Region

• Restoration and maintenance of water quality

• Environmental Risk Management

Ecological resources are shared between neighboring countries and beyond national interests. This is particularly true in the Danube region, which includes mountainous areas, such as the Carpathians, Balkans and part of the Alps. The region also has a flora and a rich aquatic and terrestrial fauna, including the few places in Europe are the habitats of pelicans, wolves, bears and lynx. They are increasingly under pressure from human activities. Cooperation is essential because the good effect of actions of some can be easily reduced by the negligence of others. The existing structures of cooperation should be strengthened.

Water. The region is the most international river basin in the world, with many important tributaries, lakes and groundwater. Ensuring good water quality is a central objective, as required by the Water Framework Directive.

Risk. Inhabitants must be protected from catastrophic events such as droughts and industrial accidents, which have a significant negative effect on transnational - the most recent took place in 2010 - through preventive measures and disaster management implemented jointly, by example, as required by directives on floods, Seveso, mining waste or the liability for environmental damage. Solitary actions relocate the problem and make the difficulty to surrounding regions. Increased frequency of droughts is also a problem, as is adaptation to climate change. Regional cooperation should facilitate the green infrastructure, implementation of ecosystem-term solutions, and learning from past events.

Biodiversity, soils. The decline of natural habitats affect the flora and fauna and the overall quality and environmental health. Fragmentation of ecosystems, intensification of land use and urban development in Europe is the major pressure factors.

Increasing prosperity in the Danube region

• Developing knowledge-based society through research, education and information technology

• Supporting business competitiveness, including the development groups

• Investing in people and skills

The region can meet the extremes of the economically and socially within the EU. For the most competitive regions to the poorest, from those with the best skills to the less educated people, from the highest to the lowest standard of living, the differences are striking.

Strategy strengthens Europe in 2020, allowing capital to compensate those areas that have high labor force, markets technologically advanced with less advanced, particularly by expanding the knowledge society and a committed approach for inclusion. Marginalized communities (especially the gipsies, whose members live mostly in the region) in particular should benefit from these opportunities.

Main problems

Education and skills

Investing in people is needed so that the region can progress and grow in a sustainable manner, focusing on knowledge and inclusion.

Research and innovation

Envisaged to support research infrastructure will stimulate excellence and will lead to deeper knowledge of contacts between providers, companies and policymakers.

Companies

In this area are some of the best performing regions. Others are far behind. These one should benefit from better links between innovation and business support institutions

Labor market.

A higher level of employment is crucial. People need opportunities near where they live. They also need for mobility.

Marginalized communities.

A third of EU citizens live at risk of poverty, many belonging to marginalized groups and live in this area. Efforts to get rid of these difficulties have effect at the EU level, but the causes must be addressed first in the region.

Strengthening the Danube region.

• Improve institutional capacity and cooperation

• Working together to promote security and to find solutions to the serious crime and organized crime.

The dramatic changes that have occurred since 1989 have transformed society. Special attention is required because the Danube region includes member states that joined at different times, the candidate countries and third countries. Most of these countries face similar problems, but with different resources available.

Effective responses to common security challenges and the fight against serious and organized crime requires coordination at all levels. Exchange of good administrative practices is important to make the region more secure and strengthen its integration into the EU.

Main problems

Security

Corruption, organized crime and serious crime is a growing concern. Issues such as smuggling, human trafficking and illegal cross-border markets requires strengthening the rule of law, both nationally and internationally. Exchange of information should be better and have developed effective joint action.

Implementation and governance

To address these issues, we need a good basis for cooperation.

A sustainable framework for cooperation.

The strategy seeks to make maximum use of existing elements, aligning efforts, in particular policies and funding. Actions are complementary. All interested parties must assume responsibility. A consolidated territorial dimension will ensure an integrated approach and will encourage better coordination of sectoral policies. Maximum concentration is needed on outcomes.

Coordination

Policy coordination will be the responsibility of the Commission, assisted by a high-level group representing all Member States. „The coordinators of priority fields" which can demonstrate commitment to the Danube region, expertise and that are accepted, ensure the implementation (eg, by consensus on planning, presenting the objectives, indicators and timetables, and by providing extensive contacts between the promoters of projects, programs and funding sources, while providing technical assistance and advice).

This activity will be transnational and institutional and inter-sectoral.

Implementation

Implementation the actions is the responsibility of all, at national, regional, urban and local level. Actions (stating the objectives to be achieved) should be transformed into concrete projects (which are detailed and require a project manager, a timetable and funding). They should be facilitated actively the submission of proposals, respecting the autonomy of decision-making program.

Financing

Strategy is implemented through the mobilization and alignment of existing funding to its objectives, as appropriate, and in accordance with the frameworks. Significant funds are available Indeed, through many EU programs. Projects may be financed through internal current financial framework of the Community, by European funds already in existence - Structural and Cohesion Fund, Solidarity EU FP7, LIFE +, the European Agricultural Guarantee Fund and the Rural Development etc. There are also other means, such as the Western Balkans investment and international financing institutions (eg EIB: EUR 30 billion in 2007-2009, to support the navigability and cleaning).

It should be paid attention to the combination of grants and loans. There are national resources, regional and local. Accessing and combination of funding, particularly public and private sources under the EU level, is indeed crucial.

Reporting and evaluation

Reporting and evaluation are made by the Commission, in partnership with the coordinators of priority areas and other stakeholders. The Commission also organizes an annual forum to discuss the work, for consultation on the revised measures and to develop new approaches.

No new European funds, no European legislation, no new European structures.

The Commission is preparing this strategy not involving special treatment, in terms of its legal budget for the region. In particular:

(1) European Strategy does not provide new funds. There may be additional funding international, national, regional or private, although the emphasis is on better use of existing funds;

(2) The strategy does not require changes to EU legislation, as the EU legislates for the 27 Member States, not only a macro. If a consensus, changes could take place at national level or other levels, to address specific objectives;

(3) The strategy does not create additional structures. Implementation is done by existing bodies, which complementarity should be improved to the maximum. There shall be any major impact on Commission resources.

The role and contribution of Romania

Romania is, along Austria, founder of the EU Strategy for the Danube Region. Romania has contributed to the EU Strategy, together with all other sovereign states, based on a defined position in the national working group, specially created for this purpose.

Danube strategy is a priority of the Romanian Government considering that the region sustainable development potential is considerable. This plan would require a transformation of the Danube in a backbone of the European area, as part of the Rhine - Main - Danube. Ministry of Foreign Affairs coordinates the realization of national project, at national level.

ESPON Programme 2013. In the ESPON 2013 - European observation network of development and territorial cohesion, have been launched new research/financing opportunities for European territorial, for research institutions in development planning and public authorities interested in studying local national or regional phenomena into an extended European context.

ESPON 2013 Programe is an operational program within the European Territorial Cooperation Objective of the EU Cohesion Policy which is accessed through financial assistance from the European Regional Development Fund 2007-2013. The total budget of the ESPON 2013 Programme for the 31 states, is 47.1 million.

The aim of the ESPON 2013 Programme is to support EU formulation policy, territorial cohesion and harmonious development of the territory by providing information, statistics, analysis and scenarios on territorial dynamics and emphasizing equity and development potential of regions and other territories, thereby increasing competitiveness, enhancing territorial cooperation, sustainable and balanced development of European territory.

Objectives of the program. The projects implemented under this priority will contribute with information and methodologies to deliver quality data in developing policies. They also contribute to the establishment and consolidation of tools, indicators and European data, used by the scientific community in science planning.

The aim of ESPON 2013 Programme is to support the formulation of policy targeting cohesion and harmonious development of the European territory by (1) providing information, statistics, analysis, and scenarios on territorial dynamics, (2) emphasizing the territorial capital and development potential of regions and larger territories, thus contributing to increased competitiveness, increased regional cooperation and sustainable and balanced developmentof European territory.

Beneficiaries eligible for funding ESPON 2013

Public bodies or public law are eligible for ESPON 2013 funding. You can formally request to the National Authority for the ESPON 2013 in Romania (AN ESPON), eligibility confirmation before participate in a multinational group project.

During implementation of the ESPON 2013 Programme, the Managing Authority and participating states will consider extending the area of eligibility to include private partners within the category of eligible beneficiaries of funding ESPON.

AN ESPON will inform potential beneficiaries about the Programme on the change the category of beneficiaries.

- The eligible area.

(1) Member States;

(2) Partner States ESPON Programme 2013: Iceland, Liechtenstein, Norway and Switzerland.

During implementation of the ESPON 2013 Programme, may decide other states involvement in applied research projects and studies. Candidate countries and the EU neighboring countries are considered a priority.

Limited to 10%, ESPON 2013 budget can finance activities unfolded partly or wholly in a country outside the EU, provided that benefit to the EU regions.

The main categories of direct beneficiaries ESPON 2013 are:

- universities;
- research institutes in the field of territorial development;
- decision makers in the field of territorial development (institutions of local and central public administration, etc);
- National ESPON Contact Points.

The target group consists of beneficiaries of research results applied to public authorities at all levels of government and community research: European Commission, all Member States and other countries participating in the program, the corresponding authorities at regional / local research institutes and public universities, policy makers in developing and implementing regional policy and cohesion.

Types of eligible expenditure

- *General conditions*
  - Costs are made (paid)
  - Costs made by partners
  - Costs directly related to project implementation
  - Respect the law
  - Are correctly reported under the budget lines
- They are made in the period of eligibility.
  - *Budget lines*
    - Budget line no. 1 - Staff
    - Budget line no. 2 – Management;
    - Budget line no. 3 – Transport and accommodation
    - Budget line no. 4 – equipment
    - Budget line no. 5 – external expertise and services

I. 3 Characterization of Danube River Basin (DRB) in terms of morphology and revitalization

The DRB covers a total area of ~801.000 km² and collects water from the territories of 19 countries in Central and South-Eastern Europe (Germany, Austria, Switzerland, Italy, Poland, the Czech Republic, Slovenia, Slovakia, Hungary, Croatia, Serbia, Romania, Bosnia and Herzegovina, the Former Yugoslav Republic of Macedonia, Albania, Montenegro, Moldova, Bulgaria, and Ukraine).

Today, ~83 million people inhabit the DRB, and ~60 cities in the DRB have a human population of more than 100.000 (after Sommerwerk et al., 2009, quoted by Sommerwerk N. et al., 2010). Culturally, the DRB consists of a wide variety of languages, traditions, histories and religions. The political and social conditions and the corresponding economic status of the DRB countries are more diverse than those in any other European river basin.

The Danube is the second longest river in Europe (2826 km), and its large delta forms an expansive wetland (area: 5640 km²) of global importance. The mean annual discharge of the Danube at its mouth is ~6480 km^3/s, corresponding to a total annual discharge of 204 km^3. The Danube is divided into three sections that are almost equally long, and separated by distinct changes in geomorphic characteristics: the Upper, Middle and Lower Danube

A characteristic feature of the Danube is the alternation between wide alluvial plains and constrained sections along the main stem. Before regulation, active floodplain width reached > 10 km in the Upper Danube and > 30 km in the Middle and Lower Danube. In the Upper Danube, most floodplains and fringing wetlands have been converted into agricultural and urban areas, or have been isolated by dams and artificial levees, and therefore are functionally extinct. However, along the Middle and Lower Danube, large near-natural floodplains still remain. Vegetated islands form another (former) prominent landscape element in the DRB. Along the Austrian Danube, ~ 2000 islands were present before regulation today, only a few remain. However, islands are still abundant in the Hungarian/Serbian (Middle Danube) and the Bulgarian/Romanian sections (Lower Danube). Remaining near-natural floodplains and vegetated islands may serve as important nuclei for conservation and management actions; at the same time, they are sensitive indicators to assess the ecological state of river corridors (after K. Tockner, unpubl. data, quoted by Sommerwerk N. et al., 2010).

Zoogeographic and phylogeographic studies clearly pinpoint the DRB as a biodiversity hot-spot region in Europe. For example, ~20% (115 native species) of the European freshwater fish fauna and 36% (27 species) of the amphibian fauna occur in the DRB today (after Sommerwerk et al. 2009, quoted by Sommerwerk N. et al., 2010).

Moreover, the Palaearctic and Mediterranean biogeographic zones overlap in the Danube Delta, resulting in an exceptionally high biodiversity, especially for birds (total: 325 species, ~50% are breeding species). The corridor of the Danube River remained unglaciated during the last ice age and therefore served as a substantial glacial refuge area, as well as an important expansion and migration corridor for many species. Today, the DRB drains areas of nine ecoregions (after Illies, 1978, quoted by Sommerwerk N. et al., 2010).

I.4 Conceptual Framework and its relevance within Danube River's Revitalisayion

I.4.1. Background & definitions

There had been developed and applied at the Danube hydrographical basin scale, especially in the second part of the XX century, a lot of management plans and policies which were grounded exclusively on neoclassical economy principles. These principles had a large class of economical and social objectives from which some were identified as driven forces for Lower Danube wetlands System structural and functional changes, such as:

1. economical objective translated as arable surface extension and increase agricultural production;
2. urban and industrial development;
3. Danube River and its main tributaries hydro-electrical potential capitalization and protection against floods;
4. to counteract the drought effects toward agriculture crops;
5. to maintain and develop the navigation conditions and infrastructure.

Achieving these strategic and political objectives required the development and implementation of management plans and programs, each consisting of a wide range of human activities and that means to exercise pressure on the Lower Danube Floodplain.

As is well known, the productivity and stability of ecosystems depends directly on their viability, to provide physical support for the use of natural resources and to provide socio-economic system services. Analysis of ecosystems as dynamic systems, nonlinear and as production units consists in lengthy processes of which variability and diversity are essential for unit stability and productivity. This analysis does not overlook the social and economic implications, taking into account the relationship between Natural Assets of the unit and the existing Socio-Economic System, following the same principles.

For a coherent understanding and interpretation due to the spatio-temporal dynamics of interactions complexity between human population and environment it is needed to tackle by a theoretical transdisciplinary integrating model framework that allows changes, transformations, trends and adjustments identification/ understanding in the system.

This first activity consists in the assessment of hydro-morphology concepts within Danube River basin.

Conceptual framework presentation took into account the following river connectivity categories:

- Lateral connectivity;
- Longitudinal connectivity;
- Vertical connectivity;
- Temporal connectivity

All these connectivity types describe the river ecosystem in the same space and time as it can be seen and explained in the **Figure 2**:

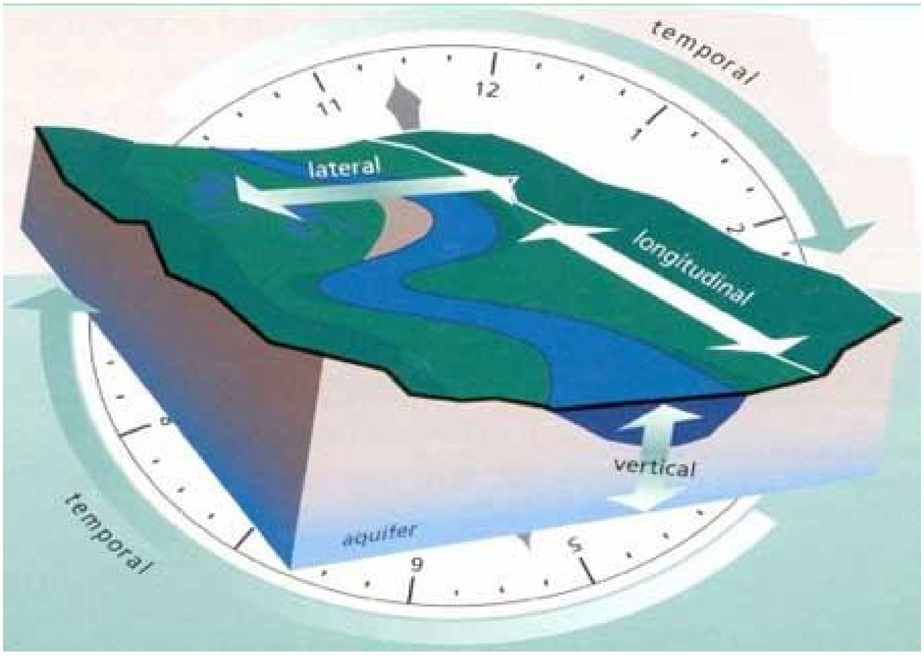


Figure 2 – Connectivity types sketch in a river ecosystem

(http://www.battleriverwatershed.ca/gfx/old-images/connectivity.jpg)

- ***Lateral connectivity*** refers to the periodic inundation of the floodplain and the resulting exchange of water, sediment, organic matter, nutrients, and organisms. Lateral connectivity becomes especially important in large rivers with broad floodplains. *(Benke, A.C., 2001*)

To discuss about the lateral connectivity it is good to have some question at the beginning and to try to find some answers as an understanding way of the concept.

***Is** the river able to connect with its floodplain (during floods etc.)?*

In a natural status the river keep connection with its floodplain especially in floods time, invading places with its water, new sediments and all its influence. Former streams become active, small pools are filled up with fresh water; parts of the ground are covered by new sediments.

***Is** there a connection between the aquatic and terrestrial (upland) environments?*

In main cases there is a connection between the aquatic and terrestrial environments by the simple fact that they lay side by side and the water through the capillarity of the soil ensures a certain degree of moisture that influence the presence of specific vegetation and animals.

***Is** there a healthy riparian area?*

Riparian area is the interface between land and a river or stream. A healthy ecosystem is an ecosystem in which structure and functions allow the maintenance of biodiversity, biotic integrity and ecological processes over time. The lateral connectivity is a premise of a healthy riparian biome.

➢ ***Longitudinal connectivity*** refers to the pathways along the entire length of a stream. As the physical gradient changes from source to mouth, chemical systems and biological communities shift and change in response. The River Continuum Concept (RCC) can be applied to this linear cycling of nutrients, continuum of habitats, influx of organic materials, and dissipation of energy. (Watershed Assessment Tool: Connectivity Concepts – Minnesota Department of Natural Resources)

For example:

- A headwater woodland stream has steep gradient with riffles, rapids and falls;
- Sunlight is limited by overhanging trees, so photosynthesis is limited;
- Energy comes instead from leaves and woody material falling into the stream;
- Aquatic insects break down and digest the terrestrial organic matter;
- Water is cooled by springs and often supports trout.

In the mid-reaches

- the gradient decreases and there are fewer rapids and falls;
- the stream is wider; sunlight reaches the water allowing growth of aquatic plants;
- insects feed on algae and living plants;

- proportion of groundwater to runoff is lower so stream temperatures are warmer;
- the larger stream supports a greater diversity of invertebrates and fish.

The river grows and the gradient lessens with few riffles and rapids

- Terrestrial organic matter is insignificant in comparison to the volume of water;
- Energy is supplied by dissolved organic material from upstream reaches;
- Drifting phytoplankton and zooplankton contribute to the food base as do organic matter from the floodplain during flood pulses;
- Increasing turbidity reduces sunlight to the streambed causing a reduction in rooted aquatic plants;
- Backwaters may exist where turbidity has settled and aquatic plants are abundant;
- Fish species are omnivores and plankton feeders such as carp, buffalo, suckers, and paddlefish;
- Sight feeders are limited due to the turbidity (MN DNR, Healthy Rivers).

To discuss about the longitudinal connectivity it is good to have some question at the beginning and to try to find some answers as an understanding way of the concept.

***How** connected is the river along its length?*

The longitudinal connectivity implies that stream (in our case river) should have a continuously path from the spring to its mouth. This is the natural case.

***Is** it broken up by dams, weirs or natural obstacles?*

This longitudinal continuity could be often tainted by natural and artificial causes. The main artificial causes are: dams for different purposes (water stocking, producing energy etc.). Natural causes are more rare and usually are accidentally (weirs created by thunderstorms by getting down the trees) and not accidentally weirs created by beavers.

➢ ***Vertical connectivity i**s represented by the connection between the atmosphere and groundwater. The ability of water to cycle through soil, river, and air as liquid, vapor, or ice is important in storing and replenishing water **(Figure 2).** This exchange is usually visualized as unidirectional–precipitation falling onto land and then flowing over land or percolating through the ground to the stream. An equally important transfer of water occurs from the streambed itself to surrounding aquifers. Groundwater can contribute to flows in the river at certain times in the year and at certain locations on the same stream. Streams may either gain or lose water to the surrounding aquifer depending on their relative elevations. Lowering the water table through groundwater withdrawals may change this dynamic exchange in unanticipated ways (Stream Corridor, FISRWG).

The slow movement of water through sediments to the river produces several ecological benefits (Minnesota Department of Natural Resources):

- The water is filtered of many impurities.
- It usually picks up dissolved minerals.
- The water is cooled.
- The water is metered out slowly over time.

This is particularly important in smaller, cooler streams for the maintenance of critical habitat for fish, wildlife and invertebrate species.

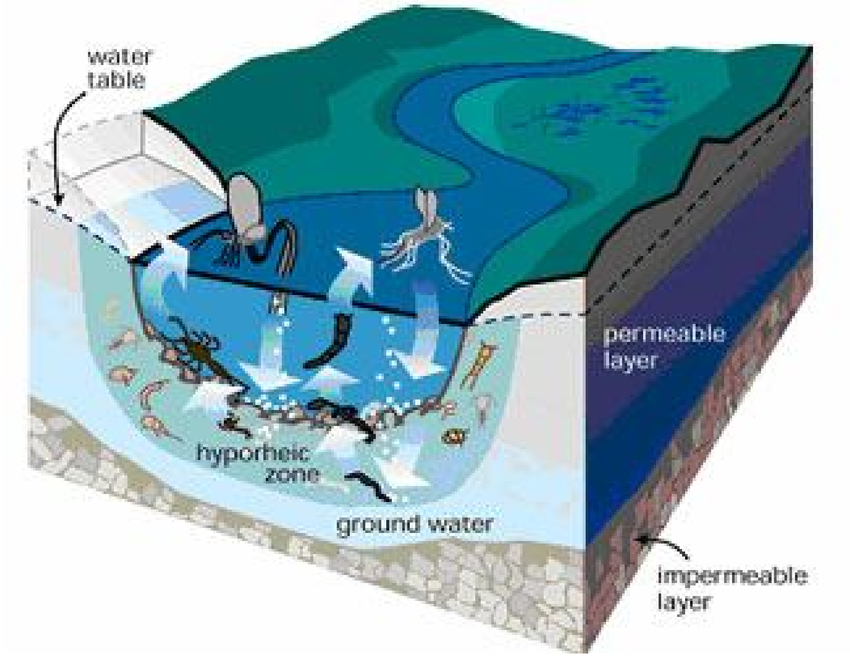


Figure 3 – Vertical connectivity sketch in a river ecosystem *(Stream Corridor, FISRWG)*

➢ ***Temporal connectivity*** consists in continuous physical, chemical, and biological interactions over time, according to a rather predictable pattern. These patterns and continuity are important to the functioning of the ecosystem. Over time, sediment shifts, meanders form, bends erode, oxbows break off from the main channel, channels shift and braid. A stream rises and falls according to seasonal patterns, depending on rain and snowmelt. Throughout most of Minnesota, free-flowing rivers experience high water in spring, falling flows in summer, moderate flows in fall, and base flows in winter. The watershed has adjusted to these normal fluctuations, and many organisms have evolved to depend on them (MN DNR, Healthy Rivers).

The importance of the connectivity

Connectivity is important because it ensures natural river processes continue to occur (channel maintenance, floodplain evolution).

It is also important because isolated (fragmented) habitats, whether aquatic or terrestrial, have fewer species (biodiversity), and it is difficult for species to re-colonize isolated habitats.

Connectivity also ensures there is a flow of energy and nutrients between and within aquatic and terrestrial (land) environments. For example, in the fall, leaves are washed into the river and provide important food for aquatic insects.

The connectivity of the river ensures also the ecosystems services. The ecosystem services are as follows (by the Millenium Ecosystem Assessment classification):

- *Provisioning* services, the products obtained from ecosystems, including, for example, genetic resources, food and fiber, and fresh water.
- *Regulating* services, the benefits obtained from the regulation of ecosystem processes, including, for example, the regulation of climate, water, and some human diseases.
- *Supporting* services, that are necessary for the production of all other ecosystem services. Some examples include biomass production, production of atmospheric oxygen, soil formation and retention, nutrient cycling, water cycling, and provisioning of habitat.
- *Cultural services*, the non-material benefits people obtain from ecosystems through spiritual enrichment, cognitive development, reflection, recreation, and aesthetic experience as well as knowledge systems, social relations, and aesthetic values.

Connectivity is crucial in the context of restoration. Many reach-scale restoration projects have been unsuccessful because they were conceived and implemented in isolation from the larger catchment context (Frissell and Nawa 1992, Muhar 1996, Wohl et al. 2005 cited by Mathias Kondolf et all). For example, instream structures used in some restoration projects have not been recolonized because of a limited pool of potential colonizers in nearby intact sites or because of barriers to dispersal of the colonizers (Bond and Lake 2003). Alternatively, the structure may be overwhelmed by sediment derived from upstream sources and carried downstream through the drainage network (Iversen et al. 1991). (http://www.ecologyandsociety.org/vol11/iss2/art5/)

Classification of Danube River's Revitalization Project on subclasses.

Methods: Starting from *The Los Angeles River Revitalization Master Plan*[1] developed by City of Los Angeles department of public works were taken and adapted several standard criterions of revitalization for Danube River, representing the base for the following 4 criterion subclasses:

- Danube River's restoration and rehabilitation through Lateral Connectivity;
- Danube River's restoration and rehabilitation through Longitudinal Continuity;
- Danube River's restoration and rehabilitation through Temporal Conectivity;
- Capture Community Opportunities & Create Value.

Danube River's restoration and rehabilitation through Lateral Connectivity

During the last decades, the perception of river-floodplain systems has been significantly improved by the application of new theoretical concepts (after Ward et al., 2001, quoted by Buijse A. D. et al., 2002). The 'river continuum concept' addresses the longitudinal linkages within rivers (after Vannote et al., 1980, quoted by Buijse A. D. et al., 2002), while the 'flood pulse concept' integrates the lateral river-floodplain connections in both tropical (after Junk, Bayley & Sparks, 1989, quoted by Buijse A. D. et al., 2002) and temperate climates (after Bayley, 1991; Junk, 1999, quoted by Buijse A. D. et al., 2002).

In most riverine systems, hydrological connectivity between the Danube River and its floodplain is restricted to groundwater pathways; geomorphological dynamics are mostly absent.

This second principle, lateral connectivity, focuses on the goals of developing continuous. This is linked to an overall network of channels connections that extend the River's influence into adjacent neighborhood and provide ways for water

[1] www.lariverrmp.org

circulation in/out for wetlands. Further, the Lateral Connectivity system develops new linkages would be created that strengthen the connectivity between riparian systems along the Danube.

Goals of Lateral Connectivity consist in:

- create a continuous ecological corridor River Greenway, adjacent to the Danube River consisting of the extension wetlands into Neighborhood;

- connect Neighborhood to the Danube River.

Danube River's restoration and rehabilitation through Longitudinal Continuity

As a very long-term goal, its ecological and hydrological functioning can be restored through creation of a continuous riparian habitat corridor within hydro network of arms and channels and through removal of concrete walls where feasible. While completely restoring the Danube Valley to a naturalized conditions is not likely feasible, the restoration projects address to flood control requirements and river channel could be naturalized in significant areas.

Three goals complement the efforts to restore river functioning ecosystems:

- *enhance flood storage* - focuses on off- channel storage of peak floods flows in order to reduce flow velocities, which is a necessary precondition for ecosystem restoration;
- *enhance water quality* - seeks to improve the quality of water within implementation of a comprehensive, landscape-based system for filtering;
- *restore the ecosystems functions* - aims to restore the natural ecosystems affected by human activity and restoration of these ecosystems function.

Restaurarea şi reabilitarea Fluviului Dunărea prin Conectivitate Temporală

Temporal connectivity is determined by multi-rate fluctuations, affecting the types of connectivity: longitudinal, lateral and vertical.

Temporal connectivity means the degree to which different bodies of water are connected in time. Due to variations in volumes, two bodies of water - a main channel and an adjacent lake - can be isolated over the year, but become connected in a period of high discharge. Or, conversely, water can become isolated during periods of drought.

Creating oportunities and values

In the past, communities have turned their back on the River, viewing it as an unsafe, unpleasant place that primarily functions to transport flow and to form a waterway. Constant danger of floods and the desire to obtain land for urban development and economic activities insured against flooding works have led to extensive damming and draining eliminating large areas of floodplains affecting natural ecosystems. These works had negative consequences for local communities near the river who have lost identity and traditional occupations.

By restoring lateral connectivity will be created new opportunities for local riparian communities.

The study will identify these opportunities, how engaging residents in the community planning process and how:

- engage residents in the community planning process and consensus building;

- provide opportunities for educational and public facilities;

- cultural heritage of the river and foster civic pride.

Creating values

Core elements of this principle include the goal of improving the quality of life by providing new opportunities for traditional economic activities and jobs. River Revitalization can introduce a broad range of benefits that will enhance Danube Valley livability and result in greater economic prosperity. Goals encompass:

- improve the quality of life;
- increase employment;
- create an adequate territorial planning emphasis on protecting natural and cultural heritage, biological diversity and land use of renewable natural resources directly benefit of local communities.

Cele patru subclase de criterii menţionate mai sus au fost legate de măsurile preliminare de restaurare şi revitalizare din proiectul FORECAST (**F**acilitating the application of **O**utput from **RE**search and **CA**se **ST**udies on Ecological Responses to hydro-morphological degradation and rehabilitation), pentru a fi analizate în faza următoare *Evaluarea completă a proiectelor de revitalizare a Fluviului Dunărea şi pregătirea unui Manual cu cele mai bune practici de revitalizare a Fluviului Dunărea.*

Aceste măsuri sunt clasificate temporar conform cu Agenţia de Mediu din Anglia şi Ţara Galilor şi Planurile de Management ale Bazinelor Râurilor ţărilor reprezentate în proiect.

The above mentioned four criterion subclasses were related to the FORECAST project (**F**acilitating the application of **O**utput from **RE**search and **CA**se **ST**udies on Ecological Responses to hydro-morphological degradation and rehabilitation) preliminary restoration and revitalization measures (Figure 2), in order to be analyzed in the next phase *Comprehensive Danube River's Revitalization Assessment and preparation of the Best Practices Danube River's Revitalization Manual*. These measures are temporary classified according to the Environment Agency of England and Wales and River Basins Management Plans of the countries represented in the project.

Preliminary classification of measures after FORECAST project:

- to improve water flow quantity;
- to improve sediment flow quantity;
- to improve flow dynamics;
- to improve longitudinal connectivity;
- to improve river bed depth and width variation;
- to improve in-channel structure and substrate;
- to improve lateral connectivity;
- to improve riparian zones;
- to improve floodplains.

Criteria and General Model for Ecosystem Performance

The general model for ecosystem performance **(Figure 4)** provides the general direction with respect to structure and function that the ecosystem is expected to take on its trajectory toward meeting the project goal. Under a restoration scenario, the goal is to move the system from a degraded condition to one that is less degraded and more desirable. For management purposes, it is assumed that there is a positive relationship between the structure and function of an ecosystem. The natural structure of an system, habitat, or community has a corresponding functional condition, and to the extent that this is predictable, this information may be used to construct the ecosystem performance model.

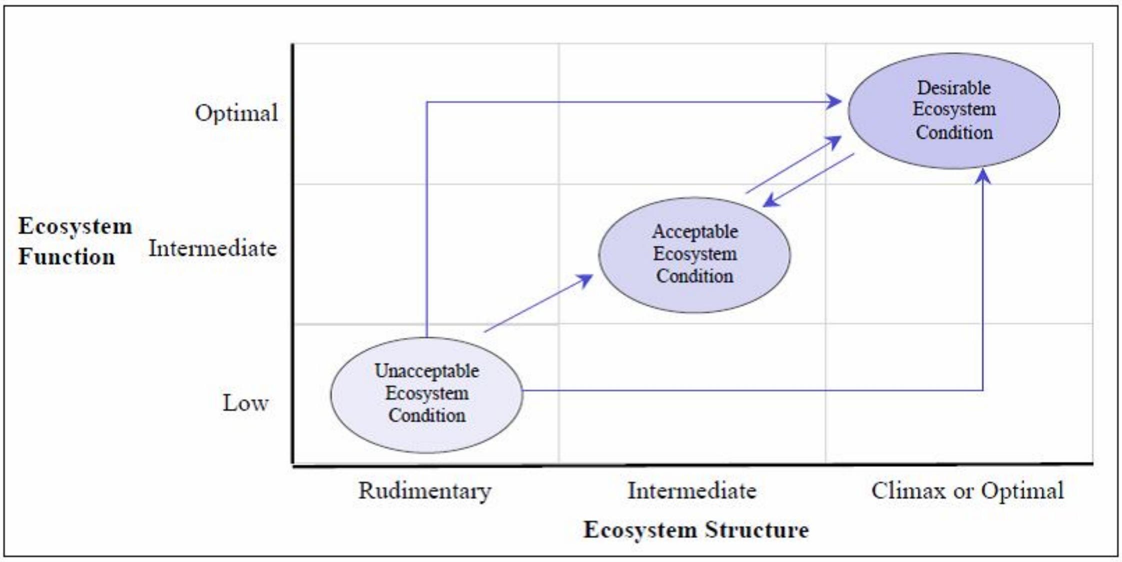


Figure 4 – General model of ecosystem performance. An ecosystem or habitat that is in rudimentary condition with low functioning develops into a system with optimal structure and functioning. Development can take several pathways, and can oscillate between system states (Thom R.M, 2004).

Figure 4 also indicates that a system may oscillate between states. This can be caused by stochastic processes such as human or natural disturbances, as well as stochastic climate related forcing. This dynamic may be more pronounced in some system types than in others. It is important to recognize that the system can move between different structural and functional states and still maintain its long-term integrity.

If stressors are removed, the natural recovery *(passive restoration)* of ecosystems will tend to take place regardless of human intervention, but this may take a very long time— decades or centuries. *Active restoration* essentially means that humans act beyond stress removal to reduce the period of time required to improve ecosystem conditions, through a combination of physical intervention and natural recovery. At the desirable ecosystem condition, the system is fully functional, has an optimal structure, is resilient to disturbances, and is self-maintaining. However, the definition of "optimal" must be made with care and with relevance to the system under investigation. In the case presented here, it is assumed that optimal conditions are met with a natural climax community that, because of its persistence, is resistant and maintains itself through the ability to buffer changes. The term "optimal" implies a human value, and the optimal state represents what humans (i.e., restoration planners) view as the "best" condition for the system.

II. DIAGNOSIS

Diagnosis is, according to Romanian Explanatory Dictionary (DEX), identifying a phenomenon based on the description of its current status or the summary of a state that distinguishes it from others or examination designed to detect errors in a program. In other words, the diagnosis, referring to the revitalization, is that preoces that establishes which are the elements that do not meet natural standards and should be restored to sustainable development.

Diagnosis can be achieved through several means, depending on the available data regarding both the subject area or system analysis. Further will be presented several methods for diagnosis methods that were used in different projects.

A first method is the one that was used in the project Ecological and Economic Resize of the of the Romanian Danube floodplain Sector (REELD), namely LEAC (Land and Ecosystem Acounting).

II.1 Methods used in diagnosis

II.1.1 Analyse through Land and Ecosistem Accounting (LEAC)

The first activity within the framework of LEAC analyse, representing “the study of existing system” trough quantitative and qualitative quantity standardized as stock raw accounts.

This activity comprise the establishment of general characteristics of analysed units, especially base function of ecosystems as productive units are able to auto sustain, total or partial, from energetic point of view and also base material resources.

The productivity and stability of ecosystems established of support capacity or possibility to ensure physique support, natural resources and services for socio/economical systems.

Analysed ecosystems as dynamic systems, unlinear and as productive units, which dynamic represent a long process where intern variability and diversity are essential priorities that ensuring the stability and the productivity.

This analyse not leave out the social and economical implications of wearing away of natural capital takes into account also socio-economical systems following the same principles.

The coherent understanding and the interpretation of complexity and dynamics of spatial-temporal interactions between human population and nature is possible through interdisciplinary integration in a frame theoretical model which permit the identification/ understanding of evolutional and adaptable transformations. From this view, could be admitted an unforeseeable component of dynamic of ecological systems. The theoretical arrangement regarding the character of functional and structural modifications is produced by 4 key- issue (Holling &Gunderson 2002):

1. Structural band functional modifications in ecological systems aren't continuously and gradually and even prevalent chaotic. They have an episodic character, with slow accumulation periods (for example physical structures, concentrate energy) conked out of sudden changes (release and reorganisation).

   The productivity and stability of ecosystems established of support capacity or possibility to ensure physique support, natural resources and services for socio/economical systems.
2. Spatial organisation of landscape is grouped and discontinuous are differing from connection and breaking up/apportionment point of view. It can differentiate functional categories of spatial scale, architecture (size, shape, connectivity) of components which are resulted throughout grouping and organisation of biotic an abiotic elements.
3. Ecological systems have an unlinear dynamic, among a complex of steady states circumcised of a stability domain in his turn dynamic. The unlinear character is given by processes as: reproduction, competition, energy flux, biogeochemical circuits of nutrients.
4. The policies and management systems which using restricts and immuable rules to ensuring of constant productions to ecological systems or economical systems, besides to take into account time and space scale, having as effect diminish of stability domain or resilience.

The package of norms and frame which LEAC **(Figure 5)** developed limiting it, is supplemented through evaluation of level and quality of ecosystems functions: a) productive, b) regulating, c) habitats for species of plants and animals, d) informational.

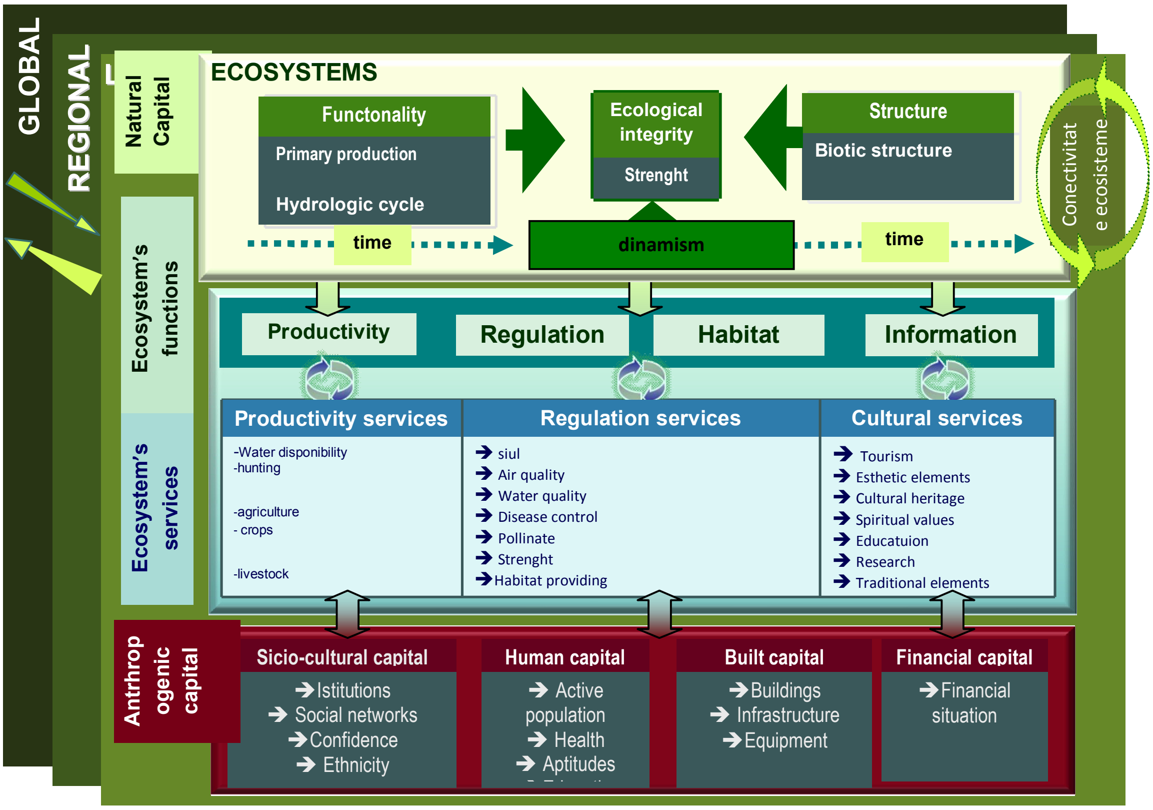


Figure 5 –LEAC methodology

The purpose of LEAC analyse is to reflect the dynamic of variables of state (functional and structural) and of control factors, through:

a. determination of indicators regarding the structure, the composition and operating of components of natural capital and socio- economical systems as well as indicators set hereby are appreciated the reports between CN and SEE or co-developing reports;

b. evaluation of impacts and ecological risk;

c. identification of tendency of structural and functional modification;

d. diagnosis of modification causes.

The LEAC methodology has the merit of starting the analyse from the existing information through a informational waterfall. This is actually a system for integration for diagnosis and for decision-making.

Starting form the Corine Land Cover maps, the LEAC information waterfall **(Figure 6)** includes the following stages:

1. Analyse of Stock Raw Accounts phisical stocks (qualitatively and quantitatively)
2. Analyse of Stock Diversity Accounts – dyversity of existing stocks
3. inventory of matter/energy flows
4. Assessement of ecosystems functionality
5. „Natural Capital acccounting

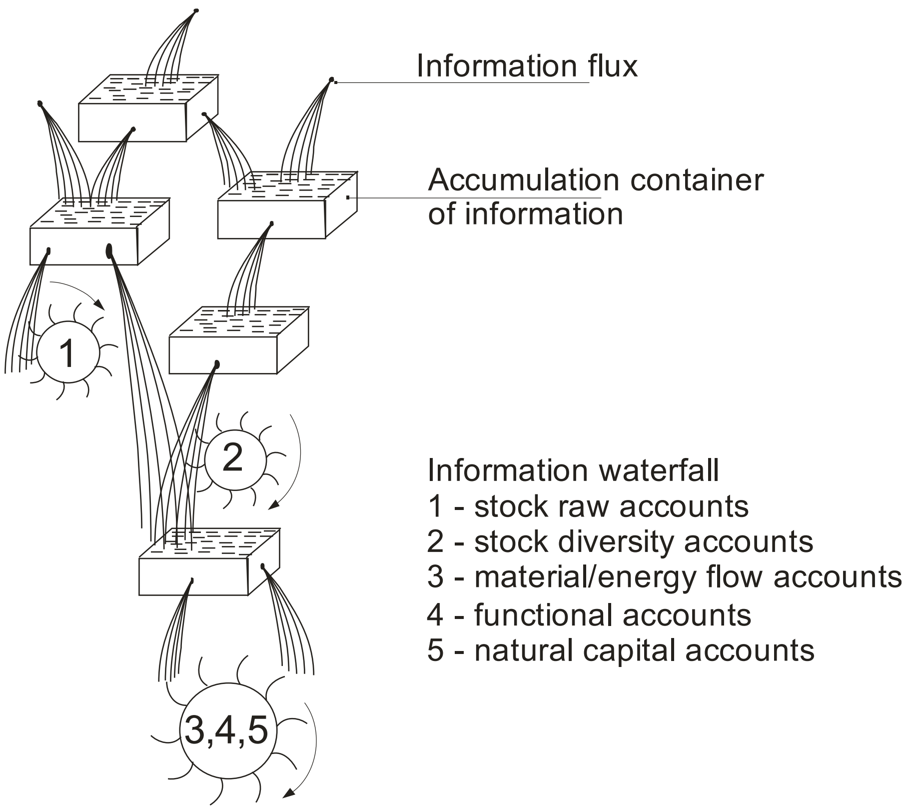


Figura 6 –LEAC information waterfall

The first activity within the framework of LEAC analyse, representing "the study of existing system" trough quantitative and qualitative quantity standardized as stock raw accounts. This activity comprise the establishment of general characteristics of analysed units, especially base function of ecosystems as productive units are able to auto sustain, total or partial, from energetic point of view and also base material resources.

Analysed ecosystems as dynamic systems, unlinear and as productive units, which dynamic represent a long process where intern variability and diversity are essential priorities that ensuring the stability and the productivity.

This analyse not leave out the social and economical implications of wearing away of natural capital takes into account also socio-economical systems following the same principles.

II.1.2 Analyse based on DPSIR indicators (Driving Force, Presure, State, Impact and Response)

European Agency of Environment based on DPSIR vision (Driving Force Pressure State Impact Response) has created an ensamble of rules and methodologies of analisis for diagnosing a system based on existing data, starting with Corine Land Cover, considering that each clasified unit represents the image and response to the pocess that take place in that unit – this ansembly was named Land and Ecosistem Accounting (LEAC).

The many technical aspects of the indicators, which refers to their definition and usage, selection criteria but also practical aspects, disponibility of using the data, quality and their collection, their usage in achieveing various objectives and at various analysis levels, tools of presentation and analysis and also the disemination ways of the collected data are extremely important in development of the LEAC metodological package developed by EEA.

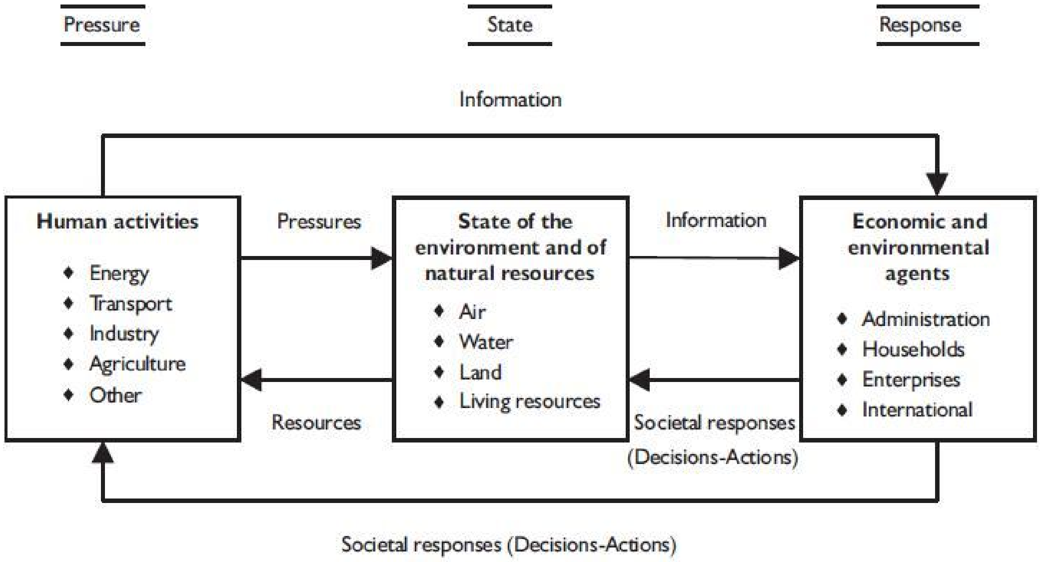
At a less detailed level, where inputs and outputs are either not relevant or not easily identified, the PSR framework is more useful. Instead of focusing on the different phases of a project, the PSR framework distinguishes between three different angles of environmental issues:

- The *pressure* variable describes human activities or aspects that exert pressures on the environment that is the underlying causes of a problem. The cause can be an already existing one or a new activity or investment. Examples of potential pressures include income growth, trade patterns and activities, energy use, and population growth.
- The *state* variable usually describes some physical measurable characteristic of the environment that results from the pressure. Examples include indicators that monitor aspects such as water quality, water availability, deforestation, soil erosion, andexistence and quality of habitats.
- The *response* variables measure to what degree society is responding to environmental changes and concerns, for example those policies, actions or

investments that are introduced to solve the problem. As responses to environmental problems they can affect the state either directly or indirectly.

In the latter case they aim to influence the pressures at work. Examples include water-pricing methods, the establishment of resource rents, the use of alternative crops, and reforestation programs.

The PSR framework (as depicted in Figure 7) is based on a concept of causality (OECD, 1994): human activities exert *pressures* on the environment and change its quality and the quantity of natural resources (the "*state*" box). Information about these changes reaches the decision-making instances in society, which respond through environmental, general economic and sectoral policies.



Source: OECD 1994.

Figure 7 - The Pressure-State-Response framework

These societal responses strive to result in a change of the human behavior, which in turn result in an improved state of the environment. While the PSR framework has the advantage of highlighting these links, it tends to suggest linear relationships in the human activityenvironment interaction. This should not obstruct the view of more complex relationships in ecosystems and in environment-economy interactions. (OECD, 1994) Another critique of the PSR framework is the missing reflection of how a degraded environment affects human welfare, that is, the pressure arrow between the "state" box and the "pressure" box could go in both ways.

The PSR framework has been developed further by various users. One such development, or change, is the use of *driving force* indicators instead of pressure indicators. The difference between these two indicator categories is their coverage. The advocates of the DSR framework claim that pressure indicators are best used for environmental issues only. Driving force indicators in comparison accommodate more for social, economic, and institutional aspects. In addition, 'driving forces' sounds more positive and can thus be used as explanations to both positive and negative impacts on sustainable development.

A second development of the PSR framework includes the addition of a fourth indicator category. Several organizations have therefore chosen to add an indicator category to the PSR framework. In the PSIR framework, the state indicators have the advantage to be able to solely focus on the physical measurable characteristics of the environment, on existing policies (such as water pricing policies), and on management practices used (for example soil management practices – do the farmers have leveled soils? Are the irrigation canals lined?). As such the state indicators explain what factors influence the pressures at work but they also illustrate the current state of the environment. The category of impact indicators is added in order to capture the effects the pressures may have on that state. These indicators would in the PSR framework be included in the category of state indicators, which may at times give less guidance when the step to decision-making, or responses, is taken.

Figure 8 depicts an operational cycle using the PSIR framework. The *pressures* at work affect the *state* of the environment resulting in a number of environmental *impacts*. For example, chemical use in agriculture may have an impact on the state of nearby water resources through excessive water pollution. This is both an impact on the environment per se, but could also risk having human health impacts. To mitigate the pressure, decision-makers need to have information about the underlying causes to the farmers' behavior (and thus the observed pressures and impacts).

Therefore, pricing policies for agro-chemicals, possible subsidies, and crop patterns, for example, need to be established with the help of state indicators to create a knowledge on which decisions can be based.

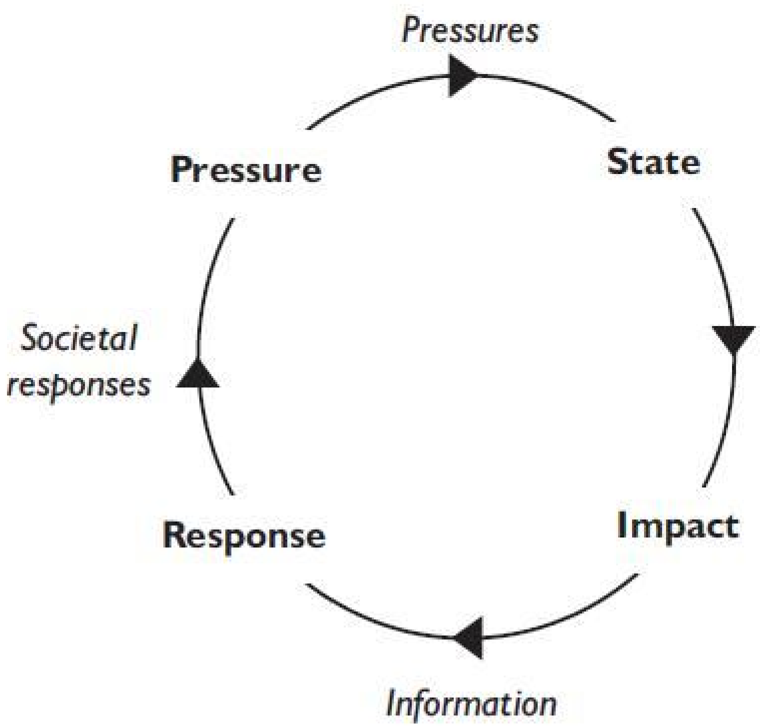


Figure 8 – Adding another category to the operational cycle . Impact indicators

Finally, the decisions made based on the information collected with the help of pressure, state and impact indicators need to be monitored. *Response* indicators can therefore be used to monitor three aspects of the societal responses: i) what policies or investments are introduced to reduce the pressure; ii) whether the mitigating measures proposed are implemented properly; and iii) whether the behavior of the involved actors and the activities exerting the pressures change as expected.

If no changes occur, or if the changes are unexpected, the project design and/or all of the indicators need to be revised. Maybe the assumed causal links are incorrect. The pressure and impact indicators then need to be revised, analyzing other plausible pressures within the area. Maybe there are other policies, management practices, or similar aspects (for example, cultural behavior) that are the explanation to the farmers' behavior, and maybe the responses need to be different to capture those aspects properly. The PSIR framework is flexible and yet complex enough to capture all of these issues. However, the critique of the PSR framework about it simplifying the relationships between the different parts of society is relevant for the PSIR framework as well. Box 2 gives examples of indicators for the water sector developed with the help of the PSIR framework.

The third, and final, development of the PSR framework is the presentation of all five indicator categories (driving force, pressure, state, impact, and response indicators) in one and the same framework, providing an overall mechanism for analyzing environmental problems.

- *Driving forces*, such as industry and transport produce… →
- *Pressures* on the environment, such as polluting emissions, which then degrade →
- *State* of the environment, which have an… →
- *Impact* on human health and eco-systems, causing society to… →
- *Respond* with various policy measures, such as regulations, information and taxes, which can be directed at any other part of the system.

The indicators selected were organized according to Major Areas, Themes and Sub-themes. The UNCSD says that "(t)he principal objective of creating a framework formed by Themes and Sub-themes that conceptualize sustainability is to support policy makers in their decision making at a national level." (UNCSD 2000)

Indicators of issues such as water use, water demand, hydroelectricity generation, water emissions (categorized as pressure variables), water availability and quality (categorized as state variables), population risk, effects on water (categorized as impact variables), water protection and water satisfaction (categorized as response variables) were suggested in **Tabel 1**:

		Detailed information	Aggregated information
Pressure	Indicators of use	Annual extraction per capita (m^3)	Water Vulnerability Index
		Annual extraction by sector (%)	
	Indicators of demand	Total demand (m^3)	
		Use efficiency (%)	
		Recycling potential (%)	
	Indicators of generation	Number of dams (no)	
		Kilowatts per hectare inundated (kW)	
		Hydroelectricity production (mW)	
	Indicators of emissions	N emissions (kg)	
		Other emissions (kg)	

State	Indicators of availability	Reserves (m^3)	Water Quality Index
		Rate of recharge ($m^3\ yr^{-1}$)	
		Annual rainfall (mm)	
		Annual extraction as % of total (%)	
	Indicators of quality	Biological oxygen demand(mg L^{-1})	
		Chemical oxygen demand (mg L^{-1})	
		Eutrophication	
		Acidification	
		Colibacilli (m L^{-1})	
Impact	Indicators of availability	People affected by diarrheic diseases (#)	Water Quality Index
		Population affected by inundation (#)	
		Toxicity/ Heavy metal concentration	
	Indicators of quality	Population risking inundations (no)	
		Capital risking inundations ($)	
Response	Indicators of effects	Watershed land use	Safe Water Index
		Watershed protected area	
	Indicators of risk	Access to potable water (%)	
		Access to drains (%)	
		Aqueducts (#)	
		Treatment of used waters (%)	
		Water price (US/m3)	

Table 1 – Indicators for water sector using PSIR framework

A feature of all of the frameworks discussed in this paper is that they enable the user to determine whether all concerns (whether they are impacts and pressures in general or related to specific themes) are being monitored and addressed. A framework based on sustainable development themes, such as the one used by UNCSD, can additionally facilitate the identification of core issues for sustainability.

For this reason, this framework is commonly used among organizations that work on a combination of aspects, such as the ones composing sustainable development. It is also common for initiatives at the international level where causal links between, for example, pressures and impacts can be difficult to determine. There are many more examples of initiatives that prefer to focus on themes rather than on categories of indicators. The Development Assistance Committee of the OECD (OECD/DAC) is one organization that used the same type of framework in its collaborative work on a set of indicators for the Millennium Development Goals for sustainable development.

To select a framework is the first step in working with indicators.

To select a framework is the first step in working with indicators. All frameworks however, need to have indicators identified for the respective categories, whether they are project phases, indicator categories, or environmental/sustainable development themes. The next section introduces a number of selection criteria – a methodological aspect that needs to be taken into account when working with indicators **(Table 2, Figure 9).**

Major Areas Themes Sub	*themes*	*Major Areas Themes Sub*
Social	Equity	Poverty
		Gender equality
	Health	Mortality
		Drinking water
	Education	Health care delivery
		Education level
		Literacy
	Housing	Living conditions
	Population	Population change
Environmental	Atmosphere	Climate change
		Air quality
	Land	Agriculture
		Forests
		Desertification
		Urbanization
	Ocean, seas and coasts	Coastal zone
		Fisheries
	Fresh-water	Water quantity
		Water quality
	Biodiversity	Ecosystem
		Species

Economic	Economic structure	Economic performance
		Trade
		Financial status
	Consumption and production patterns	Material consumption
		Energy use
		Waste generation and management
		Transportation
Institutional	Institutional framework	Strategic implementation of sustainable development
		International cooperation
		Information access
	Institutional capacity	Communication infrastructure
		Disaster preparedness and response

Table 2 - Major areas, themes, and sub-themes from the UNCSD initiative

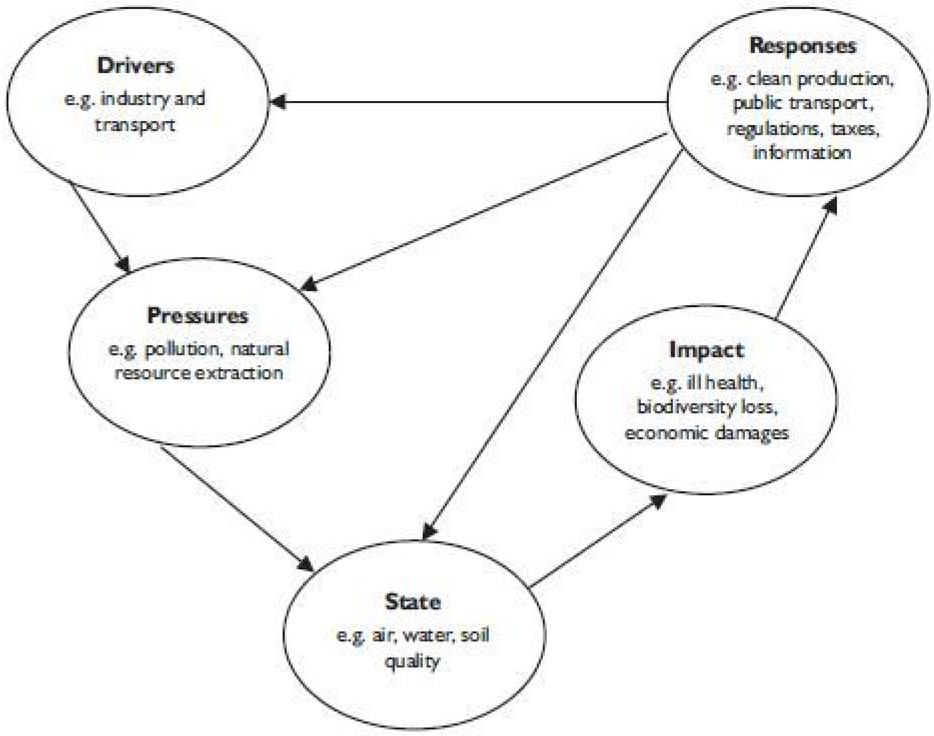


Figure 9 - The DPSIR framework

The purpose of the matrix was to provide the optimum indicators in order to apply the appropriate territorial Danube floodplain management and available means to protect natural capital, in the context of sustainable development.

This analyse not leave out the social and economical implications of wearing away of natural capital takes into account also socio-economical systems following the same principles.

Environmental degradation and natural capital should be seen as a ***synergistic effect*** that has its origins in the failure of the ecological balance of natural conditions.

Analysis of environmental degradation must lead us to a ***diagnosis*** that may be a preliminary step in formulating the environmental rehabilitation measures. Evolution of landscapes in the Danube Floodplain under anthropogenic pressure (forest exploitation, deep transformation of aquatic ecosystems and grasslands) will lead to obvious decrease in productivity, but also the disruption of functionality and productivity.

Identification of areas with ecological potential has a determinant role in the establishment of ecological restructuring measures and calculating environmental costs.

II.1.3. Multicriteria analysis

The NAIADE (Novel Approach to Imprecise Assessment and Decision Environments) MCA method developed by Munda (1995) was adopted for a study, as it offered the opportunity to mange the various types of data to address the multidimensionality of sustainable tourism. It also allows the analysis of actors and conflicts using an equity module. NAIADE is a discrete multi- criteria method whose impact (or evaluation) matrix may include crisp, stochastic or fuzzy measurements of the performance of a scenario (or an alternative option) with respect to an evaluation criterion (Munda, 1995).

In summary, NAIADE can provide the following information (i) ranking of the alternatives according to the set of evaluation criteria (including compromise solutions); (ii) indications of the semantic distance of the positions among the various interests groups (i.e. possibilities of convergence of interests or coalition formations); and (iii) rankings of the alternatives according to the actors' impacts or preferences. NAIADE has been widely implemented and compared to other MCA methods (Guitouni & Martel, 1998). Examples include (i) multistakeholder approaches to waste management in Surahammar, and (ii) snow management in Sundsvall and stormwater management in Vasastan, all in Sweden (Kain *et al.*, 2005). Others focussed on societal issues, such as (i) conflict resolution tool in land-use conflicts in Netherlands (Munda *et al.*, 1994) and (iii) an approach combining participation and institutions to address water management issues in Troina, Sicily (De Marchi *et al.*, 2004).

Implementation of NAIADE requires a number of steps:

a) Generation of alternatives:

To investigate tourism sustainability in the Seychelles, seven sustainability alternatives were devised, of which three incorporated adaptation to climate change scenarios, as summarised in **Table 3**. Final ranking with the NAIADE method results in the intersection of two ranking – the φ^{+} (a) which is based on the 'better and much better' preference relation and with a value going from 0 to 1 indicating how a is better than all of the alternatives suggested.

Secondly, φ^{-} (a) is based on the 'worse and much worse' preference relation with a value going from 0 to 1 indicating how (a) is 'worse' than all of other alternatives. The next step involves the identification of the evaluation criteria and construction of the impact matrix.

	Alternative	**Sustainability implications**
A	Business as Usual	Maintain status quo -discretionary approach to planning and development -no land-use plans -inadequate participation & conflict resolution mechanisms
B	Strong Conservation	Strong Sustainability perspective -increase protected area coverage (include outer islands) -invest economic revenue in maintaining high environment quality -maintain strict planning approaches -maintain command & control measures -precautionary approaches & limit to types/size of

C	Intensify economic & industrial activities	Weak Sustainability perspective -increase tourism development and density on most beaches & restrict public access -intensify tuna fisheries;
D	Moderate Conservation policy including multiple use areas and defined	Medium Strong Sustainability perspective -allow limited access to certain protected areas -implement fisheries rights and quota's -improve community involvement in decision-making -active conflict resolution framework in place
E	Alternative B + Adaptation to Climate Change	External effect on local sustainability -strengthen/invest in natural ecosystem resilience -undertake widespread rehabilitation of ecosystems -strengthen monitoring & reduce local impacts [illegible]
F	Alternative C +	External effect on local sustainability

Table 3 - Alternative options for sustainable tourism

b) Identification of evaluation criteria: Following discussions with various stakeholders and considering its relevance to sustainability, an agreed set of nine evaluation criteria was proposed. These criteria were evaluated based on environmental, economic and social applicability, as well as use of quantitative data and qualitative information gathered as part of these research and other research - Cesar *et al.* (2004), Payet (2003a), Payet *et al.* (2004a), Payet (2004b), and Payet (2005). The nine criteria are briefly described as follows:

The nine criteria are described as follows:

Environmental Criteria:

i. Conservation Area - Ecosystem loss due to land conversion is an important indicator of development levels. The issue of land conversion as a result of tourism development and associated activities is considered as part of this loss. Permanently lost habitats, such as forests and coral reefs will affect level of ecosystem services and resilience (Obura, 2005). Changes in land and use were determined using Geographical Information System (GIS) tools. Marine conservation areas were excluded from this criterion, as land area in small islands is usually proportionately very small to sea area.

ii. Tourism attractiveness – of the Seychelles is based upon the natural beauty of the island, its friendly people and personal security. This is an important criterion in addressing the issue of pollution and other damages related to the construction and operation of a hotel (Walker et *al.*, 1999). Climate change and severe beach erosion may also reduce the attractiveness of tourism areas. This is considered as a linguistic variable.

iii. Tourism intensity rate – encapsulates the overall pressure brought by tourism to the coastal zone. It is measured as tourist density in the coastal zone, according to Harrison (1992). It is computed as the number of visitors per capita and per square kilometre of total or arable land area.

Economic Criteria:

i. GDP – represents the total value of all goods and services produced by the economy in any given year. Most expenditure by tourists is regarded as consumption spending, and imports that are consumed by the tourist's results in leakage. Bull (1995:125) lists the factors that determines tourisms role in GDP. The data was obtained from the Seychelles Statistical Abstracts (MISD, 2004).

ii. Total Economic Value (Biodiversity) -the absolute value of ecological services, forests, protected areas and other plant and animal products.

iii. Recreational Benefits (coastal/marine) - This is calculated from welfare gains in terms of their consumer surplus (WTP), expenditures related to coastal and marine activities, indirect expenditures (travel & accommodation), and the multiplier effect on expenditures.

Social Criteria:

i. Precautionary Principle – Current thinking is clearly dominated by the 'wait-and-see' principle rather than the precautionary approach, which call for users to demonstrate that their actions are not harmful to the marine environment before they engage in any form of activity (Earl, 1992). This criterion also incorporates effective implementation of EIA tools and decision-making. This criterion is considered as a linguistic variable.

ii. Conflict resolution mechanisms – As a linguistic variable it is important to assess whether such alternatives will permit effective conflict resolution mechanisms. For example, is it considered that a strong conservation approach will actually engage in higher levels of conflicts that the other alternatives.

iii. Social inclusively (participation/involvement) - In terms of social equity and stake, participation of all concerned are measured by this criterion. The linguistic measurement aims to capture the participatory levels in implementation of the proposed alternatives.

II. 1. 4 Risk analysis

The risk analysis process requires planners to recognize and communicate the degree of uncertainty in each planning variable. The sharing of uncertainty information across a multidisciplinary planning team facilitates the identification of key variables affecting achievement of the planning objectives. The identification and inclusion of stakeholders further strengthens the knowledge base [7].

This process elevates risk management decisions from the sole province of the technical expert to the planning team and decision-makers.

Although the planning process is described in six distinct steps, in practice, these steps are iterative and often carried out simultaneously; the planning process is not linear. Planners and analysts work back and forth through the six steps until a comprehensive picture develops, which is communicated using the six steps as the reporting outline.

Risk analysis within this context has the same character. The approach for incorporating risk analysis into the project planning process provides direction intended to help the planner:

- Identify the levels of uncertainty that are acceptable, at the start of the planning process.
- Use conceptual and numerical models to communicate the planning team's understanding of the ecosystem to others, and reduce the risk of mis-specifying the system.
- Consider the uncertainty associated with the variables chosen to measure project effects.
- Use alternative designs to manage identified uncertainty.
- Use risk information to eliminate alternatives with unacceptable risk from consideration.

- Incorporate risk analysis into the USACE four criteria of effectiveness, efficiency, completeness, and acceptability.
- Use an alternative's irreducible uncertainty as an attribute to be considered along with other attributes in the comparison of alternative plans.
- Use risk information in the final plan selection process.

The proposed approach is applicable to ecosystem restoration planning. The framework is sufficiently flexible to be scaled to projects of any size or budget; the degree of specification and data-gathering can be tailored to the effort. The framework can be applied to studies of restoration, creation, reclamation, or protection alternatives.

This report makes simplifying assumptions to allow a focus on incorporating risk information in the planning and decision-making process. There are three other efforts associated with this framework document, which provide the technical detail needed to develop the necessary statistics. They offer information and guidance for incorporating risk assessment into cost-estimation, and biological and hydrologic modeling. The latter two have not yet been published. Three publications are available regarding costestimation:

Noble et al. [8] is a post-construction analysis comparing project expectations to outcomes, and Yoe's reports [9,10] provide guidance and demonstrate cost-estimation when there is uncertainty. The main idea is to evaluate the risks in each of the six stages of planning:

1) identifying problems and opportunities,
2) inventory and forecast,
3) plan formulation,
4) evaluation of plans,
5) comparison of alternatives,
6) plan selection.

The conceptual model is introduced in Planning Step 2, inventory and forecast. In Planning Step 3, plan formulation, habitat modeling methods are detailed. The fourth section is a brief conclusion, followed by Appendix A, which provides a fully developed example of a tidal wetland restoration planning process, demonstrating the application of the approach.

In ecosystem restoration, the federal objective is to "restore degraded significant ecosystem structure, function, and dynamic processes to a less degraded, more natural condition". This is further defined in USACE guidance, which states that "restored ecosystems should mimic, as closely as possible, conditions which would occur in the area in the absence of human changes to the landscape and hydrology. Indicators of success would include the presence of a large variety of native plants and animals, the ability of the area to sustain larger numbers of certain indicator species or more biologically desirable species, and the ability of the restored area to continue to function and produce the desired outputs with a minimum of continuing human intervention. In this report, a conceptual model of the site and landscape is advocated as a central organizing structure within the six-step process to achieve these objectives this is responsive to USACE directives that restoration projects be conceived in a systems context using an ecosystem and/or watershed approach. The incorporation of ecological tools and concepts into the USACE planning process for ecosystem restoration is evolving. The conceptual model delineates the empirical quantities to be addressed in risk analysis and modeling. Thus, this report describes an integration of concepts and tools from the science of ecological restoration with proven federal project planning processes. This integration, incorporating risk analysis into restoration planning, was called for by the USACE Evaluation of Environmental Investments Research Program (EEIRP).

II.1.5 Stakeholder analysis

In order to ensure an accurate representation of the local situation and the wishes of local people in relation to the revitalization of the river can be made a socio-anthropological rigorous investigation by specialists. The socio-anthropological survey mentioned above through specific methods (tree approach - from identifying the parties involved in order to implement the Focus Group method and / or semi-structured interviews) is not at the empirical level, but committed a theoretical point of view - a pragmatic approach on both the social and basic research regarding revitalisation.

From the previous projects experience*: Integrated Management of European Wetlands (IMEW), Master Plan for Master Plan - support for sustainable development in DDBR Tulcea county/ Romania Logical Framework Analyse (LFA), Ecological and Economical Resizing in Romanian Sector of Danube Floodplain (REELD), Room for* *the River in Cat's Bend, Romania,* DDNI specialists will provide a good sample of methodology for identification and analysis of stakeholders involved in flood risk management, from the following general objectives:

- To identify stakeholder institutions, to include local, regional, national and international bodies relevant to the flood risk management of each site;
- To identify the ways in which formal and informal institutions interact to affect the relationship between floods, land use and local communities;
- Assess the extent to which the management and use of resources acknowledge local needs.

Objectives 1 and 2 required the collection of empirical data from a wide selection of groups. Is necessary to adopt methodologies that are appropriate to each of the local sites and the results must to be comparable. It is important to better understand how attitudes and practices of different institutions to respond to the following questions:

1. How does the management of floodrisk and land-use acknowledge local needs?
2. How do local, regional, national and international bodies interact to affect the relationships between local communities, their livelihoods, land-use and floodrisk?
3. How does the management and spatial planning affect household livelihoods?

The objective of the first stage of the work was to identify both the formal and informal institutions that affect the management of the Galati site. This stage involved collecting data from formal institutions (including the laws and regulations associated with them) and the learned patterns of behaviour, norms and informal rules (informal institutional structures) that govern wetland site management. There are three aspects to this exploratory stage:

- identification
- relative significance to the interviewee
- relative power of the institution

Methodology. Must be carried out with key local informants from different social groups, and organisations identified by the interviewer, scientific and educational institutes, NGOs, environmental charities, local government and community organisations. Try to capture a broad range of people, e.g. of different ages, gender and different backgrounds. Also to make sure that was covered a wide enough geographical area to capture any variation.

The key question that we answered at this stage was: *''What organizations affect the risk management?''*

Rezults: The preliminary investigation will provide a list of stakeholders affecting the risk management**.**

Identifying the way in which formal and informal institutions affect the river revitalization.

In this stage must uncover the complexity of the management institutions affecting the proposed site. The empirical research was carried out with the stakeholders identified above. We saw this as falling roughly into two different groups of work:

- the formal institutions, the organizations or bodies that have an interest in this site, and the ways in which they govern the site. Much of the material to be collected from them will be written up in regulations, guidelines etc. and will be found by searching through archive and written resources. With this group the key to our understanding is determining how these written regulations are interpreted and applied in practice.
- informal aspects of the situation at the case study. In this case the same procedures apply as above. In this category you might find for example, established patterns of rights of ownership or use that are not recorded - these may change seasonally - , there may be systems that only come into being in times of crisis, such as a drought, low water level, there may be some things that women do and some things only men do.

The methodology used for this part of the research is based on one hand on literature, current legislation and on the other hand on focus groups or semi-structured interviews. It is important that you capture geographical spread and the variation within communities. We should aim to cover all the main stakeholder institutions and organizations.

For the smooth running of the survey is very important to conduct pilot interviews in each area. Data from these will be evaluated in terms of research objectives, and will note any problems that arise, such as: policy discussions, disagreements, contradictions, or what is irrelevant.

Also, all the difficulties and successes in carrying out work on practical aspects are reported. On this basis, the methodology will be adjusted and adapted. Thus, the research methodology used is improving, until satisfactory results are obtained. Although it seems time consuming, these methods are important for sociological research because it is one of the ways we can ensure the validity of results. In individual interviews with citizens will be designed a schematic overview of the issues explored during the interviews. This is a list of questions, but an "aide memoire" to help develop comprehensive interviews.

The results of interviews and focus groups will be analyzed using qualitative methods.

III. DIMENSIONS OF DOCUMENTATIONS AND ANALYSIS

III. 1 Spatial dimension

River revitalization approach must take into account the scale at which the process impact. So important are three levels to analyze the impact that has to be quantified rigorously, namely: the first level is the highest if the system is envisaged as a closed system is River Basin, next level is the regional level that includes several types of water and / or countries, and the third is the local level that has a much smaller expansion beeing limited to only a certain type of water in a single country.

III.1.1 River Basin Level

It represents the maximum scale at which can be adressed the Rhibe River as a closed system. Treating it as an open system the scale can be much wider reaching the continent level or even global scale. An example of a basin level approach will be presented below:

Rhine Integrated Plan

Prior to the 19th century, the River Rhine was still a wild river by and large untouched by man. Subsequent human intervention strongly altered the stream and resulted in a loss of floodplains. This increased the exposure to flood hazards. The first correction of the River Rhine was carried out between 1817 –1880 according to master plans by Johann Gottfried Tulla, engineer and lieutenant colonel in the former duchy of Baden. For this purpose, numerous channels of the river in the furcation zone were combined to form one main bed with a width of 200 m to 240 m, while the wide meander loops were cut through. As a result, the Rhine received a new riverbed which has essentially remained the same until today. The length of the Rhine section between Basle and Worms was reduced from 354 km to 273 km.

All in all, the correction of the Upper Rhine resulted in a major loss of natural wetlands and brought about a reduction in the frequency of floods in the areas bordering the river. The mere construction of the dam between Märkt near Basle and Karlsruhe entailed a floodplain loss of 660km2. The increased erosion of the Rhine in the South brought about the loss of another 80 km2 of floodplains.

Risk. The total damage resulting from a major flooding (1 in 200-year flood) in the Upper Rhine plain between Iffezheim and Bingen is estimated to amount to more than 6 billion euros. Moreover, it is expected that such an event will also result in human casualties.

The cause. Until the 70s prior to the construction of the dams on the Upper Rhine between Kembs and Iffezheim, the situation proved to be less dramatic. At that time, the number of natural floodplains along the southern section of the Upper Rhine was still sufficient, allowing the retention of water while reducing the river flood conveyance along the northern stretch of the Upper Rhine to an acceptable level.

With the construction of the dams, the floodplains were cut off from the natural discharge regime of the Rhine.

The solution. Raising the dams along the vulnerable section of the Upper Rhine beyond their current height must be ruled out in terms of a potential solution to the problem. Thus, the only feasible solution to attenuate critical flood peaks embraces the creation of floodplains. On the Upper Rhine, there is still a possibility of doing so in quite a number of areas. In former times, prior to the construction of the dams, these areas were always subject to inundation; today, they are mainly used for forestry purposes, with a small proportion set aside as farmland.

Therefore the main objective developed by the Integrated Rhine Programme (IRP) involves restoring natural hydrologic functions and ecological restoration of these forest and agricultural areas.

Implementation and sustainability of the plan. According to current estimates, the costs of implementing the plan amounts to 775 million euros, while the costs of losses because of floods rises to 6 billion euros plus a potential human losses. Besides the financial benefit there is a natural one, increasing the number of wetlands that are natural habitats that were once typical to Superior Rhine. Also the financial basis for the local population will be ensured, having as a results creation of opportunities and social and cultural values.

Rhine Integrated Plan (RIP). The goals pursued by the Integrated Rhine Programme include flood control as well as the preservation and/or restoration of theUpper Rhine plains. Following the example given by nature, today's floodplain protection is tomorrow's flood control. The Integrated Rhine Programme proposes the creation of flood retention areas at 13 sites located in the alluvial floodplains on the Baden-Württemberg side of the Rhine. Moreover, it aims at achieving the preservation and restoration of the alluvial floodplains on the Upper Rhine to the largest possible extent. According to the present framework concept pertaining to the Integrated Rhine Programme, this would require a retention volume of approximately 167.3m m3 on the Baden-Württemberg side of the Rhine. Essential elements for ensuring environment- friendly flood control are the preservation and creation of semi-natural floodplain biotopes.

The successful implementation of the Integrated Rhine Programme depends on a multitude of individual measures. Today, three out of a total of 13 planned IRP flood retention areas are completed. Two of them, the Altenheim Polder and the cultural weir near Kehl/Strasbourg have successfully operated for almost 20 years now. The Söllingen/Greffern Polder was brought to completion in 2005 and the Rheinschanzinsel retention area is under construction. Over the next years, further flood retention areas will be built. The Integrated Rhine Programme can only be implemented when all stakeholders join forces and take joint action. In the long run, these efforts will pay off. The Upper Rhine plain will benefit from the floodplain biotopes and their high level of species and structural diversity. At the same time, flood hazards are mitigated. The IRP is the prerequisite for the reduction of losses generated by extreme flood events along the Upper Rhine.

III.1.2 Regional Level

It is a very important level because gathers on the one hand some of the details of larger scale or local level on the other side. Most recent example of the River Danube's approach to such a level is the Ecological and Economical Resize of lower Danube floodplain, Romanian sector (REELD).

REELD ojectives:

- reconsideration of the activities from polders in accordance with cost/benefit ratio for investment and to maintain defense dykes and other hydrotechnical works;
- establishment of directional flooding regime at high levels;
- determining the regime of flooding in polders Bistreţ, Potelu, Suhaia, Greek, etc. Calarasi., for their renaturation and revitalisation.

Recent wetlands reductions are, mainly due to agricultural development through damming. This reduction takes place also through the drainage of land, or regularization of rivers (Barnard, WD et al., 1985).

Human activity affects the stability of a wetland by many mechanisms. One of these actions is deliberate intervention by improving drainage of agricultural land to extend the exploitation of peat for fuel. Such interventions have attracted public attention, especially by coverage of the danger of loss of habitat for many species that depend on the existence of these areas.

Yet little attention has been given to indirect impact of human activities on the stability of organic deposits by increasing the *Greenhouse Effect* (Dean, JV and Biesboer, DD 1985). The greenhouse effect leads to global warming and precipitation reducing. Reduced rainfall may seriously affect the stability of the peat deposits of wetlands by aerobically longer processes determined by lack of water layer. Microbiological and enzymatic degradation of the peat deposits lead rapidly releasing into the atmosphere of carbon dioxide, with direct effect on the growth of greenhouse effect and potential impact on global climate change.

For the Danube floodplain, hydrological factor characteristics change had the following consequences:

- Land is getting arid and soil salinization increasing;
- Reducing water exchange with the surrounding areas;
- Reducing habitats for birds;
- Changing major vegetation structure and composition;
- Blocking the movement of fish in neighboring areas to the site where they provide optimal breeding;
- Loss of organic matter by mineralization;
- Stop filtering role of sediments and nutrients, which came with floodwater.

Thus, in the given circumstances, the best option is to use strict wetlands policies on the Lower Danube Plain, followed by a well prepared monitoring system alert and a series of advanced tools for exploring the strategies and policies to address to detected threats. With increased effort exerted on the system and the complexity of the issues, the need for planning tools is changing rapidly.

With particular importance to planning issues are the following three aspects:
- Systems should be considered as a whole. So while a manager intervenes directly only in a limited part of the system, the consequences of these policies will send links to other parts of the system. It is possible that the problems facing the manager to have originated in actions that took place in other parts of the system to solve other problems simplistic.
- Second, human systems and natural systems are dynamic and constantly evolving but never in equilibrium. Therefore, managers intervene in system change in a certain critical point; the consequences of small interventions can be of great importance.
- The third aspect is that these systems are inherently spatial. The consequences of planning policies depend on the context of spatial planning that are implemented and how that changes the context.

Ecological and Economic Resizing Program for Romanian Sector of the Lower Danube floodplain will have to provide a spatial planning tool (IPS), developed in accordance with the three features, and built to design, analyze and evaluate long-term policies in a social, economic and environmental.

The main goal of IPS is to explore the effects of alternative policies on the quality of socio-economic and natural environment, and with this information to stimulate and facilitate conscious actions, discussions, before taking decisions (public debates).

IPS should not seek to optimize the economic, ecological and social, but rather to maximize the whole. Although this implies a loss of detail, the side benefit of this approach is strong integrative system resulting in autonomous processes play an important role.

Current policies and proposed actions perform against stakeholders on the free market and can be introduced into the IPS with the help of maps and zoning controls that behave like independent constraints on the autonomous dynamics of the system.

The main component of the IPS has to be a dynamic model of land use applied to the entire territory of the Lower Danube floodplain. To represent the processes that develop and change the layout of the Lower Danube floodplain requires a model to represent processes superimposed on three geographical levels: **national, regional and local levels**.

Regional development has become a major concern in the last decade of study for scientific research and debate for central and local authorities, the entrepreneurs and the public. Area - in support of human activities and natural capital - is objective and universal form of material existence, which looks like a continuous whole and express the real world order of coexistence. In the space-time, material movement takes place. In human existence, the space is defined as a dual meaning for the survival of biological condition, considering it as a resource that explains the role of the area played in human history, but also need psychological space is perceived as liberation from the constraints and dangers.

Anthropocentric perspective, examining space according to the cultural support - from experience, and relationships with others, people organize the space to suit their needs and social relations.

In the particular area - such is the case of wetland, spatial skills starts from the instinctive awareness of space, in a subjective way, giving well-defined value hierarchy. Spatial dimension is vital to support socio-economic system (SSE): apparently gives us space, mobility and experience. Chain of internal structures through cultural and political criteria, the geographic area physically creates quality geographic landscape - and the elements of surveying SSE urban integrated geographic area are directly related.

Natural Capital of the Lower Danube floodplain has a productive capacity to be known by its functional cells to prevent degradation, de-structuring under anthropogenic impact and promote sustainable use of its support capability. Ensure sustainable socio-economic development of the Lower Danube floodplain area is also based on knowledge ecological sustainability (durability) integrity of ecosystems, environmental carrying capacity, regional and local ecological balance of ecosystems.

Biological diversity, ecosystem function and naturality of the Lower Danube FloodPlain is a consequence of their evolution over time and of the succession of different "civilizations" that have disturbed the balance of the original environment.

The desire to understand the crisis of nature "is understandable for this geographic area, in which were defined separately the natural units. Lower Danube Plain, by its geographical position and its time history is an area with diversity in landscapes, ecosystems, beeing characterised by heterogenity, spatial and temporal dynamic of human. Space and habitat management, particularly in the Lower Danube floodplain requires finding ways and means of protection, conservation and social management of ecosystems and landscapes.

Recent evolution of Lower Danube Floodplain landscapes under anthropogenic pressure (natural resources exploitation, intensification of built land against natural ecosystems, the profound transformation of grasslands or aquatic ecosystems) leads to the obvious decrease in productivity, but also the disruption of their functionality and productivity.

Pan-European strategy for maintaining biodiversity and ecosystem functionality (Nowicki, 1996) has clear objectives, among which, for Romania and Danube Delta, awareness and participation of local communities (social management in our definition) should play a very important role.

In the taxonomic scale developed by Richard J. 1975 the ecological equipotential area corresponds to GEOTOP. Using analytical maps involves an initial assessment of the hierarchy of categories of environmental equipotential areas. After a correlation of these equipotential units with the land exploitation the following conclusions can be retained:

- Diversity of environmental types and subtypes requires temporal and spatial dynamics of equipotential ecological areas
- Changes in land use have modified the quality of environment equipotential units; in this regard were analyzed the areas with human intervention flooding (AP) forest by planting alien species in relation to the original vegetation

The landscape is defined as "portion of the space, characterized by a dynamic combination so unstable physical , biotic and anthropogenic elemnts which are reacting between them, forming territorial units-landcspes, which evolve as one, both under the effect of constituent components and under the dynamics effect of each separately "G. Bertrand (1968). The same author states that lanscapes's individuality is based on interaction between established three main components: the environmental potential 9ecological support), the biological exploitation (communities living organism) and the antropogenic (social work). They endure the dynamics of coomon geo-system physical expressed by a particular type of landscape.

Often, the dynamics of a component element may be different from al the dynamics and then, changing relationships between components, requires a new dynamic trend expressed by altering the landscape. Geo-systems may evolve between the three states defining: the biological exploitation (relationship between components imbalance caused by natural causes or anthropogenic), anthropogenic (imbalance relationship between constituents and the relationships among these having an artificial effect by anthropogenic activities) respectively ecological support (balance between relations support the operation of biological and ecological stability of morphology-structural components), they cause environmental degradation support and /or biological exploitation, effects are forwarding, then each other between all the components.

Was conducted a wide study of the Danube plains as well as on each of its natural units and were thus distinguished 13 areas, namely:

-Natural Unit Turnu Severin – Gruia
- Natural Unit II Gruia - Calafat
- Natural Unit III Calafat – Jiu
- Natural Unit IV Jiu – Corabia
- Natural Unit V Corabia – Olt
- Natural Unit VI Olt – Zimnicea
- Natural Unit VII Zimnicea – Pietrosani
- Natural Unit VIII Pietrosani – Giurgiu
- Natural Unit IX Giurgiu – Arges
- Natural Unit X Arges – Calarasi
- Natural Unit XI Calarasi – Harsova
- Natural Unit XII Ialomita – Siret
- Natural Unit XIII Siret – Ceatal Ismail

Analyses carried out allowed the identification of areas in biostazie (phase of stability in landscape evolution due to absence of erosion, where there is a vegetation layer) present all over the unbanked Danube floodplain; areas in rhehistazy that are represented by urban / rural areas; areas in parastazy (instability in landscape evolution due to erosion in the absence of a permanent vegetation layer) - characteristic for agriculture areas. The map made by the European

Environment Agency - CLC200, on land cover areas were identified three stages, as follows: 1-artificial territories are territories in rhexistazy, 2 - territories with agricultural use are in parastaziy 3 - Lands forests and semi-natural areas, 4 - Wetlands, 5 - water surface areas were considered in biostazy. Thus was created equipotential map of which areas were statistically analyzed.

III.1.3 Local level

Involves a small portion of Danuve or a a tributary of the Danube that is under investigation for possible ecological restoration and revitalization. They usually focus on a very small area or a very short stretch of the Danube River or its tributary. Further, revitalization projects will be presented which were conducted at the local level

- *The Danube restoration project between Neuburg und Ingolstadt (Germany)*

Projetc's summary:

The study area is the Danube River between Neuburg and Ingolstadt. Along the study area since the 19th century there were a lot of changes regarding the river course. In the 1970s two additional hydropower station (Bergheim in the west and Ingolstadt in the east) were built. Due to these changes occurred in the past, today typical floodplain habitats are highly endangered. In the last 150 years 75% of the Bavarian floodplain areas were lost due to human activities (after Margraf, 2004, quoted by Stammel, 2008). In the study area, however, 2100 ha of riparian forest and riparian habitats have survived as relicts of the former floodplain. (Stammel, 2008)

- *Bulgarian Wetland Restoration and Pollution Reduction Project (RIVER ENGINEERING) (Bulgaria)*

Projetc's summary:

MWH carried out the river engineering project for the restoration of Belene Island and the Kalimok/Brushlen wetlands on the Danube River for the Bulgarian Ministry of Environment and Water under a WB Financing.

The project assisted Bulgaria in meeting its international commitments in relation to the Strategic Partnership for reduction of nutrient pollution in the Danube and the Black Sea basins and the relevant requirements of the Convention for Protection of the Danube, the Convention for Protection of the Black Sea etc. All these activities are carried out in close cooperation with the local communities (Nikopol, Belene, Svishtov.Tutrakan, Slivo Pole), the Belene Island prison administration, RIEWs (Pleven, Veliko Tarnovo, Ruse), the Executive Environmental Agency, state forestry boards in Nikopol, Svishtov, Tutrakan and Ruse, scientific and academic institutions, non-governmental organizations etc.

➢ *The LIFE Project “Upper Drava-river valley” Austria*

Projetc’s summary:

The upper Drava in Carinthia in Austria is a typical Alpine river which hosts the last remnants of inner alpine floodplain forest associations and endangered species populations such as the Danube Salmon (*Hucho hucho*). The alder-ash floodplain forests are the best preserved and largest ones in the entire Alps. It is one of Austria’s largest rivers which have being preserved as a free-flowing river on over 60 km without any dams.

The main objective of the LIFE project was to maintain and improve natural flood protection and the river dynamic processes and therefore to improve natural habitats and typical species populations. This was achieved through restoring three ecological “core zones” by river bed widening and reconnection of the former side-arm system with the main river of over 7 km of its length. An additional focus lay in the restoration of the natural floodplain forests, the protection of endangered species and the creation of a combined biotope system along the whole river valley.

➢ *The LIFE Project „Wild river landscape of the Tyrolean Lech” Austria*

Projetc’s summary:

The Lech in northern Tyrol is characterised by huge gravel banks and broad areas of lowland riparian forest. It is the last major river in the northern Alps that is in a semi-natural state. For over 60 km, the highly braided river occupies a gravel bed that in parts is up to 100 m wide. The course of the river is constantly changing due to erosion and deposition.

The main objective of the LIFE project is to restore characteristic habitats of the Lech River by widening the riverbed of over 6 km of its length. In the widened sections about 35 ha of new gravel banks are going to be created which increases endangered species populations. At the same time the supply of gravel to the main river channel is being increased by gradually removing the debris dams in the tributaries. This would mean using the ecological approach for stopping further deepening or even raising of the riverbed. The project is being accompanied by species protection as well as visitor management measures.

- *Monitoring results of revitalization measures on an urban lowland River (Liesingbach, Vienna, Austria)*

Projetc's summary:

The Liesingbach, flowing through the south of Vienna, Austria, is an urban stream that has been designated as a heavily modified body mainly because the river was canalized, its bed was hard and the water quality poor due to considerable wastewater discharge. A study in 1999 before the restoration confirmed the poor ecological status in terms of hydromorphology, aquatic biocoenosis, riparian vegetation and water related terrestrial fauna. Until 2005, a 5.5 Km long reach close to the south-eastern city limit was revitalized with the intention to induce an ecological development by improving the hydromorphological conditions. However, the creation of a typical lowland river morphology was limited due to the difficulties in acquiring adjoining premises. The implementation of the European Water Framework Directive into national legislation gave rise to an interdisciplinary assessment of realistic development objectives for an urban river like the Liesingbach. Consecutively, the Liesingbach was classified as a heavily modified water body.

- *River Wien restoration project: improvement of the ecological condition of a heavily modified river in a urban environment (Austria)*

Project summary:

The Wien River has its source in the Vienna Woods, to the west of Vienna, Austria, at 620 m ASL. With a length of 32 Km and a catchments area of 230 sqKm, it is, beside the River Danube, the most important river passing through the city of Vienna. The catchments area mainly consists of flysch with a very low pore volume and a low water retention capacity. Rainfall therefore leads to high surface runoff and an immediate and strong rise of the discharge of the Wien River. For flood protection, the river was placed in a deep channel in the late 19th century and the river bottom was sealed with paving stones and concrete.

- *LIFE Nature Project Wachau of dry grasslands and Danube nase (Austria)*

Projetc's summary:

In the LIFE Nature Project these particular habitats are maintained by re moving bushes and mowing grass cover. Grazing with Waldschaf sheep prevents open spaces from becoming overgrown. The focal areas for dry grassland management are in the communities of Dürnstein, Rossatz-Arnsdorf, Spitz and Weissenkirchen. The Arbeitskreis Wachau group cleared and recreated over 50 hectares of overgrown dry grassland and meadow. Recurrent land management procedures were carried out on a further 100 acres.

The LIFE Nature project, in collaboration with the municipality of Mautern, has taken the semi-natural forest around the Ferdinand-Warte look-out point near Unterbergern out of utilisation. Forest protection areas covering almost 160 hectares have been established, in collaboration with the Rossatz agricultural association and the communities in Rossatz-Arnsdorf and Spitz. These untreated areas form the habitat for many endangered bird species such as the black stork, white-backed woodpecker, red-breasted flycatcher and many more. Old and deadwood are necessary for the survival of endangered beetles such as the Great Capricorn beetle and the stag beetle.

- *Lobau (Austria): reconnection at floodplain*

Projetc's summary:

The improved connectivity between water bodies at higher mean water levels in the floodplain has decreased the risk of massive eutrophication events, improved the water levels in small oxbows and some semi-aquatic areas, and conserved the existing species diversity in aquatic habitats (after e.g. Bondar-Kunze et al., 2009, Funk et al., 2009, Sommerwerk N. et al., 2010).

- *National Park Donau – Auen (Austria): side arm restoration and river bank restoration*

Projetc's summary:

To enhance riverine morphodynamics, several sidearms have been reconnected since 1995 (Rkm 1905.0-1906.5; 1905.2-1902.0; 1910.1-1906.5) and since 2005 river embankments and grayness have been removed from 2.85 kilometres (Danube Rkm 1885.75-1882.9) and from 1.2 km (Danube Rkm 1883.1-1881.9). The long-term goal of the project is to come as close as possible to the pre-regulation status of this Danube section. Implementation is by the Austrian Waterway Agency (via donau) and Danube Floodplain National Park subsidized by the EU LIFE-Programme.

➢ *Morava River (Slovakia and Austria): reconnection of meanders*

Within the project GEF-Biodiversity four cut-off meanders were partly reconnected to the river between 1993 and 1995 (Morava-Rkm 12, 19, 65). The aim was to increase the flow dynamics in the former anabranches. The bypass-canals stayed fully active, water inflow to the re-opened meanders was limited by rock dams.

➢ *LIFE05NAT/SK/000112 „Restoration of the Wetlands of Zahorie Lowland“ (WETREST) Slovakia*

The project area consists of eight wetlands – Sites of Community Importance that are located in the area between the district cities of Malacky and Senica (west Slovakia). Four of them – Rudava, Orlovské vŕšky, Meŝterova lúka and Kotlina – are situated within Zahorie Military District. Rudava is also designated as an internationally important wetland (Ramsar site) according to the Ramsar Convention.

➢ *Krapje Djol (Croatia): reflooding of oxbow*

During the implementation of the UN-World Bank SAVA 200 program the site suffered as its surroundings were drained in a polder, large flooded pastures were transferred to arable land and herbicides delivered by airplane directly over the colony. A ditch drained the water from the oxbow and the site dried out in 1989 (after Dezelic and Scheider-Jacoby, 1999, Sommerwerk N. et al., 2010).

➢ *Camenca river restoration (Moldova) – Lessons learned for river restoration in the eastern part of the Danube River Basin*

The Camenca River represents a heavily modified watercourse. The channel constructed in the 70s dried the wetlands from the lower part of the river and reduced the river discharge into the Prut river. The channel length is shorter with 7 Km than the natural course (50-60 Km length). Dried lands were used for agriculture purposes, and the surface covered by water was reduced up to 90 %. (Drumea, 2008).

➢ *Ecological Restoration in the Danube Delta Biosphere Reserve (Romania) – Babina and Cernovca islands*

The study areas are the islands of Babina and Cernovca situated in the north-east of the Danube Delta. The reason for dyking and drainage on the islands was the intention to transform swampland into arable soil. All typical and traditional forms of land use, including fishing and reed harvesting, were eliminated. Before they were dyked, both islands had a water network which regulated their hydrological balance. Due to embankments the vegetation of the islands was submitted to dramatic alterations.

- *Research for ecological restoration in the Dunavat-Dranov region, Danube Delta (Romania)*

The aquatic ecosystem of one of these former fish-ponds, namely Holbina II, was observed to change during the mid-nineties from a highly diverse mesotrophic state to one of turbidity with low natural value. The objective of this report is to summarize all research related to the ecological restoration of these fish-ponds, in particular Holbina II, conducted over the past decade. Based on this review, some recommendations have been formulated. Holbina II is, in common with the other fish-ponds, surrounded by a dike and almost isolated from Danube river water.

III.2 Typological dimension

Water typology. Given that the Danube River Basin covers an area of significant amount of the entire European continent, which determines the existence of a rich diversity in types (morphology) of river tributaries (regardless of their order), but the river itself requires a systematization of the research in question the river revitalization.

To gain first hand information on the reconstruction of the Danube River Basin areas or along the river should consider the following two aspects: first is the scale at which the ecological reconstruction taking into account the impact of it, and the second is the type (morphology) of the tributary or even the Danube River sector where renaturation occurs.

River morphology (at least for the European continent) is stipulated in an official document: the European Water Framework Directive.

III.2.1 Surface water. Characterisation of surface water body types

Member States shall identify the location and boundaries of bodies of surface water and shall carry out an initial characterisation of all such bodies in accordance with the following methodology. Member States may group surface water bodies together for the purposes of this initial characterisation

(i) The surface water bodies within the river basin district shall be identified as falling within either one of the following surface water categories . rivers, lakes, transitional waters or coastal waters . or as artificial surface water bodies or heavily modified surface water bodies.

(ii) For each surface water category, the relevant surface water bodies within the river basin district shall be differentiated according to type. These types are those defined using either system A. or system B.

(iii) If system A is used, the surface water bodies within the river basin district shall first be differentiated by the relevant ecoregions in accordance with the geographical areas identified in section 1.2 and shown on the relevant map in Annex XI. The water bodies within each ecoregion shall then be differentiated by surface water body types according to the descriptors set out in the tables for system A.

(iv) If system B is used, Member States must achieve at least the same degree of differentiation as would be achieved using system A. Accordingly, the surface water bodies within the river basin district shall be differentiated into types using the values for the obligatory descriptors and such optional descriptors, or combinations of descriptors, as are required to ensure that type specific biological reference conditions can be reliably derived.

(v) For artificial and heavily modified surface water bodies the differentiation shall be undertaken in accordance with the descriptors for whichever of the surface water categories most closely resembles the heavily modified or artificial water body concerned.

(vi) Member States shall submit to the Commission a map or maps (in a GIS format) of the geographical location of the types consistent with the degree of differentiation required under system

III.2.2. Ecoregions and surface water body types

III.2.2.1.Rivers

System A

Fixed typology Descriptors

Table 1: River typology, Sistem A, WFD (2000)

Indicator	Class		
1	Ecoregion		
		1	Based on latitude and longitude Ecoregions shown on map A in Annex XI
2	Altitude		
		1	high > 800 m
		2	Mid-altitude 200 - 800 m
		3	lowland < 200 m
3	Size typology based on catchment area		
		1	small: 10 - 100 km2
		2	medium: > 100 - 1000 km2
		3	large: > 1000 - 10000 km2
		4	Very large: > 10000 km2
4	Geology		
		1	Calcareous
		2	Siliceous
		3	Organic

System B

Alternative characterisation	Physical and chemical factors that determine the characteristics of the lake and hence the biological population structure and composition
1 Obligatory factors	
	1 altitude
	2 latitude
	3 longitude
	4 geology
	5 size
2 Optional factors	
	1 distance from river source
	2 energy of flow (function of flow and slope)
	3 mean water width
	4 mean water depth
	5 mean water slope
	6 form and shape of main river bed
	7 river discharge (flow) category
	8 valley shape
	9 transport of solids
	10 acid neutralising capacity
	11 mean substratum composition
	12 chloride
	13 air temperature range
	14 mean air temperature
	15 precipitation

III.2.2.2 Lakes

System A

Fixed typology Descriptors

Table 2: River typology, Sistem A, WFD (2000)

Indicator	Class		
1	Ecoregion		
		1	Based on latitude and longitude Ecoregions shown on map A in Annex XI
2	Depth typology based on mean depth		
		1	small < 3 m
		2	medium 3-15 m
		3	large> 15 m
3	Size typology based on surface area		
		1	small: 0,5-1 km^2
		2	medium: 1-10 km^2
		3	large: 10-100 km^2
		4	Very large: > 100 km2
4	Geology		
		1	Calcareous
		2	Siliceous
		3	Organic

System B

Alternative characterisation	Physical and chemical factors that determine the characteristics of the lake and hence the biological population structure and composition
1 Obligatory factors	
	1 altitude
	2 latitude
	3 longitude
	4 depth
	5 size
2 Optional factors	
	1 mean water depth
	2 lake shape
	3 residence time
	4 mean air temperature
	5 air temperature range
	6 mixing characteristics (e.g. monomictic, dimictic, polymictic)
	7 acid neutralising capacity
	8 background nutrient status
	9 mean substratum composition

III.2.3 Establishment of type-specific reference conditions for surface water body types

(i) For each surface water body type characterised in accordance with section 1.1, type-specific hydromorphological and physicochemical conditions shall be established representing the values of the hydromorphological and physicochemical quality elements specified in point 1.1 in Annex V for that surface water body type at high ecological status as defined in the relevant table in point 1.2 in Annex V. Type-specific biological reference conditions shall be established, representing the values of the biological quality elements specified in point 1.1 in Annex V for that surface water body type at high ecological status as defined in the relevant table in section 1.2 in Annex V.

(ii) In applying the procedures set out in this section to heavily modified or artificial surface water bodies references to high ecological status shall be construed as references to maximum ecological potential as defined in table 1.2.5 of Annex V. The values for maximum ecological potential for a water body shall be reviewed every six years.

(iii) Type-specific conditions for the purposes of points (i) and (ii) and type-specific biological reference conditions may be either spatially based or based on modelling, or may be derived using a combination of these methods. Where it is not possible to use these methods, Member States may use expert judgement to establish such conditions. In defining high ecological status in respect of concentrations of specific synthetic pollutants, the detection limits are those which can be achieved in accordance with the available techniques at the time when the type-specific conditions are to be established.

(iv) For spatially based type-specific biological reference conditions, Member States shall develop a reference network for each surface water body type. The network shall contain a sufficient number of sites of high status to provide a sufficient level of confidence about the values for the reference conditions, given the variability in the values of the quality elements corresponding to high ecological status for that surface water body type and the modelling techniques which are to be applied under paragraph (v).

(v) Type-specific biological reference conditions based on modelling may be derived using either predictive models or hindcasting methods. The methods shall use historical, palaeological and other available data and shall provide a sufficient level of confidence about the values for the reference conditions to ensure that the conditions so derived are consistent and valid for each surface water body type.

(vi) Where it is not possible to establish reliable type-specific reference conditions for a quality element in a surface water body type due to high degrees of natural variability in that element, not just as a result of seasonal variations, then that element may be excluded from the assessment of ecological status for that surface water type. In such circumstances Member States shall state the reasons for this exclusion in the river basin management plan.

III.2.4 Identification of Pressures

Member States shall collect and maintain information on the type and magnitude of the significant anthropogenic pressures to which the surface water bodies in each river basin district are liable to be subject, in particular the following.
Estimation and identification of significant point source pollution, in particular by substances listed in Annex VIII, from urban, industrial, agricultural and other installations and activities, based, inter alia, on information
gathered under:

(i) articles 15 and 17 of Directive 91/271/EEC;
(ii) articles 9 and 15 of Directive 96/61/EC (1) and for the purposes of the initial river basin management plan:
(iii) article 11 of Directive 76/464/EEC;

estimation and identification of significant diffuse source pollution, in particular by substances listed in Annex VIII, from urban, industrial, agricultural and other installations and activities; based, inter alia, on information gathered under:

(i) articles 3, 5 and 6 of Directive 91/676/EEC (4);
(ii) articles 7 and 17 of Directive 91/414/EEC;
(iii) directive 98/8/EC and for the purposes of the first river basin management plan:
(iv) directives 75/440/EEC, 76/160/EEC, 76/464/EEC, 78/659/EEC and 79/923/EEC.

estimation and identification of significant water abstraction for urban, industrial, agricultural and other uses, including seasonal variations and total annual demand, and of loss of water in distribution systems.

estimation and identification of the impact of significant water flow regulation, including water transfer and diversion, on overall flow characteristics and water balances.

identification of significant morphological alterations to water bodies estimation and identification of other significant anthropogenic impacts on the status of surface waters, including identification of the main urban, industrial and agricultural areas and where relevant, fisheries and forests

III.2.5 Assessment of Impact

Member States shall carry out an assessment of the susceptibility of the surface water status of bodies to the pressures identified above. Member States shall use the information collected above, and any other relevant information including existing environmental monitoring data, to carry out an assessment of the likelihood those surface waters bodies within the river basin district will fail to meet the environmental quality objectives set for the bodies under Article 4.

For those bodies identified as being at risk of failing the environmental quality objectives, further characterisation shall, where relevant, be carried out to optimise the design of both the monitoring programmes required under Article 8, and the programmes of measures required under Article 11.

III. 3 Thematic dimension

Manipulation of the phisical environment. Mining, overgrazing, deforestation, cultivation and soil compaction dramatically alter the physical environment of terretrial ecosystems. Among the more serious changes are damaged hydrologic processes (infiltration), accelerated erosion 9fluvial and eolian) and unfavourable miccro-environmental conditions (wind, temperature and relative humidity). These changes inhibit both processes and our ability to direct succesional development with ecological restoration. Properly functioning ecosystems have natural recovery processes that maintain sustainable flows of soil, nutrients, water and organis materials. During degradation, positive feedback mechanisms reinforce and accelerate damaging processes (**Figure 10**) leading to irreversible vegetation change once a site's capacity for self-repairing has been exceeded. Contemporary suvccession theory describes this catastrophic change as having crossed a transition threshold that inhibits natural recovery. Designing restoration strategies that overcome threshold barriers to natural recovery processes is one of the more important challenges for ecological restoration. That requires an understanding of treatment strategies that reduce threshold barrier effects. Two types of thresholds barriers limit the natural recovery of damaged ecosystems. It is important to distinguish between the two, because they require different restoration approaches. The first is controlled by interference from the other organisms, ususally invasive weeds or other plants that prevent natural recovery. Reducing problematic species 9selective plant removal with herbicides, fire, mechanical, or hand treatements) and/or adding appropriate species are the most effective strategies for these circumstances. The second barrier oparates when dysfunctional hydrologic processes create abyotic limitations to recovery. After identifying limiting features of the phisycal environmnet, we can design restoration strategies that jumps-start the ecosystem's self-repairing mechanisms. Two aspects of the phisycal environment are most relevant to ecological restoration: physical controls over resource fluxes and physical controls over micro-environmental conditions.

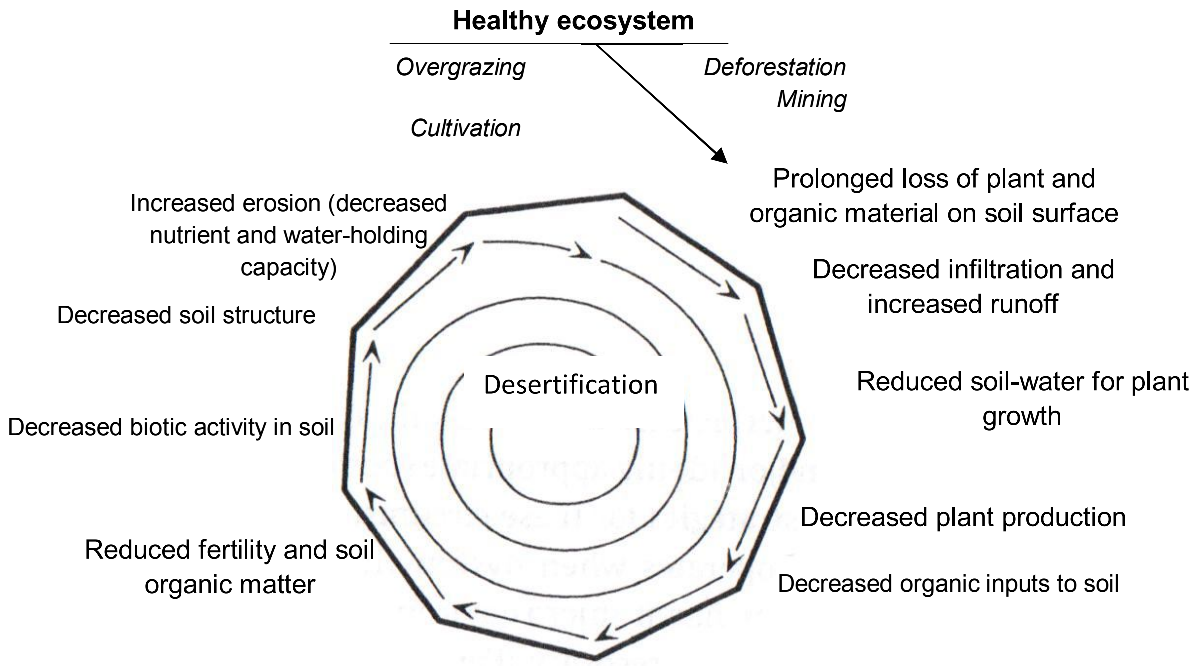


Figure 10 – Soil degradation cycle (after Martin R. Perrow)

Manipulation of the biota. The reconstruction of an approapriate plant communisty is a sine qua non for the restoration of any degraded ecosystem. Clearly, the plant communities of any ecosystem have an element of intrinsic distinctiveness that represents the biodiversity of the system. Furthermore, attempts to restore most other aspects of ecosystem structure and function cannot suceed, partially or wholly, without the authentic primary producers. The phyical structure and chemical composition of the stands of plants that are establishes, combined with the specificity of many trophic relationships, strongly influence the potential for restoration of animal and microbial communities. For the purpose of restoration, land-form and the proprietes of the soil environment are determinants of plant communities in two senses.They are integrated attributes of succesional status that are part of the functional specification of any target ecosystems and hence the vegetation it can support. The staring point for the restoration of plant communities must be the restoration of phisycal and soil environments apppropriate to them, or their succesional precursors. Even where highly satisfactory emulations of a desired pfysico-chemical environment can be achieved, it will usually be necessary to introduce populations of desired plant species, to regulate their relative abundance and to remove or discourage unwanted, invasice species. Such manipulations may become the mainstay of restoration when the initial disturbance is primarly the result of the removal of crucial species or of invasion by alien species.

III. 4. Progressive development of tree problems (Logical Framework Analyse) and the SketchMatch method for scanrios and possible renaturation measures

III.4.1 Progressive development of tree problems. In time, favorability and restrictiveness factors have played an important role in changing by damage or loss of geographical landscape components in the Danube River (abiotic, biotic, factors arising from local connection with the natural life, ethnic identity elements or religious life). Information about existing problems came from a variety of sources including semi-structured interviews, ethnographic agenda, local media and specialized literature.

Problem analysis was conducted to create the conceptual model of human intervention in the geographic landscape of the Danube River, starting from identifying key factors that have a modifier role and their effect as shown in the problem tree. Tree problems show the problems in a hierarchical order. First will be identified causes and effects, then they will be summed and placed in a wider range, then building the tree as follows:

— what are the causes are at the bottom of the tree;

— what are the effects are at the top of the tree.

III.4.2 Metoda SketchMatch (SM)

An interactive planning method, developed by the Government Service for Land and Water Management in the Netherlands.

The sketch match is a method that is used to identify and visualise potential development paths and so facilitate the decision-making process for managers, policymakers and local stakeholders. It is an intensive process that organisations and other interested parties can use in their own development areas.

The SketchMatch is a workshop method and works as a 'creative pressure cooker'. During a minimum of 1 to a maximum of 3 days, a group of stakeholders involved in projects described above come together to analyze, define and find out the best practices regarding Danube River Revitalisation.

The strength of this method is that these analyses are done collectively.

A SketchMatch is facilitated by a process supervisor and one or more project's evaluation specialists, who visualize the status of the projects, problems and solutions by sketching them out on maps. Various disciplines come together in a SketchMatch: spatial design, GIS, ecology, hydrology, hydraulics, cost estimation etc., depending on the nature of the project and issues involved.

Organising a sketch match involves a substantial investment. The working hours that specialists would usually spend on a project over the course of a longer time period are now condensed into a few days. Experience has shown that this accelerates the planning process immediately. It energises the client and the residents of the area and gives them a sense of community and shared responsibility. A sketch match can create the momentum a project needs to really take off, or the impetus required to overcome a deadlock.

However, to have this effect a sketch match must meet a number of conditions regarding:

a) Definition

The definition must clearly identify the parameters of the problem(s) to be addressed. In other words: the assignment or problem must be clearly defined.

b) Drafting and visualising

A sketch match is only useful if design and visualisation will genuinely be of help in identifying potential new development paths and solutions for the issues that need to be addressed. A sketch match can prove to be useful at any stage of the planning and implementation process, as long as choices need to be made concerning spatial planning in a well defined specific area.

c) Results

Drafts must always be produced; calculations are optional. Whenever there are doubts about the financial and economical feasibility of a project the costs of different solutions can be calculated immediately. The result of a Sketch Match is a spatial design, in the form of a manual, guideline, map, book, visual story, model, or whatever form suits the project best.

Focus groups and semi-structured interviews

There will be organized within each category of subgroups defined by basic principles of revitalization focus groups. Two researchers must attend every focus group.

Making a larger number of groups allows drafting of behavioral trends for categories of subjects interviewed.

a) Not all Focus groups are the same. The interviews will not be exactly the same in each location. It is very important that the results from different locations are comparable, and the most important thing is to ensure that, however Focus groups are arranged.

b) *The number of partcipants at Focus group.* In terms of numbers, the ideal number is 5-7 participants. Participants in the discussion will have time to make their views known about Danube River ecological restoration.

c) *The Focus groups structures (homogeneous or heterogeneous groups).* An important decision is whether to mix people up in group's interviews, or have organized separate groups on the criterion of gender, age. Heterogeneous groups are useful for hearing differences of opinion, and understanding how conflicts are negotiated and resolved. However, where there are power differentials between groups, some people may be afraid to say what they really think.

d) Duration of a interview group. Duration of a interview group shall be determined according to what should be investigated, and the needs of individuals / institutions concerned.

e) Instruments used in the Focus groups. In order to make best use analysis, the investigator shall have different work techniques with applicability to Focus groups.

Semi-Structured Interviews

The purpose of these interviews is to deepen some interesting issues that arise during the focus groups.

a) *Recruiting people.* The ideal place for the selection of subjects for individual interviews is during the group interview in order to analyze certain aspects relevant to the discussion group.

b) Location is as important as focus groups. It may use the interviewee for a walk outside to stimulate him to answer questions.

c) Recording the interview. The researcher's interviews/observations will be recording on tape or noted in reseracher's notes book after the free decision of the subjects and transcribed and processed for analysis. The interviews will be carried from the interview guide that explains the main criteria and sub-criteria to be addressed throughout the interview.

d) *Questions.* These will vary from one interviewee to another, depending on the person being discussed and the problems of group interview. Use your local knowledge to modify and add to this list.

Begin the conversation by asking your interviewee a few things about themselves. Anyway you need to know something about the person for the information gained in the interview to be useful.

A general point is to be over prepared rather than under prepared. It doesn't matter if you do not get around to asking all of the questions. Individual interviews should be preceded by pilot interviews. It is necessary to record the information provided by the interviewee and how the interview went, because the methodology can be improved further. This is done by keeping a permanent contact with the coordinator, and that results are comparable between different areas of study.

IV. LESSONS FOR BEST PRACTICES

The facts that we intend to address are often very challenging. Degraded land areas are rising. Some systems are severely degraded and their reconstruction costs will highly increase. Moreover, people still use many of these degraded systems. It will not succeed in fully eradicating the causes of degradation in these circumstances, but there are enough conclusive results from a variety of case studies to be optimistic. These results clarify that ecological restoration will be key not only for conservation but sustainable development also.

Experience accumulated over time in terms of restoration, reconstruction and environmental rehabilitation, all united under a single term, namely: revitalization. For the present project will be taken to exemplify several actions and activities that have been made in the revitalization projects along the River Danube and the Danube Basin based on questionnaires completed by project partners (Annex 1).

Nb.	**Name of the project**	**Restoration measures**
1	*Initial solution to the issue of renaturation of the Morava River in the section Tvrdonice - Devin , Slovacia*	- reconnection of side arms has led to changes in river flow solid, - the simple reconnection upstream arm is not sufficiently,
2	*Restoration of steep river banks as nesting bird habitats , Slovacia*	- main threat to this habitats was fortification of Danube river banks on the majority of the Slovak Danube section. - Removing the embankment,s determined the Sandmartins to visit this place almost immediately
3	*Activation of the Danube floodplain between Neuburg and Ingolstadt, Germania*	- a permanent flow of water passing the hydroelectric plant ensuring longitudinal continuity - through the detour channel are controlled the floods - detour channel provides, in summer,

		groundwater levels at an optimum level for the floodplain forest.
4	*Sidearm restoration project Schönau Austria*	- Embankment at Danube river banks was locally lowered to get more inflow into the side arms - Check-dams were adjusted with bridges to increase throughflow (2 times);
5	*Sidearm restoration project Orth, Austria*	Embankment at Danube river banks was locally removed to get more inflow into the side arms (3 places); - Check-dams were adjusted with culverts - Check-dams were removed
6	*Sidearm restoration project Haslau, Austria*	Sidearms have been disconnected from Danube during river regulation; Sidearms are cut into smaller stretches by check-dams;
7	*River bank restoration project Witzelsdorf (Austria)*	- Embankment at Danube river banks was removed or lowered for 1,3 km of banks - positive effects in terms of flood protection - mitigation of river bed erosion
8	*River bank restoration project Thurnhaufen (Austria)*	- positive effects in terms of flood protection - mitigation of river bed erosion - Embankment at Danube river banks was removed or lowered for 3 km of banks; - groynes were removed or lowered (7 times)

IV.1 Multicriterial analyse

Within this activity was developed a matrix of multicriterial indicators grouped on 4 main assessment criteria as follows: **Stakeholder success, Ecological success, Learning success, River system. E**ach indicator must receive a value between 1 and 5 corresponding to success level achieved by each restoration project: value 1 represents the most unsuccessful result and value 5 is given to the most successful result.

Stakeholder success reflects human satisfaction with restoration outcome, whereas learning success reflects advances in scientific knowledge and management practices that will benefit future restoration action.

Ecological success

1. Guiding image exists evaluation standards should follow the principles below:

i. Ecological integrity. Because of strong interference from human activities, it is not possible to restore urban water ecosystems to the pristine state. Ecological restoration should be based on achieving the greatest natural state for the specific region, in reference to its natural state, with the relative ecological integrity as the target. The health of the ecosystem may not be the original ecosystem, but it must be a relatively complete ecosystem.

ii. Management categories. In this paper, the evaluation standard is divided into 3 levels ''healthy, critical state, unhealthy''.

iii. Objective integrity. Danube River Valley is a complex of ecosystems, and should meet the flood control objectives, landscape function, and achieve a harmonious water–human relationship.

iv. Spatial distribution. Within the context of integrated river basin ecosystem theory, the evaluation of the ecological restoration sites should consider the characteristics of the different spatial components and the differences of environmental problems in each area, including differences between upstream and downstream locations and different ecosystem service function.

2. Ecological improvement. Ecologically successful restoration will induce measurable changes in physicochemical and biological components of the target river or stream that move towards the agreed upon guiding image.

3. Self sustaining

The ecosystem is self-sustaining. It has the potential to persist indefinitely under existing environmental conditions. Aspects of its biodiversity, structure and functioning will change as part of normal ecosystem development, and may fluctuate in response to normal periodic stress and occasional disturbance events of greater consequence. As in any intact ecosystem, the species composition and other attributes of a restored ecosystem may evolve as environmental conditions change.

Ecologically successful river restoration creates hydrological, geomorphologic and ecological conditions that allow the restored river to be a resilient self-sustainable system, one that has the capacity for recovery from rapid change and stress (Holling 1973; Walker *et al* . 2002, cited by Palmer, 2005). Natural river ecosystems are both self-sustaining and dynamic, with large variability resulting from natural disturbances.

4. No lasting harm is done

In the last century, Aldo Leopold (1948) , cited by Palmer, 2005, stated that the first 'rule' of restoration should be to do no harm. Restoration is an intervention that causes impacts to the system, which may be extreme (e.g. channel reconfigurations). Even in such situations, an ecologically successful restoration minimizes the long-term impacts to the river. For example, a channel modification project should minimize loss of native vegetation during in river reconstruction activity, and should avoid the fish-spawning season for construction work. Indeed, removal of any native riparian vegetation should be avoided unless absolutely necessary. Additionally, restoration should be planned so that it does not degrade other restoration activities being carried out in the vicinity (e.g. by leading to permanent increases in the downstream transport of sediments that are outside the historical range of sediment flux).

5. Ecological assessment is completed- pre and post project assessment is conducted and the information made available

Ecological success in a restoration project cannot be declared in the absence of clear project objectives from the start and subsequent evaluation of their achievement (Dahm *et al* . 1995). Both positive and negative outcomes of projects must be shared regionally, nationally and internationally (Nienhuis & Gulati 2002, cited by Palmer, 2005).

Learning success

The circumstances that we seek to address are often very challenging. The areas of degraded land now present in various parts of the world are large. Some systems are severely degraded and will be costly to repair. Further, people are still using many of these degraded systems and many of these people are poor. We may not succeed in fully eradicating the causes of degradation in these circumstances but there is sufficient evidence from a variety of case studies for us to be optimistic. This evidence makes it clear that ecological restoration will be a key element not only of conservation but also for sustainable development worldwide.

River system it is about the river connectivity (lateral, longitudinal & temporal).

Further more, the matrix developed was applied on each identified project in previous phazes in order to stress out its eficacity **(Table 4, 5**).

Assessemnt Criteria		Project Identification Number (ID) and values															
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Stakeholder success	Aesthetics	5	5	5	4	3	2	3	4	4	5	4	3	5	4	5	4
	Economic benefits	-	3	3	-	-	4	-	4	-	5	-	-	-	-	4	4
	Tourism and recreation	3	5	5	3	3	-	-	4	4	5	-	4	5	-	3	5
	Education	5	4	4	3	4	-	-	4	4	4	-	5	4	4	5	3
	Traditional activities renew	-	3	3	-	-	-	-	4	-	-	-	-	-	-	5	5
	Health	-	3	3	-	-	5	-	-	-	-	-	-	-	-	3	2
	Governance	4	4	4	4	3	4	3	3	-	5	2	5	4	2	5	5
	Security – Flood risk management	-	3	3	-	4	-	-	-	-	5	2	-	-	-	3	-
Ecological success	Guiding image exists	-	5	5	-	3	3	-	4	4	5	2	4	4	4	5	5
	Ecological improvements	-	5	5	-	3	3	3	5	4	4	2	4	4	4	5	4
	Self sustaining	-	5	5	-	-	-	5	5	4	4	1	4	4	3	5	4
	No lasting harm done	4	4	4	4	1	1	4	3	4	5	1	4	2	4	5	4
	Assessment completed	5	3	3	4	4	5	4	4	4	5	4	4	3	4	5	5
Learning success	Scientific contribution	4	4	4	3	-	2	3	3	4	4	3	3	3	3	5	5
	Management experience	4	4	4	4	-	3	-	5	4	4	2	5	4	3	5	5
	Improve methods	5	3	3	4	-	1	2	3	4	3	2	4	3	2	4	4
River system	Lateral connectivity	5	3	3	4	3	-	-	4	5	5	2	4	3	3	5	3
	Longitudinal connectivity	-	-	-	-	-	-	-	-	-	4	2	-	2	-	-	-
	Temporal connectivity	-	5	5	-	3	-	3	4	4	4	1	4	2	3	4	4
T O T A L (max. 95 p.)		**44**	**71**	**71**	**37**	**34**	**33**	**30**	**63**	**53**	**76**	**30**	**57**	**52**	**43**	**81**	**71**

Table 4 – Assessemnt criteria Matrix (the "-"means lack of information)

No. Crt.	Project name	Subclasses
1	The Danube restoration project between Neuburg und Ingolstadt (Germany)	River restoration Capture Community Opportunities
2	Bulgarian Wetland Restoration and Pollution Reduction Project (RIVER ENGINEERING) (Bulgaria)	River restoration
3	Extension of the existing Belene Islands Complex Ramsar Site Bulgaria	Create Value
4	The LIFE Project "Upper Drava-river valley" Austria	River restoration Create Value
5	The LIFE Project „Wild river landscape of the Tyrolean Lech" Austria	River restoration Create Value
6	Monitoring results of revitalization measures on an urban lowland River (Liesingbach, Vienna, Austria)	Capture Community Opportunities
7	River Wien restoration project: improvement of the ecological condition of a heavily modified river in a urban environment (Austria)	Capture Community Opportunities
8	LIFE Nature Project Wachau of dry grasslands and Danube nase (Austria)	River restoration
9	Lobau (Austria): reconnection of floodplains	River restoration
10	National Park Donau – Auen (Austria): side arm restoration and river bank restoration	River restoration
11	Morava River (Slovakia and Austria): reconnection of meanders	River restoration
12	LIFE05NAT/SK/000112 „Restoration of the Wetlands of Zahorie Lowland" (WETREST) Slovakia	Create Value
13	Krapje Djol (Croatia): reflooding of oxbow	River restoration
14	Camenca river restoration (Moldova) – Lessons learned for river restoration in the eastern part of the Danube River Basin	River restoration
15	Ecological Restoration in the Danube Delta Biosphere Reserve (Romania) – Babina and Cernovca islands	Capture Community Opportunities River restoration
16	Research for ecological restoration in the Dunavat-Dranov region, Danube Delta (Romania)	Capture Community Opportunities River restoration

Table 5– Link between projects and the 4 clases of revitalization identified

V. GUIDE OF MANAGEMENT MEASURES

In this report we present a guide managemnt measures to achieve a balance of functions (production, habitat for plant and animal species, regulation and control, information) and structure (species, associations, communities) of actual ecosystems through work of revitalisation in the Danube Floodplain.

In practice, the beneficiaries of these sensitive areas like the Danube Fllodplain have difficulties regarding the management of the areas, especially in agricultural and fishery polders, which were created for specific purposes altering / deteriorating the balance of the individual components of the system. Thus many such areas are often unused because of fragmentation of the energy flow between components of the socio-ecological.complex.

The first activity from the guide (**Figure 11**) is **the primary decision-making unit** on the existing system by standardized qualitative and quantitative assessments of ecosystem functions and their structure.

This includes the general characteristics of the observation unit, particularly on the basic functions of ecosystems. As is well known, productivity and stability of ecosystems is in direct relation with their support ability to provide physical support for the use of natural resources and provide socio-economic services.

Analysis of ecosystems as dynamic systems, nonlinear and as productive units, is a long term proccess whose variability and diversity are essential fo rthe stability and productivity of the unit.

This analyse not leave out the social and economical implications of wearing away of natural capital takes into account also socio-economical systems following the same principles.

The coherent understanding and the interpretation of complexity and dynamics of spatial-temporal interactions between human population and nature is possible through interdisciplinary integration in a frame theoretical model which permit the identification/ understanding of evolutional and adaptable transformations. From this view, could be admitted an unforeseeable component of dynamic of ecological systems. The theoretical arrangement regarding the character of functional and structural modifications is produced by 4 key- issue (Holling &Gunderson 2002):

1. Structural band functional modifications in ecological systems aren't continuously and gradually and even prevalent chaotic. They have an episodic character, with slow accumulation periods (for example physical structures,

concentrate energy) conked out of sudden changes (release and reorganisation).

The productivity and stability of ecosystems established of support capacity or possibility to ensure physique support, natural resources and services for socio/economical systems.

2. Spatial organisation of landscape is grouped and discontinuous are differing from connection and breaking up/apportionment point of view. It can differentiate functional categories of spatial scale, architecture (size, shape, connectivity) of components which are resulted throughout grouping and organisation of biotic an abiotic elements.

3. Ecological systems have an unlinear dynamic, among a complex of steady states circumcised of a stability domain in his turn dynamic. The unlinear character is given by processes as: reproduction, competition, energy flux, biogeochemical circuits of nutrients.

The intern or extern instability forces chime in assuring, creating and maintenance of diversity stability (durability) and opportunities of answer, and stabilizer forces have an importance to maintenance of fundamental ecological process: energy flux, recycling of nutrients, respectively
to ensuring the level of productivity.

4. The policies and management systems which using restricts and immuable rules to ensuring of constant productions to ecological systems or economical systems, besides to take into account time and space scale, having as effect diminish of stability domain or resilience.

This block is thought to supplement through evaluation of level and quality of ecosystems functions: a) productive, b) regulating, c) habitats for species of plants and animals, d) informational.

The purpose of this analyse is to reflect the dynamic of variables of state (functional and structural) and of control factors, through:

e) determination of indicators regarding the structure, the composition and operating of components of natural capital and socio- economical systems as well as indicators set hereby are appreciated the reports between CN and SEE or co-developing reports;

f) evaluation of impacts and ecological risk;

g) identification of tendency of structural and functional modification;

h) diagnosis of modification causes.

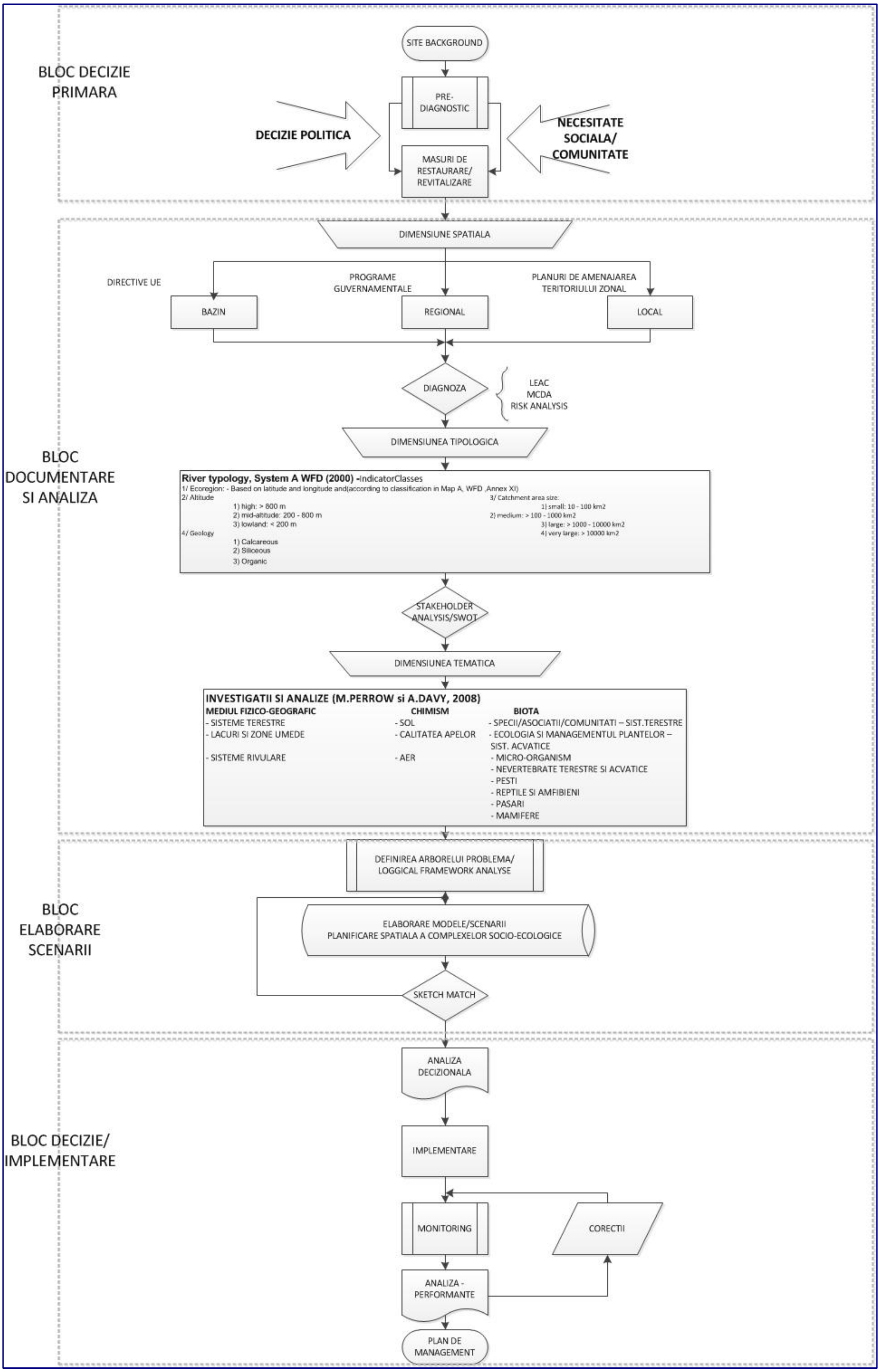
This block is meant to start the process of developing the functional and stochastic models and scenarios based on existing information through an information cascade. In fact, it is an integration system for both diagnosis and for decision-making.

It is important to point out that the final evaluation from the **final decision and implementation block** should take into account the financial aspect, the economic analysis type, and cost-benefit.

This assessment framework is very useful in areas of comparative assessment of natural and economic use. A general assessment of Services flow provided by the system must take into account its dynamics.

The revitalised system will be monitored both in the implementation but particularly after the implementation phase. In block implementation were mentioned works for correction, when the evolution of the system does not correspond with the foressen one.

The final phase of such a project should lead to inclusion in the list of protected areas and realise a management plan for it.



Figuea 11 – The structure of measurement guide

VI RELATION BETWEEN THE DANUBE PARKS NETWORK AND REVITALISATION PARKS

The overall objectives of the Danube Parks network of protected areas must take into account the following aspects:

- maintaining the biodiversity of Europe, for example ensuring the ecological coherence and connectivity of the Natura 2000 network (Article 10 of the Habitats Directive);
- protection and restoration of valuable natural ecosystems to a more general level that they can continue to provide valuable services to humanity.

In this context, the subject of revitalization areas can contribute and even support the Danube Parks network , for example, to help expand the size of protected areas, increase the areas of food, breeding or rest for the species and to to assist in the migration / dispersion process.

The Danube Parks network can be developed through:

- Improve connectivity between existing natural areas to counter fragmentation and enhance their ecological coherence,
- Greater permeability of the landscape to support species dispersal, migration and movement, for example using land in a favorable for fauna and flora or introducing agricultural or forestry environmental schemes that support extensive agricultural practices
- Identification of multifunctional areas. In such areas, compatible land use that supports healthy ecosystems is favored against destructive practices.

In practice, one of the most effective ways of achieving these principles is adopting a more integrated approach to land management at three levels: local, regional, watershed. This in turn is best achieved through a Spatial Planning, which allows investigation of spatial interactions between different components.

Spatial planning is also a way to bring together different economical sectors for them to decide on local / regional / basin priorities of land use in a transparent, integrated and cooperative way. Spatial planning can guide the development of infrastructure outside sensitive sites, thus reducing the risk of further fragmentation of habitats

It also can find ways to reconnect the natural remaining areas, or even encouraging habitat restoration projects in areas strategically important, or incorporating elements of continuity / connectivity in the new eco-development schemes.

VI.1 Spatial planning approach in river basin

It is considered that a unified approach to river basin has its advantages over other approaches, where revitalization is addressed in an integrated manner, including coordination and coherence between mitigation and adaptation and policies.

There are several reasons why spatial planning should be in the river basin. Among them:

- water management can contribute to improving processes (eg, hydropower) and the processes of adaptation (eg water retention);
- a holistic approach stimulates cross-disciplinary research and develop improved policies;
- Currently there are no dichotomy in mitigation and adaptation processes: planning practices will determine, whether relevant, the integrated responses between mitigation and adaptation
- The river basin approach allows to assess possible synergies, compromises and adaptation measures to improve the water catchment area in an integrated manner
- Most indicators of impact measures could be monitored at the catchment scale, which would allow more effective assessment

Improvement and adaptation strategies can be more easily integrated spatial planning process.

Of course, some disclaimers may be made. First of all, changing the traditional way is not something that can be modified easily and takes time.

Moreover, there remains a mismatch between the basin approach and other socio-economic processes that has to be reconciled. In order to fully use the response capabilities for both mitigation and adaptation measures should be included socio-economic processes (such as technological development, development of knowledge and, perhaps most importantly, economic development).

VI.2 The concept of Integrated Regional Ecological Network in the National Ecological Network and European international initiatives

Protection and conservation of biodiversity is central to nature conservation strategies worldwide. It became apparent that one of the key elements to ensure a healthy environment for future generations is to maintain a high level of ecological biodiversity. Even in protected areas, species disappear. Experts realize that our knowledge on the dynamics involved in the protection of nature, gives us new opportunities to improve how we organize nature protection.

One of the key events in establishing new trends has been the United Nations Rio Convention on Biological Diversity (1994 Rio de Janeiro). Over 160 countries have signed the Convention, which aims to preserve biodiversity, encourage sustainable use and equitable sharing of benefits from the use of genetic resources. Convention is built on a number of previous regulations and conventions, as a Ramsar Convention (1971) on Wetlands of International Importance, CITES (1973) Convention on International Trade in Endangered Species of Wild Flora and Fauna, and Bern (1979) Convention on Conservation of Natural Habitats and Wild from Europe.

Rio Convention (1992) gave a new impetus for international activities. It coincided with the Habitats Directive, Council Directive 92/43/EEC on the conservation of natural habitats and wild flora and fauna. Habitats Directive is the most important EU instrument for nature protection, and anticipates the preparation and establishment of sites of Community Importance for inclusion in Natura 2000, a network of representative habitats.

Due to EU membership, countries should harmonize their legislation, which in the environment sector is particularly affected by the Habitats Directive. Was mentioned the European Natura 2000 network, which have been associated with other countries. Should also mention that EMERALD Network tends to be implement Berne Convention (1979). Bern Convention Habitats Directive (1992) follows the same objectives, which hich tend to conserve wild flora and fauna, natural habitats. The EMERALD concerns Europe and parts of Africa. Both initiatives, however, are closely coordinated and not overlapping.

In 1995 the Ministerial Conference "Environment for Europe"in Sofia has identified the requirements for a "Strategy for Pan-European Biodiversity and Landscape Diversity", including several action plans. The first plan of action is to establish a pan-European ecological network. Based on sharing information and coordinating initiative, the strategy addresses to all the existing measures and identify any additional actions required.

The concept of ecological networks

Nature conservation was based on protecting sites. were identified Areas with a particular ecological interest and human intervention was limited. Protected areas that resulted were often isolated in a desert, surrounded by vast hostile territories (intensive agriculture, cone constructed, and monocultures). Worse, protected areas were often designed (selected) not by their ecological value, but because of their reduced ecological value. Habitats that have become isolated can not maintain the original species richness unless they are connected to similar habitats elsewhere. Clearly, many factors influence the resilience of species in protected areas.

The effects of isolation will be offset by the size of the protected area, the original size and species diversity. Potential accidental migrations will depend on the distance between areas inhabited by certain species, and may have beneficial effects (maintaining biodiversity) or harmful (invasive species competition). Ecological networks tend to increase the possibility of migration through the corridors.

Spatial coherence

Ecological principles have now evolved to include landscapes. "Island Biogeography" and "Metapopulation" theories introduce spatial "coherence" in nature conservation strategies and planning organization. The idea that supports ecological networks is that populations can migrate from an inhabited area (whether protected or not) to another. The result would be an increase of energy flow, migration and genetic adaptation to local conditions. When resources are scarce in an area, populations can migrate to avoid failing. Furthermore, migration can "complete" certain gaps in abandoned sites.

As it may be observed, the concept of ecological networks is based on the introduction of coherent spatial structures. The Core Areas, corridors, buffer areas and areas of ecological restoration are essential to ecological networks. Designing a complete network will include each of these support elements. As the classical principles of nature conservation, using different levels of protection is associated with ecological networks. To allow multiple use of the network - avoiding unnecessary or excessive restrictions - the level of protection will be adapted to local needs. This will vary from strict protection (restrictions for recreational use, for example.) to partial limitation for economic uses.

The core areas are areas that contain unique landscapes and habitats, with special ecological value. Preserving these characteristics contributes to biodiversity protection. The level of protection of this areas should be most intense, because they are home to those items that have the greatest need of protection.

The corridors are essentially characterized by migration, dispersal, genetic exchange and energy flow. They make the connection between the various core areas allowing these exchanges, and decreasing isolation and "island" situations.

Buffer areas surround a specific interest areas (usually areas with full protection) in order to reduce or buffer the negative impact from the outside. Limitations on certain economic or recreational activities in buffer areas prevent affecting the core areas.

Ecologival restoration areas may be important for the global design of the ntwork or may present a high environmental and ecological potential. We have shown above that only the least favorable sites, dry and nutrient-poor tend to be left for the implementation of conservation projects while the most interesting areas from ecological point of view are generally used for agriculture. Reconstruction supports the return to nature of high biodiversity areas with significant landscape value.

Design a network may seem simple in theory, but it is a very complex task because often need to combine conflicting interests. Different species do not always have the same needs, and may be required for priority setting and a combination of goals.

Selection and identification of ecological network components is a complex process based on a comprehensive view of natural and human activities. In this process must be collected and analyzed a large amount of data. Tools as maps of forestry, land, biota, water quality, biodiversity monitoring data must be used to provide the basis for a coherent network. EU CORINE Biodiversity and CORINE Land Cover initiatives are very valuable tools for such purposes.

Stages of an ecological network

The first step to achieve ecological networks would be to define areas of a certain importance. This activity depends on the criteria and careful analysis of the data. At this stage, one must try to balance the various modes of land use, based on priorities.

Policymakers should first be able to identify landscape elements that define a certain corridor, and then to understand how individuals and local populations respond to it. The effectiveness of a corridor regarding the mobility of species that occur can not be easily defined when it includes a wide variety of organisms (large and small mammals, insects, small birds). The presence of individuals of other species such as predators that could influence the migration and survival of target species is another example of the complications that arise when it comes to networking.

However, once all information is gathered, priorities and criteria defined are defined and analysed can expect to design a network, at least on paper. The next step is a very simple procedure and requires making sure that all items are enjoying a level of protection required. This includes defining the exact extension of the area, ensuring that they are all available for protection (eg. some may be privately owned) and to obtain all necessary local support.

VI.3 National and european ecological network

European Ecological Network (EECONET) started to develop at the initiative of the Netherlands- Institute for European Environmental Policy, which developed the concept of ecological network in 1991. This concept has expressed the idea of an integrative and dynamic protection of species and organisms related with their environment and rely on identifying the most significant ecosystems as 'fully protected areas'. It also includes protection of 'green corridors', promoting the migration and dispersal of living organisms and, naturale'semnificative development areas particularly in terms of functional ecological network and its individual subsystems (Bennett, 1991).

The idea of European ecological network (EECONET) recommends to be included and unprotected areas that have not so far been protected by law significant for EECONET dynamic and also requires the protection of ecological corridors within the meaning of the corridors of European importance, national or regional .

EECONET emphasizes the importance of interconnection fragmented and diffuse biotopes, with ecosystems in the landscape with econoomic use, significantly changed or disturbed. EECONET can also play an important role in reducing the consequences of global warming; many species are endangered, if they do not have new habitats and routes to areas with suitable climatic conditions .

Creating European Ecological Network is now focused on two levels:

a. EECONET –European ecological network is a network of fully protected areas and other important elements in terms of biodiversity and ecosystems, at European level,
b. NECONET –National Ecological Network is a network of fully protected areas and other major national importance, in some cases at the multinational level.

At the international conference in Maastricht "Towards a European Ecological Network by protecting the natural heritage" in 1993, was defined EECONET as an effective pan-European framework for a more effective nature conservation in Europe. Components EECONET concept became a full European biodiversity conservation strategies. Integrated in NECONET concept, the regional ecological networks will develop on specific physical and geographical units, consisting of fully protected areas, ecological corridors and areas of ecological restoration in anthropogenically disturbed areas.

There have been declared the main strategic goals of biodiversity conservation at a conference in Maastricht, and formulated the conclusions, as follows (Bennett, 1994):

a. protect and restore all key ecosystems and all important species of European importance
b. management of high nature value areas (including biodiversity) by means of professional managers and extensive agriculture, forestry and fisheries sustainability.
c. restoring natural processes with minimal interference with human activities across Europe;
d. increase quality of the farm areas as a whole, including coastal areas for conservation of all ecosystem’s conditions.
e. accept the principle of sustainability as the main principle for decision and action plans.

f. strengthen a broad public support for nature protection and enhance biological and landscape diversity in farm areas;
g. all European nations to contribute to a sustainable living.

EECONET support existing international systems of territorial conservation and facilitate the construction of a coherent European ecological network (including full protection areas) representing all types of habitats. This network will support effective ways to conserve species and fragile ecosystems, transboundary conservation areas with high natural value, conservation of migratory routes identified. The result must also be shifting the emphasis on nature conservation policies of the species to habitat, from sites to ecosystems, from regional measures to national and even international measures (Bennett, 1991).

At national and internationallevel the ecological network has been proposed so far in the Netherlands and Spain. Similar concepts have been applied in the Czech Republic and Slovakia, however, still not including pan-European criteria more widely accepted.

EECONET basic concept – dutch experience

In 1990 the Dutch government and parliament accepted the National Strategy for the conservation of nature - the nature Plan of decision-making - NPP, in which EECONET was an essential component. Netherlands ECONET idea appeared in 1987, and its preparation took four (4) years. Choosing the key species was based on:

1. their international significance (including IUCN list or western Palearctic species of which at least ¼ nest in the Netherlands), the negative trend - a significant withdrawal of the species at national scale (50% decline in the number of World War II, 25% decline in bird species)
2. rarity – national level (their distribution less than ¼ of the area, or species of birds, more than 12,500 breeding pairs).

On the list of tracked species were included the following taxonomic groups: plants, mammals, birds, reptiles, amphibians, fish, butterflies, dragonflies and other and others, together representing about 700 species.

Criteria for selection of core areas (Bennett, 1991):

a. fully protected areas are typical habitats, characterizing each biogeographical region
b. they are characterized by natural ecological processes (protection of areas with substantial representation of the original ecosystems)
c. they are characterized by a high degree of biodiversity (conservation areas with a high genetic diversity, high diversitu of species and ecosystems)
d. are characterized by an abundance of endemic species and critically endangered (conservation of endemic species, endangered, rare,
e. are particularly significant for migration or dispersal of species (both nationally and at European level)

In addition, the minimum size criterion was applied to the full protection areas of national and international fixed at 500 hectares (1,000 ha for forest). However, for unique or significant areas in particular, have been included even smaller areas. There have also been taken into account other functions of the protected areas as support function for agriculture, forestry, fishery, and their synergistic impact on the value area (Bennett 1991, Lammens 1994).

Selection criteria for ecological corridors (Opschor, 1993):

a. size of connected coreareas (to be connected to each other);
b. distance from other equivalent habitat types;
c. nature corridor, size and presence of barriers;
d. corridor anthropogenic pressure (urbanization, agriculture);
e. the degree of degradation of the corridor
f. . where necessary, taking into account the possible consequences of global warming.

Ecological corridors have been proposed to consider in particular the necessary data available and also of river Rhine and Mase that were chosen as EECONET elements (Lammens, 1994).

Criteria for selection of areas of natural development (revitalisation areas):

a. ecological significance, the necesity to build a corridor;
b. potential vegetation structure in a new corridor;
c. the existence of reserve corridors;
d. pressure development on newly created corridor (Van Dijk, 1993)

Areas with greatest potential of restoration were designated wetlands, forests, desertified agricultural areas and for renaturation nutrient poor grassland, swamps and wooded areas. ECONET also stimulated revegetation plans for endangered species habitat , (Van Genne, 1994).

Basic priciples of ECONET adopted at Stefanova (Slovacia)

There are different views of experts regarding the design of NECONET and ECONET. in September 1994 took place in the village of Stefanova in Slovakia, a small seminar in which IUCN adopted the following additional criteria for selecting basic elements ECONET:

A. For selecting ecological network components, is important that:

1. biogeographical units work to be done at the sub provincial level;
2. networks must be functional entities for long-term survival of natural communities, including species dispersal and migration;
3. networks should be as consistent with existing protected areas;
4. network designing can be done at different scale stil are recommanded scale 1:500.000 and 1:1.000.000 for national and pan-European

B. the selected core area must have the following features:

1. to be representative of a certain sub region biogeographic, and / or unique importance in terms of pan-European;
2. to be composed of natural ecosystems and / or semi and / or restored natural ecosystems ecological reconstructed;
3. have high importance for biodiversity and / or to accommodate endangered species or threatened;
4. to have a certain minimum size (500H recommended at European level) and its spatial position to work for species that are endangered and those native
5. to function as a source for native species distribution over a larger surrounding area.

C. Selection of ecological corridors should be made taking into account the following features:

1. to facilitate the dispersal of species in suboptimal habitats from surrounding full protection areas;
2. a pathway (by linking protected areas with full natural development areas) for migration and dispersal of species on a European scale;
3. be a refuge for species as an extension of full protection areas.

D. Selection of the natural areas shiuld be done taking into account the follolwing features:

1. ites will be selected for proper management of nature;
2. areas for restoring natural values necessary for network sustainable;
3. areas with prospects and ability to expand protected areas in full size, for example. using points with a great diversity in abiotic conditions, which can be preserved long term '
4. To be located in the way of important migration routes of indigenous species at the European level.

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