ECRR
Addressing practitioners

ECRR

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Introduction

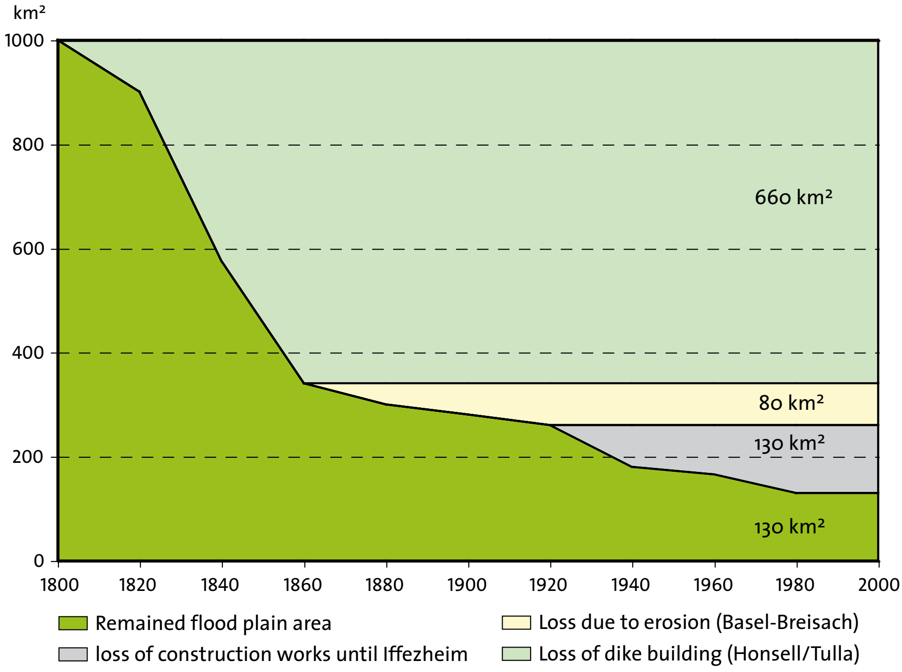
Throughout Europe the ever-increasing intensity of use of rivers and their floodplains for the benefit of mankind has resulted in a widespread physical, chemical and biological deterioration of aquatic and riverine habitats. The rapid increase in population numbers and focus on intensified economic developments in the 20th century, and related pressures on water and land resources resulted in river management being predominantly focussed on technology rather than ecology. In this "development" process the importance of good ecological state, natural values and functioning of the river environment were pro-actively ignored. Modifications of rivers often served improvement of one dominant function of interest to the human community, being i.e. hydropower, discharge of wastewater, shipping, irrigation.

As a result, the physical conditions of rivers and streams were affected by means of damming, embanking & channelling as well as stream flow alterations and the drainage of wetlands, reducing the capacity of natural rivers and riverine habitats to temporarily store water during flooding. These changes in combination with deforestation, the expansion of agricultural & urban areas and climate change resulted in increased flooding risks and safety hazards in downstream river stretches. On the other hand, in some areas freshwater withdrawals became so extreme that the year-round physical flow of water to the sea virtually no longer exists.

The chemical degradation of the river environment was conditioned by industrial, agricultural and communal pollution by organics matter, nutrients and other contaminants via diffuse and point sources. Even though the increased attention paid to waste water treatment has significantly reduced the concentrations of industrial and communal point-source pollutants, eutrophication problems remain due to the high nitrogen levels originating mainly from diffuse agricultural sources. The reduction in riparian wetlands surface area due to physical changes also has reduced the contribution of these wetlands to retaining pollutants and natural self-purification processes, while affecting oxygen-generating processes in the aquatic environment.

The combined impact of physical and chemical alterations in combination with increased human population densities and pressure on land resources caused increased biological stresses, negatively affecting the extent and quality of habitats for the majority of water-bound flora and fauna species. Today, the extinction rate of freshwater fauna is assessed as being five times that of terrestrial fauna. As an additional combined effect of physical, chemical and biological river deterioration, their aesthetic and recreational values deteriorated.

Graph is showing loss of floodplain surface i.e. Upper Rhine



As such, in Europe on average today less than 20% of all rivers and floodplains still are in a (near-) natural physical state. The disappearance of wetlands has been dramatic, ranging from 60% in Denmark to 90% in Bulgaria (WWF, 2006). The remaining pristine rivers mainly are located in remote boreal and arctic regions. In stead, monotonous rivers developed, unable to perform their vitally important natural functions. As a result, natural riverine ecosystems are among the most endangered landscapes in the world. Meanwhile, during the last decades there is an increased understanding among scientists and managers on causes and consequences of river and wetland degradation, and agreement on the needs for river restoration practices as a mean to improve the physical, chemical and biological quality of the water environment. There is an increasing awareness on rivers and riverine wetlands fulfilling important hydrological and biogeochemical functions while providing habitat and food web support for a wide array of organisms. These functions have great value for human society, e.g. in the form of recreational and commercial fishing, safety against flooding. Re-establishing the capacity of rivers to flood their natural riverine floodplains reduced downstream flooding risks during peak discharges, while the longer local storage of surplus water contributes to creating more diverse natural habitats for water-bound flora & fauna biodiversity. Riverine wetlands also contribute to the maintenance of water quality, reduction in global warming and have an important aesthetic value. Ecological river restoration focuses on regaining lost ecological functions, contributing to biological diversity and, as such in many respects, to human society itself. Stream and river restoration can support species recovery,

improved inland and coastal water quality by means of sediment particle retention and associated nutrients and pollutants during flooding, making use of natural ecological processes in the riverine environment, the development of new habitats for wildlife, while promoting alternative human activities like recreation. Restoration efforts take time and need space.

Spatial scales and objectives for Wetland restoration (Coops et al, 2006)

River system	Gradients	Rehabilitation targets	Management actions	Biological indicators
River basin (10^2-10^4 km^2)	Longitudinal gradient, stream/river order, river to estuary transition	Improved water quality, reinstated upstream-downstream connectivity (corridor and flyway protection)	Emission control (legislation), dam removal, designation of conservation areas	Regional biodiversity, migratory fish, birds
River section (10-100 km^2)	Transverse gradient, river to hillslope transition, flooding intensity, minimum discharge	Undisturbed river-floodplain ecotone, landscape complexity	Mitigation of hydrological alterations (e.g. dam or weir operations, removal of minor embankments)	Resident fish, mammals, birds, flora
Local reach or floodplain (1-10 km^2)	Geomorphic variability, surface and subsurface flow, flow velocity (flow-reduced areas)	Enhanced connectivity (Geomorphology, hydrology) of channels, naturalised vegetation dynamics	Introduction of large herbivore grazers, sediment displacement, creating side-channels	Vegetation patterns, reptiles, amphibians, birds
Site or ecotope (0.01-1 km^2)	Patterns in soil and vegetation structure	Maintenance/creation of local structures and ecotones	Localised management (mowing, tree-cutting), reconnection of single oxbows or pools	Plant species composition, invertebrates, algal communities
Eco-element (< 0.01 km^2)	Microgradients related to humidity, nutrient availability, flow velocity, water depth, etc.	Maximum habitat availability, species conservation	Local management (mowing, fert-ilisation, tree-cutting), naturalising structures, pool maintenance	Plant species composition, macroinvertebrates

Ecological restoration is necessary due to all the inferences that take place at present or took place in the past but most important is:

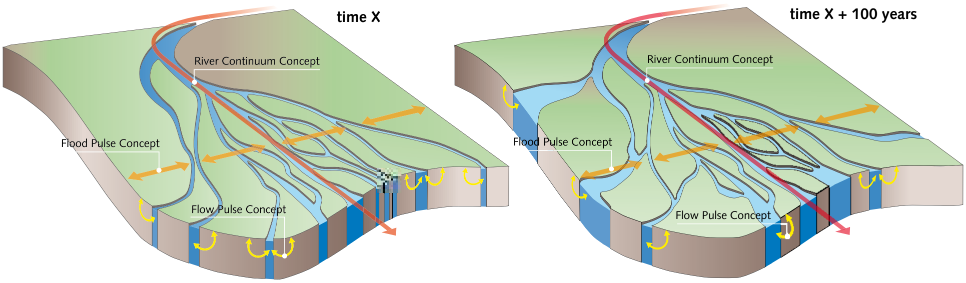
"To conserve and protect the remaining natural river and wetland ecosystems on our globe."

Principles of river restoration

Physical, chemical and biological variability are major characteristics of a naturally functioning river system. Sources of variability include short- and long-term patterns of climate change, alterations in runoff and sediment transfer patterns, and changing hydrological and geomorphologic responses to these patterns. The dependence of biota on these physical processes is reflected in the temporal variable composition of plant and animal communities both in-stream and in riparian zones.

During the last decades, our perception of river-floodplain systems has been significantly improved by the application of new theoretical concepts - the 'river continuum concept' addressing the longitudinal linkages within rivers, and the 'flood pulse concept' integrating the lateral river-floodplain connectivity. More recently the temporal dimension was additionally valued as important aspect of connectivity.

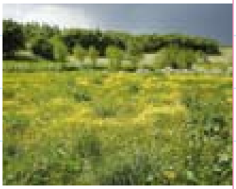
Flood pulse graph



In a natural environment of a river, frequent changes occur.

River restoration refers to a large variety of measures aiming at restoring the natural state and functioning of the river and the riverine environment. By restoring natural conditions, river restoration aims at providing the framework for the sustainable multifunctional use of rivers.

The increased attention paid to the needs for river restoration developed partly due to the increased understanding on the needs to maintain and improve the status of biodiversity in Europe, as reflected in the European Union's Environmental Action Programme, the EU Water Framework Directive and the Convention on Biological Diversity. The European Water Framework Directive demands: to reach the good ecological status for natural water bodies and the good ecological potential for artificial and heavily modified water bodies.



Today, river and stream restoration have become a worldwide phenomenon as well as a booming enterprise. However, examples of river and floodplain restoration and rehabilitation projects are few and mainly recent, while most are still in the planning stage. Also most of these project focus narrowly on the permanent aquatic habitats, with only a few paying attention to the integration with the riparian zone and the floodplain. Also it has to be taken as a fact that large navigable rivers in i.e. Western Europe cannot be restored to their natural state. Human interference can only make adjustments to rehabilitate stretches to reach a good ecological potential on the mid- and longer term.

A number of guiding principles for river and riverine wetland restoration can be formulated:

- ***Dynamic characteristics of rivers***
  In most rivers and riparian ecosystems physical, chemical and biological processes, biodiversity as well as river functions predominantly are conditioned by variable hydrologic and geomorphic processes - natural discharge, high & low floods, migration of the river channel within the alluvial plain. Loss of function in rivers can occur because due to human interference these processes no longer create and maintain the habitat and natural disturbance regimes necessary for ecosystem integrity. Riparian ecosystems typically can be considered as mobile habitat mosaics along a linear river corridor characterized by variability and unpredictability. River restoration initiatives aiming at improving the multi-functionality of the riparian zone by (partly) re-installing natural hydromorphological processes should aim to mimic these attributes. This requires an increased understanding and institutional capacity to accept some levels of both variability and unpredictability in the ecological outcomes of river restoration projects. Besides defining short-term objectives, river restoration projects should also formulate long-term restoration trajectories that are less predictable but more representative of real system attributes. Restoration trajectories could be defined using a range of ecological outcomes to accommodate interannual variability.

- ***Adapting human needs to the natural river system***
  Throughout ages, modifications in rivers and floodplains have been initiated by man to adapt them to human needs. Often these modifications focussed on improving one function of the river, as a result of which the potential of the river to support other functions deteriorated, either foreseen and planned or unintentionally and unexpectedly. Today there is a increasing understanding in society about the loss of functionality due to mono-focal river management practices, and of the increased benefits of a healthy, multi-functional river system for society. River restoration today therefore is based on adjusting the human demands and use

functions to the conditions of the natural riverine environment, and no longer on adjusting the natural river system to the needs of mankind.

- ***Definition of reference conditions***

During their planning phase, river restoration projects typically use some form of information on historical or contemporary reference conditions to define objectives and to help in the evaluation process. However, the definition of reference conditions can be very difficult in regions where most river systems have changed at least to some extent following centuries of increasing land use activities in the river basin. Reference systems therefore need to be defined and used with caution not to create a false sense of the predictability of ecological outcomes, because: (1) many catchment parameters have changed since the times of chosen historic reference systems, due to natural and human-induced processes, (2) climate change has been continuous throughout the Holocene, (3) projected climate change is of uncertain magnitude, (4) alien species cannot be avoided, (5) landscape context changes through time, and (6) long-term variation in hydromorphological processes is unpredictable. As such, there are often no appropriate reference systems to use. Determining the degree to which a river has been altered from its reference condition requires besides knowledge on the natural environment also knowledge of historical land use and the associated effects on rivers. Ignorance of regional land use and river history can lead to restoration that sets unrealistic goals because it is based on incorrect assumptions about a river's reference condition or about the influence of persistent land-use effects.

- ***Hydrologic connectivity***

Hydrologic connectivity refers to the water mediated transfer of matter, energy and organisms within or between components of the river basin environment - the aquifer, floodplain, river bed etc. Connectivity operates in longitudinal, lateral and vertical dimensions and over time, underpinning nearly all ecosystem processes and patterns in rivers at multiple scales. Human developments - dam construction, water diversions, straightening and deepening of the river bed, construction of embankments - in general result in alterations of hydrologic connectivity and flow variability. The resulting disconnection is considered to explain much of the ecological degradation of rivers. Therefore, in the context of successful river restoration, connectivity is crucial. Many reach-scale restoration project could have been even more successful when they would not have been conceived and implemented in isolation form the larger catchment context. However, in restoration care should be taken not to raise connectivity above the natural level. In nature, the opposite of connectivity, "isolation" is an important factor regulating species distribution, e.g. through natural predator-prey relationships. Enhanced connectivity also provides opportunities for the introduction and distribution of invasive species while exposing endemics to new competitors.

~ ***The human perception***

River restoration is commonly undertaken to create a river and riparian zone that meets expectations with regard to its appearance and functioning, or both. Whether or not undertake restoration, as well as the decision about what type of restoration should be attempted strongly depends in addition to scientific understanding on the public's perception of present and ideal river conditions. A river that is preserved in a simplified but attractive form nevertheless may have lost valuable functions. On the other hand, in many cases increased ecosystem variability and biodiversity resulting from human interference in the riparian zone or the river basin often is perceived as positive, in which attempts to restore the original more monotonous and biodiversity-poor natural riparian landscape conditions is considered less desirable. Especially in western Europe, inhabited and practicing extensive agriculture for many centuries already, the resulting man-made riverine landscape are highly valued by the community, and a envisioned restoration of the natural state as having existed before human intervention often does not receive wide support.

In general, the vision is simple and practical. River restoration takes into account the historical situation -both physical-morphological and natural in relation to human activities - and aims to preserve and capitalize the remaining natural values, in the context settings of socio-economic developments towards a more sustainable approach. The high investments costs in ecological restoration often are not realistic in economic sense, as natural values poorly are expressed in money equivalents.

Overall, river restoration should be an integrated part of integrated river basin management (IRBM). By viewing the river and its basin from the river sources to the sea as an organic unity, the complete spectre of measures suitable to provide a good ecological status for waters on the one hand, and safety, prosperity and sustainable economic development on the other can be applied. Options range from enhanced soil conservation, catchment land use and environmentally appropriate agriculture, water retention, storage and aquifer recharging in upstream wetlands and downstream floodplains. Moss and Monstadt (2008) analysed the changed approach and have found principal differences between so-called "early" and "new" generation schemes.

It should be noted that river restoration should be considered only as a response measure to counter negative consequences of human activities, which altered the physical habitat and ecological functioning in natural ecosystems. At least equally important is increasing efforts to conserve those river ecosystems that today are still characterised by a more or less natural state, but which increasingly are subjected to the dangers of human interference. Except for remote areas, especially in Eastern Europe still rivers can be found with limited alterations in the physical wetland habitat and still dynamically ecological functioning of the natural ecosystems. However, the envision upcoming economic development is expected to have serious impacts on the quality of these near-natural rivers and riverine habitats.

Changed approach in restoration schemes (Moss and Monstadt)

	Early generation scheme (before 1990)	New generation scheme (after 1990)
Objectives	Limited objectives (main focus on nature conservation)	Multiple objectives/benefits for different stakeholder groups
Spatial scope	Limited spatial scope/ site orientation	Broad spatial scope/catchment orientation
Temporal scope	Immediate interventions	Long term vision/strategy
Stakeholders	Limited number of stakeholders	Strong partnerships and participation
Policy fields	Primarily single-sector orientation	Interpolicy linkage/ high public profile
Instruments	Limited instruments	Instrument mix
Management	Simple	Complex

The European Centre for River Restoration 1996-2008

Waters throughout in Europe and beyond are increasingly stressed to provide sufficient quantities of good quality water for a variety of human purposes. During the last decades individual European countries as well as the European Community have acknowledged the widespread degradation of the aquatic environment, the human cause of this degradation, and the need for the restoration of rivers and their floodplains as one way to increase the benefits for mankind from natural riparian zones. Also the increased focus on climate change and biodiversity conservation contributes to the growing understanding for the need to sustainable and integrated water management practices.

These developments have resulted in the EU initiating the financing of a number of isolated river restoration projects, both providing support to and obtaining guidance from the elaboration and acceptance of the Water Framework Directive. Individual countries initiated many more large and small national and transboundary projects. Together they created a need for the exchange of information and learning from experiences on a Pan-European scale, and provided the momentum for the establishment of a European Centre for River Restoration.

The European Centre for River Restoration was established in 1995 as part of a joint demonstration project between Denmark and the United Kingdom. The results of a European-wide enquiry in 1998 showed a sufficient baseline for the broadening of activities of the initiative to other European countries. The official constituting Meeting of Parties of the European Centre for River Restoration (ECRR) was held in Silkeborg, Denmark in 1999, in the presence of 55 participants from 22 European countries.

The overall objective of the ECRR is to support the development and implementation of concepts on river restoration into integrated and sustainable river basin management initiatives in the European framework, by providing a platform for information exchange between people and organisations.

At the policy level the ECRR is guided by and providing support to the Convention on Biological Diversity, the Ramsar Convention, the Helsinki Convention, the EU Water Framework Directive, the EU Habitat Directive, the EU Bird Directive, the EU Nitrate Directive as well as a variety of national and international basin conventions.

Strategic activities of the ECRR include:

- To facilitate contacts between practitioners of the network by means of a web-based matching service, to encourage the exchange of information and experience on river restoration, and to promote the development of new visions and ideas;
- To organise conferences, workshops, seminars and other working meetings to actively promote the development of the learning community;
- To provide access to information on research, planning, implementation and monitoring activities and techniques in the field of river restoration, by means of a web site and publication of newsletters;
- To facilitate the establishment and functioning of national networks on river restoration throughout Europe.

The ECRR functions as a non-profit organisation with participants mainly from but not limited to the European continent. The ECRR provides an international network platform in which all practitioners have the opportunity and responsibility for the exchange of information and experiences, through newsletters, web-based home pages and regular meetings. Within its structure, the ECRR facilitates and encourages the establishment of national networks, organising individual experts and organisations active in the field of river restoration in individual countries. The ECRR also facilitates the establishment and exchange of information among and between thematic subgroups of experts with certain common interests, providing them with a European platform for dissemination of information and experience. Today, national networks on river restoration exist in the following countries: Belgium, Denmark, Finland, Italy, the Netherlands, Norway, Romania, Russian Federation, Spain and the United Kingdom.

For the general management and organisation of the ECRR a Management Board with seven representatives was established. Its activities are related to the organisational and coordinating aspects, e.g. contributing to the development of structure and working practices, the organisation of meetings & conferences. The Board promotes the equal distribution of institutions from participating European countries, including at least one representative from TACIS and PHARE countries each, as well as from southern Europe. The Management Board meets on a bi-annual basis on different locations throughout Europe as to promote direct information exchange on a wide range of geographical differences. The Management Board has elected and installed a secretariat for the period of 3-5 years, with the main responsibility to function as contact centre for the practitioners of the ECRR.

Between 2002 and 2006, the secretariat was managed by the Dutch Institute for Inland Water Management & Waste Water Treatment RWS-RIZA, part of the Dutch Ministry of Transport, Public Works & Water Management. The secretariat and the ECRR website were handed over to the Italian Centre for River Restoration CIRF in 2006.

Funding for the operational development and functioning of the ECRR needs to be covered from external sources. Between 1999-2002 the EU LIFE programme provided funding for the establishment and operation of the ECRR Secretariat at the Danish National Environmental Research Institute NERI and RWS-RIZA. Between 2003-2006 the Dutch Ministry of Transport, Public Works & Water Management provided funding for the ECRR and its Secretariat. By now, the Dutch Ministry continues their support for the ECRR network by providing the Chairman and a member of the Technical Scientific Committee. Activities of ECRR practitioners require funding from additional sources, such as EU funding sources or in-country national funding. The Italian River Restoration Centre generously obtained funding form the Venice regional authorities to run the ECRR Secretariat for the 3-year period 2006-2009.

The three ECRR secretaries (Hans Ole Hansen, Ute Menke, Francesco Pra Levis

Regional differences

Both natural and man-affected rivers in Europe support a broad range of functions important for the economy and the common good. Natural functions include the support of flora & fauna habitats, flood mitigation, water quality improvement, all of which also are valuable support functions for economic activities. Economic functions include river navigation, agriculture, irrigation, industrial and communal drinking water and process water supply, fisheries, extraction of minerals (sand, gravel), cooling water, recreation, and housing.

Although there is a large similarity in the functions and problems facing rivers in Europe, in different regions of Europe, the importance of the functions provided by the river as well as the present-day problems vary in importance. Differences in functions and problems originate from variations in the natural conditions of river basins (climate, geology, relief, etc.) and dominant human use functions. A questionnaire research executed by the ECRR among its practitioners in 2000 showed the following regional differentiations in functions and problems:

~ Northern Europe: hydropower, fisheries, flood protection;
~ Eastern Europe: nature, flood protection, fisheries, water quality;
~ Southern Europe: nature, hydropower, irrigation, flood protection;
~ Western Europe: nature, flood protection, shipping.

Retention reservoir border Portugal -Spain

As with the main functions of rivers in different regions of Europe, also the main present-day problems vary among the regions:

~ Northern Europe: Loss of flora & fauna, worsened water quality;
~ Eastern Europe: insufficient availability of water, worsened water quality;
~ Southern Europe: insufficient availability of water, flooding threats, fragmentation & loss of habitat;
~ Western Europe: fragmentation & loss of habitat, flooding threats.

In Northern Europe especially the loss and decreased quality of fish habitats is considered a major problem. Both Southern and Eastern Europe face problems with water availability conditioned by dry hot climate conditions in summer. In Southern Europe and Western Europe the loss of identity and beauty of river landscapes is related to the intensive use of rivers for tourism and recreation.
Even in countries with normal rainfall such as the Netherlands, in summertime droughts can occur. A very dry year was for example 2003, in which the Rhine River reached very low water level that hampered shipping on the river during a few weeks. The Water Framework Directive is likely to play a mayor role in finding the balance between the current water availability and the water demands by including a specific drought management plan into the River Basin Management Plan of which some examples already exist with EU Member States.

Manmade secondary channels along the river Waal, The Netherlands

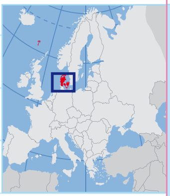
The 4th International European conference on River Restoration in Europe in Venice June 16-21, 2008

The ECRR organises a one-week conference in June 2008 in Venice. Many abstracts from a large variety of countries and organisations worldwide have been received based on the call for abstract through the ECRR website which ended on January 15th, 2008. A broad range of themes will be covered during the conference in keynotes, parallel sessions and workshops. The (applied) research field is highly present. For the sessions "Biodiversity and restoration of hydro-morphological processes" and "Evaluating and monitoring success in river restoration plans/projects" received each more than 35 contributions. Many different organisations will participate in the conference, such as universities, governmental organisations, consultants and NGO's. Universities and research centres delivered about 65% of the abstracts. Concerning the countries, 70% of the abstracts were derived from 23 European countries. Another 13% from America and 12% from Asia were received.

The conference organisation worked out a balanced programme of keynotes, presentations and workshops. A field trip to the river restoration project to the Zero River close to the Venice lagoon will be part of the programme.
A post-conference field trip will be organised to the Tagliamento River in the Alps and to the Drava River. The Tagliamento River is often used as a reference river for braided rivers in the upstream part. In the downstream part the river is also very much affected by the humans, especially agriculture. The Drava River in Austria is affected very much by hydropower generation.

The last 12 years, a lot of work along rivers in Europe and worldwide was carried out. The approaches on how to develop these kinds of projects have changed a lot in the meantime. More emphasis is put on integrated approaches and involvement of public participation than just implementing projects by the competent authority. Spatial planning and economic development in combination with flood alleviation offer often quite good rehabilitation possibilities. But: Often in urban areas, it happens that the only focus is put on to the economic development instead of a well-balanced and real integrated project implementation or planning.
Our conference in Venice will be an excellent platform for practitioners, researchers, consultants from different organisations to exchange new experiences and methods to design and implement ecological river restoration project successfully. The findings will be summarized in conference recommendations to support further upcoming events - like the next World Water Forum in 2009 in Istanbul.

Denmark



The Skjern river restoration project

General

The Skjern river, the largest river in Denmark, is located in western Jutland. The river drains a catchment area of 2,500 km², and has an average discharge of about 35 m³/sec. The catchment area is a typical lowland area in a humid temperate climate, most of which is in use for intensively cultivated farmlands. At the mouth of the river a delta of about 4,000 ha has been built up over centuries. The river drains into the Ringkøbing Fjord, a shallow costal lagoon connected with the North Sea.

Natural dynamics, hydromorphological processes and ecology

The landscape of the Skjern river valley was formed after the end of the last ice age, with the main shape of the valley being created by melt water carving its way through the landscape. Since then, the formation and development of the riverine landscape is mainly conditioned by the force of the river water. The natural landscape was subjected to constant change, involving dynamic interactions of many different forces - currents, waves, drifting sands, tidal water, marsh and peat formation.
Daily the riverbed and its banks were eroded and new land was formed by combined marine and riverine hydromorphological processes. The delta was progressing to the sea constantly, due to the large quantities of sand and gravel imported from upstream areas. Regular flooding was a typical feature, occurring mainly late winter and spring,

as well as after irregular rainstorms and storm surges. During flooding, fertile sediments, nutrients and organic matter were deposited, providing the valuable substances for the rich meadow vegetation. Before human interference, the Skjern delta was a marshland characterised by a mosaic pattern of reed-swamps, meadows, meandering watercourses and shallow lakes. The variety of wet ecosystems habitats provided excellent habitats for a variety of aquatic and terrestrial flora and fauna species. Besides being of imminent ecological importance, for centuries this area was also an agricultural oasis in the surrounding barren heath land of western Jutland, with the fertile meadows serving to fodder livestock, and livestock providing fertilisers to support the meadow vegetation. In general a delicate balance between nature and extensive agriculture existed.

Problems of the area, reasons for restoration

Coping with the permanent uncertainty of flooding, farmers for centuries tried to regulate the river, by means of irrigation & drainage channels, dikes and attempts to straighten and clean river courses in order to increase the reliability of their meadow cultivation. In the 1960s Denmark's largest drainage project was implemented in the lower reach of the Skjern river, turning 4,000 ha of wet meadows and marshes into arable land. Meandering watercourses were straightened out and dikes were constructed to prevent flooding. Pumping stations and drainage systems were installed to lower the groundwater level to suit agricultural production. Soon the channelling of the river and the cultivation of the former wetlands showed to have

a large negative effect on the wild flora & fauna of the region. Only minor patches of natural meadows and wetlands providing suitable habitats remained after completion of the project. The reclamation severely affected the water quality, and as such the fish and waterfowl populations in both the river and the Ringkøbing Fjord, including stocks of Atlantic Salmon (*Salmon salar*). Together with several other species the Bittern (*Botaurus stellaris*) disappeared from the region. After some years it also became apparent that land subsidence due to drainage and oxidation of organic soils exceeded expectations, requiring considerable future expenses to upgrade the drainage system and maintain the agricultural production.

Measures executed

In 1987 the Danish Parliament approved the Skjern river restoration project. The main objectives of the project included the restoration of the meandering river course and natural floodplain dynamics, the improvement of water quality by restoring the self-purification and nutrient retention capacity in the lower reach of the river and its floodplain, the restoration of wild flora & fauna in an internationally valuable wetland and to increase the recreational values of the area. Following necessary land acquisition, surveying and detailed design, stakeholder hearings and Environmental Impact Assessment, the restoration project was approved by a public works act of the Parliament. Implementation of the project started in 1999 and was completed in 2002. Main restoration activities included the excavation of the river course, following as much as possible old meanders as mapped in the 19th century, the removal of dikes, the filling of old canalised river stretches, the removal or disconnection of pumping stations. Further, the Skjern river and the Ringkøbing Fjord were designated as Sites of Community Interest under the EU Habitat Directive, while the Skjern River Delta and Ringkøbing Fjord also were designated as a Specially Protected Area under the EU Bird Directive. The area is part of the Danish Network of Protected Areas under Natura 2000.

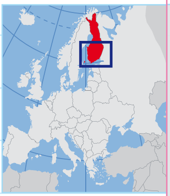
Results

The project has recreated an overall 2,200 ha of river valley with valuable habitats for birds, plants, mammals and insects. After the completion of the technical excavation and filling activities, in total moving 2.7 million m^3 of soil, birds arrived again in thousands, including Spoonbills, Avocets, Black-necked Grebes, Ruffs, White-tailed Eagles and Bitterns. The area once again became an important staging area on the bird migratory routes along the west coast of Europe. Monitoring shows a significant increase in the number of fish, amphibians and insects. Otters and Salmon are thriving again. The remaining population of the red-listed water plant *Luronium natans* is spreading from refuges into the restored river. The management of the restored wetlands is executed by the Danish Forest & Nature Agency, and includes grazing, reed cutting and haymaking. Maintenance costs are covered by leasing agreement for grazing, haymaking, hunting and fishing. In total about 1100 pieces of cattle and horses are allowed in combination with haymaking. Winter reed cutting currently covers 75 ha, or 3% of the area, but is expected to increase in future.
An extensive networks of firm paths; bridges and rope ferries provide opportunities to explore the area on foot, by bicycle or on horseback, while regulating the level of possible wildlife disturbances. Bird observation towers allow wildlife observations in the area. An extended monitoring scheme was installed to follow the way landscape and wildlife develops naturally.

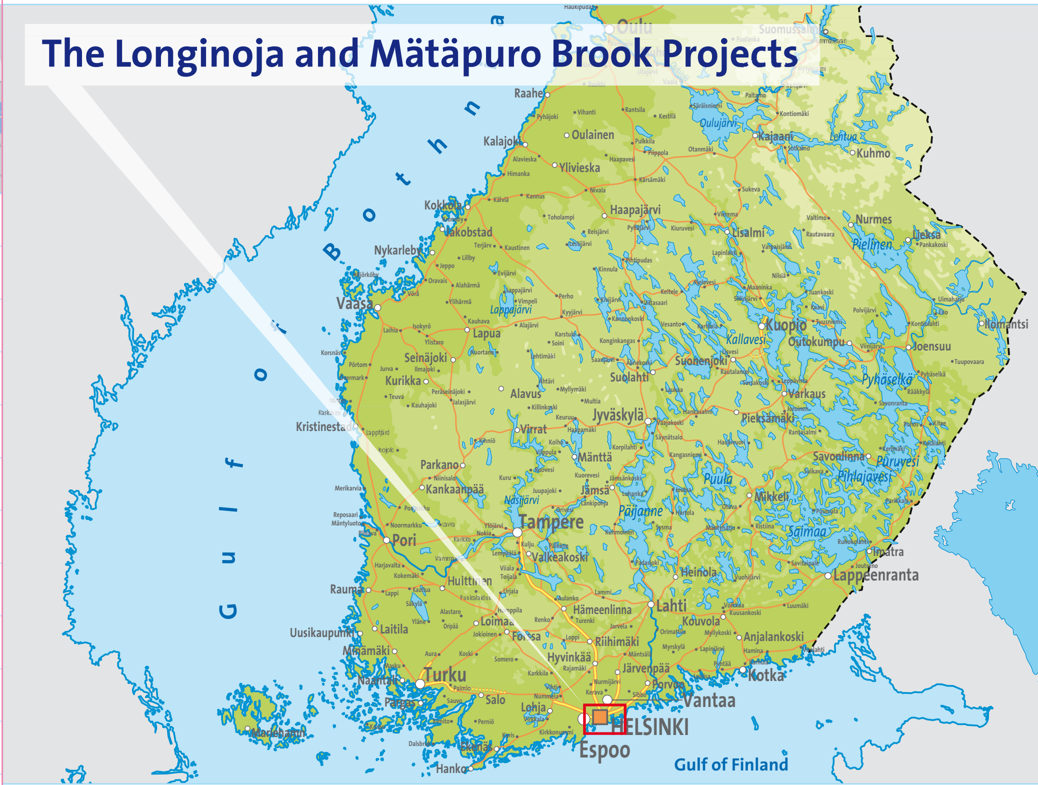
Cost-benefit analysis

The total costs of the project amounted to 38 million €, of which 3.4 million € were contributed by the EU Life Fund. Despite EU subsidies the agricultural income in the area was negatively affected by the project. Although the restoration of habitats and the return of wildlife cannot be expressed in financial terms, it is assessed that the increased retention of nitrates and phosphates in the restored valley will provide positive socio-economic effects from fishing and recreation in the Ringkøbing Fjord. The restored wildlife and recreational facilities will also positively affect the demographic conditions in western Jutland. Today, the number of visitors to the area amounts already to 100,000 per year, expected to increase in future.

Finland



The Longinoja and Mätäpuro Brook Projects



General

The Longinoja and the Mätäpuro are two urban brooks located within the boundaries of the city of Helsinki on the southern coast of Finland. The Longinoja in the eastern part of the city is the most downstream tributary of the Vantaa river. The brook's catchment area covers 12 km²; the length of the main stream is approximately 7 km, while the average discharge of the Longinoja is estimated at 115 l/s. The Mätäpuro in the western part of the city is a small stream with a direct outflow into the Gulf of Finland at the Pikku Huopalahti Bay. Its catchment area covers 11 km²; the length of the main stream is approximately 12 km, and its average discharge is estimated at 101 l/s. Both brooks are predominantly spring-fed.

Natural dynamics, hydromorphological processes and ecology

The most important feature of the Longinoja and Mätäpuro brooks is their biotic richness. At least twelve species of fish, in addition to a diverse insect fauna, have been encountered in the Longinoja, including the brown trout (*Salmo trutta*), the Atlantic salmon (*Salmo salar*), and the grayling (*Thymallus thymallus*).

Problems of the area, reasons for restoration

The most significant human-induced changes in the Finnish capital, Helsinki, since there has been development in other areas on the southern coast have taken place only during the last two centuries. Founded in 1550 at the mouth of the Vantaa River, Helsinki remained a minor town until the early 19th century. Fuelled by profound changes in the Finnish society and economy, Helsinki soon experienced an unprecedented urban and industrial growth. By the year 2000, the greater metropolitan area included some 1.2 million inhabitants, or, well over twenty percent of the entire population of Finland. The rapid urbanization of Helsinki inevitably resulted in enormous changes in the city's natural environment. Among the natural systems most affected by urban and suburban development are the city's numerous small streams and brooks.

The most important spawning site for brown trout in the Mätäpuro is located less than ten meters from a busy highway

Photo: Aki Janatuinen, October 2006

In addition to being spring-fed, both brooks acquire additional water from runoff delivered by natural and man-made drainage systems. Today, the Longinoja brook's catchment area is characterized by 111 km of open channel and 110 km of underground storm water drainage systems. Less than 5% of the main stream is embedded in culverts. The Mätäpuro catchment area includes 94 km of open channel and 92 km of underground storm water drainage systems. More than 75% of the main stream is open.

Channel morphology of both brooks has been heavily altered in the past due to dredging, ditching, and channelization in connection with intense urban development. This has resulted in a flashier hydrograph, severe loss of natural meandering, simplified flow patterns, and increased erosion and silt load for both streams, with adverse effects to resident fauna. Altered channel morphology, combined with littering, construction of migration barriers, and elevated concentrations of nutrients and contaminants in stream water (due to both storm water runoff and legacy pollutants) has resulted in serious reduction in the streams' biological diversity and loss of their recreational value. Especially migratory fish such at the endangered anadromous brown trout (the so-called sea trout) have suffered from these developments.

Today, despite alterations, the Longinoja and Mätäpuro brooks with their streamside vegetation and surrounding park areas create important ecological corridors within the city and represent high recreational value for local inhabitants. Despite continuous urban development within the catchment areas of the Longinoja and Mätäpuro and a persistent littering problem, the overall water quality in both streams has improved considerably during the last two decades, making restoration work feasible.

Restored stream section in the upper reaches of the Longinoja.

Photo: Juha Salonen, fall 2002

Measures executed

From the beginning, restoration efforts have been planned and carried out by volunteer organizations. Virtavesien hoitoyhdistys, in short Virho (Finnish Society for Stream Conservation), is a voluntary organization carrying out river restoration work in southern Finland. The society promotes an ecological approach to watershed management and also maintains its own fish hatchery. The society is currently involved in numerous projects of varying sizes. Among the smaller ones are restoration efforts with these two urban brooks, the Longinoja and the Mätäpuro. In addition to the Virho, another volunteer organization with many shared members, the Taimentiimi (Trout Team), has been active at these sites.

Restoration work in the Longinoja commenced when the first anadromous spawner, a trout much too large to be a resident fish, was sighted in the fall of 2001. The work in the Longinoja significantly contributes to a much larger project of the restoration of the whole Vantaa River and its tributaries. First observations of spawning trout in the Mätäpuro were made in the fall of 2003. At both locations the restoration work has concentrated on the improvement of the stream channel as fish habitat with the aim of establishing viable populations of anadromous brown trout. In the beginning, work in the Longinoja consisted mainly of restoration of lost spawning areas with new gravel beds. During the last few years, attention has also focused on the diversification of channel structure, erosion prevention, removal of migration barriers, and creation of nursery habitat. Restoration efforts in the Mätäpuro commenced in 2006 with construction of new spawning and nursery areas.

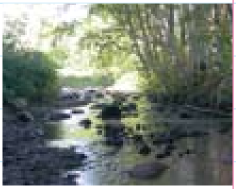
Spawning trout on a restored Longinoja gravel bed

Photo: Juha Salonen, October 2005

Each of the restoration projects run by the Virho has its own coordinator, who is responsible for planning activities and maintaining contact with landowners and other stakeholders. Practically all labor for restoration work at the Longinoja and Mätäpuro sites has been provided by volunteers, who typically have used their own spades, rakes, wheelbarrows, and other tools. Volunteers have traditionally met once or twice a year to carry out restoration at the sites. The “Restoration Days” have been attended by 12 to 18 people who, in addition to other work, typically moved a truckload (13-17 tons) of gravel and stone material into the streams. Restoration work has attracted sponsors from the local business community who have donated gravel and boulders - not to mention food for the volunteers. The City of Helsinki has furthermore contributed wood material for instream structures. In addition to volunteer work, the city and the Uusimaa Regional Environment Centre in 2006 worked on a 150-meter stretch of dredged and channelized stream in the Longinoja, using heavier machinery. This pilot project aimed at restoring a naturally meandering stream channel.

Results

Since the late 1990s, the brown trout has been reintroduced to both streams with parr coming from Virho's own hatchery. The Finnish Game and Fisheries Research Institute documented the successful reproduction of the species at both locations for the first time in 2005. The growth rates for parr born in both of these streams have been well above the Finnish average. Significantly, the number of anadromous spawners has shown a constant rise during the last years.

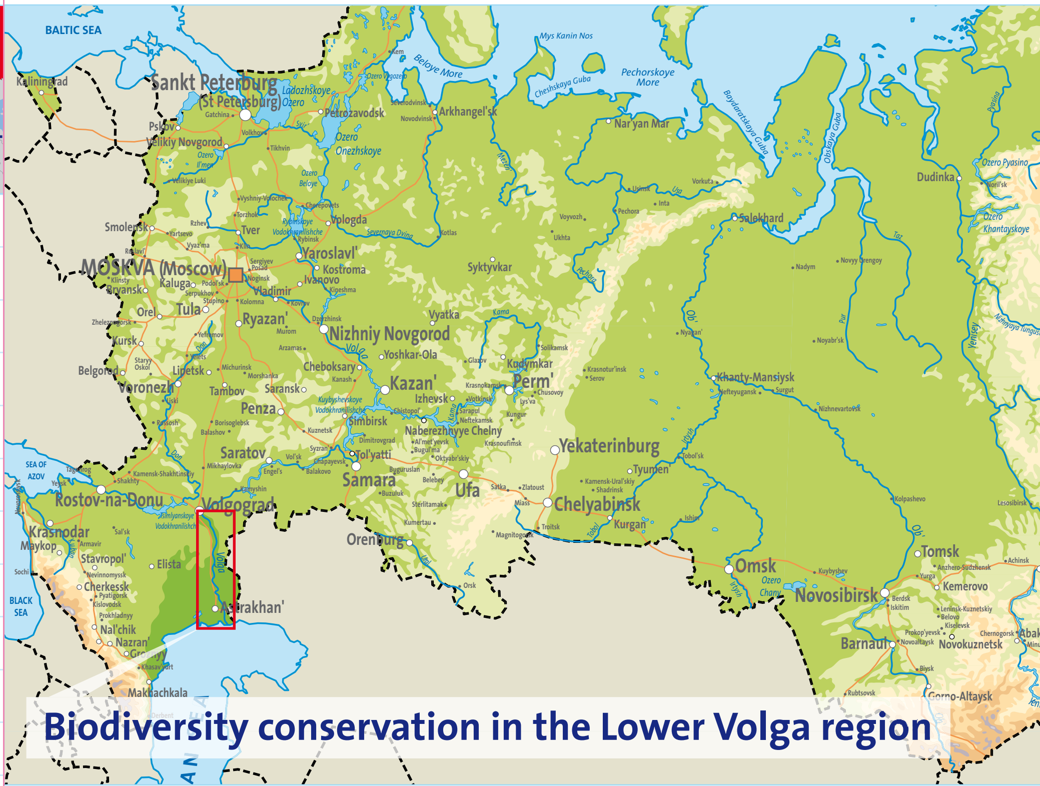


The restoration efforts in the Longinoja and the Mätäpuro have received considerable attention in the media, including national newspapers, radio, and television. The ecological and recreational value of both streams is today widely acknowledged by local inhabitants and public authorities. For example, a major highway construction project adjacent to the Mätäpuro has to take into account the trout population in the stream. In 2007, both the Longinoja and the Mätäpuro were incorporated into the Helsinki Small Streams Program with a special status, providing substantial public funding for future restoration work. Thus the volunteer work carried out in these two brooks has, despite the small scale, raised local -and even national- awareness of the plight of the small streams and their inhabitants and will possibly serve as an example for future urban restoration projects in Finland.

Cost-benefit analysis

Stream restoration utilizing volunteer work is typically of low cost and intensity and not suitable for large river restoration projects. Still, the results attained at the Longinoja and Mätäpuro brooks show a remarkably high cost-benefit ratio. Naturally reproducing brown trout populations have been successfully re-established in a highly urbanized area with minimal monetary input. In addition to numerous resident trout, endangered anadromous fish are now regularly encountered in the streams during the spawning period. Fishing is currently prohibited in the Longinoja, and a similar city ordinance for the Mätäpuro is under preparation. Still, fishing pressure (especially recreational gillnetting) in coastal waters and at the mouth of the Vantaa River severely hampers the movement of smolts and mature fish between the feeding and spawning areas.

Russia



Biodiversity conservation in the Lower Volga region

General

The Lower Volga region is situated in the south-eastern part of the East European plain. The area is comprised of: a) the complete Volga-Akhtuba floodplain area between the cities of Volgograd and Astrakhan, including the part belonging to the Republic of Kalmykia, b) the Volga Delta (the largest inland delta in Europe and the largest delta bordering the Caspian Sea) including the shallow waters of the fore-delta, and c) the Ilmen-Steppe areas to the West and East of the delta. The total area is approximately 30,000 km² or 3 million ha.

Natural dynamics, hydromorphological processes and ecology

The wetlands of the Lower Volga region are a vital natural interface between the upstream Volga catchment area and the marine environment of the Caspian Sea, buffering the Caspian sea from upstream impacts of agriculture, industry and urbanization, providing important products and supporting a rich and very diverse flora and fauna. Both at the national and international level the global importance of the Lower Volga region for biodiversity is widely recognised. Occupying a strategic position on 3 important flyways, the Lower Volga region supports at least 15 globally threatened migratory bird species during stages of migration. In addition, 4 threatened and highly valuable sturgeon species depend on the region for

spawning and feeding. Moreover, at least 20 endemic subspecies of fish also occur in the region. Additional ecological importance is given to the area by its geographical location and structure, being one of the few riverine north-south land corridors crossing the extended dry semi-desert and steppe area of southern Russia and Kazakhstan. The area is also regionally important because it serves as a feeding area for Saiga antelopes.

The region's rich wetland biodiversity is an expression of its varied and dynamic aquatic resources. Under natural conditions, the wetlands of the Lower Volga - their location, surface area and conditions - were subjected to large inter-seasonal, annual as well as long-term fluctuations in Volga river discharge. The long-term variation in total yearly discharge is assessed to be strongly related to cyclone activity above European Russia, causing continental-scale variations in precipitation and evaporation. The Volga river discharge also has a profound effect on the Caspian Sea's water level, since it is a closed sea and the Volga provides 80% of its inflow. The continuous hydrology-induced changes in habitat location and quality was reflected in increasing or decreasing numbers, and the presence or absence, of aquatic and terrestrial plant and animal species, affected fish spawning and stocks.

Photo: Geesink

The wetlands' natural resources have also long supported the local population, providing products like waterfowl, fish, caviar and reeds. Due to the combination of pressures arising from the increasing human population's use of natural resources, the direct loss and transformation of wetlands following diking and water level changes, pollution, and the regulation of natural river water regimes, the wetlands' biodiversity values are now under intense and increasing pressures.

Problems of the area, reasons for restoration

During the 20th century, the natural dynamic water discharge cycle of the Volga river has been modified by human interventions including dam construction and water reservoir development, industrial, communal & agricultural water usage, the construction of dikes, the drainage of wetlands. Introduced dam management maintained the typical spring flooding period, and introduced a "fishery benchmark" and "agricultural benchmark" for the benefit of fish spawning and agricultural needs. However, the total amount of water discharged during Spring (April-June) significantly decreased, both in total volume as well as in relative volume compared to the total yearly discharge. With changes in monthly discharge volume during the summer-autumn low water period being minimal, the discharge volume in winter (December-March) significantly increased. The ratio between the discharge volume during the flooding period and the winter period reduced to 1.6 from 4.5, the average maximum spring discharge from 33,250 m^3/sec to 28,000 m^3/sec.

Last Volga dam near Volgograd before Caspian Sea

The steady and fast increase of the water level in the Caspian Sea, on average 13 cm/year between 1978 and 1997 resulting mainly from increased total yearly Volga discharge, has resulted in the intrusion of brackish seawater far into the fore-delta by wind-induced surges, as well as the seepage of brackish and salt water into the agricultural fields behind dikes. In the southern part of the Delta the sea level rise resulted in a loss of shallow aquatic habitats, in the drowning of land and swamp vegetation, and changes in the feeding and breeding conditions for many mammals and water birds. Habitat loss could not compensated for inland, because dikes protecting agricultural fields have not been relocated and no agricultural fields have been restored to wetlands. Overall, therefore, habitats important for wetland biodiversity have decreased significantly.

The Lower Volga region, like other areas in the Russian Federation today, faces significant problems. The region is confronted by difficult economic conditions and administrative deficiencies that complicate and hamper environmental management efforts to protect and use natural resources in a sustainable way. The decrease in economic activity has caused large-scale unemployment and poverty in the region. This, in turn, has resulted in increased pressures on the region's natural resources. Although legislation and administrative structures to manage the use of natural resources exist, natural resources are still increasingly subjected to illegal practices such as poaching. The efforts of regional and local authorities at regulation and control are constrained by the country's economic conditions and resulting lack of management capacity. Organisations lack financial means to regularly cover expenses for salaries and equipment, and local communities lack alternative forms of livelihood. Although a system of payment for resources and pollution was developed, only part of the payments is actually received, because enforcement is difficult, time-consuming, and additionally hampered by deficiencies in legislation.

Floodplain of the Lower Volga

Photo: Leummens

Measures executed

In order to tackle the above problems, the UNDP developed a comprehensive project proposal for the conservation and sustainable use of unique wetlands and associated globally significant biodiversity in the Lower Volga region. Successful conservation measures will be based on the development of a responsive management system to ensure the protection of the wetlands biodiversity under changing environmental conditions and socio-economic development processes.

The resulting full project proposal will focus on the conservation of the Lower Volga wetlands and provide for their sustainable use through the following action packages:

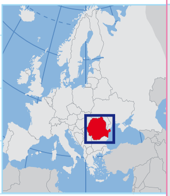
- ***Updated biodiversity information and its management***
  Knowledge on regional biodiversity and interrelations with a dynamic environment and human activities will be improved through strengthening of interregional co-operation on the collection, storage and exchange of information.

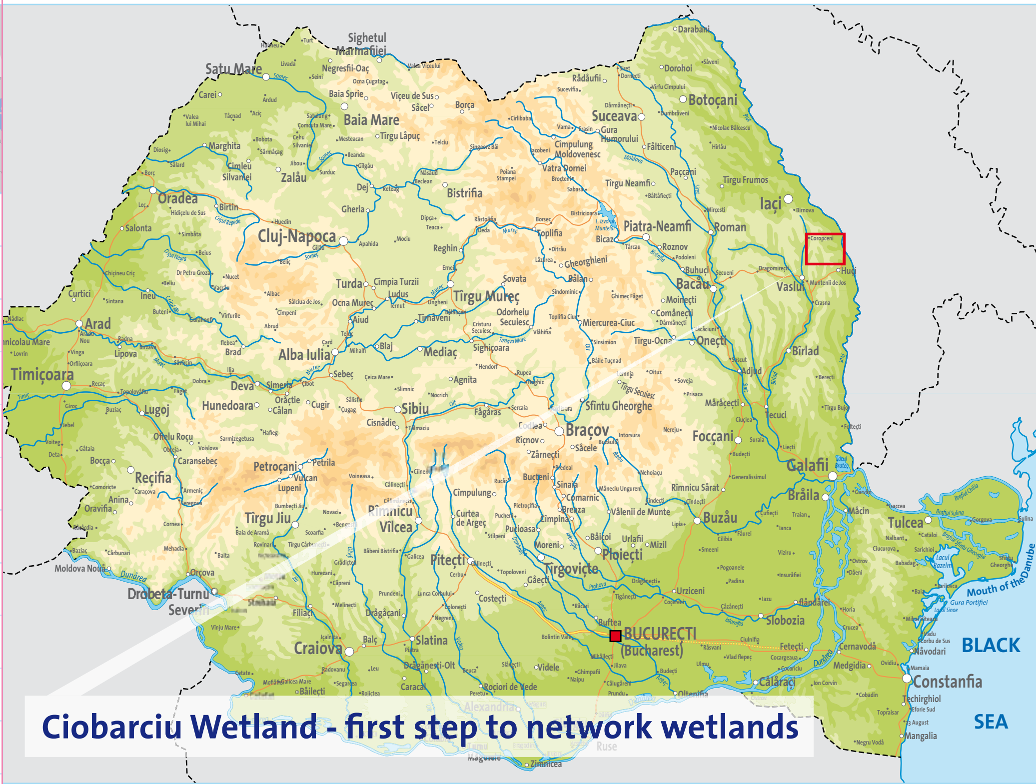
- ***Facilitated improved regional wetland biodiversity conservation policy, legal and regulatory framework***
  The project will clarify and rectify existing constraints to wetland management and biodiversity conservation - gaps, inconsistencies, and other deficiencies in the current regulatory and policy base. Actions include focus on economic assessment of biodiversity values and its introduction into the regional policy and legal framework.
- ***Established and strengthened core wetland areas, including well-planned, effective protected area management capacity and operation***
  Four selected core wetland areas will be strengthened by elaborating and implementing management plans, zoning & use regulations, sustainable finance mechanisms, stakeholder participation.
- ***Demonstrated sustainable integrated resources development in selected pilot areas***
  Alternative livelihood options for the local population will be demonstrated, e.g. sustainable fisheries, including sturgeons, and tourism facilities, supported by targeted training & awareness.
- ***Increased biodiversity awareness and advocacy***
  Through training and awareness raising actions and the establishment of regional information centres, both decision-makers and the community will improve their understanding of biodiversity values

Resources sought from the GEF project account for 4-5 million USD, used to secure the global benefits of biodiversity conservation. Additionally baseline conservation and restoration costs are co-financed. Most of the co-funding for Lower Volga project is going to be provided by the Russian national and regional governments. The project development stage was also co-financed by the Netherlands Ministry of Agriculture, Nature Management & Food Security (LNV) and the RWS-RIZA.
During the implementation period, started in 2006 and lasting until 2019, the project is expected to address the following root causes currently threatening biodiversity in the Lower Volga:

- lack of awareness at all levels on biodiversity values and their response to a dynamic environment;
- deficiencies in the legal, regulatory & control framework on conservation and use of natural resources;
- inadequate land and water management practices;
- lack of capacity for wetland management and biodiversity conservation;
- lack of opportunity to develop alternative livelihood options for the local population.

Romania





Ciobarciu Wetland - first step to network wetlands

General

The Prut River is the most downstream large tributary of the Danube River. The surface area of the Prut river basin is 27,500 km², of which 10,990 km² are located on the territory of Romania. The rest of its basin is located in the Moldova Republic and Ukraine, sharing a common border of 740 km. Originating in the eastern part of Carpathian Mountains and flowing North-South to its confluence with the Danube river, the Prut valley is an important route for migratory birds, with currently three Important Bird Areas being already identified.

Natural dynamics, hydromorphological processes and ecology

In the past the Prut valley was almost yearly flooded, after which the lowest parts of the floodplains remained wet for a long time. During high floods the whole width of the floodplain, 3-7 km, became one lake-like water surface, especially in spring with combined discharge of snow melt water and rainwater discharging over frozen soils. In the middle stream section, the Prut river shares a common floodplain with its tributary the Jija river. The natural valley mainly included reed marshes, wet riverine forests and meadows, which for ages were extensively used as grasslands. Regular relocations of the riverbed create many closed-off branches filled with water during flooding, creating a mosaic pattern of a variety of habitats attractive for many plants and animals. These areas were of special importance as feeding and resting places for migratory birds.

Problems of the area, reasons for restoration

Recent studies showed that over 80% of the Danube river basin's wetlands and floodplain have been destroyed in the 20th century. In the Prut basin, like everywhere in the world, human activities had a large impact on the natural water system causing severe losses to natural values and biodiversity. In the Prut River basin about 300 fish ponds, 29 reservoirs, 4 calamity polders, 358 km of dikes and 300 km river regulation works were constructed. The Jija river was rerouted into the Prut river and its previous floodplain developed for irrigated agriculture. As a result, many wet habitats of critical value for wetland flora & fauna were destroyed or significantly altered. Following the political changes in the 1990s, arable farming was mainly replaced by grazing, the irrigation scheme became into disuse, and fishponds no longer profitable. Despite the past human activities, still opportunities for restoration exist, mainly due to the absence of large settlements and infrastructure and declining agricultural interests. Also several vulnerable and endangered bird species still occur in the region. Today, a complete restoration of the original ecological conditions is impossible, it would destroy the many positive results of the hydro-technical constructions and as such also socially be unacceptable, while also during the period of human intervention the river system has changed such that the reduction of human interference would not automatically result in a restoration of the former ecosystems.

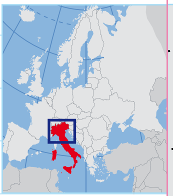
Measures executed

The proposed target for ecological restoration is to create a network of small wetlands in the Prut basin, metaphorically named “string of pearls”. The natural values related to widespread flooding can be partly restored by creating a longitudinal network of disconnected marshes, shallow open water and drying pools. The “string of pearls” will restore an important aspect of the river landscape and water dynamics, taking in account the limitations of safety and human use. The basis of this network of wetlands is already present in the existing reservoirs and ponds. Making use of existing structures helps reduce the costs of restoration investments. The “string” will start with the first “pearl” pilot project - the Costuleni wetlands. More specifically the following objectives are pursued: demonstrate the possibilities for the restoration of wetland values and functions in the Prut valley; Develop a management plan and the organisational structure needed for the management of the project area; Expand knowledge and experience in the field of interactive planning and stakeholder participation. First activities include Raising the water level of the embanked area with a regulating water outlet structure, Creation of a variety of habitats -from dry land to spots with deep water- by digging; and opening up of old river meanders that have been filled up. Important practical activities include the negotiation on the purchase of land, raising awareness and understanding,

Results

The network of wetlands restores currently rare wetland habitats in the Prut basin. The wetlands will be used by migrating water birds for feeding, resting and breeding. The network of wetlands will contribute to the preserve and improvement of the quality of an important migratory route for water birds. In this way ecological restoration in the Prut valley has not only regional importance, but international importance as well. Besides birds also wetland vegetation, amphibians, reptiles, fish species and insects like dragonflies will profit from the project.

Italy



General

The Dese Sile Drainage Consortium manages a river network of more than 600 kilometres, in an area of 43.464 hectares, distributed in 20 municipalities in the Provinces of Venice, Treviso and Padua. The area under Consortium's authority, is mainly covered by the Zero, Dese and Marzenego rivers' catchments area, that flow into Venice Lagoon. The close connection between these rivers and lagoon ecosystem let the consortium participate to the "Plan for pollution prevention and water purification of Venice Lagoon drainage basin" (Law n. 139/1992) and to be involved by Veneto Region in a few projects that aim at reducing the nutrient load (nitrogen and phosphorus) flowing into Venice Lagoon.
Within this activity the Consortium designed and realized the project "Environmental Restoration of the low course of Zero River for the reduction of nutrient load flowing into Venice Lagoon", that aims at improving the purification processes inside the river and in the riparian areas, creating buffer zones and recovering the existing wetlands.

Problems of the area, reasons for restoration

Beside the main objective of reducing the total nutrient load that flows into the Lagoon, there are other important targets that characterize the project, according to the multidisciplinary logic typical of the modern River Restoration approach.

For the design of the intervention in the low course of Zero River, the Consortium considered different aspects, all connected to the safeguard of freshwaters quality:

- Solution of the problem related to the hydraulic risk (facilitating the seepage of water, reducing the speed of water flow and increasing the storage capacity)
- Better use of the water resource (i.e. irrigation and minimum ecosystem flow)
- Sediment control (creating localized sedimentation areas in order to reduce the maintenance workings)
- Improving natural and landscape value (i.e. more biodiversity, ecological network)
- Improving fruition
- Agronomic improvement of the soils and creation of new economic chances for farmers (i.e. woody biomasses to be used for energetic purposes)
- Studies for new maintenance techniques
- Experimentation and monitoring

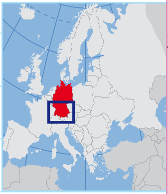
Measures executed

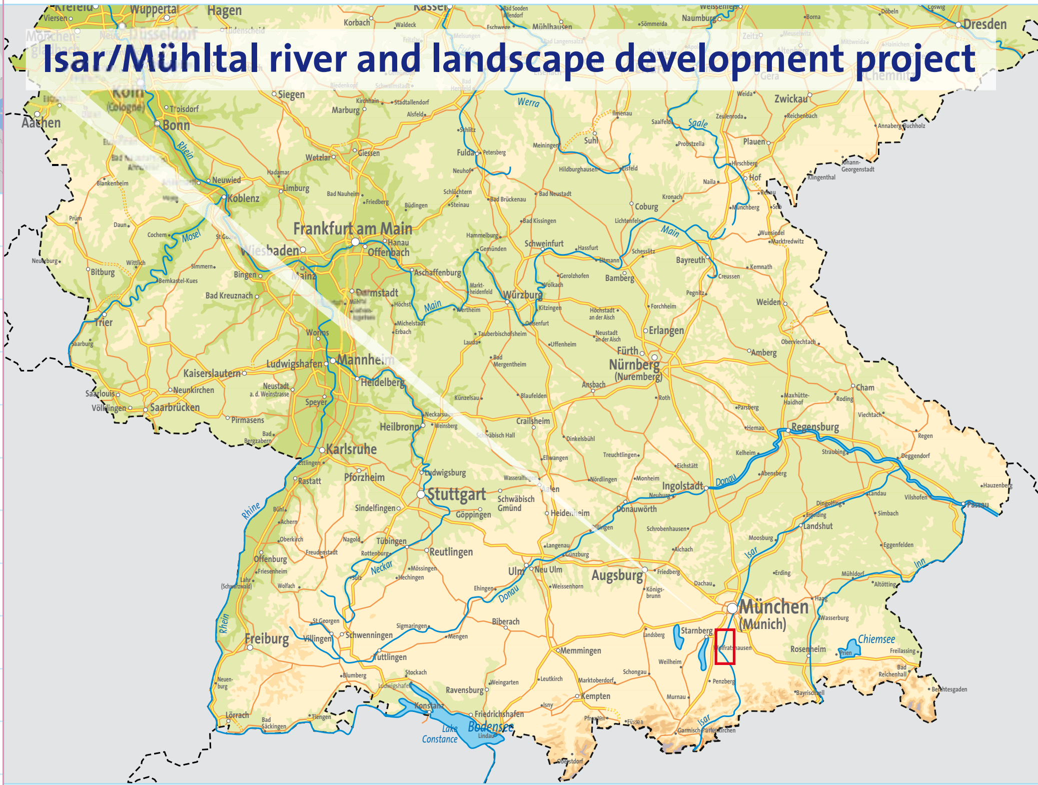
The river restoration of the low course of Zero River represent a practical example of how the Dese Sile Drainage Consortium tries to connect different targets, in order to protect the environment. Many different fields of activities have been integrated and this permitted to use innovative criteria beside the traditional ways. For example:

- Integration between hydraulic solutions and high environmental value solutions;
- Integration between interventions inside the river and the surrounding areas, identifying strategic areas both for water quality and flood peaks reduction;

- Integration of private and public actions, without using expropriation procedures and aiming at finding a common solution between public and private subjects, in order to protect the ecosystems;
- Facilitating the participation of the population living in the area, through involvement and the promotion of economic support from public sectors (i.e. agriculture and rural development funds, communitarian funds);
- Reversibility of all solutions: the adopted actions could not be the right ones...;
- Auto-sustainability of the solutions proposed: new formula were searched in order to make the project/process sustainable as well as the economic and financial point of view;
- Repeatability of the process.

Germany





Isar/Mühltal river and landscape development project

General

The project area is located 15 km South of Munich in the South-German federal state of Bavaria. The Isar river stretch subjected to redevelopment covers a length of about 10 km.

Natural dynamics, hydromorphological processes and ecology

In the beginning of the 20th Century the Isar was still and natural system with a braided riverbed within a wide alluvial forest, compared to the reference status, the once braided system.

Problems of the area, reasons for restoration

In order to satisfy the growing demand for electricity of an increasing population, between 1923 and 1927 a hydro-electric power station was constructed and an artificial bypass channel of the Isar river at Mühltal. The availability of sufficient water level was conditioned by constructing a weir at Icking and a hydropower channel system providing the station continuously with water. As a result, the long term natural low water discharge (MNQ = 40 m^3/s) of the river Isar in this area was reduced to 2 to 5 m^3/s in the remaining natural riverbed of the water course below the weir “Ickinger Wehr“. Additionally concrete bank constructions were installed to control floodwater and to support maintaining sufficient water levels for the hydro-electric station. As a result, the natural connectivity of the riverbed and the floodplain was disturbed, valuable wetland habitats were lost with resulting reductions in wild flora & fauna species, and the migration routes of fish species to upstream spawning areas became blocked.

A: Isar with the weir of Icking 1999 before the restoration project had started. B: Isar with weir of Icking, 2002. The restoration is on the way. By taking off the bank protection 1999 the hydromorphological processes to widen the river bed

Measures executed

The concession to run the power plant expired 1997. With the prolongation of the concession for the hydropower station there was the chance for redefining the Legal Conditions for the operation of the station. Major objectives for the project were: to transform the canalized river from static into more dynamic state systems (closer to its natural state); to enhance morphodynamic processes and to prevent further river bed erosion; to promote natural habitats in the riverbed and the riparian zone as well as their interconnection; to improve ecological quality for a variety of species; to allow the natural development of rivers where possible instead of continuous maintenance; to increase the landscape quality for the experience of nature („wilderness adventure“) and recreation; to use regularly flooded areas as retention basins in order to support flood storage capacity, flood control & safety; to re-establish the longitudinal biological river continuum („fish ladder“).

Results

A major requirement for approval of the concession was to restore the discharge at the “Ickinger Wehr“ up to 15 m^3/s (seasonal variation between 13 and 17 m^3/s). Additional measures improved the existing fish ladder by a pass enabling fish and other freshwater fauna to move freely upstream and downstream. The removal of concrete-reinforced river banks allows again the hydromorphological processes with erosion and sedimentation of gravel and more naturally-structured river banks. Weirs along the smaller tributaries, flowing into the Isar are replaced by ramps to improve also the lateral continuity of the main Isar river system, the continuous irrigation of specific areas in the meadow floodplain forest, the transport of gravel downstream of the weir “Ickinger Wehr“ and halting the removal of gravel upstream of the weir.

An information trail is established, explaining nature, techniques and culture along this Isar section. A recreation area near a bridge with parking facilities and restrooms is established

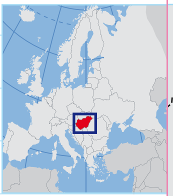
Cost-benefit analysis

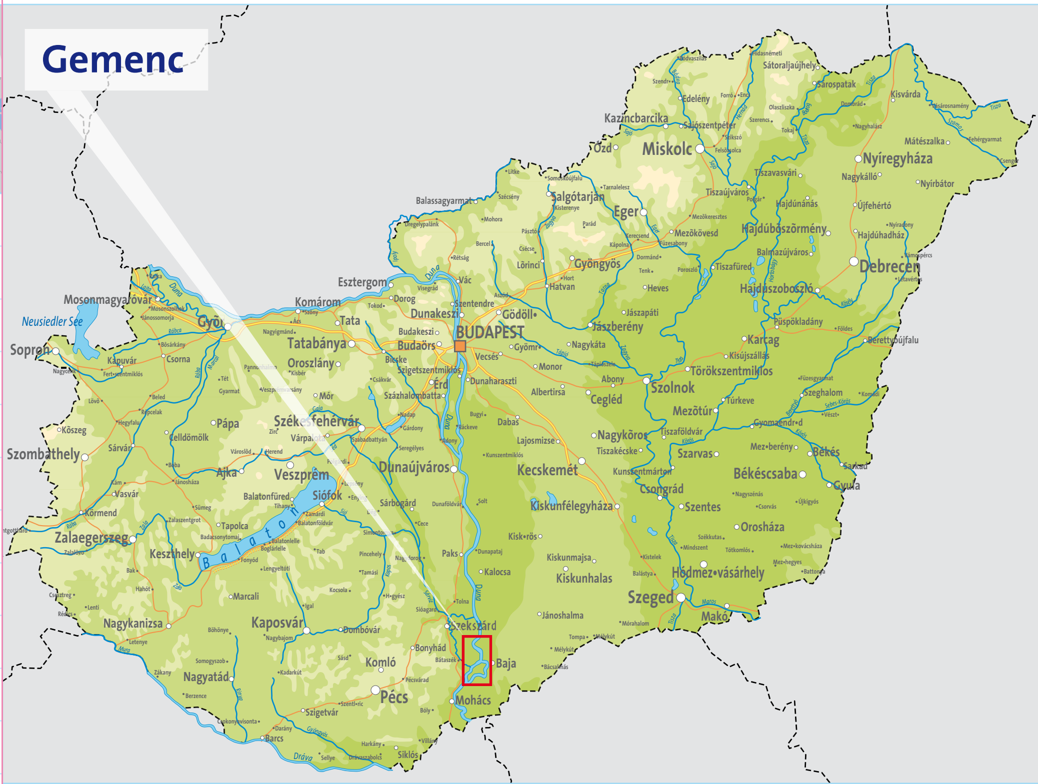
Costs for the Isar river reconstruction measures at "Mühltal" - the removal of bank protection and the construction of a bypass amounted to about 2 million euro.

Isar Mühltal, 2005, a natural river landscape is back again

● *Location of power pole in the Isar river bed*

Hungary





General

The Gemenc Protected Landscape Area is the widest floodplain zone in Hungary, situated on the right bank of the southern stretch of the main Danube stream, between the Sio channel and the city of Baja. The floodplain is characterised by several formerly active meander arm sections dissecting densely forested land, cut off the main stream or becoming isolated from it as a result of river training works. The Ven-Duna side arm is one of the shortest side arms connecting water bodies on the floodplain to the main Danube arm situated in the Gemenc floodplain.

Natural dynamics, hydromorpho-logical processes and ecology

Under natural conditions the Gemenc floodplain water bodies were characterised by flowing conditions and rheophilic fauna and flora, in which natural sedimentation processes conditioned the proactive decrease of water flow and related dynamic changes in environmental conditions.

The construction of water training works for river regulation along the Hungarian part of the Danube started in the middle of the 19th century. The main aim was to prevent extreme and destructive flow and flooding regimes, while improving the navigation conditions as additional purpose. The deepening of the Danube main stream, the accelerated siltation and up-filling of old side arms and the lack of water flow during average and low water flow conditions resulted in partial isolation and individualisation of different parts of the floodplain water bodies.

The Ven-Duna arm had the additional problem of being closed by a perpendicular rock dam on its upper part, completely inhibiting the water flow during average and low discharge conditions in its lower stretch. The dam excluded the side arm from water transport, resulting in more water and better navigation conditions in the main Danube channel, especially during average and low water flow conditions. As a consequence, the Ven-Duna increasingly showed problems of water quantity and water quality, and the original rheophilous flora and fauna was replaced by biota typical for stagnant water types. Meanwhile, on the terrestrial floodplain original hard wood forests characterised mostly by Quercus species were replaced by artificial plantations of soft wood species, mostly *Populus taxa*. Additionally non-indigenous invader species like *Fraxinus pennsylvanica* and *Solidago serotina* entered the area.

Measures executed

In order to obtain knowledge and experience on possibilities to restore natural hydro-morphologic conditions and the connectivity between the river and floodplain zone, a small-scale case study river restoration intervention was designed for the Ven-Duna side arm. The main objective of the restoration project was to provide for a direct water flow connection of the side arm with the Danube main stream in order to restore the natural biodiversity and rheophilic communities typical for aquatic

floodplain landscapes. The technical intervention of re-opening the side arm, executed in 1998, was accompanied by an extensive scientific research & monitoring program carried out in the Ven-Duna side arm and the River Danube between 1997 and 2000. The scientific research provided an adequate in-depth understanding to evaluate the positive and negative environmental consequences of the river restoration pilot study. These results of the detailed investigations and documentations provide knowledge of high benefit for comparable river & floodplain restoration projects in Europe.

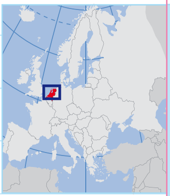
Results

Detailed physical and chemical monitoring performed to follow the hydromorphological, water quality and hydrobiological changes after the side arm rehabilitation activity being carried out in the Ven-Duna clearly showed that processes related to water flow were crucially important in determining the chemical and biological conditions in the Ven-Duna side arm.

Four years of monitoring showed changes in riverbed morphology upstream and downstream of the former rock dam. Restored high floods showed increased sediment transport, erosion and deposition. Biological monitoring revealed an increase in suitable habitats for rheophilous invertebrate and fish species. As such both species diversity as well as population numbers typical for dynamic water bodies increased, while stagnant water habitats and their species also remained. The deteriorated water quality in the side arm was restored completely following the opening of the rock dam. The study also showed that re-opening the side arm did not have negative impacts on the directional flow and navigational conditions in the Danube main stream.

As 4 years of monitoring maybe limited for understanding the complete processes of changes introduced by restoring the dynamic water flow pattern, it is worthwhile to continue the monitoring activities further in future, in order to follow long-term developments in the region.

The Netherlands



The Duursche Waarden Nature Development Project

General

The project area is located between the villages of Olst and Wijhe, some 20 km north of the old *Hanse* town of Deventer along the river IJssel - the northern branch of the river Rhine. The nature development area comprised a floodplain of 120 hectares.

Natural dynamics, hydromorpho-logical processes and ecology

About 150 years ago the river IJssel was already normalised and even some groins were installed. But the floodplains were still part of the river system and showed a large variety of side channels, pools, muddy banks and marshes. There was some space for natural dynamics such as sedimentation and erosion.

Problems of the area, reasons for restoration

At the end of the eighties there was movement within the nature organisations (NGO's) that started with the so-called "Plan Stork". The plan showed the possibilities of combining different functions in a riverine area successfully. End of the eighties national policy on nature and water management was ripe to carry out a by that time "big-scale" restoration project. The Duursche Waarden area was chosen because there were no changes in river functions due to the execution of the measures. The area was almost fully owned by the National Forest Service of Overijssel (*Staatsbosbeheer*). Therefore no problems concerning land acquisition occurred at this stage.

The leftovers of valuable natural nucleuses in the area promised to be a good start for further development. But the connection of the floodplain to the river was limited before 1989. Isolated waters occurred in the floodplain due to sand and clay mining. The area is mainly covered with grasslands, which are very attractive to meadow birds.

New chorelines for pioneer vegetation

Measures executed

Digging out the material connected the old clay pits and a big side channel was re-created because there was once an old gully running here. The summer dike along the river IJssel was partly excavated so that there was again the downstream connection of the river and the side channel. To get a bit more variation in landscape, another smaller channel was dug, which was fed only at higher water levels. Already in the first year after implementation the overflow barrier was eroded during high waters and so nature took over the redesign of the floodplain immediately.
A sand layer was put close to the river, to stimulate the development of Aeolian dunes. In order to increase the natural diversity due to flooding, droughts, sedimentation and erosion, another management was applied here - natural grazing. The natural grazers create smaller habitats and what is very important from water management point of view - they keep the vegetation growth in certain limits.

Results

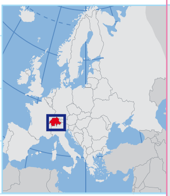
Bringing back dynamics into the floodplain was the driving motor for more diversity. Large monitoring programmes after the implementation of the project showed the developments of flora and fauna. In the evaluation report, it was realised that the limited water dynamics due to the fact that the side channel is just connected at one side downstream the river might be too limited in future especially for current-loving

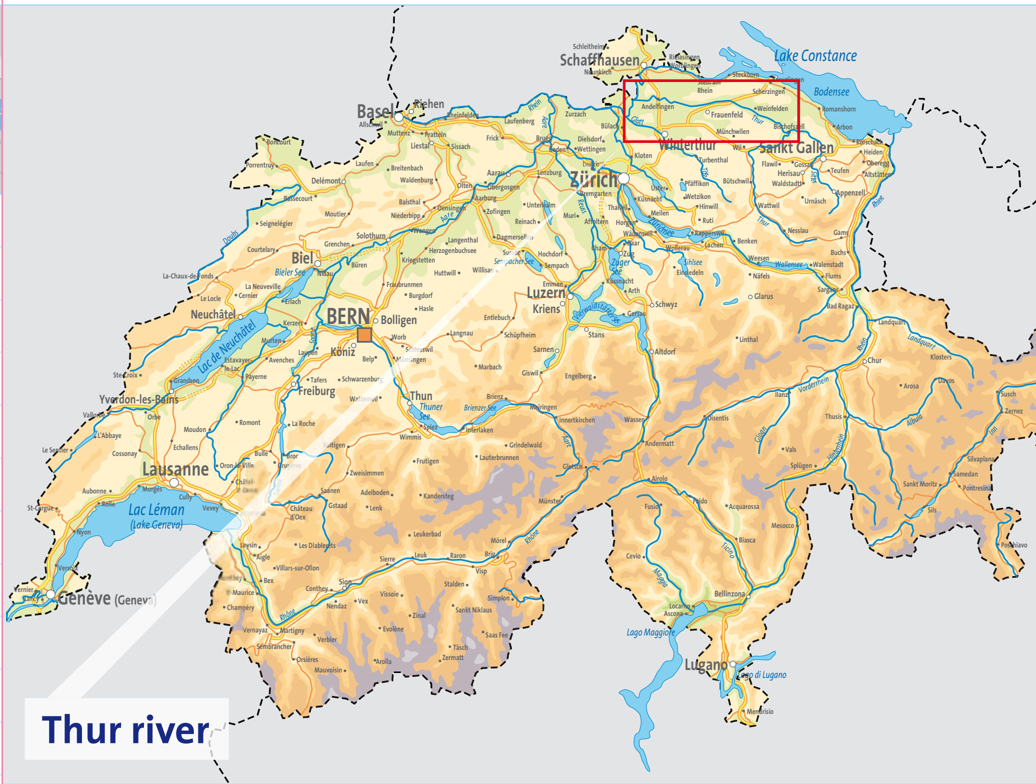
fish species and macro invertebrates. On the long term - the side channel maybe filled up with sediments and therefore might be separated from the river in a natural way. Recreation in the area increased and in 1998 a rubber boots path of 2,5 km length was implemented which shows all different habitats but is located along the border of the project area to not disturb the special species. Annually more than 15,000 visitors come to visit this area mainly for bird watching and walking. School classes, nature groups, government bodies and nature lovers join the field visits guided by a ranger. Meanwhile new works are carried out in a bigger area of the Floodplains of the IJssel (*IJsseluiterwaarden Olst*) about 450 hectares. This is due to the implementation of the National Programme of "Room for the River" in which floods of 16,000 m^3/s at Lobith (the location where the Rhine River enters the Netherlands coming from Germany) must be accommodated by the river Rhine. This means for the floodplains along the IJssel that more gullies or waters will be excavated in the coming years. The work will also be used to clean-up spots of contaminated soils or sites in the area.

Cost-benefit analysis

Costs for the implementation of the Duursche Waarden project were about 450,000 euro. The rebuilding of a chimney of the old brick factory (a cultural landmark) in the project area cost 252,000 euro. Now the implementation of the new plan in 3 phases is calculated at 26 million euro.

Switzerland





General

The Thur river is one of the main rivers in the Cantons St. Gallen, Thurgau and Zürich in Switzerland. The catchment area of the Thur river covers 1,750 km^2 with about 456 creeks and brooks. The Thur (length: 127 km) is a wild river with no lake or dam or big floodplain for retention (HQ100 = 1,350m^3/s, lowest runoff Q=2,24m^3/s, the average runoff is 47m^3/s). The highest point is the summit of Säntis (2,551m above sea level).

Natural dynamics, hydromorphological processes and ecology

Heavy rainfall combined with melting of snow and/or previous saturated soil cause a rapid rise in the water level and the river transforming into a fast-flowing torrent. Flood peaks commonly occur within a few hours after the onset of rains. The amount of bed load is 12,000 m^3/year.

Problems of the area, reasons for restoration

The first technical flood control works were constructed in the second half of the 19^{th} century. Their main purpose was taming the Thur river to protect the main Thur-valley against the regular intensive floodings ever causing immense damages to buildings, roads and crops, and to satisfy the need for new agricultural land on which to cultivate more food crops. Today, the ancient dikes and other measures applied in the late 19^{th} century no longer adequately cope with modern discharge conditions,

mainly due to insufficient heights, inappropriate construction materials, and poor maintenance. The river bed has been filled with sediment deposits, limiting discharge capacity and increasing flood peaks, while the increased human occupation of the valley in some places limits the extent of the floodplain while interfering with surface roughness (trees) in others.

Widening of Thur river stretch

Measures executed

After the catastrophic flooding due to the breaking of the dikes in 1978, urgent response measures included the repairing and heightening of the dikes and the removal of surface layer sediments from the confined stream bed. The increased attention paid to ecological aspects in later years resulted in a removal of the old stonewall parallel to the stream bed, while groynes were build in combination with obliquely placed blocks and willow trees.

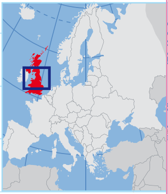
Results

The resulting variety of river works provide both protection while allowing the river a greater freedom to spread and move. Over a length of 1,500 m and a width of 500 m the Thur river now can redevelop its natural course, in which erosion and sediment deposition processes freely alternate. Scours and rapids as well as wandering gravel beds have once again become a part of the river. The newly designed successfully was tested by the flood of 1999 (Q 1,000m^3/s), in which only a few blocks have been moved downstream, and no extensive repairing appeared necessary. The river restoration works also proved a great success for the ecological state of the Thur river - fish species like the *Chondrostoma nasus* and bird species like the *Actitis hypoleucos* found

new habitats within the new river landscape. The experiences with the river restoration project of the Thur river provide important perceptions for further projects on other rivers. More space for rivers gives opportunities to restore natural wild flora and fauna. Besides, the character of the river changes from a dull canal to a diversified river environment, offering opportunities for tourism and recreation. The Thur river restoration project shows that flood control by means of nature friendly technical river works not necessarily oppose nature conservation interests.

Bank protection with rip-rap of willows

United Kingdom



The Skerne restoration project

General

The river Skerne flows in to the River Tees south of the town of Darlington, County of Durham. The lowland river basin catchment covers 250 km², mainly consisting of limestone geology capped with boulder clay, with river floodplain areas of glacio-fluvial sands and gravels. Besides Darlington the basin includes several small towns and a number of industrial sites that historically polluted the river.

Natural dynamics, hydromorphological processes and ecology

Old maps show that once the Skerne river meandered freely within a wide floodplain. Typical features of the natural meandering river and its floodplain included meander cut offs, regular flooding of the floodplain to store water in times of high floods. The variety in aquatic and terrestrial riverine habitats provided the basic conditions for a rich and abundant flora and fauna diversity.

Problems of the area, reasons for restoration

Throughout its urban reaches, the river floodplain has become affected by the long-term encroaching of industrial and urban developments. Over the past 200 years the River Skerne has undergone straightening and deepening for flood control and drainage of the surrounding area. Much of the floodplain has been raised high above the river by industrial waste tipping (mainly from iron workings).

Today, river restoration opportunities are limited further by housing and industry built upon the raised floodplain.

In Haughton-le-Skerne, a northeast suburb of Darlington, a small stretch of floodplain has more-or-less survived the consequences of human developments. The surviving river however is severely impacted by previous river straightening and dredging works, and has many utility services (gas and sewer pipes), as well as the presence of buried electricity lines, routed through it. Housing and a landfill also encroach onto the floodplain locally, limiting public access.

New constructed meander

Measures executed

Between Autumn 1995 and Spring 1997, restoration works were implemented along a 2 km stretch of the Skerne river in Darlington. Main objectives of the project included the restoration of physical features, flood management, habitat diversity, water quality, landscape and access for the community. In addition, the project paid special attention to designing innovative techniques, methodologies and practices suitable for implementation in an urban environment. Comprehensive monitoring increased the practical knowledge of river processes and possibilities for their restoration. Community understanding and support was enhanced by involvement and co-ordination by a locally based full time Project Liaison Officer.

Restoration primarily but not exclusively focussed on returning a more appropriate channel form over 800m in single ownership. Four new meanders have been formed in a remaining section of floodplain used as open parkland. Backwater zones important for wildlife were restored. During high floods the backwaters provide shelter especially for young fish. The related wildflower wet grasslands attract other flora & fauna species including dragonflies and damselflies feeding on the grassland plant species. The excess soil was used to landscape nearby valley slopes to screen industry from the residential areas. In the re-meandering zones, natural techniques were applied to strengthen the banks with a combination of stone, wood and plants (willow and reeds) to prevent erosion by means of a protective natural cover. Thirteen ugly surface water outfalls have been replaced with underground inspection /collection chambers that firstly intercept pollution and then discharge the water into the river below water level. Elsewhere, where the river could not be re-meandered, it has been enhanced by reshaping and narrowing the bed using riffles and in-stream flow deflectors to vary the flow, forcing the water to change direction, forming pools and shallows. Banks were re-profiled to a gentler, safer angle to increase visibility, remove alien species and help native riverside plants to flourish. New footpaths and planting schemes complete the theme of "bringing the countryside into town", which locally has been greatly appreciated.

Results

The Skerne river restoration demonstration project shows what can be achieved in an urban environment. Today, restored shallow flooding of planted grassland removes silt from the river, while waders feed in remaining floodplain pools. Introduced riffles and deflectors created pools and shoals resembling natural conditions. Wetland flora and fauna was enhanced, recording previously absent or uncommon swans, fish species, dragonflies and the protected water vole. The method of surface water draining into the river has been improved, while visibility has decreased by subsurface outflows. A variety of planting schemes added colour and life to the floodplain, created visually more attractive landscapes. Foot paths, bridges and shallow bank slopes provide additional opportunities for recreation.

Cost-benefit analysis

The situation is typical for many small rivers traversing towns and cities where the ecological, visual and recreational capacities have suffered. The Skerne river restoration project as such is a valuable pilot site demonstrating various methodologies for improving more natural river conditions within an ever expanding urban landscape environment. The knowledge and experiences gained in the demonstration project means that other projects can be more confident about organising, funding, designing and implementing river restoration projects.
Total costs of the demonstration project are assessed at 500,000 for implementation of technical works. A detailed independent community survey showed the support of 82% of the community only one year after completion of the technical works. Main perceived community benefits include “increased wildlife & habitat”, “improved landscape quality”, “improved recreation”, “reduced flooding risk”, and “good value for money”.

Arial view of the river

Acknowledgements

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List of abbreviations

CIRF	Italian Centre for River Restoration
ECRR	European Centre for River Restoration
EU	European Union
GEF	Global Environment Fund
LIFE	Financial Instrument for the Environment of EU
LNV	Netherlands Ministry of Agriculture, Nature Management & Food Quality
NERI	Danish National Environmental Research Institute, part of the university of Aarhus
PHARE	Programme of Community aid to central and east European countries
RRC	River Restoration Centre, United Kingdom
RWS-WD	Rijkswaterstaat - National Centre for Water Management, The Netherlands
TACIS	Technical Assistance in the Commonwealth of Independent States
UNDP	United Nations Development Programme

Main EU acronyms and abbreviations are listed at:
http://publications.europa.eu/code/en/en-5000400.htm#fnp

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