Restoration Cases Flagship Collection

Case #19

Restoring floodplains and wetland corridors in the Lower Danube River and Danube Delta

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FORESTORATION INTERNATIONAL

A channel in the Danube Delta Biosphere Reserve.
Photo credit: Daniel Petrescu/Danube Delta Biosphere Reserve Authority

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In brief

Overview

From its origins in Germany, the Danube River flows through 19 countries. Decades of mismanagement led to devastating impacts on forests and wetlands in the Lower Danube floodplains, which extend over 1,000 km though Bulgaria, Romania, Moldova, and Ukraine before reaching the Black Sea. By 2008, 72% and 30% of the floodplains were lost in the Lower Danube and the Danube Delta, respectively. In response to more frequent flooding, declining soil fertility, and species and habitat loss, international efforts began in 2000 to protect and restore the forested floodplains and wetland ecosystems through the Lower Danube Green Corridor Declaration. By 2020, over 60,000 hectares of Lower Danube floodplains were under restoration. Water quality has improved and flood risk has decreased. The Danube Delta Biosphere Reserve has largely achieved its objectives for conservation of globally significant biodiversity.

Exemplary practices

Country-level action plans designated priority areas of floodplain for protection and restoration. International conventions focused on improving water quality and reducing flood risk in the Danube River Basin. The Danube Delta Biosphere Reserve created opportunities for restoration and cooperation between countries, government agencies, NGOs, and local communities. European Union support for research and strategic partnerships has increased knowledge and capacity of organizations. Dikes were removed in some parts of the Danube Delta to restore flooded wetlands. In many small sites, invasive plant species were removed and tens of thousands of native trees were planted, assisting forest natural regeneration over larger areas. These activities, along with other floodplain management plans, are contributing to more effective floodwater retention, improved freshwater ecosystem services, and return of native biodiversity in the region.

Key lessons learned

- *Site-based restoration interventions through small-scale pilot projects serve to demonstrate and test approaches, engage local communities, and provide capacity building opportunities.*
- *Transboundary collaboration and implementation require the support of internationally-accepted institutional mechanisms and capable NGO partners.*
- *Restoring floodplains enables positive impacts across sectors, including agriculture, energy, transport, and tourism.*
- *The first step of restoration often requires stopping or reversing degradation.*
- *Restoring floodplain ecosystems requires paying attention to the complexity of feedback loops across different ecosystems.*

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Restoration narrative

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Restoring floodplains and wetland corridors in the Lower Danube River and Danube Delta

Visit and learn more about the project's ecological analytics here:

Danube Delta Biosphere Reserve
Romania

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"Nature is fundamental to people: you cannot separate us from nature. It directly affects us when water is polluted, or when villages are flooded because of destroyed dikes."

—Mykhailo Nesterenko, team leader of Rewilding Ukraine

Geography and ecological setting

From its origins in Germany's Black Forest, the Danube River flows eastward over 2,850 km through 19 countries to the Danube Delta on the Black Sea. It is the second-longest river in Europe, covering nearly 80,000,000 ha (ICPDR, 2015). The Danube Basin provides drinking water, hydropower production, fisheries, agricultural production, and transport for 80 million people (Mansourian et al., 2019). Along its entire course, the Danube River connects with 27 large and over 300 small tributaries (Schmid et al., 2023).

The Lower Danube River cuts through the Iron Gate gorge in the Carpathian Mountains of Romania and Serbia and extends over 1,000 km through Romania, Bulgaria, Moldova, and Ukraine before reaching the Black Sea (Figure 1). The floodplain of the Lower Danube River originally covered 8,173 km^2, and the Danube Delta's floodplain covered 5,402 km^2 (Schneider et al., 2009). These floodplains broaden downstream and comprise numerous floodplain lakes, river islands, wetlands, gallery forests, levees, and sand dunes (Schneider et al., 2009). The Lower Danube has a total of 255 islands: 58 in Bulgaria (10,492 ha), 167 in Romania (75,954 ha), and 30 in Ukraine (31,251 ha) (Mansourian et al., 2019). The Lower Danube River is one of the last free-flowing stretches of river in Europe and provides drinking water, recreation, and other environmental services that support the lives of 29 million people (WWF, 2012).

As it enters the Delta, the Danube River forms three major branches: Chilia, Sulina, and Stântul Gheorghe (Saint George). The Danube Delta is a low alluvial plain, consisting of an intricate pattern of marshes, channels, streamlets, and lakes, and is Europe's largest wetland, with 170,000 ha (420,079 acres) of reed beds (Danube Delta Biosphere Reserve). Vegetation of this ecosystem consists of the common reed (*Phragmites communis*), cat tail (*Typha latifolia, Typha angustifolia)*, sedge (*Carex dioica, Carex stricta*), Dutch rush (*Scirpus radicans, Schoenoplectus lacustris*), and brook mint (*Mentha aquatica*). The Danube Delta is a meeting point of Palearctic and Mediterranean biogeographic zones with a high number of wetland habitats and rich biodiversity (Schmid et al., 2023). Located along major migratory routes, the Delta attracts birds from six major ecoregions of the world, including the Mongolian, Arctic, and Siberian.

Figure 1. The Lower Danube Green Corridor (in dark green) is an international effort involving four countries: Romania (RO), Bulgaria (BG), Moldova (MD), and Ukraine (UA). Source: WWF Fact Sheet, 2010; http://awsassets.panda.org/downloads/wwf_ldgc.pdf

During the summer, over 320 species of birds use the Delta, of which 166 are nesting species and 159 are migratory (Gâştescu, 2009; Figure 2). The transboundary Danube Delta Biosphere Reserve was designated in 1998 to protect its unique biodiversity.

In the Lower Danube River, white willow (*Salix alba*) stands predominate in frequently flooded gallery forests and islands. In less flooded areas, black poplar (*Populus nigra*), white poplar (*P. alba*), and grey poplar (*P. canescens*) grow on alluvial soils with a high proportion of sand. On the Romanian stretches of the Lower Danube, hardwood forests include stands dominated by Balkan oak (*Quercus pedunculiflora*) and small-leaved ash (*Fraxinus angustifolia*), with sub-dominant common oak (*Quercus robur*) and hairy ash (*Fraxinus pallissae*) (Schneider et al., 2009; Mansourian et al., 2019).

Diverse habitats in the floodplains of the Lower Danube support a high diversity of aquatic and terrestrial fauna. Seven of Bulgaria's islands and island groups are classified as Important Bird Areas (IBA), three are transboundary Ramsar sites, and almost all of the islands are included in the EU network NATURA 2000, highlighting their ecological and conservation importance (Mansourian et al., 2019). Animal diversity is high along the lower stretch of the river, including 42 different species of mammals, such as the near threatened Eurasian otter (*Lutra lutra*), the critically endangered European mink (*Mustela lutreola*), and the steppe polecat (*Mustella eversmanni*), in addition to 69 species of fish (Sommerwerk et al., 2009; Schmid et al., 2023). Insects make up 74% of the total aquatic species biodiversity in the Danube River (Graf et al., 2015).

Within the Danube Delta Biosphere Reserve, 135 species of fish have been recorded (Gâştescu, 2009). Several species of fish migrate upstream annually from the Black Sea to spawn in the river's rocky substrates, including the highly threatened Stor sturgeon (*Acipenser stellatus*), Black Sea sturgeon (*Acipenser gueldenstaedti*), and Beluga sturgeon *(Huso huso*) (Schneider et al., 2009). Danube sturgeon species have become flagship species for conservation efforts in the Danube Basin (Schmid et al., 2023).

In addition to their importance for supporting biodiversity, floodplain forests and wetlands play a crucial role in regulating flooding, maintaining water quality, preventing soil erosion and sedimentation, and storing carbon. The carbon sequestration value alone of the entire Danube basin was estimated at EUR 29 million per year (Tucker et al., 2010).

Figure 2. Dalmatian Pelican (Pelecanus crispus) and Great Cormorant (Phalacrocorax carbo) in the Danube Delta. The Dalmatian pelican is classified as Near Threatened on the IUCN Red List. Photo credit: Cody Escadron Delta, Wikimedia Commons

Population density in the Danube Delta is low, approximately 5 persons/km². The population has been declining for the past 25 years. High levels of out-migration from the Danube Delta to other counties and out of Romania, has resulted in a steady population decline from about 14,000 in 2002 to about 11,000 in 2012 (World Bank, 2015). With 14 nationalities represented, most residents are Romanians (77%), Russian Lipovans (17%), or Ukrainians (3.5%), and there are small communities of Greeks, Roma, Turks, Tatars, and Hungarians (Gâştescu, 2009; Gómez-Baggethun et al., 2019). Historically, fishing was the main livelihood of residents (Gâştescu, 2009). Now, roughly two-thirds of the population are supported by fisheries and agriculture. Less common livelihoods include animal husbandry, cattle grazing, beekeeping, and tourism (Gómez-Baggethun et al., 2019).

Environmental degradation history

River courses in the Danube River Basin have been altered since the 16th century for flood control, generation of hydropower, and navigation (Giosan et al., 2012). Since the 1960s, more intensive management, development, and flood control measures led to devastating impacts on forests and wetlands in the Lower Danube River and the Danube Delta (Figure 3; Ebert et al., 2009). The floodplains of the Lower Danube River were impounded on a large scale to enhance navigation, and large areas of wetland were drained and converted into agricultural holdings and ponds for fish production (Staras, 2001; Hein et al., 2016).

In Bulgaria, floodplain forests were converted to hybrid poplar monocultures on a large scale, leaving only 30% of the area covered by native tree species in 2000 (Mansourian et al., 2019). From 1930 to 1972, dammed areas on the Romanian sector of the Lower Danube reached a cumulated total area of 410,227 ha (Dumitrescu and Carsmariu, 2014).

By 2008, 72% and 30% of the floodplains were lost in the Lower Danube and the Danube Delta, respectively (Schneider et al., 2009; Figure 3).

Extensive loss of floodplains in the upper and central reaches of the Danube River (95% and 75%, respectively), further impacted water flows and quality for downstream ecosystems. Cutting off the floodplains from the river dramatically reduced fish populations and caused decline of river fisheries. Of 51 species recorded in the first half of the 20th century, only 31 have been recorded recently (Schneider et al., 2009). Large dikes and cross-cutting meanders and river branches also affected the quality of drinking water in certain areas by suppressing the exchange of water between the rivers and groundwater reserves (ICPDR n.d.).

In the Danube Delta, embankments were built across more than 100,000 ha to reclaim land for agriculture (ICPDR n.d.). In the 1980s, the communist regime in Romania aimed to convert 41% of the Delta into agricultural areas; by 1990 more than 80,000 ha of wetlands were reclaimed for agriculture, fish farming, and forestry (Ionescu et al., 2022). Water flows were extensively altered by the development of agricultural polders, predominantly in the Northwestern part (Gómez-Baggethun et al., 2019).

Floodplain loss took a significant human and economic toll (Ebert et al., 2009). Between 1992 and 2005, floods in Romania caused an estimated EUR1.66 billion in damages, exceeding the gross national product (GNP) by 0.6% (Ebert et al., 2009).

Figure 3. The Kalimok marsh, Bulgaria in the Danube River Basin has been reconnected with the river, restoring spawning places for aquatic animals. Photo credit: Alexander Ivanov

In 2005 a flood in Bulgaria killed 20 people, displaced 10,000 people, and caused USD 625 million (EUR 444 million) in damages. In 2006 a flood in Romania displaced 15,000 people and inundated 80,000 ha (Ebert et al., 2009). Conversion of floodplain forest to agriculture and monoculture hybrid poplar plantations resulted in more extreme flood events, which are worsening with climate change. In 2010, the severity of floods in the Danube River Basin led to 35 casualties and damages valued at EUR 2 billion (ICPDR, 2012).

Anthropogenic pollution from cities, agriculture, and industry particularly affected the lower reaches of the Danube River, leading to a hypoxic “dead zone” in the Black Sea Estuary (Behrendt, 2008; Ebert et al., 2009). In the early 2000s, nutrient emissions into the Danube River were estimated to be about 70% higher than in the 1950s (Mölder and Schneider, 2011).

Seeds of invasive plants spread by the natural water flows and were aided by transport vessels. The proliferation of non-native invasive tree and shrub species—including false indigo bush (*Amorpha fruticosa*), the tree of heaven (*Ailantus altissima*), ash leaved maple (*Acer negundo*), and green ash (*Fraxinus pensylvanica*)—negatively affects the species composition, structure, and function of floodplain ecosystems. (Mansourian et al., 2019).

Poplar plantations and open areas are particularly vulnerable to invasion.

The Danube River Basin is highly vulnerable to invasive aquatic animals due to direct linkages with other large water bodies (Schmid et al., 2023). Nine of the 10 most frequent macroinvertebrate species are non-native. Benthic assemblages of the Danube River are now dominated by nonindigenous, invasive, or cosmopolitan species, and about 30 fish species have been introduced or migrated into the Danube River Basin (Schmid et al., 2023).

The turning point

The transformation of the Lower Danube floodplain was considered the most devastating anthropogenic alteration of a fluvial wetland in post-war Europe (Constantinescu et al., 2015). Continued diking and dredging would lead to incision of the river bed and sinking of ground water, causing wells and riparian wetlands to dry up (WWF, 2012). Restoration actions in the lower Danube River and Delta were motivated by a convergence of several urgent issues: devastating floods, toxic pollution, nutrient loading, declining productivity of agriculture, and biodiversity loss. But it took major political and social change to stimulate action. The fall of the Iron Curtain in 1989 created new opportunities for political, economic, and cultural development in Eastern Europe, encouraging national and international efforts to address environmental and ecological problems (Dorondel et al., 2021; Schmid et al., 2023).

In 1990, the Romanian government established the Danube Delta Biosphere Reserve (DDBR), covering 5,800 km^2. In 1998, an adjacent Ukrainian portion of the Biosphere Reserve was designated, enlarging the surface area to 7,322 km^2 (UNESCO, 2019). The area was placed on the List of the World Cultural and Natural Heritage Sites in 1990 (Gâştescu, 2009).

Under the RAMSAR Convention the DDBR was recognized as a wetland of international value and major water bird habitat in 1991. Policy instruments established by the European Union, such as the Habitats Directive in 1992 created an important framework for countries wishing to join the European Union (such as Romania and Bulgaria which joined in 2007) to integrate and upgrade their environmental standards (Mansourian et al., 2019).

In 1992, the World Wide Fund for Nature (now World Wildlife Fund for Nature; WWF) initiated the Green Danube program, focused on conservation, restoration, and sustainable management. The program required governmental and non-governmental groups to work together throughout the basin. In 1994, the Convention on Cooperation for the Protection and Sustainable Use of the Danube River was signed. National and international organizations joined together to implement basin-wide management plans, culminating in the formation of the International Commission for the Protection of the Danube River (ICPDR) in 1998 (Schmid et al., 2023). The ICPDR implemented the Danube River Protection Convention (DRPC) to achieve three key objectives: 1) ensure sustainable water management; 2) control pollution and reduce inputs of nutrients and hazardous substances; and 3) control floods and ice hazards.

The Bulgarian National Forestry Board (NFB), Ministry of Environment and Water (MoEW), Green Balkans, and WWF came together to form a Wetlands Working Group in 1998 to coordinate and support floodplain and wetland conservation and restoration in the Bulgarian part of the Danube basin. Over 130 environmental NGOs signed a joint declaration drafted by the NFB, MoEW and the Ministry of Rural Development and Public Works on the importance of Danube wetlands and the need for their conservation, restoration, and sustainable management (Mansourian et al., 2019).

Following these efforts, a joint declaration was signed in 2000 by the Environment Ministers of Bulgaria, Romania, Ukraine, and Moldova to establish a Lower Danube Green Corridor (Figure 1). This agreement commits the four countries to preserve a total of 935,000 ha, including enhanced protection for 775,000 ha of existing protected areas and new protection for another 160,000 ha; to restore 224,000 ha of former wetland areas; and to promote sustainable development along the Lower Danube (WWF, 2012). The declaration provided the backbone for restoration activities in the wider Lower Danube corridor or landscape, generating a series of projects over the next 20 years (Table 1; Figure 4). Seventeen wetlands along the Lower Danube were identified as priority areas for restoration (Dumitrescu and Carsmariu, 2014). The stage was now set for initiating restoration interventions all along the Lower Danube River and the Danube Delta (Figure 4).

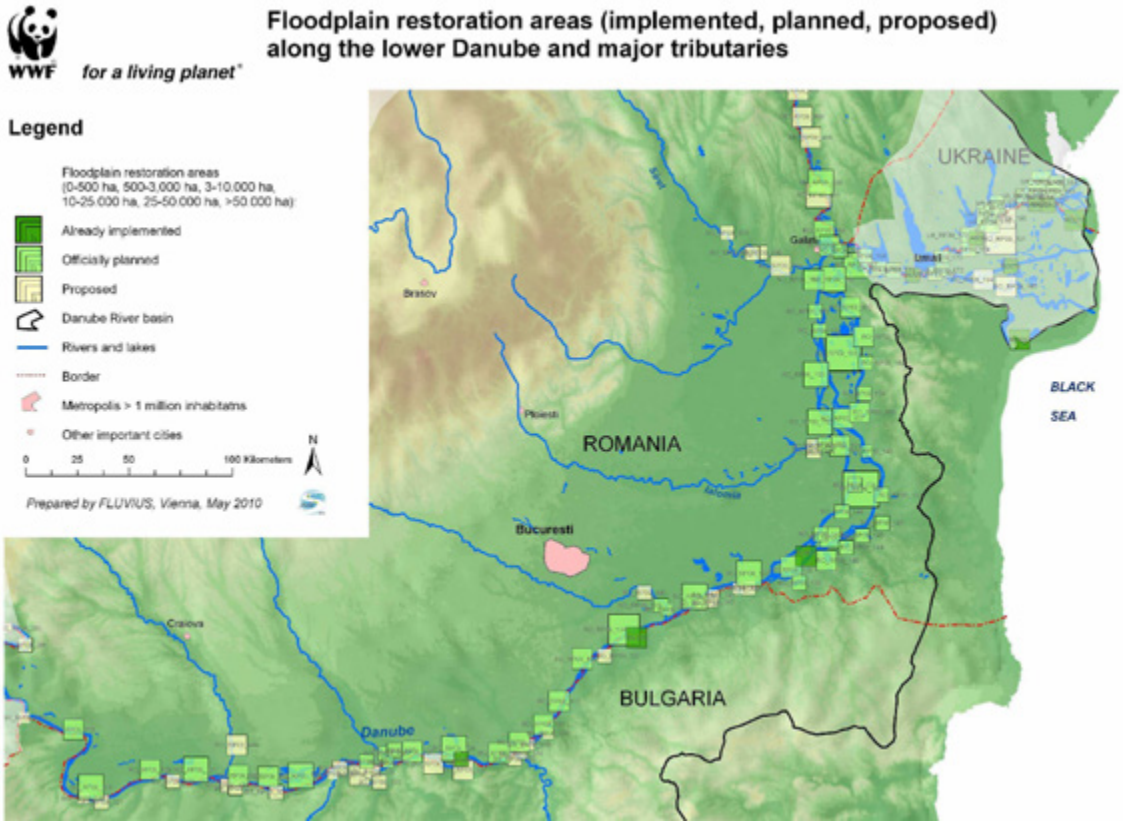


Figure 4. Floodplain restoration areas (implemented, planned, and proposed) along the lower Danube River and major tributaries. Source: Schwarz, 2010

Actors and international platforms

A diverse group of actors became engaged in restoration activities within the Lower Danube River and the Danube Delta, operating at local, regional, national, and international scales. At the local district level, communities participated in tree planting and other activities. However, the main actors involved in planning and implementing restoration projects have been public sector land managers from the forestry and the environment departments, guided by a series of national and international directives. National forestry agencies played a key role in restoration planning and implementation, as the public forest estate composed most of the forestland in all countries within the Danube River Basin. The Ministries of Environment and Waters initially provided the enabling framework and policy environment to initiate Lower Danube restoration programs (Mansourian et al., 2019).

In the late 1990s and early 2000s, WWF played an important role stimulating partnerships to promote restoration of the Lower Danube corridor. WWF was actively involved in developing forest landscape restoration projects in the region and in 1999 collaborated with the World Bank to influence the Bulgarian Danube forestry strategy (Mansourian et al., 2019). Following intense lobbying by WWF and other NGOs, the government of Bulgaria developed a new strategy in 2001 for its Danube River floodplain forests. WWF, the World Bank, the United Nations Development Program, the UN Food and Agricultural Organization as well as the Bulgarian NGO Green Balkans supported the government to implement this strategy for the conservation and restoration of the Danube islands floodplain forests.

The ICPDR provided regional strategy and a platform for negotiations across the four Lower Danube countries and with other partners. For the nine EU countries of the Danube Basin, the Water Framework Directive (WFD) provided another important framework for restoration interventions in the Danube. This directive serves to protect and enhance the status of aquatic ecosystems, prevent their deterioration, and ensure the long-term, sustainable use of water resources throughout the EU (Mansourian et al., 2019).

The Danube Delta National Institute for Research and Development (DDNI) was established in Romania in 1970 to conduct basic and applied research for scientific support of the management of the Danube Delta Biosphere Reserve (DDBR) and other wetland areas of national and international interest, with particular focus on biodiversity conservation and sustainable use.

They carried out research projects in collaboration with RIZA Institute (Netherlands), Institute for Floodplain Ecology, Rastatt, World Bank, and WWF Germany.

Other European and regional NGOs became engaged in restoration efforts. As of 2012, a Dutch foundation called Rewilding Europe began rewilding efforts in the Danube Delta (Rewilding Europe, 2018). Rewilding Europe and Rewilding Ukraine signed a five-year partnership in 2017 to work together to promote and conduct rewilding activities on the Ukrainian side of the Danube Delta. By linking the Romanian and Ukrainian sides of the Delta, this milestone agreement supported cross-border cooperation involving a range of local authorities and partners. Rewilding Europe works with four main partners as part of the Danube Delta Initiative (UNEP, 2022; Table 1): Rewilding Danube Delta, registered in Tulcea (Romania), Rewilding Ukraine, registered in Odessa (Ukraine), Verde e Moldova (Moldova) and WWF-Romania. Rewilding Danube Delta has their own local partners, such as Danube Delta Biosphere Reserve Authority in Romania, Danube Biosphere Reserve in Ukraine, the Danube Delta Research Institute (INCDDD) in Romania, and the municipality of Sfântu Gheorghe in Romania. Currently, they have financial support from the Endangered Landscapes Program to integrate the Delta's aquatic and terrestrial components at a landscape scale—from steppes and small tributaries to wetlands, lakes, streams and extensive, ancient coastal sand dune systems (Rewilding Europe, 2018). The local Birdlife International partner 'Romanian Ornithological Society' and the conservation project Pelican Way of LIFE also played a role in restoring floodplain forests on the Danube islands.

Costs, funding and other support

Overall, the cost of floodplain restoration along the 37 sites of the Lower Danube Green Corridor was estimated at EUR 183 million (Ebert et al., 2009; Faivre et al., 2018). But the financial benefits of restoring ecosystems in the Lower Danube River and Danube Delta greatly exceed these costs. Expected earnings through ecosystem services, restored fisheries, and enhanced tourism are estimated to yield EUR 85.6 million per year. A study by Schwarz et al. (2006) found that, on average, ecosystem services from one hectare of floodplains can provide an estimated return of EUR 500 per year. Based on Romanian pilot projects, dike removal costs were estimated to be EUR 50,000–200,000 per km (Schwarz et al., 2006).

Further, the restoration of four polders (drained lands used for agriculture or forestry) covering 1,000 km^2 in Romania would cost around EUR 20 million, hold 1,600 million m^3 of floodwaters, and generate ecosystem services worth EUR 50 million per year (Schwarz et al., 2006). Implementation costs for restoring Babina and Cernovca agricultural polders in the Danube Delta were USD 83,176 for each polder (Cox et al., 2022; Box 1).

Funding sources have diversified widely since the first restoration projects began in 1992. The European Commission provided important sources of funding for early projects to restore the Middle and Upper Danube River. Floodplain restoration in the Lower Danube has mostly been supported by external aid, in large part from the European Union. The European Commission provided funding for restoration projects in the Lower Danube River and Danube Delta, supporting over 30 LIFE projects to restore the Danube River since 1992 (Mansourian et al., 2019).

The World Bank and the Global Environmental Fund (GEF) also provided support for reforestation and floodplain restoration, including a contract with the Moldovan government to buy 1.3 million tons of carbon through the BioCarbon Fund from 2002 to 2022 (Mansourian et al., 2019). The private sector also became engaged in supporting projects. The Coca Cola company invested in a partnership with WWF and the ICPDR to restore over 5,300 ha of wetland habitat by 2020 (WWF, 2021b).

Implementation and results of pilot projects

For the first 20 years, restoration of floodplains in the Lower Danube River and Danube Delta was implemented through a series of small pilot projects. Over time, successful projects have expanded or were replicated under similar conditions, led by evolving partnerships at local, regional, national, and international scales (Table 1).

Early on, capacity building efforts were undertaken in Bulgaria to train forest service staff. WWF, in partnership with its WWF-Auen Institute in Germany (now the Department of Wetland Ecology at the Karlsruhe Institute of Technology), offered courses and exchange visits to assist the Bulgarian forest service in mastering the management of native tree species. Networking and study tours also broadened understanding of Bulgarian forest agency staff. In Moldova, WWF and IUCN staff were trained to identify priority areas within a landscape for restoration using the Restoration Opportunities Assessment Methodology (ROAM) in three communities (Mansourian et al., 2019).

Restoration interventions in the Lower Danube River were concentrated along the banks of the river and the floodplain forest on the islands, in the landscape defined by the Lower Danube Green Corridor Declaration (Figure 1 and Figure 4; Mansourian et al., 2019).

From 1996 to 2000, riparian forest restoration activities were implemented by the Bulgarian forest authorities along the Danube River and Golyam Vardim Island. A series of pilot projects from 2004 to 2019 focused on restoring native forest ecosystems in former poplar plantations; each time lessons were learned that improved success. One of the largest restoration projects on Gradina Island involved removal of false indigo, full soil preparation, and planting an area of 27 ha with pedunculate oak, black poplar, white willow, and white elm (Mansourian et al., 2019).

In Romania's Turcescu and Fermecatu islands, invasive species were mechanically removed from 2006 to 2010 followed by active planting of white willow and white poplar on 26 ha to replace hybrid poplar plantations. Once these trees established, black poplar also started regenerating spontaneously, enriching the composition of native species (Mansourian et al., 2019).

In 2016, a floodplain area of the Romanian section of the Danube formerly used for fish farming, Gârla Mare and the adjacent Vrata site, was reconnected to the river channel and restored to a 400-ha marsh (WWF, 2021b). Interventions involved consolidating and raising the banks of the transversal canal to increase the water flow from the Danube and creating water holes to obtain a mosaic of habitats for aquatic species (Figure 5).

Date	Event	Actors	Accomplishments
1990	Establishment of Danube Delta Biosphere Reserve	Romanian government	Protected and restored 5,800 km^2 of wetlands and floodplains
1998	Formation of the International Commission for the Protection of the Danube River (ICPDR)	12 countries that compose the Danube Basin	Encouraged sustainable water management, reducing inputs of nutrients and hazardous substances, controlling floods and ice hazards
1998	Formation of Wetlands Working Group	The Bulgarian National Forestry Board, Ministry of Environment and Water, Green Balkans, WWF	Coordination and support for floodplain and wetland conservation and restoration in the Bulgarian part of the Danube basin
1998	Designation of Ukrainian portion of Danube Delta Biosphere Reserve	Ukrainian government	Surface area of Biosphere Reserve enlarged to 7,322 km^2
2000	Establishment of Lower Danube Green Corridor	Environment Ministers of Bulgaria, Romania, Ukraine and Moldova, WWF	Protection and restoration of floodplains in pilot projects
2010	Development of European Union Strategy for the Danube Region (EUSDR)	12 countries that compose the Danube Basin	Financed management of water resources, environmental protection, sustainable transport, programs to foster economic prosperity and improved governance
2014-2021	Living Danube Partnership	WWF, Coca-Cola Foundation, Coca-Cola company and its bottling partners, and the International Commission for the Protection of the Danube River (ICPDR)	Formed cross-sectoral collaborations to promote the conservation and restoration of wetlands in the Danube Basin
2018-2020	Interreg Danube Floodplain Project (LIFE)	12 countries that compose the Danube River Basin	Strengthened transnational water management and flood risk prevention
2018-2023	Danube Delta Initiative	Rewilding Europe, Rewilding Ukraine, Danube Biosphere Reserve (Romania), Danube Biosphere Reserve (Ukraine), Verde e Moldova, and Endangered Landscapes Program	Improved ecological integrity and ecosystem functioning of 40,000 ha of wetland and terrestrial habitat in the Danube Delta region through rewilding interventions.
2022–present	Danube Basin Lighthouse Program (Horizon)	40 partners	Learning from pilot projects in the Danube Delta and Danube River Basin; present recommendations to policy makers

Table 1. Timeline of conservation and restoration actions and partnerships focused on the Lower Danube River and the Danube Delta

Figure 5. Gârla Mare reconstructed area.
Photo credit: Raed Kristan, WWF

In addition, dams were strengthened to sustain active fish farms for the local community (WWF, 2021b). The stakeholders involved in this project were the owners of the fish facility, the neighboring landowners, and the local authorities. The area is a Natura 2000 site.

Between 2010 and 2014, restoration projects were undertaken in 11 Natura 2000 riparian and wetland habitats in Bulgarian forests, led by the forest agency with support from WWF Bulgaria. Sites included the important Persina Nature Park along the Lower Danube, which was created in 2000 and covers 21,762 ha, encompassing 11 islands (Figure 6).

Research and implementation of ecological restoration projects in the Danube Delta began soon after the Biosphere Reserve was declared (Schneider et al., 2008). The first restoration projects began in 1993, focusing on degraded and inefficiently used agricultural lands, forestry polders, and fish ponds. Two agricultural polders, Babina and Cernovca, were selected as pilot project areas (Box 1). Restoration projects were also implemented at the Furtuna Forest East-West (2115 ha), the Popina II fish polder (3600 ha), and at the fishing polders Holbina I/II (4370 ha) and Dunavăț II (1260 ha). Restoration projects to improve water circulation and connectivity through cleaning of fishery channels were implemented over a length of 494 km of aquatic complexes of the Danube Delta (DDNI, 2018; Gómez-Baggetun et al., 2019; Figure 7).

The first restoration project area in the Ukrainian part of the Danube Delta was on Tataru island, a site of uneconomical poplar plantations (WWF, 2004). From 2003–2008, WWF and the local forestry authority removed 7.5 km^2 of dikes, allowed natural flooding on the island, and reconnected Katlabuh Lake to the river (Ebert et al., 2009). Re-establishment of natural flooding conditions created rich feeding, breeding, and spawning grounds for fish, flora and fauna. By 2007, poplar monoculture plantations began to die out (Mansourian et al., 2019). A herd of grey cattle was released onto the island in 2005 to take the place of former grazing animals that had been hunted to extinction. Without them the floodplain forest ran wild due to lack of grazing. After only 4 years, the herd had grown large enough to supply the local community with meat (WWF, 2009). Complementary release of 10 semi-wild hutsul horses was carried out in 2019 by Rewilding Europe, which became involved in activities in the Danube Delta in 2013.

*Figure 6. Persina Nature Park shelters two nesting colonies of the Dalmatian Pelican (**Pelecanus crispus**) in Bulgaria. A nesting platform was built in the Peschina swamp by volunteers and experts of the Bulgarian Society for the Protection of Birds (BSPB) and the Directorate of Persina Nature Park – Belene. Photo credit: BSPB archive/Pelican Way Of LIFE*

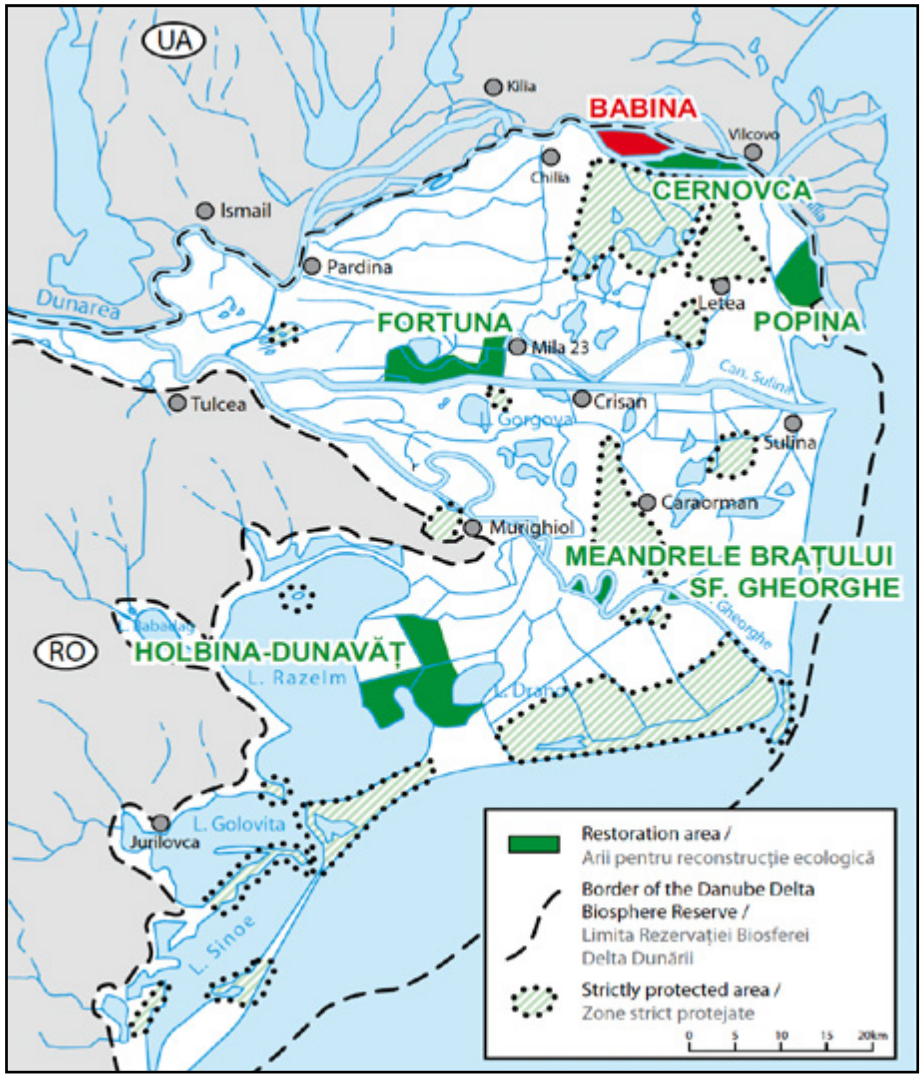


Figure 7. Restoration areas and protected areas in the Danube Delta Biosphere Reserve Romania. Source: Schneider et al., 2008

Several valued species of birds now thrive on the island, including white-tailed eagles and pygmy cormorants, and the inner lakes provide spawning grounds for young fish. The area of gallery forest on Tataru almost doubled from 2003 to 2015 (Mansourian et al., 2019). On nearby 3,500-ha (8,650-acre) Ermakov Island, dikes were removed to restore flooding in 2009 as part of a WWF project. The island now shelters flocks of white pelicans, greylag geese, mallards, great white egrets, and other wetland birds. Rewilding Europe and Rewilding Ukraine reintroduced big grazers on the island in 2019, particularly water buffalo and Konik horse (Hance, 2019; Figure 9). In 2021, they removed 200 meters of dams surrounding Ermakov Island to restore the natural water exchange of the internal lakes of the island with the Danube, continuing the restoration works started here by WWF in 2010.

A new phase of restoration is underway with a multi-partner five-year project led by Rewilding Europe. This project aims to improve the ecological integrity and ecosystem functioning of 40,000 ha of wetland and terrestrial (steppe) habitat in the Danube Delta region through rewilding processes such as flooding and natural grazing.

These interventions are designed to encourage the return of wildlife, increase biodiversity and foster the development of local nature-based economies (Rewilding Europe, 2018). Starting in 2018, Rewilding Europe has worked in collaboration with the local municipality and Biosphere Reserve Authority, to restore polders surrounding Sfantu Gheorghe in the Danube Delta. They established a Tauros breeding site in Sfantu Gheorghe in 2015 and launched a natural grazing project in partnership with three local livestock breeders.

Rewilding Ukraine carried out work in 2020–2021 on Lake Kartal to reconnect it with nearby Lake Kugurluy and Lake Kagul and with the Danube itself (Figure 10). They removed a fish screen and sediment bar, boosting flow into the lake from the Danube. “We have already seen fish species migrating into Kartal from the Danube over the last year,” says Mykhailo Nesterenko, Rewilding Ukraine Executive Director. “Eventually the dynamics of all of these reconnected lakes should more or less follow the dynamics of the Danube itself. There will be periods of flooding and periods of drought – this is completely natural. A thriving, wilder Danube Delta shaped by natural processes is the ultimate objective here” (Rewilding Europe, 2022).

Box 1: Rehabilitation of two agricultural polders in the Danube Delta

In 1993, a pilot project was initiated through a strategic partnership formed by the Danube Delta National Institute (DDNI), the Danube Delta Biosphere Reserve Administration (DDBRA), the Institute for Floodplains Ecology from Rastatt, Germany and WWF Germany to rehabilitate the islands of Babina (2200 ha) and Cernovca (1580 ha) in the northern Danube Delta (Figure 7 and Figure 8; DDNI, 2007). In 1985 and 1987, dikes and channels were built on the islands to establish agricultural fields. The rehabilitation project aimed to reestablish the flood regime on these islands and to regain habitat and breeding areas for fish, water birds, and other species. A further aim was to provide better economic benefits for the local population, as much of the agricultural land was abandoned and provided little economic benefit (Schneider et al., 2008). Reconnection of Babina polder was accomplished in 1994 and Cernovca polder in 1996. With support from the World Bank, the DDNI implemented a monitoring program in Babina to evaluate trends and changes in hydrological, biogeochemical, and ecological functions (Schneider et al., 2008). Monitoring data showed a rapid recovery of the hydrological regime, with fluctuating floods and dry periods. Reconnection to river dynamics allowed reestablishment of site-specific macro- and microhabitats in the aquatic, semi-aquatic, and terrestrial areas, reed beds, and ecosystem functions such as nutrient retention and improvement of water quality (Schneider et al., 2008). Fish reproduction was reestablished, supporting subsistence fishing by local communities. Marsh vegetation and moist grasslands rapidly recovered, and saline-adapted vegetation declined due to increased freshwater flooding. Habitats of site-specific birds have redeveloped and diversified and avifauna diversity increased from 34 to 72 species (Zöckler, 2000). Rehabilitation on the islands benefited populations of the European mink (Mustela lutreola) and the European otter (Lutra lutra) (Schneider et al., 2008).

The Babina project was viewed as a big success and a model for further ecological restoration projects. In 1996, the President of WWF International, the Duke of Edinburgh, presented an Award for Conservation Merit to the director of the DDNI (Schneider et al., 2008). The return of birds, fish, and reeds led to economic benefits of the restoration works in terms of increased natural resources and tourism, estimated to be about EUR 140,000 per year (Mansourian et al., 2019). Despite these notable achievements, the restoration project is viewed as a failure from a social perspective, as the project did not incorporate local ecological knowledge nor include any participation of local villagers (Dorondel et al., 2021). The DDBRA restricted fishing catch to 3 kg per day and required fishing licenses to be issued annually (Damian, 2019). On Cernovka island, morphological processes, such as sediment management, were not fully taken into account, leading to excessive siltation and overgrown areas of reed on the island. Rewilding Europe is now engaged to further restore Cernovka to a more dynamic natural state.

Figure 8. Pre-(top) and post-(bottom) rehabilitation on Babina Island. Source: RESTORE, 2017

Figure 9. Rewilding on Ermakov Island in the Danube Delta, Ukraine. (Top) A newly released water buffalo stands. (Bottom) Konik horses being introduced from Latvia. Photo credits: Andrey Nekrasov/Rewilding Europe

Figure 10. Dam removal in the Danube Delta Biosphere Reserve. Photo credit: Maxim Yakovlev

More recent interventions highlight two major shifts in restoration work in the Danube Delta region. One shift is from small-scale pilot studies to landscape-scale interventions following principles of rewilding and economic development based on restoring ecosystem functions and biodiversity. A new Horizon Europe program, the Danube River Basin Lighthouse Program, will support a process to scale up from pilot projects and engage a wider set of actors, stakeholders, and economic sectors in restoration programs. The second shift is incorporating social and economic benefits for local communities into restoration projects (Box 2). As described by Camelia Ionescu of WWF Romania, "It was a long process for us to start to identify the potential benefits that could be put in place and also the alternatives for those who are affected. It took ten years, from the idea to the implementation."

Box 2. A communal pasture becomes a communal wetland in Mahmudia, Romania

In 1993, a pilot project was initiated through a strategic partnership formed by In 2011, the local residents of Mahmudia on the Sfântu Gheorge Channel initiated an effort to ecologically restore part of the Danube Delta. The village had become physically disconnected from the river channel and land was producing poorly, reducing their quality of life and livelihood options. The Mahmudia local council recognized that the village could benefit from restoring wetlands and the new economic opportunities offered. They proposed a restoration project that would create conditions for maintaining biodiversity and reduce habitat fragmentation due to the damming and drying of aquatic systems in the Danube Delta. Over the next five years, they partnered with WWF-Romania and the Danube Delta Biosphere Reserve Administration to transform a 924-ha area of degraded communal pasture into a thriving wetland (Ganea and Sabin, 2021). Heavy earthmoving equipment was employed to reconnect the Carasuhat communal land to the Danube Delta, flooding the area to reconstruct 18 distinct habitats (Figure 11). This restoration approach marked a major shift in philosophy because the project aimed to not only restore wetlands, improve water quality, and mitigate flooding but also was planned to provide opportunities for development of ecotourism, fishing activities, and traditional agriculture to the local community. As stated by Camelia Ionescu, freshwater manager at WWF Romania, "This environmental reconstruction project must be a starting point in developing a model for local communities to develop businesses that are friendly to nature" (WWF, 2016).

The project accomplished its objectives. Over 30 species of aquatic birds have returned to the wetland, attracting an increasing number of tourists, invigorating the local economy, and stimulating entrepreneurship (Figure 9). The reconstructed wetland has reduced flood risk and traps sediments from runoff. Additional outcomes of the restoration project are enhanced awareness of environmental issues in the community and sustainable subsistence fishing. A recent study found that 90% of the Mahmudia residents surveyed believe that project outcomes will continue to be positive and 60% believe that community development would have been much slower without the ecological restoration project. (WWF, 2021c) The communal area is now bringing many benefits to the people of Mahmudia as well as to local species of fish, birds, and other wildlife, providing a new model for restoration in the Danube Delta (WWF, 2016; Ganea and Sabin, 2021).

Figure 11. Removing dykes to reconnect Carushuhat pasture in Mahmudia with the Danube Delta. Photo credit: Cristian Mititelu, WWF Romania

Figure 12. White pelicans returned to the Mahmudia-Carasuhat reconstructed area. Photo credit: Bogdan Lungu, WWF

Basin-wide outcomes and impacts

By 2020, restoration was underway in over 60,000 ha of floodplains in the Lower Danube region (Climate-ADAPT, 2023). In Romania, 6,000 ha of floodplains on islands were reconnected to the river, creating diverse habitats that support recovery of floodplain ecosystems. Decommissioning of poorly-performing flood protection dikes and restoring floodplains is reducing risk of flooding and providing more dependable freshwater ecosystem services with reduced costs of infrastructure maintenance (Climate-ADAPT, 2023).

From a biodiversity perspective, the outcomes of restoration efforts have been largely successful. Numerous bird species have returned and fish populations have increased (Climate-ADAPT, 2023). The Danube Delta Biosphere Reserve has largely achieved its objectives for conservation of globally significant biodiversity, especially birds (World Bank, 2015). But reduction of wetland habitat, over-exploitation of floodplain resources, and the spread of exotic species continue to threaten the maintenance of ecological systems and ecosystem services that underlie local livelihoods and sustainable development (World Bank, 2015). Assessments of water quality for 15 monitoring stations in the Lower Danube and Danube tributaries in Romania, from 1996–2017 showed that water quality improved significantly at most stations during the studied period (Frîncu, 2021).

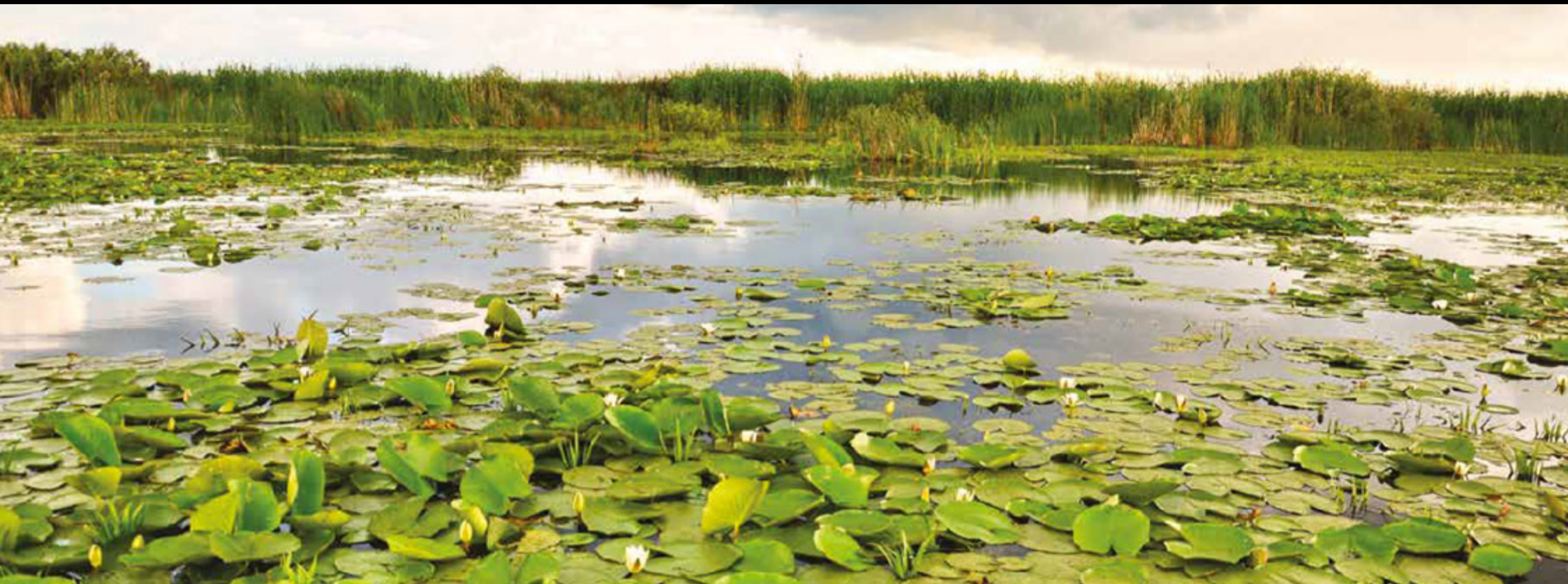
The INTERREG Danube Floodplain Project has several key outputs that have contributed to the development of better environmental policies in the region. Key project outputs include a Danube River Basin (DRB) Floodplain Restoration and Preservation Manual, DRB Floodplain Management Strategic Guidance, and a Floodplain Restoration/ Preservation Action Plan (INTERREG, 2021). Two online training courses on Danube Floodplain were developed and offered in September and November 2021.

Parting shot

"Until 2016, the Carasuhat area was the village's pasture, there were no tourists. There was nothing for them to see here, nothing to do. It was just like going into the fields. These days, the community of Mahmudia is very happy with the ecological restoration in the Crasuhat Area. We now have fish and a lot of water birds and the tourists have started to come to visit our place."

—Constantin Musat, local entrepreneur

Figure 13. View of Mahmudia wetlands that replaced the communal pasture. Photo credit: WWF-Romania



Key lessons learned

- ***Small-scale, site-based pilot projects serve to demonstrate and test restoration approaches and provide capacity building and learning opportunities.*** *Local projects allow communities to become engaged, to learn, to become advocates, and to benefit from restoration activities. As noted by Mansurian et al. (2019), "a project-by-project approach that builds on previous projects in time and space may prove to be more realistic and sustainable in the long-run than one large overall programme" (p. 34).*

- ***Restoration often requires first stopping or reversing degradation.*** *In the context of the Danube River Basin and Danube Delta, restoring habitats required removal of infrastructure (dikes or impoundments) or other drivers of ecological degradation (pollution) (Mansourian et al., 2019).*

- ***Restoring floodplains enables positive impacts across sectors, and successful interventions require engaging stakeholders from multiple sectors, including agriculture, energy, transport, and tourism.*** *Restoration activities need to be linked with policies across sectors by identifying synergies and benefits of interventions within sectors (Ionescu et al., 2022). Conflicts across sectoral priorities can constrain effective floodplain restoration and compromise the effectiveness of restoration actions if they are not resolved.*

- ***Transboundary collaboration and implementation are possible but require the support of internationally-accepted institutional mechanisms and partnership with non-government organizations.*** *These organizations need to have internal capacity and financial stability to remain engaged in the long-term (beyond project cycles) and to be resilient in the face of challenges and dynamic processes.*

- ***Planning for the future requires taking stock in what has been accomplished and applying that knowledge to developing a long-term strategy that can be adapted to unexpected and uncertain circumstances.*** *"It takes time to find solutions and to maintain what you have implemented and to learn from what has been done," states Camelia Ionescu of WWF.*

- ***Restoring floodplain ecosystems requires paying attention to the complexity of feedback loops across different ecosystems and linking protected area management with restoration efforts.*** *Floodplains are highly dynamic systems that host a variety of habitats and species within close vicinity (Schwartz et al., 2010). For example, the restoration of both floodplains and oxbows are critical components for re-establishing river connectivity and restoring aquatic habitats.*

- ***The rewilding process in the Danube Delta has provided examples of new or additional ways to make a living based on enhanced wild resources.*** *Livelihoods include wildlife-based tourism and the sustainable harvesting and marketing of fish and wild meat in the buffer zones of the rewilding area (Rewilding Europe, 2023).*

Learn more

Further information and resources

Websites

Lower Danube green corridor: floodplain restoration for flood protection https://climate-adapt.eea.europa.eu/en/metadata/case-studies/lower-danube-green-corridor-floodplain-restoration-for-flood-protection
ICPDR website: http://www.icpdr.org/main/

News Stories and blogs

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Videos

Danube Floodplain project to reduce flood risk for floodplain restoration: https://www.youtube.com/watch?v=pzgd-A9XqT8

10 dams removed in Danube Delta: https://www.youtube.com/watch?v=iHFTrvqGB6U

Kartal Lake Restoration (Ukraine): https://www.youtube.com/watch?v=nhyHyVRJjZU

Rewilding in the Danube Delta: https://www.youtube.com/watch?v=bO5RzzepaqI&t=57s

The Gorgeous Danube Delta from Tulcea Romania: https://www.youtube.com/watch?v=S5eIs04VZEE

Mahmudia Wetland Restoration: https://www.youtube.com/watch?v=-RJ86HoqXwE

Wetlands restoration in Garla Mare: https://www.youtube.com/watch?v=ZTd4AUluNqY

Wetlands restoration in Persina I WWF-Bulgaria: https://www.youtube.com/watch?v=sxNowF8Eqrw

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Acknowledgements

We thank Rewilding Ukraine, Pelican Way of LIFE, and WWF Romania for providing historical information and photos. Camelia Ionescu provided essential information and perspectives for the case study. This case study is made possible by funding from the World Economic Forum and was edited and managed by Rebecca J Cole and ETH Zurich's Crowther Lab.

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