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ACTIE

The potential for paludiculture in the Eastern Partnership

Case studies from Moldova, Ukraine and Georgia

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1. INTRODUCTION

Because of its low tidal range and presence of many large river deltas (including Danube, Dniester, Dnipr and Don), the Black Sea region is particularly well-endowed with wetlands in the lower river floodplains and around the coast. According to the Black Sea coastal wetlands inventory published by Wetlands International in 2003, there are 94 significant wetlands in the region covering nearly 2.5 million ha, of which 35 are listed by the Ramsar Convention as wetlands of international importance. However, this represents less than half of the wetland area that once occurred in the region before drainage and polderisation schemes were introduced from the 1950s to early 1990s for agriculture, fisheries and afforestation purposes.

Drainage of wetlands, especially peatland, is connected with several environmental problems such as: emission of huge amounts of greenhouse gases (GHG) to the atmosphere; release of dissolved nutrients to the ground and surface waters; and loss of natural hydrological regulation of floods and groundwater recharge. Wise management of the remaining wetland areas (as required by the Ramsar Convention), as well as rewetting of drained former floodplains, can remediate environmental pollution and restore their ecosystem services. Thus, they can either be restored to close-to-natural conditions or they can be used for biomass production under wet conditions.

Paludiculture (wet agriculture and forestry on peatland) is a promising land use alternative on wetlands. Pilot implementation projects and accompanying research, particularly in Scandinavia, Germany, UK, Austria and Ukraine, show that paludiculture provides several ecosystem services. It has great potential to substantially cut GHG emissions and so help Parties to meet the UNFCCC global action plan to limit global warming to well below 2°C, agreed in Paris in December 2015.

At the same time, paludiculture contributes to sustainable development by providing alternative sources of income in structurally weak regions, for example in organic fish production, wetland restoration and harvesting and processing biomass. The latter activity has been shown to generate significant sources of renewable energy for local communities through production of biogas, briquettes and pellets.

The main aim of the paludiculture project (see inside cover) was to promote its role as a means of reducing carbon emissions, supporting sustainable development, and generating community-based renewable energy in the Black Sea region. Accordingly, one of the project objectives was to to prepare case studies from Ukraine, Moldova and Georgia about the potential for paludiculture at existing and adjacent former wetland sites. The findings of the three case studies are presented here as a contribution to the activities of Working Group 3 of the EaP Civil Society Forum.

2. OVERVIEW OF CASE STUDIES

The three case studies on the potential for paludiculture at existing and adjacent former wetland sites were carried at Lower Prut Scientific Reserve, Cahul, Moldova; Lake Kagul (lower Danube floodplain) in Odessa, Ukraine; and central Kolkheti wetlands of Kolkheti National Park in Samegrelo and Guria regions, Georgia (Figure 1, Table 1).

Figure 1: Location of the three case study sites

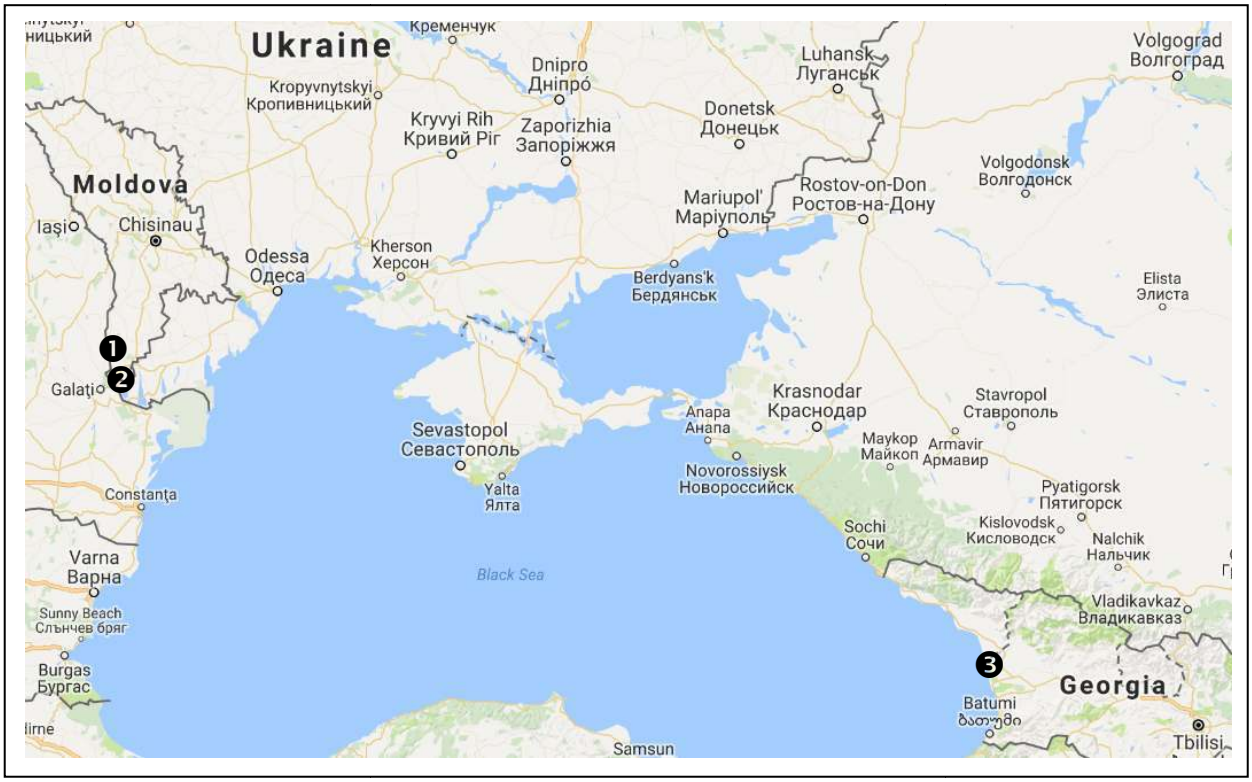


Table 1: Summary of main characteristics of the case study sites

No.	Name	Country	Area (ha)	Main charactersitics
1	Lower Prut Scientific Reserve	Moldova	1,691	River floodplain with lakes and fens. Listed in Ramsar Convention.
2	Lake Kagul	Ukraine	2,895	River floodplain and lake with reedbeds, riverine forests, farmland and fish ponds. Not protected.
3	Central Kolkheti wetlands	Georgia	29,300	Mires, lakes and riverine forests at Rioni river mouth. Part of Kolkheti National Park.

At all three sites, some economic activities were already carried out based on the available wetland resources which could provide a foundation for sustainable use in line with the principles of paludiculture. Indeed, there were opportunities to expand the range of economic activities which could benefit both local businesses as well as improve environmental conditions such as rewetting

abandoned arable land to grow wetland biomass and expanding ecotourism facilities. These are set out in Table 2.

Table 2: Current and potential activities at the three case study sites

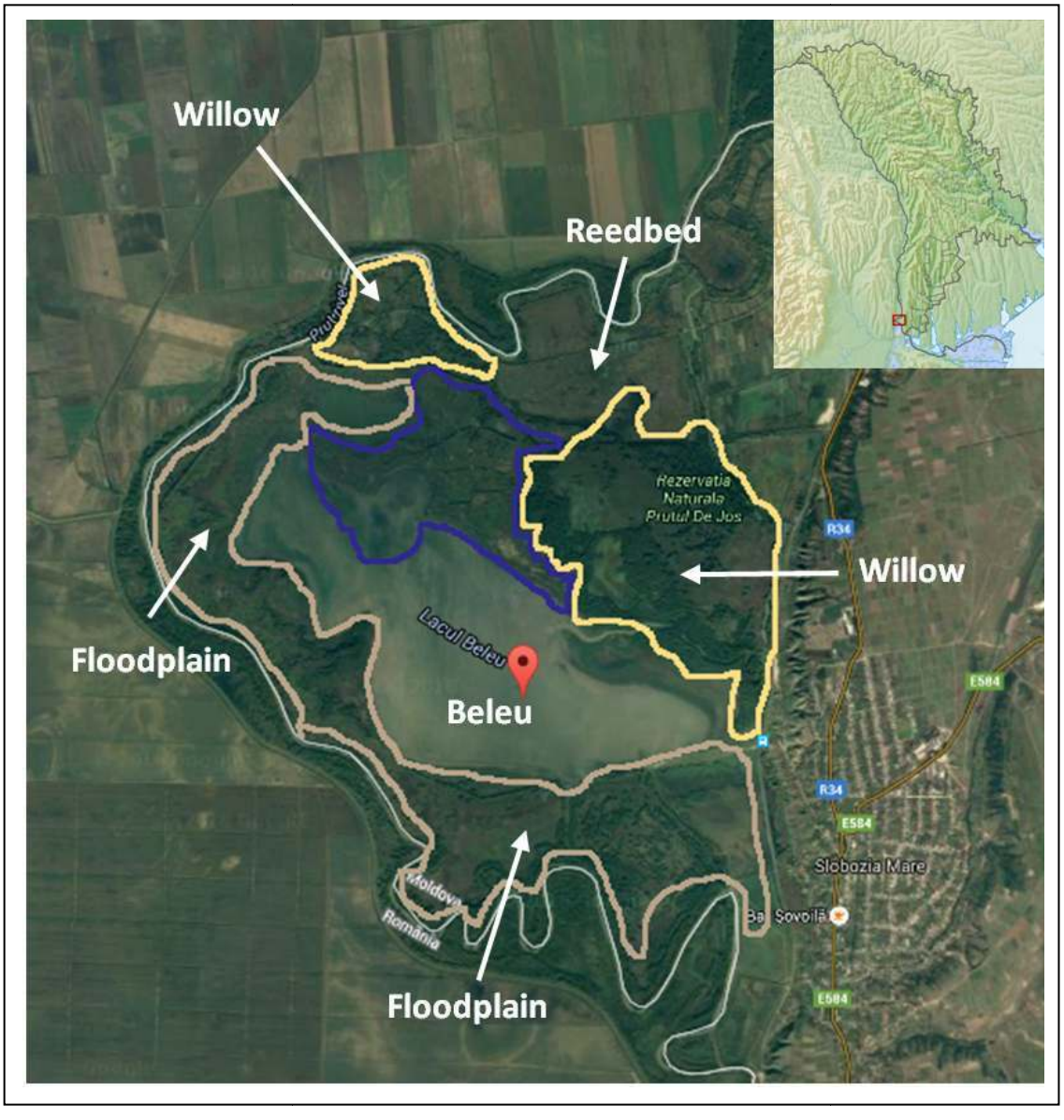
Activity	Lower Prut	Kagul Lake	Kolkheti wetlands
Grazing	Exists (sheep and cattle) at a low level with potential for increase if abandoned areas are rewetted	Exists (sheep, cattle, horses) at a low level with potential for increase if abandoned areas are rewetted	Cattle and buffalo grazing exists
Construction materials	Exists at a low level (reed cut for roofing and fencing), with potential for increase	Exists at a low level (reed cut for roofing, insulation panels and fencing),with potential for increase	Exists at a low level with potential for increase
Craft products	Feasibility study needed	Feasibility study needed	Exists at a low level with potential for increase
Biomass energy	Some potential, especially if abandoned areas are rewetted	One company already producing pellets from reed biomass; considerable scope for expansion	Feasibility study needed
Ecotourism	Exists at a low level with potential for increase; needs investment and capacity building	Exists at a low level with potential for increase; needs investment and capacity building	Exists, with level increasing as NP invests in visitor centres, accommodation, boat tours, observation towers
Sport fishing	Exists at a low level, could be increased somewhat	Exists at a low level, could be increased somewhat	Fishing is regulated at a sustainable level
Sphagnum moss cultivation	Feasibility study needed	Feasibility study needed	Conditions favour Sphagnum farming on degraded peatlands as well as on recently abandoned alluvial soils
Education / research	Exists at a low level with potential for increase	Very limited. A small wetland information centre is being established and a nature trail has been set up	Exists at a good level with potential for further increase

The general conclusions from the case studies can be summarised as:

- Naturally wet soils are best used wet, not drained.
- Floodplains, peatlands, fens and marshes provide essential ecosystem services (hydrological balance and control, carbon emissions reduction, nutrient removal, sediment filtration).
- Paludiculture delivers sustainable economic benefits: fisheries, livestock rearing, construction materials, biomass, ecotourism.
- Drained areas should be restored by rewetting in order to regain these lost services, and also as a least cost adaptation to climate change scenarios in the Black Sea region.

MOLDOVA CASE STUDY

Lower Prut Scientific Reserve



Physical features of the site

The "Lower Prut" Scientific Reserve (LPSR), with an area of 1,691 ha, was created by Government decision no. 209 / 23.04.1991. The main objective of this reserve is to protect and conserve wetlands and aquatic ecosystems, including Lake Beleu, which is inhabited by rare and endangered species of plants and animals. It is located in the south-west of Moldova, along the lower course of the River Prut, the last main tributary of the Danube. It is situated close to the Moldovan-Romanian border. The reserve is flanked by Valeni and Slobozia Mare villages. The main component of the LPSR is the Lake Beleu area of 628 ha. The LPSR geographical coordinates are 45°36'32" N and 28°9'14" E.

Geology and geomorphology

Origins

The surface layer is composed of quaternary deposits (silt deposited on river levees, including pebbles, gravel, sand and silt). In terms of geomorphology the LSPR area belongs to the geomorphological region of the Lower Prut river (Lower Prut plains) and is represented by the floodplains originating during the Holocene period. Lake Beleu is strongly linked to the current Prut River, but has its own evolution. Manolescu channel in the first half of the twentieth century was the first human interference in the area. The emergence of the first human settlements in the Lower Prut date back to the early fifteenth century (Văleni – 1430, and Slobozia Mare - 1436).

Soil type

The soils of the region are mainly chernozem with a humus content ranging from 2% to 5%, total salt content index is from 5 to 7%. The soil contains some rare elements such as Cu (25-35 mg/kg), Zn (40-50 mg/kg), Ni (20 to 25 mg/kg), Co (8-10 mg/kg) and Mo (3-4 mg/kg).

Hydrology and hydrochemistry

The surface waters in the LPSR area come from the Prut River and Lake Beleu. Because Lake Beleu is located on the left bank of the Prut floodplain, its hydrological regime is usually determined by that of the Prut River. Thus, in 1946, a very dry year, due to unusual natural conditions of the Prut River, the maximum depth of the lake was 4.3 m, while the annual average level was about 3.10 m. But during another very dry year in 1987, but with a different hydrological regime, the maximum depth of the lake reached 4.4 m and the average annual value did not drop below 3.46 m. These data show the difficulties of accurately forecasting the water level in the lake and thus the problems arising for the local ecosystems due to significant variation of the hydrological regime.

Water supply to the lake is done in two ways: rising water of the Danube and Prut rivers during spring, and summer floods during periods of heavy rains. Such a regime of water supply compensates for water evaporation, the amount of evaporated water being quite high in the summer months. The hydrology and rainfall ensures a maximum depth of 6 m in the lake. In other cases, the depth of the

lake is usually between 4-5 m. Prut water is currently flowing through Lake Beleu and there is no human involvement in water level control.

The water is fresh with a preponderance of hydrocarbon ions. The water of the Prut river is generally moderately polluted. Sometimes the concentration of some components (especially heavy metals such as zinc and copper) can exceed the permitted statutory levels established by the Republic of Moldova.

At present, the concentration of suspended matter in river waters varies between 13-404 mg / l. The pH varies from 7.38 to 8.89 and oxygen saturation is between 56% and 100%.

Climate

The annual amount of precipitation in the area is less than 400 mm. Winters are mild, frosts are regular and permanent in winter. Ice thickness can usually reaches 5-10 cm. In some very cold winters (when the temperature falls to -20°C) the thickness of the ice may reach 37 cm. The average period of ice cover is 63 days. Snowmelt starts in March and lasts for about 10 days. Weather becomes warm and stable in spring. This season can be characterised by many sunny days and relatively high temperatures (often exceeding 20°C), sometimes the temperatures can reach 30°C in the end of spring.

In the summer period, most of the days are sunny, torrential rains are frequent mostly in June, the second half of the summer being more dry. The autumn is quite warm with occasional light rain, until mid-November when it is getting colder with longer periods of rain. Northern and north-eastern winds dominate in winter. Their average speed is 2-5 m/second.

General ecological features

The major habitats (exceeding 20 hectares) of the Lower Prut Natural Reserve are set out below:

Code	Name	Description	Approx. Area (ha)
C1	Surface standing waters	Lakes, ponds and pools of natural origin containing fresh water. Manmade freshwater bodies, including artificially created lakes, reservoirs and canals, provided that they contain semi-natural aquatic communities.	607.1
C3	Littoral zone of inland surface waterbodies	Reedbeds and other water-fringing vegetation by lakes, rivers and streams; exposed bottoms of dried up rivers and lakes;	544.5
G1	Broadleaved deciduous woodland	Woodland, forest and plantations dominated by trees that lose their leaves in winter. Includes woodland with mixed evergreen and deciduous broadleaved trees, provided that the deciduous cover exceeds that of evergreens. Excludes mixed forests (G4) where the proportion of conifers exceeds 25%.	432.9
E3	Seasonally wet and wet grasslands	Unimproved or lightly improved wet meadows and tall herb communities of the boreal, nemoral, warm-temperate humid, and steppic zones.	89.6

Flora and fauna

Due to the presence of Lake Beleu there is a complex ecosystem in the area with a rich biological diversity.

Flora

Postolache (1995) has recorded 160 species of vascular plants in the LPSR. The most species-rich families are: Asteraceae (21 species) and Poaceae (20 species), as well as Lamiaceae and Cyperaceae (7 species each), and the remaining 35 families comprising 1-5 species. Phenological analysis revealed the dominance of perennial plants (64 species). Annual plants are represented by nearly 40 species. Perennial woody plants are represented by willows, with white willow *Salix alba* the most important species, but also with clumps of *S. fragilis, S. viminalis* and *S. triandra*. In addition, there are associations of sedge *Carex riparia* and *Elitrigia repens*.

Lake vegetation is represented by aquatic plants and shore plants. The shore is occupied by reed *Phragmites australis* and reedmace *Typha angustifolia*. Most of the surface water is covered by higher aquatic plants such as pondweeds (*Potamogeton crispus, P. pectinalis, P. gramineus*), hornwort *Ceratophyllum demersum* and white water lily *Nymphaea alba* whose roots lie beneath the bed, and their leaves float on the water surface or lie underwater. Associations formed by reed *Phragmites australis* and *Eleocharis palustris* are the most common of the shore plants. The most common floating plant species is *Lemna minor*.

The second layer of plants is represented by reedmace (*Typha latifolia* and *T. angustifolia*), and meadowsweet *Thelipterus palustris*. The area provides habitat for rare and endangered species in Moldova: white water lily, water fern *Salvinia natans*, water chestnut *Trapa natans*, wild vine *Vitis sylvestris* and rare species such as sedge *Carex pendula*, water arrow *Sagittaria sagitifolia* and ash *Fraxinus pallisae*.

Fauna

Research conducted in recent years has demonstrated that the Prut River and associated meadows are an important bird migration route, with the wetlands providing good places for resting, feeding and nesting. During the breeding season up to 70 species of birds nest in the reserve, while around 50 species of waterfowl stop here to feed and rest during spring and autumn migrations. In all, some 189 species of birds, 34 species of mammals, 7 species of reptiles, 11 species of amphibians and 27 species of fish have been recorded in the LPSR over a period of several years. Among them, 21 species of birds, 5 species of mammals, 1 species of reptile and 1 species of amphibian are included in the Red Book of Moldova. These include otter *Lutra lutra*, European mink *Mustela lutreola*, stoat *Mustela erminea*, wild cat *Felis sylvestris*, whooper swan *Cygnus cygnus*, mute swan *Cygnus olor*, Dalmatian pelican *Pelecanus crispus*, white pelican *Pelecanus onocrotalus*, great egret *Egretta alba*, squacco heron *Ardeola ralloides*, osprey *Pandion haliaetus*, white-tailed eagle *Haliaetus albicilla*, glossy ibis *Plegadis falcinellus*, Eurasian spoonbill *Platalea leucordia*, black stork *Ciconia nigra*, pond turtle *Emys orbicularis* and large whip snake *Dolichophis jugularis* etc.

The state of threatened vertebrate populations within the reserve is precarious. They comprise only a few individuals, and the European mink occurs sporadically in the Danube region for feeding. Many species have significantly decreased since 1990, including: great egret, mute swan, ferruginous duck *Aythya nyroca* and short-eared owl *Asio flammeus*. Other species such as white pelican, Dalmatian pelican, and black stork visit the LPSR just for feeding, or during migration (e.g. whooper swan, osprey, white-tailed eagle).

Due to an increase of the willow forest areas that replaced shrubs, favourable nesting conditions for many species of herons, spoonbills and cormorants were created. The continued growth of mixed colonies of marsh birds can be explained by the emergence of new favourable nesting places and the low water level of Lake Beleu.

Among reptile species, the most numerous is the dice snake *Natrix tesselata* which preys on fish and can be found everywhere. Its breeding period begins in April. The grass snake *Natrix natrix* is a less prevalent, with an irregular distribution. The green lizard *Lacerta viridis* is also fairly common, and inhabits the buffer zone. Amphibians have favourable conditions for feeding and breeding throughout the reserve. The most numerous species is Marsh frog (Rana ridibunda), followed by the pond frog (Rana lessonae) and grass frog (Rana temporaria).

In recent years there has been an explosion of breeding European green toads *Bufa viridis*. Hundreds of young frogs can be seen on the shores of Lake Beleu in June. Some of them become prey for the marsh frog when moving to the lake. European fire-bellied toads *Bombina bombina* inhabit small ponds and European tree frogs *Hyla arborea* inhabit areas with vegetation. The spadefoot toad *Pelobates fuscus* is included in the Red Book of Moldova.

Lake Beleu provides favourable breeding conditions for nearly 18 species of fish, which later return to the Prut River. These include valuable economic species such as bream *Abramis brama*, roach *Rutilus rutilus*, carp *Cyprinus carpio*, zander *Sander lucioperca*, catfish *Silurus glanis*, Caspian shad *Alosa kessleri* and pike *Esox lucius.*

Natural values

Although the LPSR is relatively small, the territory included in the reserve is of particular importance for preserving the biodiversity of the region because the flora and fauna of the area (see above), which has remained little changed, maintaining the typical features of the region.

Social and cultural values

The wider Lower Prut valley had in the past a very picturesque landscape, populated by thousands of migratory waterfowl, and local people obtained abundant amounts of fish for food. With the draining of the marshlands, much of the territory was transformed for the use of collective farms. At the end of the 1990s, the land became private property. As a result of poor land use practices, the sedimentation rates of Lakes Beleu and Manta have accelerated.

The educational value of the site is also very important. The existence of several types of ecosystems (aquatic, wetland, forest, grassland) within the reserve serves as a natural laboratory for organising various forms of training and awareness, especially for children and youth.

The LPSR may be of tourism interest because of the unique ecosystems it contains. Only here can various species of terrestrial vertebrates and plants included in the Red Book of Moldova can be seen, which can be of particular interest to a large number of people. With the development of appropriate infrastructure, the Prut River wetlands could become a favoured destination for tourists.

The diversity of species and landscapes allow scientific research in the fields of biology, ecology and nature conservation. The vertebrate fauna and flora have been catalogued in past years. In future, it is necessary to continue investigations in relationships within ecosystems, ecosystem protection and ecosystem services, using common methods so that the data obtained can be compared.

Land tenure/ownership

The entire territory of the LPSR (approximately 1691) is state property. The territories nearby have various type of ownership. Most of the adjacent land is agricultural land owned by inhabitants of Valeni and Slobozia Mare, as well as municipal areas of these two villages. There is a process underway to substantially expand the protected area (see below).

Current land (including water) use

Lake Beleu occupies 35.9% of the total area of the LPSR, 32.2% are marshes and swamps, pastures are 5.3%, forests are 25.6% and 1% other uses. Of the total area of 379 ha of Văleni village, 61.6% is arable land, 27.8% is covered with perennial agricultural plants and 10.6% is pasture. In Slobozia Mare, of the total area of 10,909 ha, 48.5% is arable land, 14.3% is used for perennial crops (vineyards, orchards), 7.1% are pastures, 6.3% are forests and 10.6% wetlands.

Agriculture is the main occupation of the transition zone. The most important agricultural activities are:
- Cultivation of agricultural crops (wheat, corn, sunflower, vegetables etc.)
- Livestock (sheep, cattle, pigs, poultry etc.)
- Viticulture and fruit growing.

Factors (past, present or potential) adversely affecting the area's ecological character

According to a SWOT analysis of the LPSR for its management plan, there are several risks of various intensities and probabilities of occurrence that could affect the area's ecological condition.

Threats to local flora include mowing grass in core areas, abusive grazing, illegal cutting of trees and shrubs, and vegetation burning.

Threats to local fauna comprise illegal hunting, water basin sedimentation, pollution by oil products, and biological pollution of water resources.

Threats to landscape, cultural and historical values: lack or inadequacy of feasibility and spatial planning studies of these territories, that could lead to some human interventions which could alter the landscape.

Threats related to the social and economic development of the area: insufficient or lack of production, processing and storage technologies of agricultural products in the neighbouring villages; poor quality of roads and other infrastructure.

Threats related to recreational facilities and tourist values: deterioration of existing tourism resources; poor tourism and recreational infrastructure as well as insufficient accommodation facilities; insufficient cross-border projects and little funding received up-to-date; unsustainable exploitation of area's natural recourses.

Threats related to climatic changes: climate change is accompanied by frequent droughts in summer and may lead to catastrophic decrease in water level. It can also lead to an increase of aquatic ecosystems eutrophication, as well as water and soil salinisation

The intensive land use in the floodplain and in the hilly area surrounding it, and the erosion it has caused, has led to a process of sedimentation in Lake Beleu. Moreover, there is ongoing extraction of oil from the Lake Beleu bed, causing pollution from leaks and posing the threat of a major spill. At present, Lake Beleu is in danger and requires restoration activities with external financial support.

Conservation measures in place

The LPSR territory is listed in the Ramsar Convention as a wetland area of international importance. It is under state protection and all economic activities are banned to avoid disturbing the natural processes. A buffer zone around the reserve was created to reduce human impact on the natural area.

LPSR administration is coordinated by the State Agency for Forestry MOLDSILVA. Administration headquarters is located in the village of Slobozia Mare and has a staff of 28 employees, headed by a director and a deputy director.

Currently, efforts are made to undertake additional steps of including new territories in the protected area, especially the Manta lakes and upgrade its status to a biosphere reserve (see Figure 1).

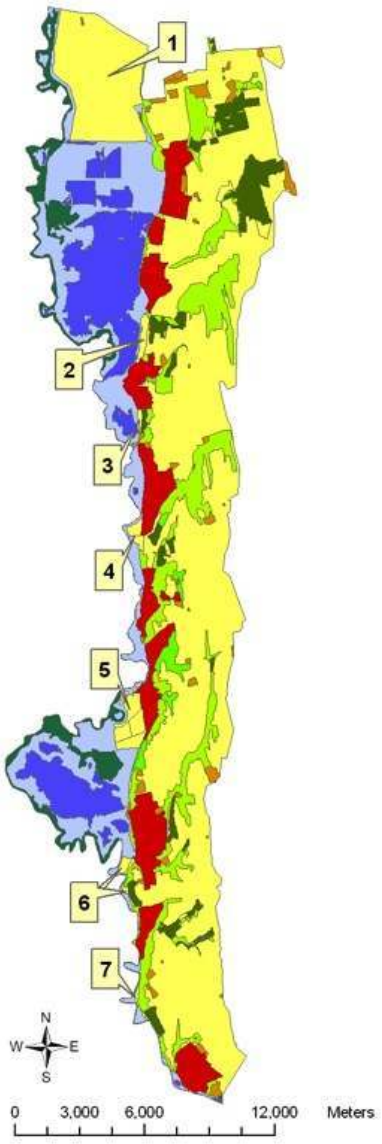
Alternative scenarios based on paludiculture

The wetlands areas in the Lower Prut region are relatively small compared to what they once were due to the Soviet era policy of draining wetlands and using them for agriculture. That is why Lakes Beleu and Manta and adjacent areas cannot be used extensively for economic activities due to their small size, and the potential impact on local ecosystems of those economic activities could be too high. In

the short term, the best scenario would be to use these areas for such activities as ecotourism, sport fishing and educational purposes. There are already measures taken in this direction but much more has to be done: informing local population and authorities, training local businesses, and investing in small scale infrastructure (observation areas, information signs etc.).

In some areas some limited biomass harvesting and some grazing could be done as well (Figure 1). For the more distant future it could be possible to reclaim some of the drained wetlands due to the fact that they are not suitable for agriculture anymore. For instance, some agriculture lands that are regularly flooded could be used for growing short-rotation willow (or energy willow) or maybe poplar that has also a good potential for being cultivated in the area.

Figure 1: Planned future extent of the "Lower Prut" Biosphere Reserve and possible uses



Site 1:
Suitable area for wetland conservation:

- A polder (590 ha) close to lake Manta (Annex 2, fig 1.1 & 1.2).

Site 5:
Suitable area for wetland conservation:

- An area (11 ha) cultivated with annual crops between Prut river and a canal (Annex 2, fig 2.1 & 2.2).
- 2 polders presented in Annex 2, fig 2.3 & 2.4.

Site 6:

- An agricultural area (8 ha), presented in Annex 2, fig 3.1 & 3.2.

Sites 2, 3, 4, 7
Sites 2, 3, 4, and 7 are not suitable for wetland restoration because of the new developments in the area (railroad recently built) and because many of the agricultural lands are close to villages or/and do not have proper hydrological conditions.


View of Lake Beleu with fringing willow forest and yellow water lilies


Woodland with wild vine, and water fern


Fire-bellied toad and tree frog


Great white heron and white pelicans

UKRAINE CASE STUDY
Lower Danube River Floodplain – Lake Kagul

Physical features of the site

The site covers some 2,895 ha in Reni raion, Odessa oblast, at 45.3715 N; 28.4493 E. It is largely comprised of the heavily modified northern (left bank) Danube floodplain between Reni and Orlivka, adjacent to Lake Kagul. At this point, the Danube forms the border between Ukraine and Romania. It also flows through one of its narrowest and deepest points, having a very rapid flow. From here, the river begins to broaden out and area is considered to be at the hydrological beginning of the Danube delta.

Origins

Prior to 1945, the site was a natural, marshy floodplain of the River Danube with a levee separating it during low water from the inland valley and mouth of the small steppic River Kagul. Following the incorporation of the region into the Soviet Union at the end of the Second World War, and subsequent construction of the Danube embankment to mark the border and control flooding, the floodplain was gradually converted to arable farmland. At the same time, the lower contours and hydrological regime of the river valley changed to its current situation.

Lake Kagul is comma-shaped, with the tail end formed by the Kagul river valley. Its southern shore is flat, with reedbeds, marshes and some fish ponds. The western and eastern sides have narrow shores, sometimes with fringing reedbeds, and eroded cliffs. The lake is connected directly to the Danube via the Viketa canal. Kagul is relatively shallow in relation to its area because it is actually a liman (flooded river valley). It is the first of a sequence of five such limans proceeding westwards within the natural Danube floodplain leading to the Danube delta.

Main features of Lake Kagul catchment

Total length of main river	71 km
Total length of tributaries	80 km
Catchment area	807 km^2
Average annual inflow volume	1,400 m^3

Key physical parameters for Lake Kagul

Length (max)	24 km
Width (max)	14.4 km
Area of open water (spring)	10,100 ha
Mean depth	2.5 m
Volume	250 $x10^6$ m^3

Geology and geomorphology

The geomorphological conditions of the Lower Danube region are defined by its position at the junction of the Eastern European and Scythian tectonic plates. The bedrock is characterised by the presence of Palaeozoic graben and extrusion of Upper Palaeozoic bedrock, located within the structure known as the Pre-Dobrudgea downfold and Dobrudgea fold formations.

The broad delta of the Danube and its left-bank tributaries were formed during the Pliocene period (1.6-5.0 m ybp). Within the valleys, the red-brown clays, Pontic limestone, and sometimes the Upper Miocene deposits were washed out. The lowlands were then filled with alluvial sediments, forming the ancient Pliocene terraces. The Upper Pliocene alluvial deposits of the Danube terraces are characterised by sands with clay bands and inclusions of gravel. The depth of the deposits is 1 to 30 m. The thickness of the alluvium varies from 1 to 25 m. Upper Pliocene lake alluvial deposits are represented by clays, sands, siltstone, and sometimes loam with an almost similar depth and thickness.

During the Pleistocene, there was extensive lowering of the land and flooding of the pre-coastal zone including the lower parts of the river valleys, forming vast water bodies such as Kagul. Thus, the modern (Holocene) alluvial deposits are covered by eroded ancient (Pliocene) alluvial sediments and loess from the lower Pliocene terraces. This geological history also led to the development of the present broad floodplain and extensive reedbeds in the river delta, composed of thick (30-40 m) ancient alluvial deposits, and covered by modern alluvial sediments.

Soil type and chemistry range

The predominant soil-forming materials are loess and loess-loam that have a pale brown colour and are highly porous (up to 50-60%) carbonised ($CaCO_3$ content of 14-18%), and and slightly alkaline (pH 7.6-8.1). The granular composition is dominated by coarse dust (0.05-0.01 mm) that comprises 35-45%, but sometimes 50-55%, of the material, and there is a complete absence of medium and fine sand (1.0-0.25 mm). There is a tendency towards lightening of the granular composition of the loess southwards: from hard loam (in the watershed plateaux) to medium loam (on the Lower Danube terrace plain). Within the Lower Danube terrace plain the soils are mainly of a dark-brown mycelium-carbonate type with broad sand banks and alluvial deposits with meadows and marshes developed on waterlogged gley soils.

Hydrology and hydrochemistry

The Lower Danube region is part of the Black Sea artesian basin and is characterised by rather complex hydro-geological conditions. Groundwaters are found in all the stratigraphic subdivisions: from the modern alluvial-loess deposits of the Quaternary age, to the Precambrian deposits. The main inputs of water to the aquifers come from precipitation and irrigation. Nine main aquifers are found:

- Holocene alluvial-loess aquifer, distributed in loam, sandy clay, sand with some inclusions of limestone debris found in gullies. The depth of the aquifer is 0.9-5.0 m with the typical depth being 0-3.0 m.
- Holocene lake-alluvial aquifer found in the lower reaches of large gullies and small rivers. The water-bearing media are loam and sand with gravel lenses and interstrata. The thickness of the

water-bearing layer is 0.8-17.5 m, with a typical thickness of 3-7 m. The water content depends on the lithology of the rocks and the season. The upper part of the aquifer discharges into the riverbed, whilst in the lower areas it drains into the lakes.

- Upper Quaternary lake-alluvial aquifer of the Danube valley, formed by loam, silt and sand, with frequent lenses of alluvial clay. The thickness of the deposits is 5-25 m. The aquifer discharges through riverbed deposits and via evaporation. Mid Quaternary loess loam aquifer characterised by a very low water yield due to the structural features and mechanical composition of the deposit. The aquifer discharges into adjacent horizons and the gully network. Quaternary loess and lake-alluvial aquifer of the secondary level, with water-bearing strata in sand and loam. The groundwater lies at a depth of 1.0-15.0 m, with the most common depth ranging from 3-7 m. It discharges into the Danube and the lakes.
- Upper Pliocene (Kuyalnik) coastal aquifer with groundwater held in lenses and interstrata of sand-clay and siltstone. The thickness of the aquifer is 0.5-10 m and it discharges into adjacent aquifers.
- Pontic aquifer composed of fractured and karsted limestone with a thickness of 1-13 m, at a depth of 0.5-10 to 30 m. It discharges into river valleys and gullies.
- Meotic aquifer associated with some layers of fine-grain sand and limestone, enclosed by thick layers of clay. Its depth ranges from 1-2 m (on the slopes) to 50 m (on the watersheds). The general flow direction is from north to south and from watersheds to the river valleys and estuaries where it is discharged.
- Upper Sarmatian aquifer contained in many sand (1-3 m), siltstone and limestone (2 m) interstrata. These are mainly artesian.

Within the watershed plateaux the groundwater level is usually up to 20-30 m deep; closer to the river valleys the depth reduces to 3-5 m. The water confining layer is red-brown clay and the groundwater discharges mainly south-east into the Pliocene-Quaternary aquifer complex of the Lower Danube terrace plain, although within the plateau itself it discharges into the lakes and river valleys. The chemical composition of ground water is varied, with mineral content varying between 1-15 g/l. The salt levels are 3-5 g/l, mainly composed of sodium chlorides and sulphates.

The watercourses entering the Lower Danube Lakes are of an East European type with their main source of water being melting snow and rain. The groundwater-fed base-flow appears to be extremely small, and is even absent in some watercourses. These rivers contain low levels of water and dry out during the summer. Typically river water levels rise in the spring, and are low over the period from summer to autumn although there are occasional floods from heavy summer rain showers, which can raise the water level by 1.0-2.5 m above the mean water level (MWL). The water levels begin to increase from late February to early March and then decrease. The water level increases during the spring flood by 0.5-2.7 m above MWL and lasts for 1-2 days. The mean water level is established by mid-April.

Climate

The Lower Danube region combines the features of both mild-continental and Mediterranean climates. Winter is short and mild, with a variable frost period; summer is long and hot. Among other steppe zones in the region, this area is noted by the highest thermal resources: with an average annual temperature of the air ranging from 9.8-10.8°C, it has the warmest winter and the least continental

climate. The period of active vegetation growth lasts 190 days, whilst the frost free period amounts to 200 days.

The climate is influenced by the Black Sea: sea breezes contribute to the dispersion of clouds and reduced precipitation. Thus, while the annual precipitation in areas near the Danube is generally within the 380-410 mm range, evaporation exceeds 800 mm, which means the region lies in a drought-prone area. There is great amplitude of annual precipitation: from 570-590 mm (high-rainfall year) to 190-220 mm (low-rainfall year). On average, only 65-85 days of rainfall occur annually. Droughts of different intensity can last up to 30-40 days and occur once in 3-4 years, though during the past 20-25 years prolonged drought periods have been observed. Some 65-70% of the total annual precipitation falls in the summer during heavy rain storms that cause extensive soil erosion. The cold period is characterised by rains of low intensity. These autumn and winter rains play an important role for increasing soil humidity.

Snow cover is not formed every year. Snow can fall as early as the beginning of December and normally stays until the end of February or early March. Soil frost occurs from late December till the end of February, affecting the ploughed soil horizon only. During the frequent snow-free periods in winter, the soil absorbs up to 60-70% of the precipitation, which penetrates down to 1-3 m. During the growing season, the upward movement of water transports carbonates. The latter process has given rise to the development of a “mycelium-carbonate” black zone, especially in the southern and south-western parts of the region.

General ecological features

The main habitats (i.e. those occupying more than 20 ha) present in the site comprise those in the table below.

Code	Name	Description	Approx. Area (ha)
C1	Surface standing waters	Lakes, ponds and pools of natural origin containing fresh water. Manmade freshwater bodies, including artificially created lakes, reservoirs and canals, provided that they contain semi-natural aquatic communities.	115
C3	Littoral zone of inland surface waterbodies	Reedbeds and other water-fringing vegetation by lakes, rivers and streams; exposed bottoms of dried up rivers and lakes.	800
G1	Broadleaved deciduous woodland	Woodland, forest and plantations dominated by trees that lose their leaves in winter. Includes woodland with mixed evergreen and deciduous broadleaved trees, provided that the deciduous cover exceeds that of evergreens.	50
I1	Arable land and market gardens	Croplands planted for annually or regularly harvested crops other than those that carry trees or shrubs. They include fields of cereals, of sunflowers and other oil seed plants, of beets, legumes, fodder, potatoes and other forbs.	1,907
J2	Low density buildings	Buildings in rural and built-up areas where buildings, roads and other impermeable surfaces are at a low density, typically occuping less than 30% of the ground.	23

Flora and fauna

The site has a rich aquatic vegetation where large areas are occupied by associations formed by attached, submerged and floating species. The most commonly occurring rooted submerged plants are *Ceratophyllum demersum, Potamogeton perfoliatus, P. pectinatus, Vallisneria spiralis* and *Elodea canadensis*. The most abundant rooted species with floating leaves is *Nymphaea lutea* (a protected species). The floating vegetation is mainly composed of *Spirodela polyrhiza, Lemna minor, Salvinia natans* and *Hydrocharis morsus-ranae*. The marsh vegetation communities mostly comprise tall-growing plants dominated by *Phragmites australis* (which is harvested for biomass)*, Typha angustifolia* and/or *Scirpus lacustris*. The riparian vegetation is represented by willow-poplar forests (*Salix alba, S. fragilis* and *Populus alba*) located on levees and drier parts of the floodplain. Plantations of *Populus nigra* are also present. Planted or invasive patches of *Eleagnus angustifolia* are present. Ruderal vegetation is found along tracks, dominated by: *Onopordon acanthium, Anisantha tectorum, A. sterilis, Hordeum leporinum* and *Senecio vernalis*.

No specific studies of mammals have been undertaken. However, 41 species have been recorded in the Lower Danube region of which 11 are predators; wild cat *Felix sylvestris* and fox *Vulpes vulpes* are regularly recorded at the site. The nine species of rodents include the invasive muskrat *Ondatra zibenthicus* that is one of the most important wetland species; it is bred for its fur in some places. Five species of bat are known to occur (*Nyctalus noctula, Pipistrellus pipistrellus, Plecotus austriacus, Vespertilio murinus*, and *Myotis daubentoni*). The raccoon dog *Nyctereutes procyonoides* is another invasive species that originated from Moldova. Regarding ungulates, roedeer *Capreolus capreolus* migrated in 1969 from Romania to Kislitsky Island, and now occurs at the site. During the same time wild boar *Sus scrofa* also colonised the region.

Recent surveys conducted in the area between 2010 and 2014 have recorded a total of 146 species. Out of these, 17 species are in the Ukrainian RDB, 19 in the European RDB, and 6 in the IUCN Red List as shown below.

Latin name	Name, UA	Name, EN	Red Data Book of UA	Species of European Concern	Red List of IUCN
Microcarbo pygmaeus	Баклан малий	Pygmy Cormorant	x	x	
Branta ruficollis	Казарка червоновола	Red-breasted Goose	x		EN
Anas strepera	Нерозень	Gadwall	x		
Aythya ferina	Попелюх	Pochard		x	
Aythya nyroca	Чернь білоока	Ferruginous Duck	x	x	NT
Ardeola ralloides	Чапля жовта	Squacco Heron	x		
Ciconia ciconia	Лелека білий	White Stork		x	
Plegadis falcinellus	Коровайка	Glossy Ibis	x		
Platalea leucorodia	Косар	Spoonbill	x	x	
Pelecanus onocrotalus	Пелікан рожевий	White Pelican	x		
Pelecanus crispus	Пелікан кучерявий	Dalmatian Pelican	x	x	VU

Latin name	Name, UA	Name, EN	Red Data Book of UA	Species of European Concern	Red List of IUCN
Haliaeetus albicilla	Орлан-довгохвіст	White-tailed Eagle	x	x	
Circus cyaneus	Лунь польовий	Hen Harrier	x		
Circus macrourus	Лунь степовий	Pallid Harrier	x	x	NT
Circus pygargus	Лунь лучний	Montagu's Harrier	x		
Pandion haliaetus	Скопа	Osprey	x		
Falco vespertinus	Кібчик	Red-footed Falcon			NT
Vanellus vanellus	Чайка	Lapwing		x	
Philomachus pugnax	Брижач	Ruff		x	
Larus canus	Мартин сивий	Common Gull		x	
Coracias garrulus	Сиворакша	Roller		x	NT
Picus viridis	Жовна зелена	Green Woodpecker	x	x	
Lanius minor	Сорокопуд чорнолобий	Lesser Grey Shrike		x	
Lanius excubitor	Сорокопуд сірий	Great Grey Shrike	x		
Sturnus roseus	Шпак рожевий	Rose-coloured Starling	x		
Phoenicurus phoenicurus	Горихвістка звичайна	Redstart		x	
Carduelis cannabina	Коноплянка	Linnet		x	
Emberiza hortulana	Вівсянка садова	Ortolan Bunting		x	
Emberiza calandra	Просянка	Corn Bunting		x	
Emberiza hortulana	Вівсянка садова	Ortolan Bunting		x	
			17	**19**	**6**

Eleven amphibian and five reptile species have been recorded in the Lower Danube area. The most numerous are frogs *Rana ridibunda, Hyla arborea* and *Bombina bombina*; whilst among the reptiles *Natrix natrix* and *Emys orbicularis* are the most common species. Other abundant species are *Pelobates fuscus, Bufo viridis* and *Lacerta agilis*. The most threatened reptile species is the Danube crested newt *Triturus dobrogicus* which is endemic to the Lower Danube region; it is listed in the IUCN Red List as Near Threatened.

The fish fauna of the Lower Danube Lakes area once comprised over 80 species, but the large-scale drainage of the floodplain has led to a reduction of fish species found on both sides of the Danube. According to the most recent surveys, 54 species of 13 families still occur. The most represented families are *Cyprinoidae* with 13 species, *Percoidae* with 6 species, and *Gobiidae* with 5 species.

The entomofauna of the Lower Danube region is directly connected with the variety and distribution of vegetation types. During the 1990s, Kotenko recorded over 2,000 species representing 23 orders; however, some 86% of the species came from only six orders: Hymenoptera (41%), Diptera (21%), Coleoptera (10%), Lepidoptera (6%), Hemiptera (5%), and Homoptera (4%). Forty species are listed the Red Data Book of Ukraine.

Some fifty species of macrozoobenthos have been recorded. These include the bivalve mussels *Unio pictorum, Anodonta cygnea, Dreissena polymorpha*, larvae of the chironomid *Chironomus plumosus*, the amphipod *Corophium curvispinum*, and the oligochaete worm *Potamotrix hammoniensis*.

Natural values

The reedbed areas in the northern and southern parts of the site are the most important areas for biodiversity, especially for breeding waterbirds. The northern area serves as a sediment and nutrient trap and provides habitat for spawning fish. The floodplain area is heavily modified, but in recent times has acted as a water storage area when the main Danube embankment was breached, preventing extensive flooding.

Social and cultural values

The main activity carried out in the floodplain area is arable agriculture for wheat, sunflower, rape and root crops. However, the loss of infrastructure and cost of power have meant that winter drainage and summer irrigation have ceased since the mid-1990s. As a result, fields are increasingly being invaded by common reed, which is often burned off to clear cultivated areas.

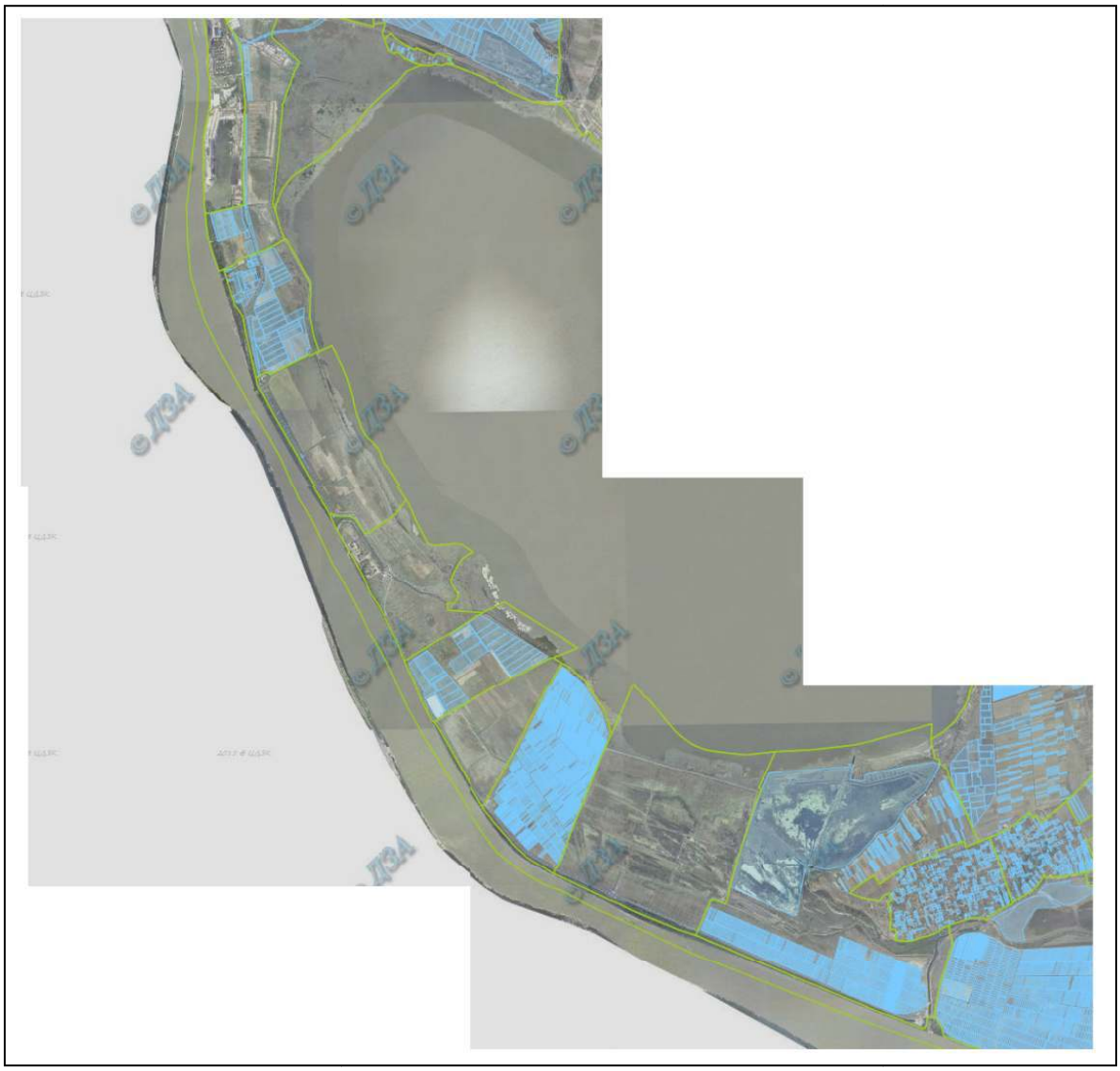
Although there are fish ponds constructed in the southern part of the area, they are in decline and little production takes place at present. Most fishing is conducted in the lake on an artisanal basis by a few fishermen from Kirgani, or anglers from Reni. This village was founded by Lipovans (Old Orthodox Believers) in the 19th Century and contains traditional-style dwellings. However, its population is declining.

Some 50 ha of the northern reedbed is harvested by a local company, BioTop. The reed is used to produce thatch bundles, construction mats and biomass pellets (see below). Other activities include sheep and cattle grazing, hunting (geese, ducks, deer and boar), summertime bathing, collecting herbs and berries, and a low level of ecotourism.

The southern part of the area is overlooked by the Roman garrison fort of Aliobrix. Built on the site of a captured native Geto-Dacian settlement, the Roman proconsul Marcus Plautius built the fortress in the 1st century BC. Archaeological evidence shows that the Roman garrison consisted of legionnaires of the Vth Macedonian Legion and sailors of the Meziya squadron.

Land tenure/ownership

Out of the 2,895 ha of the site, about 910 ha has been cadastrated to date (the blue parcels shown in the map below), out of which 420 ha are in state fish farm at Orlivka. The rest remains in municipal, local or regional authority ownership.



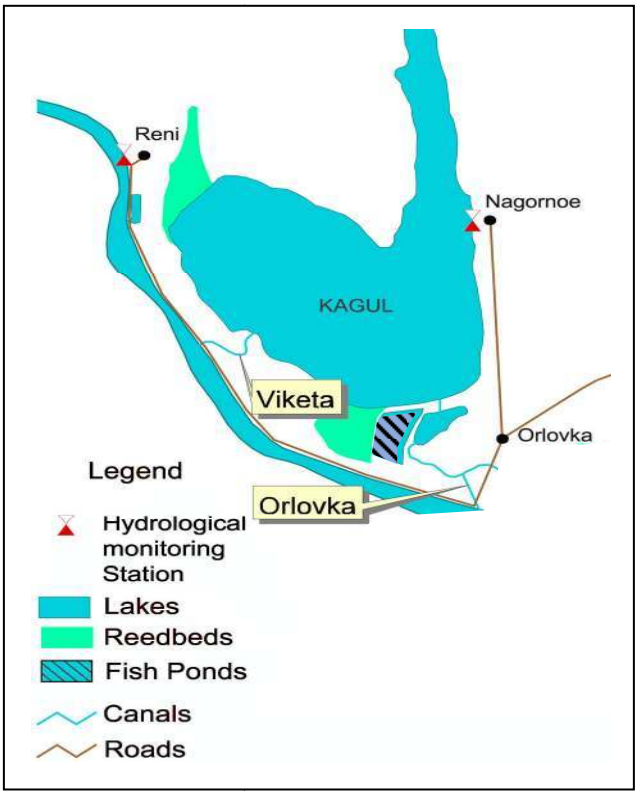
Current land (including water) use

The Kagul river catchment has been severely altered. Extensive modification of the river drainage system has taken place throughout the catchment areas in Moldova through the installation of barrages and other water storage schemes for irrigation. The past heavy use of pesticides and fertilisers for crop production, and the discharge of untreated effluents by villages situated beside channels have greatly affected the water quality of various rivers.

From the mid-1950s the Danube river floodplain was embanked to improve access to Reni and border security. This led to a reduction the seasonal flooding of the area and the original annual inundation that naturally flushed out the water held in Lake Kagul ceased. Since the embankments were built the water exchange between the Danube and the lake has been actively managed. A sluice and the Viketa canal was constructed to fill the lake during the Danube spring flood, and the Orlovka canal used to draw water down to recharge lakes further east. From mid-December, when the Danube begins to rise again, the lake is partially filled for the winter in order to ensure sufficient depth for fish survival. This

system is meant to flush the lakes and improve the water quality, especially in terms of reducing the mineral content that accumulates as a result of evaporation and inflows.

Water Management System at Lake Kagul



The legislation of Ukraine stipulates the following categories of water protection: i) protected water areas; ii) protective riparian belts; iii) coastal belts; iv) specially designated areas; and v) sanitary protection zones. These areas have specific legal status and corresponding limitations on economic activity. However, the protected water areas are not demarcated in the field (including in the area concerned here) and their use is rarely enforced in practice.

Protected water areas are established for all water bodies – along river banks, coasts and estuaries, lakes and reservoirs. The borders are determined on the basis of corresponding special land planning guidelines, and include floodplain land and lower terraces (for small rivers). Within the protected water areas it is permitted to carry out regulated economic activity, though it is prohibited to (i) use persistent and strong pesticides; (ii) establish cemeteries, cattle burial grounds, dump sites, filtration beds; and (iii) discharge untreated sewage. In some cases sand and gravel mining in the dry part of the floodplain are allowed (if approved by the environmental authorities).

Protection zones along water bodies are demarcated within the protected water areas. They are established along both sides of rivers, around lakes, on islands, along the water edge (at mean water level) and having the following widths:

- for small rivers and brooks, and lakes under 3 ha – 25 m;
- for medium-sized rivers, reservoirs and ponds over 3 ha – 50 m;

- for big rivers, reservoirs and lakes – 100 m.

However, where the slope inclination is more than 3°, the minimum width of the riparian protection belt is doubled. The protection zones belts are established taking into consideration the features of population distribution.

Riparian protection zones are nature protection territories, which are characterised by a regime of limited economic activity. It is therefore prohibited:

- to plough (except for preparation of soil for meadows) and plant gardens;
- to store and use pesticides and fertilisers;
- to build summer cattle pens;
- to build any structures, including summer houses and camps (except for waterworks and linear structures);
- to wash and service machinery and vehicles;
- to organise dump sites, dung yards, cattle burial grounds, cemeteries, filtration beds, and cesspools for liquid and hard industrial waste.

For the purposes of operation and prevention of damage and pollution of main and minor irrigation canals, waterworks, and dams on rivers, designated areas with special regimes are established. Plots of land within these areas are transferred to water management bodies and other institutions for special use (planting of protection forests, coast reinforcement, anti-erosion waterworks, ferries, buildings).

Factors (past, present or potential) adversely affecting the area's ecological character

The principal threat to the area at present is the construction of a by-pass road around Reni for traffic using the border to Moldova and on to Romania. The route crosses the northernmost part of the Kirgani reedbed (which has therefore been excluded from area). The road could be a potential source of pollution, and have impacts on the hydrological regime.

Other threats include illegal dumping of waste near to the wetlands, use of agri-chemicals, and setting fire to reeds.

Conservation measures in place

Although the site is recognised by BirdLife International as an Important Bird Area (UA080), and there are several other non-bird protected species present, no protected areas have yet been designated. However, by Decree of the President of Ukraine of March 10, 1994 No. 79/94, protected areas should be established at Lake Kagul — upper (1,650 ha) and lower (2,800 ha) parts.

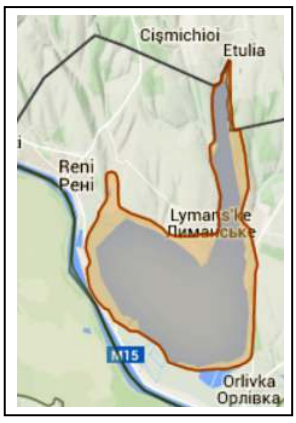
The EU has adopted a number of vital biodiversity conservation measures such as the *Habitats Directive* (92/43/EEC) and *Birds Directive* (79/409/EC). In addition, the Water Framework Directive (2000/60/EC) now provides a unifying approach for environmental management of river basins which is particularly relevant for the Lower Danube region. Although these instruments do not apply to

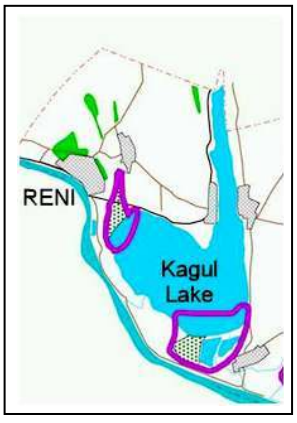
Ukraine yet, this situation will change as the process of Ukrainian integration with the EU progresses following signature of the EU-Ukraine Association Agreement in 2014.

Ukraine, as one of the Danube River basin countries, signed the *Convention on Cooperation for the Protection and Sustainable Use of the River Danube* (the Danube River Protection Convention) on 29 June 1994, in Sofia and recently ratified the Convention, which is aimed at achieving sustainable and equitable water management. The CPs have agreed to cooperate on fundamental water management issues by taking: "all appropriate legal, administrative and technical measures to at least maintain and improve the current environmental and water quality conditions of the Danube River and of the waters in its catchment area and to prevent and reduce as far as possible adverse impacts and changes occurring or likely to be caused". The Convention is based on commonly acknowledged guidelines for environmental protection, and in particular on integrated river basin management.

On World Environment Day, 5 June 2000, Bulgaria, Moldova, Romania, and Ukraine signed *The Declaration on Co-operation for the Establishment of the Lower Danube Green Corridor.* The objective of this declaration is to assist in the conservation and restoration of the landscape and biological diversity of the Lower Danube. The Green Corridor should be composed of a minimum of 773,000 ha of existing protected areas; 160,000 ha of proposed additional protected areas and some 230,000 ha areas to be restored to regain their former ecological services as natural flood plain areas. As regards the latter, some of the 230,000 ha will be covered within existing or proposed protected areas.

Boundary of Kagul IBA Proposed protected areas at Kagul





Alternative Scenarios based on Paludiculture

Production of reed biomass for renewable energy

In the study area floodplain, common reeds *Phragmites australis* grow prolifically because of specific continental climate conditions as well as abundant nutrient input from continuous sediment deposition from the Danube. However, overgrown reed beds in the Lower Danube region have become widespread as a result of floodplain modification since the 1950s. They are now burned by local people in an attempt to recover some pasture, but these efforts invariably fail to the detriment of wildlife and the environment. A company based in Reni (BioTop Ltd) has started a pilot project to

harvest and pelletise the reeds as a biomass energy source, to meet a constantly increasing demand for a reliable supply of biomass fuels.

Most biomass sources being exploited around the world today require an agricultural approach to cultivation, with significant capital expenditure and operational costs, totalling several hundred dollars per hectare per annum. Natural reedbeds, on the other hand, can be harvested on a rotational basis to provide raw biomass sustainably without the need for any cultivation or additional inputs. The only parallel between agriculturally cultivated crops for biomass and using reed is in the need to harvest the crop. In most years the cold winters freeze ground and surface waters allowing us to use specialised mobile harvesting machinery that can operate on the ice and also in water depths of up to 60 cm, while avoiding soil compaction.

The main obstacle for processing reed is its relatively high proportion of silica content. The raw material is therefore fairly stiff, brittle and abrasive, and making pellets entails higher operating temperatures and more robust machinery than for woodchips. Over several years of trials, BioTop has developed a system that can effectively chop and pellet reed efficiently in a single production line while coping with the challenging operating conditions.

The basic parameters of the test pellets produced are:

Diameter	6 mm
Density	ca. 650 kg / m^3
Net calorific content	ca. 15 GJ / ton
Ash content	ca. 8% (of which ca. 80% silicon dioxide)

These parameters (and the chemical characteristics) are well within the limits for industrial use in biomass boilers. In January 2013, having certified the production and composition of the reed biomass pellets, BioTop started to supply local customers in lots of 100 kg to 20 tons.

Following on the encouraging results of the pilot phase, BioTop has recently invested in upgrading its production line, and will soon expand its area of harvest. Ultimately, it hopes to lease unused arable land in the study area floodplain in order to produce reed as a crop. This would also lead to restoration of some of the lost floodplain functions such as water retention, nutrient recycling and carbon storage. BioTop also provides employment for 3 – 6 people.

Development of ecotourism

The Lower Danube region has a high tourism potential. The combination of the unique and picturesque wetlands, woodlands and floodplains; the great diversity of birds and plants; as well as historic sites and preserved ethnic traditions provide a solid basis for the further development of the tourism sector. Moreover, the location of the region near two borders provides opportunities for international tourist routes that centre on a cross-border network of protected areas.

An Odessa-based company, Salix Ltd, has already begun to organise tours around Lake Kagul featuring the railway journey from Reni to Etulia (in Moldova), a nature trail around Kirgani reedbed, and cycle routes. It owns a traditionally-built cottage in Reni (listed on booking.com) where visitors can stay.

	
View over western part of Lake Kagul	Open water with Nuphar lutea
	
Southern part of Danube floodplain	Visitors at Aliobrix Fort
	
Dense, tall reeds at Kirgani	Harvesting reed in winter
	
Pellet press	Reed pellets

GEORGIA CASE STUDY

Central Kolkheti Wetlands

Physical features of the site

The territory covers a low-lying coastal area of some 29,300 ha. It is located on both sides of the Rioni river mouth in the central part of the Black Sea eastern coast at 42°12'N, 41°42'E, within the administrative regions of Samegrelo and Guria.

Geology and geomorphology

The territory is situated in a tectonic depression: it comprises a Quaternary coastal alluvial plain, constructed by marine, riverine and lacustrine clays and sands, small rivers, peat wetlands and lakes, hydromorphic and alluvial hydromorphic soils. It was affected by tectonic sinking over a long geological period, which was compensated by accumulation of sediment brought by rivers from the slopes of the Caucasus and of Adjara-Imereti. The territory, together with the entire Kolkheti lowlands, is a net sedimentation area to this day, where sediments of costal, estuarine, riverine and lacustrine origin accumulate. The process of sinking is ongoing.

Origins

The coastal plain is a swampy area and well suited for the development of vast peat bogs. The surface of the mires is located almost at sea level and consequently the peat layers form a single layer. The peat deposits in these bogs extend to a depth of 12 m. In almost all coastal mires the middle and lower peat layers lie below sea level. Using radiocarbon and lithological methods, it was established that peat accumulation in the coastal mires began about 6,000 years ago and is continuing up to the present.

Soil type and chemistry range

The national park area, along with the entire Kolkheti lowlands, represents an area of intensive sedimentation, where marine, fluvial and organic sediments are being accumulated. According to borehole data, the bottom of the park, from the surface to the depth of 10-14 m, consists of sediments of alluvial (sands, silt, clay), mire (peat, swamp clays) and marine (sands, silt) origin.

Hydrology and hydrochemistry

Because of their absorption characteristics, the Central Kolkheti wetlands have significant water storage and water regulation functions. They help to maintain reliable supplies of clean water to rivers. They mitigate flooding, reduce erosion, protect the town of Poti and other settlements, roads, and agricultural fields against floods. They also play an important role in the regulation of the local climate, maintaining a humid climate in the region and mitigating the effects easterly winds. Because of the large volumes of fossil carbon stored in the peat bogs, removed from the atmosphere by plants and accumulated over thousands of years, they play a major role in the regulation of the global climate.

Due to abundant precipitation, the park and its adjacent areas are crossed by perennial flowing rivers fed from diverse sources (snow, rain, ground waters). Some of them flow across the site (Supsa, Rioni, Khobistskali, Tsivi, Tekhuri, and Enguri); others originate in the local peat bogs (Maltakva, Dedabera,

Tsia, Tsiva, Churia, and others). As a result of the amelioration works in the past some of the mire riverbeds were artificially straightened. They are generally characterised by seasonal discharges, and absence of low-water levels. Floods can occur at any time of a year, while catastrophic flooding occurs periodically, especially on the Rioni River.

A number of lakes are found within the territory. The largest, Paliastomi Lake, is of lagoon origin, with an area of 18,200 ha and a maximum depth of 3.2 m.

The ground water horizons are constantly recharged. They have high levels (0.5 – 1.5 m above the surface) and contribute to feeding wetlands, lakes and rivers. In wetland areas, rivers banks are reinforced by flood protection works.

Water chemistry is hydrocarbonic (contains Cl, Na, Mg, Ca). The territory receives surface and ground waters from nearby mountains and hills.

Water level in wetlands -0.2 – 0.7m; in lakes -0.5 – 3.0 m; in rivers -1 – 1.2 m.

Climate

Climate is humid subtropical. Winter is without snow, the summer moderately hot. The total annual precipitation averages 1,500 - 1,700 mm per year. The average long-term temperature is +14C; minimum temperatures are between -13 to -17C, the maximum is +41C. The territory is characterized by intense precipitation, high relative humidity and strong monsoon regime winds. Frosts are rare within the area, however some years have in excess of 20 days of frost.

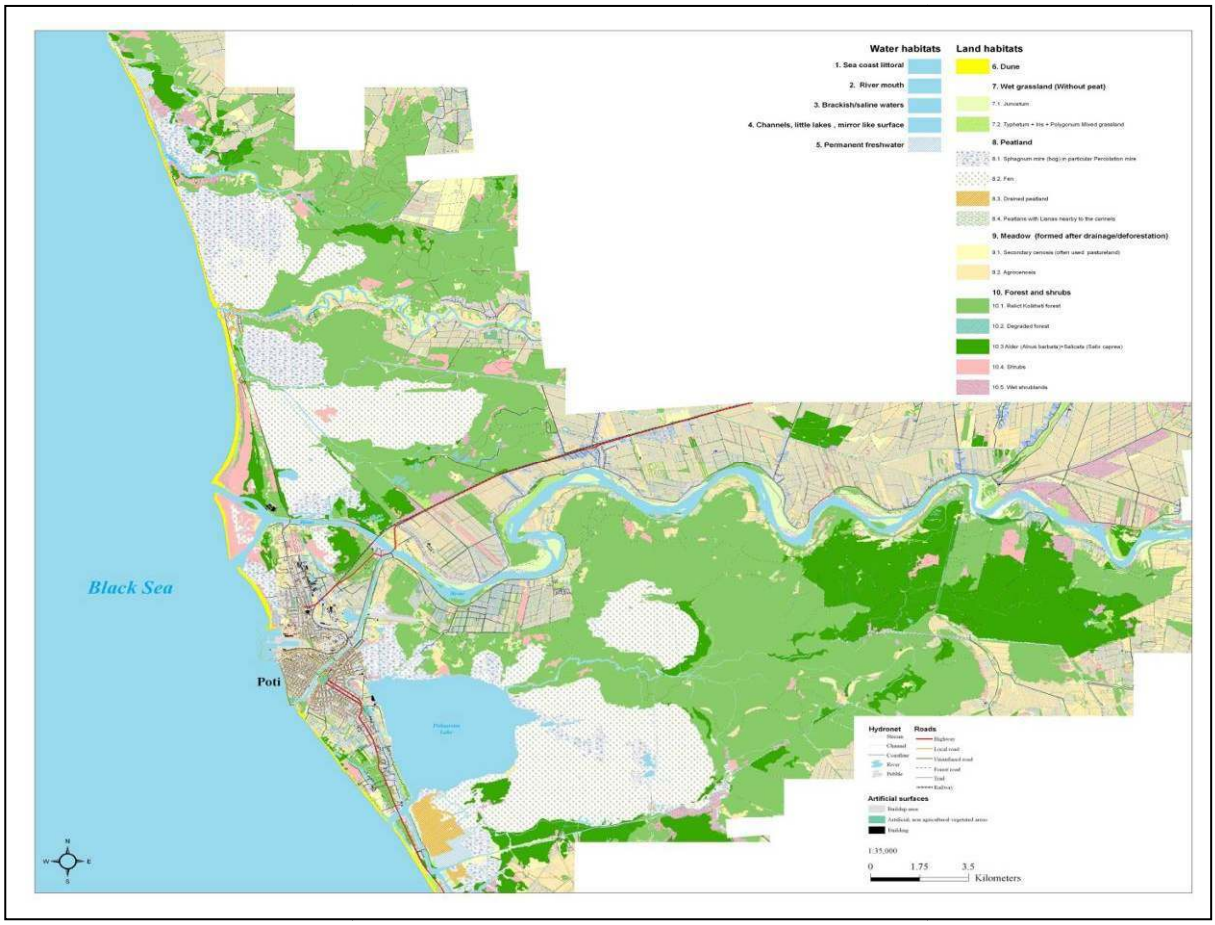
General ecological features

Out of the total 29,300 ha of the area:
Surface standing waters: 2,200 ha
Woodland: 16,100 ha
Peatland: 11,000 ha

The following habitats are found within the Kolkheti National Park (Figure 1).

Coastal sandy dunes. The original appearance of this habitat is preserved almost entirely in the coastal zone between the mouths of Khobistskali and Churia. The landscape made of vegetative associations of littoral psamophytes (*Euphorbia paralias, Eryngyium ratium*), bulbous plants, perennial xerophytes (*Anthemis euxina, Silene euxina, Stachys maritima*) and xerophytes shrubs (*Paliurus spina-christi, Hippophae rhamnoides*) has developed on the well-heated, brackish surface of the sandy slightly elevated dune ridge that stretched on the meadow sandy–turf soils along the coast. Here one can also find rare Mediterranean species (*Glaucium flavum, Pancratium maritimum*) and a number of adventives plants (*Paspalum digitaria, Erigeron canadensis*).

Figure 1: Habitat map of Kolkheti lowlands



Carex-Juncus mires. Separate patches of this type of habitat are found in every coastal mire. It occupies especially vast areas in the Anaklia, Churia and Nabada mires. This type of landscape is characterized by ideally flat relief with peat surface, swampy small meandering rivers, where Carex (*Carex acutiformis, C. vesicaria*) and Juncus (*Juncus effusus, J. inflexus*) predominate. The structure of the Carex-Juncus mires is almost natural in the south part of the Anaklia mire, on much of the Churia mire's surface and in some districts of the central part of the Nabada mire. The vegetative cover in the remaining areas of the above mires has, to different degrees, lost its original appearance, while in the places of peat extraction it has been almost completely destroyed.

Grassy-Sphagnum mires. This type of habitat is developed in the central part of the Imnati mire and on small patch in the northeast part of the Churia mire. Grassy-Sphagnum mires are distinguished by dome-shaped peat surface that is noticeably elevated over the nearby mires. Sphagnum creates a micro-relief of different shaped and sized small islands on the surface of peat domes. In the vegetative cover the main edificatory species are *Sphagnum imbricatum, S. papilosum, S. acutifolium, S. palustre*, co-dominated by *Carex lasiocarpa, Menyanthes trifoliata* and *Rhynchospora alba*.

Phragmites-Typha mires. Such habitats are mainly developed along the mire riverbanks and lakes, and also in the peripheries of some mires. In this landscape *Phragmites australis, Typha latifolia* and *T. angustifolia* predominate; in some places *Bolboschoenus maritimus* and *Iris pseudacorus* are found. Swampy Alder forests. This type of habitat is mainly developed in the peripheries of the coastal mires and along the riverbeds on the flat heavily wet relief with peat, swamp silt soils. *Alnus barbata* predominates in this landscape, which creates low growth class forests (the height of plants and trees does not exceed 10 m).

Shrubby-grassy mires. This habitat is mainly developed in the strip where the peat bogs and swampy alder-tree forests meet. This type of landscape is formed by integrity of *Carex acutiformis, C. vesicaria, Juncus effuses, J. inflexus*, other swampy grass formations and alder trees and shrubs. In most cases shrubby-grassy mires are of secondary (anthropogenic) origin.

Humid Alder forests. This type of habitat is mainly developed in the north-east, east and partly south-east parts of the KNP. *Alnus barbata* predominates in the vegetative cover of this landscape, but *Quercus imeretina, Q. hartwissiana, Pterocarya pterocarpa, Carpinus caucasica, Frangula alnus* and other species also play an important role.

Secondary shrubby-meadows. This type of habitat has been developed as a result of felling; isolated fragments are found everywhere throughout the KNP areas covered with forests. The landscape mainly consists of *Alnus barbata*, rarely by *Quercus imeretina, Carpinus caucasica* or *Pterocarya pterocarpa* shrubs of secondary origin supplemented by grass associations.

Secondary meadows. Small or large fragments of this type of landscape are found in every part of the KNP. They have succeeded in areas formerly covered with forests or in drained mires. *Paspalum digitaria and P. dilatatum* predominate in the vegetative cover of meadows. In the swamp meadows *Juncus effesus, J. acutus, Trifolium repens, Carex acutiformis* are common. In the wet secondary meadows *Paspalum digitaria, P. dilatatum, Agrostis alba, Poygonum hydropiper, P. minus, Sorghum halepense* and other species are found.

Anthropogenic-aquatic landscape. This type of habitat within the KNP has mainly developed as a result of drainage works. Since 1930s tens of drainage canals have been cut through the wetlands, certain meandering mire rivers have been straightened. As a result of peat extraction, different shaped pools have developed. Presently, the basins of the Pichori River and Paliastomi Lake, as well as the surface of the Nabada mire are netted with shallow canals.

Flora and fauna

The vegetation of Kolkheti lowlands include rare relics of a tropical and subtropical landscape that stretched across the Eurasian continent approximately 10 million years ago. A more recent plant community, adapted to the far north, arrived here after the glacial periods less than 10,000 years ago.

Some mosses and plants that grow in the Kolkheti mires are the same types that live far away in northern mires. These include the *Sphagnum* mosses; the insect-eating Sundew *Drosera rotundifolia* and the Royal Fern *Osmunda regalis*. The last two species are listed in Georgia's Red Data Book.

Among endemic species is *Trapa colchica*, spread along canals, lakes and other reservoirs, bays of rivers and stagnant water places. *Hibiscus ponticus* is a rare endemic, found in peaty wetlands.

Among the wildlife of this site, birds are the most visible. Over 194 different bird species are found within the territory of the Central Kolkheti and adjacent areas, including 62 resident, 76 migratory, and 56 wintering species. They belong to Gruiformes, Ciconiiformes, Charadriiformes, Falconiformes, Galliformes, Passeriformes, Anseriformes, Pelecaniformes and other orders.

The Ramsar site and adjacent areas provide resting and wintering grounds to: *Pelecanus onocrotalus, Pelecanus crispus, Ciconia ciconia, C. nigra, Anser erythropus, Tadorna ferruginea, Marmaronetta angustirostris, Oxyura leucocephala* (IUCN), *Haliaeetus albicilla, Buteo rufinus rufinus, Aquila heliaca* (IUCN), *Aquila clanga, Falco cherrug* (IUCN), *Falco vespertinus, Falco naumanni* (IUCN), *Aegolius funereus, Tyto alba, Grus grus*. All of them are included in a Red List of Georgia as vulnerable and endangered species. From other birds species it should be mentioned: *Anser fabalis, Anser albifrons, Anas platyrhynchos, Aythya fuligula, Crex crex, Botaurus stellaris, Ixobrychus minutus, Egretta alba, Egretta garzetta, Ardea cinerea, Anthropoides virgo, Gallinago media, Phasianus colchicus*.

Several species of reptiles have been identified and documented within the Ramsar site and its adjacent areas, such as *Emys orbicularis, Angius fragilis, Natrix natrix, N. tesselata*, and *Elaphe longissima*. From amphibians, *Triturus vulgaris, T. karelinii, Bufo viridis, Hyla arborea*, and *Rana ridibunda* are found.

The fish fauna of Lake Paliastomi includes 24 species, among which are: *Alosa caspia palaeostomi* – an endemic species – and a number of important commercial fish, including the marine mullets *Mugil cephalus, M. auratus* and *M. saliens*.

Natural values

The wetlands of central Kolkheti are very important for biodiversity. Coastal swamps are rich with endemic and relict wildlife species. Churia, Nabada, Imnati and other ecosystems have water regulatory and water cleaning functions; the relict Kolkheti swamp forests located next to peat bogs; Paliastomi, Imnati and other lakes are habitat for breeding, wintering and migratory birds. Kolkheti mires play a role in protecting local communities from flooding. During periods of heavy rain, these mires act like a sponge, absorbing large quantities of water. After the rains the mires release water slowly, keeping the surrounding area from becoming too dry.

Social and cultural values

The site contains valuable natural features for recreation and ecotourism development. Visitors can explore a variety of natural areas found nowhere else in Georgia: wetland forests, quiet waterways, peatland mires. They can enjoy boating, kayaking, birdwatching, photography and educational programmes (routes are arranged in Imnati and Nabada peat bogs).

The special humid landscapes of the territory contain palaeographic, biogeographic, landscape, hydro-climatic and other characteristics which have a large potential for attracting scientists and researchers. Based on archaeological and historical-ethnographic evidence, the territory has been occupied by humans since the Neolithic Era. In the third millennium BP, there was a highly developed civilization in Kolkheti. Results of archaeological excavations in Kolkheti lowlands prove that the river banks of the protected territory were populated during the Bronze Age and later periods. Furthermore, old settlements near the village of Chaldidi located along both banks of the river Rioni were studied, among them Zurga and Simagre. Several monuments of late bronze and ancient age were found between the beds of Rioni and Pichori.

Land tenure/ownership

As shown in Figure 2, land within the protected area is state-owned. Land in the surrounding area is partially state-owned property, partially private property.

Figure 2: Boundary of the Kolkheti National Park (green dotted line)

Current land (including water) use

Within the traditional use zone of the National Park, grazing and cutting firewood are allowed. Restricted fishing is allowed in Lake Paliastomi. The peripheral zone of the National Park (especially swampy and humid forests, secondary forest-shrubs and meadows, also the edges of the peat bogs) is used for cattle (cow and water buffalo) grazing by the local population. Aside from grazing, the surroundings of the National Park are used for crops (principally maize) and woodcutting.

Factors (past, present or potential) adversely affecting the area's ecological character

Human activities are the most adverse factors affecting the site's ecological character, among which illegal woodcutting and pollution of Paliastomi Lake are the most severe. Moreover, the increasing salinity of the lake threatens indigenous fish species (see below).

Woodcutting, mire drainage, peat extraction, uncontrolled hunting and fishing had negative impacts on the Kolkheti wetlands before the establishment of Kolkheti National Park. As a result of intensive woodcutting, certain forest areas were greatly degraded, especially along the Churia, Tsiva, Tsia and Pichori rivers, where almost pristine forest stands were still found in recent times. Currently, much of these stands are represented by degraded forests, secondary forest-shrubs and secondary meadows.

In the past, the northern part of Anaklia mire, the southernmost parts of the Imnati and Nabada, much of the Maltakva, and the northern part of the Grigoleti mires were exploited as peat-pits. Peat extraction for organic fertilizers began in Kolkheti in 1930. Peat extraction from the coastal mires of Kolkheti Lowlands was stopped in 1990.

Anthropogenic influences on Lake Paliastomi have led to significant impacts on its ecological structure since the 1920s. Following the construction of the Maltakva channel joining the lake to the Black Sea for flood protection, the lake has changed from freshwater to a brackish/freshwater ecosystem. The salinity of the lake fluctuates, peaking following onshore storms from the Black Sea. Further impacts have resulted from the extraction of peat in nearby areas; mire rivers carry harmful biogenic elements, resulting from peat decomposition, into the lake. These factors are perceived to have had a strong negative effect on biodiversity. Periodically (either early in spring, before the vegetation starts, or late in autumn) the mires' vegetation is set on fire.

In the area surrounding the National Park, construction and operation of nearby Kulevi Oil Terminal represents one of the main negative factors. Mitigation measures are identified in an Environmental Impact Assessment and by the terms of the Environmental Permit.

Conservation measures in place

For the protection/preservation of the unique ecosystems of Central Kolkheti Ramsar site, Kolkheti National Park was created in 1999, by the Law of Georgia on Establishment and Management of Kolkheti Protected Areas.

The Government of Georgia received a credit from the International Development Association (IDA) and a grant from the Global Environmental Facility (GEF) for establishment of the Kolkheti Protected areas under the Georgia Integrated Coastal Management Project (GICMP). Within the frame of this project, a series of measures were conducted:

- Kolkheti protected areas management plans were developed and approved and demarcation of boundaries of Kolkheti National Park was finalised.
- Biodiversity monitoring programme for Kolkheti National Park was developed.
- Kolkheti National Park resources use (grazing, logging, fishing, hunting) was studied.
- The Administration of Kolkheti National Park was properly equipped.
- An interpretation programme for Kolkheti National park was developed in cooperation with the US Fish and Wildlife Service.
- Kolkheti National Park infrastructure was put in place.
- Winter waterbird counts were carried out in compliance with Wetlands International format (2003, 2005).
- Kolkhetian pheasant (Phasianus colchicus) assessment study was undertaken.
- Imnati mire was studied in detail by scientists from the Greifswald University Institute of Botany (hydrology, vegetation, anthropogenic impact (grazing, fire), peat stratigraphy).

In addition, the Government of Georgia has received a grant from Japan Social Development Fund for implementation of a project on Improving Livelihood Security in Kolkheti Lowland. 30 small projects were implemented in villages adjacent to the National Park to minimise the pressure on natural resources. Moreover, based on the measures defined in the management plan, the National Park is widely advertised on TV, with the purpose of popularisation.

In 2012, the Kolkheti Protected Areas Development Fund was created. It works in three directions: (i) implementation of monitoring programs; (ii) designing infrastructure; and (iii) construction and reconstruction works. These are all necessary activities for tourism development. Various projects have been carried out with the financial support of the fund, including:

- Waterbird monitoring (Ilia State University)
- Implementation of a monitoring plan for Kolkheti National Park (Association “Flora and Fauna”)
- Monitoring of Black Sea mammals (Ilia State University)
- Hydrological regime monitoring programmme (Ilia State University)
- Updating Kolkheti National Park Management Plan
- Preparing Black Sea mammals conservation plan
- Lake Paliastomi fish and hydrobiological research (Association “Flora and Fauna”)

Future conservation activities include:
Identification of priority sites for wetland restoration.
As Kolkheti National Park Administration cooperates with different public bodies as well as with non-governmental organisations, it is planned to work on some environmental projects that will benefit peatlands, their effective monitoring and conservation. The forthcoming Joint Operational Program Black Sea Basin 2014-2020 gives the opportunity to work on projects with different partners that will improve joint environmental monitoring and promote common awareness-raising and joint activities against river and marine litter.

Alternative Scenarios Based on Paludiculture

Macrophyte harvesting

Macrophytes such as rushes, reeds and sedges grow around the margins of Lake Paliastomi. In the past, local people cut and dried them and wove the material into products including hats, baskets, brooms and mats. It was a traditional and widespread activity for the region. Today, this tradition has almost disappeared but could be reintroduced for the growing tourist market. Macrophytes can be harvested in the traditional use zone of the National Park.

Grazing

Local people keeping cows and buffalos can graze them in the traditional use zone of the National Park.

Eco-tourism

The region has a high potential for eco-tourism development. The combination of the unique wetlands, woodlands and waterways; the great diversity of birds and plants; as well as historic sites, preserved ethnic traditions and traditional cuisine, provide a solid basis for the further development of the eco-tourism sector.

The National Park Administration offers boating on Lake Paliastomi and River Pichori. Several observation towers have been built in the territory for birdwatching. In Poti, as well as in Churia district (on the north part of the National Park), visitor centres provide information about the area and offer guest rooms. There is some potential for additional guesthouse business where organic food is provided, that will be source of revenue for the local population.

Sphagnum peat moss farming

The warm and humid climate of the Kolkheti Lowlands encourages a high natural productivity of peat moss (Sphagnum). It can grow throughout the year since there are neither long periods of temperatures below 0°C nor long dry seasons. These conditions favour Sphagnum farming on degraded peatlands as well as on recently abandoned alluvial soils.

The potential for Sphagnum farming in the Kolkheti Lowlands have been conducted by Greifswald University[1], involving trials on the establishment and productivity of two species: Sphagnum papillosum and S. palustre. The study proved a high potential for local cultivation of both Sphagnum species due to the availability of agricultural sites and suitable climatic conditions. However, methods ensuring the establishment of Sphagnum cultures and managing the water levels (to avoid desiccation or flooding of the peat mosses) have to be developed.

[1] See http://paludiculture.uni-greifswald.de/en/projekte/sphagnumfarming/projekte.php_georgien.php


Churia Peatlands


Wetlands of Central Kolkheti with dense reedbed


Sphagnum (peat moss) and fisherman on Lake Paliastomi


Boating tour on River Pichori and birdwatching tower

Through its Re-granting Scheme, the Eastern Partnership Civil Society Forum (EaP CSF) supports projects of EaP CSF members with a regional dimension that will contribute to achieving the mission and objectives of the Eastern Partnership Civil Society Forum. The donors of the re-granting scheme are the European Union, National Endowment for Democracy and Czech Ministry of Foreign Affairs. The overall amount for the 2016 call for proposals is 307.500 EUR. Grants are available for CSOs from the Eastern Partnership and EU countries. Key areas of support are democracy and human rights, economic integration, environment and energy, contacts between people, social and labour policies.