Anlage 1a: Desk Study – Englische Version

ReedBASE

Development of a cross-border innovation platform/cluster for using common reed *Phragmites australis* biomass as a source of sustainable energy

DESK STUDY ON WETLAND BIOMASS RESOURCES IN THE LOWER PRUT, LOWER DANUBE and LOWER DNIESTER FLOODPLAINS

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Disclaimer

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This desk study was coordinated on behalf of the ReedBASE project partners by Agricola. Following on from the desk study and stakeholder meetings, there will be a separate "Assessment Report" that will identify suitable sites for implementing sustainable wet reedbed management (highlighting sites on peatland), and promising project constellations in the Danube, Prut and Dniester river areas.

1. INTRODUCTION

Because of its low tidal range and presence of many large river deltas (including Danube, Dniester, Dnieper 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 (Marushevsky, 2003) Directory of Azov-Black Sea Coastal Wetlands. Revised edition. 230 pp. Wetlands International, Wageningen, 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.

The drainage of wetlands, especially peatland, is often associated with severe 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.

A new approach, known as paludiculture (wet agriculture and forestry on peatland), is emerging as a promising land use alternative on both existing peatlands and rewetted former peatlands (Wichtman *et al*., 2016).

Experimental projects and accompanying research, particularly in Scandinavia, Germany, UK, Austria, Belarus, Georgia and Ukraine, are underway. These have shown that paludiculture has the potential to substantially cut GHG emissions from drained peat soils hence helping states 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:

- Peatland and wetland restoration;
- Sustainable regional planning;
- Provision and safeguarding of ecosystem services;
- Substitution of fossil resources;
- Generation of alternative sources of income in structurally weak regions.

Alternative income may be generated by ecotourism and by harvesting and processing of renewable biomass resources for food, materials, and energy. The latter has been shown to generate significant sources of renewable energy for local communities through production of biogas and biomass fuel briquettes and pellets.

1.1 Project Context

Reeds grow prolifically in the lower parts of the Prut, Danube and Dniester basins in Ukraine, Moldova and Romania. Indeed, one of the most extensive reedbeds in the world occurs in the region. Due to high nutrient availability and favourable climate, reeds can reach unusually large dimensions, exceeding 4 m height and some 6 to 8 tons of dry biomass per hectare. However, dense, overgrown, monotonous reedbeds have become widespread as a result of floodplain modification since the 1950s (Goriup and Goriup, 2015). This has had significant

impacts on other wetland habitats and biodiversity, as well as wetland ecosystem services.

Models of climate change impact on the Danube basin indicate that the lower Prut, Danube and Dniester river areas are likely to experience lower flows, with higher intensity and frequency of floods and droughts, in future (Stagl and Hattermann, 2016) Conservation and restoration of reedbeds including their sustainable utilisation can improve natural water storage capacity to achieve a water balance such that river flood peaks and droughts are mitigated with minimal economic cost.

In recent years, many organisations (NGOs, protected area administrations, research institutes and the private sector) have sought to address reedbed management in a way that can recover wetland ecosystem services, improve biodiversity and also generate a sustainable source of biomass for material utilisation and local energy needs (principally heating). As reeds mostly grow on land that is marginal for conventional agricultural production (due to regular flood events) they represent a substantial biomass feedstock which avoids the 'food or fuel' debate, and has the potential to establish short carbon energy cycles in local communities.

The approach furthermore contributes to climate change mitigation by:

- storing CO_2 on mid-term scales in construction materials;
- safeguarding carbon stocks in peat soils formed by the accumulation of reed rhizomes; and
- substituting fossil fuels by renewable biomass for energy production.

1.2 ReedBASE Project

Following on from the above, the ReedBASE project therefore concerns the development and fostering of a broad-based cross-border innovation group (covering Ukraine, Moldova and Romania) for using reed biomass as a source of sustainable energy as well as other products. This in turn will promote the conservation and wise use of reedbeds around the north-west coast of the Black Sea.

In **Ukraine**, the Cabinet of Ministers of Ukraine approved the National Renewable Energy Action Plan up to 2020 on 1st October 2014 (Executive Order No. 902). The Action Plan commits Ukraine to achieve an 11% share of energy from renewable sources in its gross final consumption of energy by 2020. The Action Plan notes that the bioenergy sector in Ukraine has one of the greatest potential for development because of climate specificities, agricultural potential and availability of necessary manpower. However, realisation of the available bioenergy potential is retarded by weak development of supply and demand capacities. A smooth supply of biomass in the needed quality and quantities is not possible yet as the raw material base, the corresponding infrastructure, and industries supplying equipment are not sufficiently developed. The present amount of each unit's power generation is rather small and consequently biomass-based electricity production dynamics lags behind electricity generation from other renewable sources. However, the use of biomass can become an important component in the heat production balance. Accordingly, an important part must be played by the implementation of stimulating tariff setting for heat generation from renewable sources and by the development of an energy biomass market in Ukraine. Addressing these issues forms a core part of the ReedBASE project.

In **Moldova**, since 2011 the EU and UNDP have been implementing the Moldova Energy and Biomass Project (MEBP), which aims to contribute to a more secure and sustainable energy production in Moldova through targeted support to renewable energy in form of biomass from agricultural waste. The idea is to increase the use of renewable energy sources, thus contributing to a more secure, competitive and sustainable energy production, as well as to local development. The MEBP project has participated in developing national standards and regulations to support the local biofuel industry. To date, the Government has approved 37 national standards governing the production and quality of biofuels. Moreover, 35 businesses were launched and promoted in the sector of solid biofuel manufacturing; 100 new jobs were created; 620 families have biomass boilers installed; and 30 companies assemble biomass boilers locally and sell them to consumers. The project will continue during 2017 and ReedBASE will explore opportunities for incorporating reed as a feedstock for biomass production.

Romania, as an EU Member State, must comply with the Energy Directive 2009/28/EC which requires that, by 2020, 20% of the energy consumed in the EU stems from renewable resources. This sets mandatory national targets for renewable energy (24% for Romania), primarily to provide certain guarantees to investors and encourage development of novel technologies and innovations in this field. However, the lack of coherent support policies and yielding strategies make biomass irrelevant in the Romanian energy mix at present. Despite a high theoretical potential, there is only about 55 MW of installed biomass or biogas capacity in Romania.

All three countries included in the project are covered by the EU Danube Region Strategy, and participate in the implementation of the Danube Region Strategy Action Plan. ReedBASE links to relevant EUSDR Action Plan Priority Areas, especially PA2 "To encourage more sustainable energy" that is committed to launching technological developments, that will increase the energy efficiency of the region and enhance the use of renewable energy sources. It also addresses PA7 "To develop the Knowledge Society (research, education and ICT)" and PA8 "To support the competitiveness of enterprises".

1.3 ReedBASE Implementation

ReedBASE aims to establish a working group of interested organizations, including so-called "Triple Helix" institutions (government, business, and researchers), which already exist, and consolidate their collaboration. The group will seek to establish appropriate links e.g. with relevant Knowledge and Innovation Communities (especially KIC InnoEnergy) within the European Research Infrastructure Consortium, and identify priority investments for improving renewable energy production from reed biomass (including innovations in harvesting machinery, processing equipment, biomass boilers, material utilisation possibilities, and wetland management). Over time, it is expected that the group could expand to other Danube basin states with rich reed resources such as Hungary, Austria and Slovakia.

ReedBASE comprises the following main stages to be carried out by March 2018:

1. Preparation of a desk-based study concerning the former and current status of wetlands in the project area, and identifying strengths and weaknesses in existing reed harvesting and biomass processing and combustion technologies;
2. Compilation of a data base of stakeholders and decision makers from different governmental and non-governmental organisations from national to local level, which are or should be involved in sustainable reed bed utilisation in the project area;
3. Holding two stakeholder workshops in order to form a strong network for promoting the

sustainable use of reed biomass harvested in the project area; and

4. Identifying suitable sites on peat soils with potential for paludiculture implementation through up-scaling of biomass harvesting and processing.

The present document addressed stages 1 and 2 in the above list. Overall, it is expected that the combination of environmental research, engineering and practical implementation of paludiculture will lead to innovations that contribute to the:

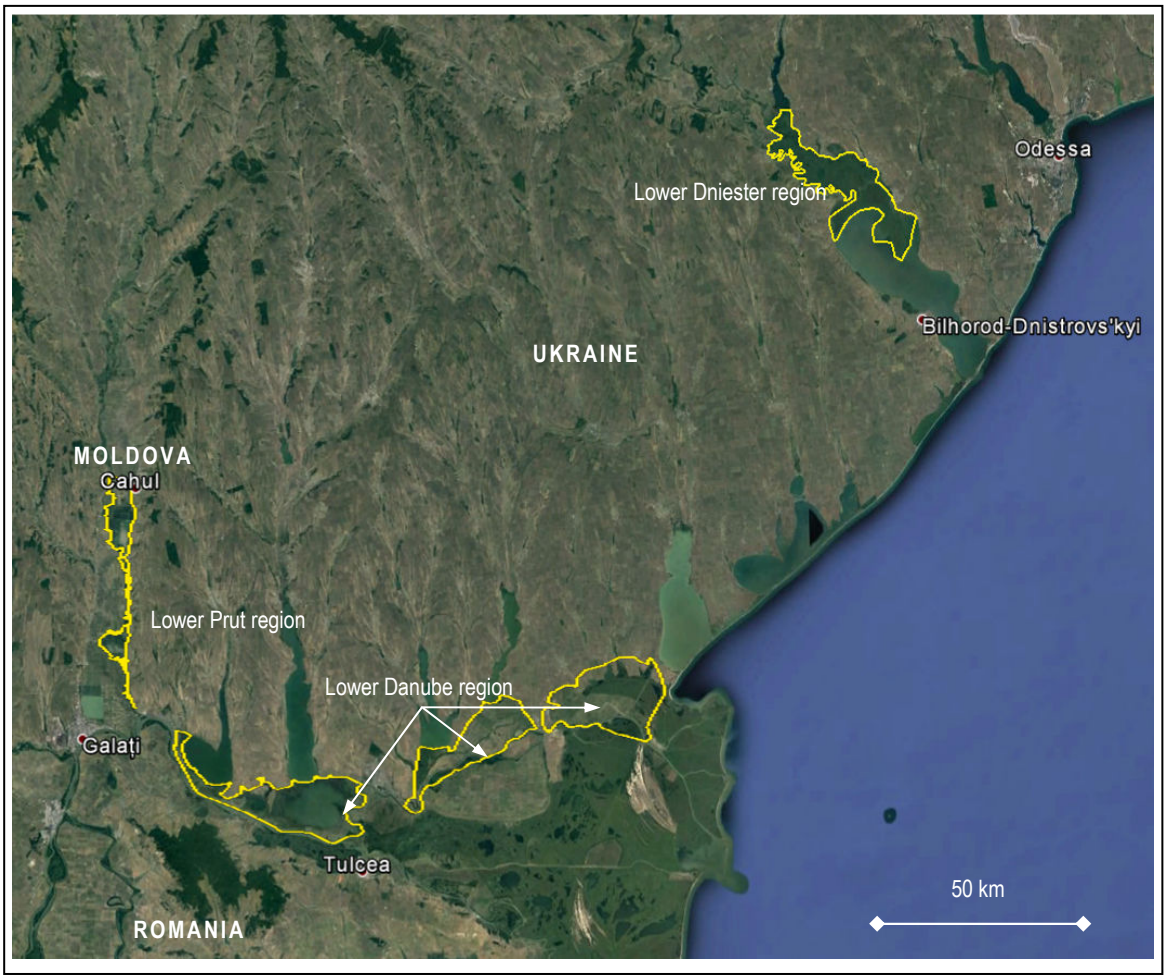
- Restoration of ecosystem services including amongst others the habitat improvement for migratory birds and waterfowl and the mitigation of GHG emissions;
- Nutrient retention and water purification in reedbeds and therefore improvement of water quality of the Black Sea;
- Development of climate change adapted land management schemes;
- Provision of renewable biomass for energy production and material use;
- Reduction of energy imports on regional scale;
- Support of regional economies and increase of local job perspectives;
- Establishment of showcase paludiculture implementations with business plans ready for up-scaling to other regions.

2. REEDBASE STUDY AREAS

The project study area covers two regions in Ukraine and one in Moldova (shown in Figure 1), and consists of:

1. The Lower Prut floodplain in Moldova, from Cahul to Giurgiulesti.
2. Three sections of the Lower Danube floodplain in Ukraine, between Reni and Vylkovo: (A) from Reni to Izmail, (B) from Izmail to Kiliya, and (C) from Kiliya to Vylkove and Primorsky, the latter comprising the northern lobe of the vast deltaic area shared with Romania; ; and
3. The lower reaches of the Dniester/Turunchuk rivers in Ukraine, from the Moldova border to their entry to the Dniester liman.

Figure 1: Location of the three study regions
Source: ReedBASE project



In each site, reviews were undertaken of:

- The distribution of river floodplain soils (focusing on the presence of peat or mineral soils);
- Description of floodplain conditions and current hydrological infrastructure and alterations (inventory of drainage ditches and channels, pumping stations etc. and their condition);
- Land cover and utilisation;
- Extent of protected areas.

The main data sources for the maps produced by the ReedBASE project were as follows.

1. Landownership maps

- Public Cadastre map of Ukraine. Access under link: http://map.land.gov.ua/kadastrova-karta
- Informational portal of real estate cadastre of Moldova. Access under link: https://www.cadastru.md
- Road network based on OSM data
- Background: World Imagery ESRI layer

2. Land cover / land-use maps

- High-resolution satellite imagery available via Google Earth, Bingmaps and Yandex maps services. Access under links: https://www.google.com/earth, https://www.bing.com/maps, https://yandex.ua/maps
- Road network based on OSM data
- Background: World Imagery ESRI layer

3. Soil maps

- Bilanchyn *et al*. (2014)
- National geospatial data fund of Moldova. Soils. Access under link: http://geoportal.md
- Public Cadastre map of Ukraine. Access under link: http://map.land.gov.ua/kadastrova-karta
- National atlas of Ukraine. Soils. Access under link: http://wdc.org.ua/atlas
- Road network based on OSM data
- Background: World Imagery ESRI layer

4. Protected areas maps

- The Ukrainian Scientific Center of Ecology of the Sea. Ecological network of Odesa oblast. Access under link: http://ims.sea.gov.ua:8081/econetwork/
- Official web-page of Danube biosphere reserve. Access under link http://www.dbr.org.ua/search/label/maps_ua
- Official web-page of Lower Dnister National Nature Park. Access under link: http://nnpp.org.ua/sample-page/
- Official web-page of Department of Ecology and Natural Resources of Odesa State Regional Administration,. Access under link: http://ecology.odessa.gov.ua/regonalna-ekologchna-merezha-odesko-oblast-eskzna-kartoshema/
- Road network based on OSM data
- Background: World Imagery ESRI layer

The three study regions in present-day Ukraine and Moldova were incorporated into the Soviet Union in 1944. As border areas, they were heavily guarded and movement in and out of them was strictly controlled. Subsequent intensive land use development had far-reaching consequences for the former steppe and wetland areas. From the early 1960s, various small-scale irrigation systems were introduced to bolster cereal production in the regions.

These initiatives gathered pace and by 1966 work had started on a grand scheme for a Danube-Dniester irrigation system, which was comprised of canals and storage reservoirs intended to turn the drought-prone area between the two rivers into arable farmland (Marples, 1985). The work undertaken as part of this project included the 1974 construction of a huge canal – from the Danube, across the Stentsovsko-Zhebryanski marshes north of the Danube delta, to Sasyk Liman. The plan was to introduce fresh water to an erstwhile coastal lagoon by damming the connection with the sea.

Unfortunately, the work not only destroyed a huge area of pristine wetland and meadow, but it also failed agriculturally because soils in the region are highly vulnerable to degradation after drainage. Oxygen penetrates drained peat soils and accelerates mineralization rates leading to high emission of CO_2 and severe changes in soil structure. In addition, the high evaporation rates in the steppe zone leads to topsoil salination and both processes severely reduce productivity. By the late 1970s, cereal production on irrigated land had started to fall behind that of non-irrigated land and the scheme was abandoned in the mid-1980s.

After the dissolution of the USSR in 1991, farmland in Ukraine and Moldova, which was still organised as communal "kholkoses", were returned to private ownership and leased to management companies. However, these companies generally could not pay for agrichemicals, electricity for pumping water, equipment or much else. As farm activity slowed, ongoing chemical pollution of soils and waters declined and some fields in the floodplains were abandoned. Plans to extend irrigation systems and further intensify agriculture were stopped. A window of opportunity for a new, more environmentally friendly low-input and smaller-scale land use system has recently opened up, encouraged by the collapse of the old style of farming and the coincidental rise of markets in Western Europe for organic products.

2.1 Hydrology and soils

All three study areas feature the lower sections of running surface waters (rivers), with some connection to groundwater layers, and having associated lakes, limans, marshes, meadows, willow scrub and moist deciduous forests dominated by various willow species with some white poplar.

2.1.1 Lower Prut Region

The River Prut is the last significant tributary of the River Danube and forms the boundary with Romania. The study region lies between Cahul and Giurgiulesti, a distance of about 48 km. Apart from the river itself, the surface water mainly comprises Lakes Beleu and Manta (the latter largely converted to fish ponds). Beleu is situated on the left bank of the Prut water-meadow between Valeni and Slobozia Mare villages. In general, its hydrology depends on that of the Prut, to which it is connected by three channels. The lake receives water in two ways: during the spring river flood period and during the summer rainy season.

This inflow regime smoothes the high losses from evaporation that occur during the summer months. The filling of the lake by the Prut to a level of 6 m occurs in 60 years out of 100; otherwise the naturally achieved level is between 4 and 5 m. At present, water from the Prut passes freely through Beleu lake because the sluices installed to regulate the water level in the lake have ceased to function properly. The calculated level of the Prut at the entrance to Beleu (near Valeni village) is 9.91 m at a normal flow of 1,260 m^3/s. The minimum level of Beleu lake water with a minimum sanitary flow in the Prut of 20 m^3/s is 3.03 m. The water level fluctuation is about 1.2 m.

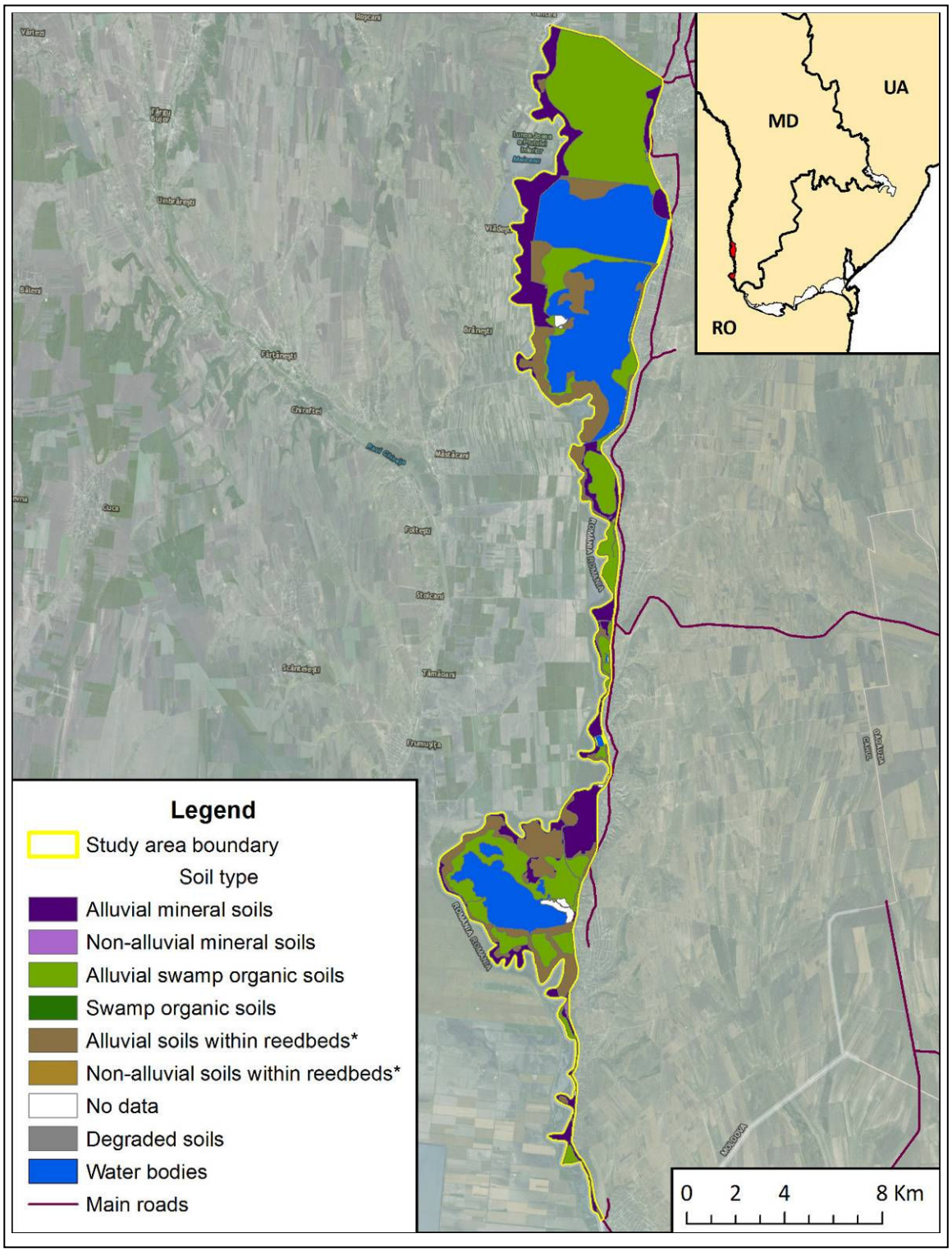
The groundwater layer in the river valley varies from 5 to 10 m. The water is fresh with a preponderance of hydrocarbonate ions (mineralisation up to 1.0 g/l). The Prut water is generally moderately polluted, but sometimes pollutant concentrations (especially trace metals like zinc and copper) exceed the levels set by the Government of Moldova. Moreover, organochlorine pesticides and other toxic substances are regularly found in the Prut, and its self-purification capacity has been reduced below the confluence with the River Jijia. At present, the concentration of suspended solids in the Prut varies from 13 to 404 mg/l; the pH ranges from 7.4 to 8.9, and the oxygen saturation between 56% and 100%.

The soils of the site (Table 1, Figure 2) are dominated by dry to wet mineral alluvial soils which comprise almost 95% of the total area. No areas of peat formation were identified, which reduces the potential for soil carbon accumulation here.

Table 1: Lower Prut soils
Source: ReedBASE project

Soil type	Area, ha
Non-alluvial mineral soils	10.7
Alluvial swamp organic soils	3,872.8
Alluvial mineral soils	1,672.9
No data	80.2
Degraded soils	1.6
Alluvial soils within reedbeds	1,664.4
Total	**7,302.6**

Figure 2: Lower Prut Region – Soils
Source: ReedBASE project



2.1.2 Lower Danube region

The information provided in this section is largely derived from Goriup (1983).

i) Groundwaters

The Lower Danube region is part of the Black Sea artesian basin and is characterised by rather complex hydro-geological conditions. Ground waters are found in all the stratigraphic subdivisions from the modern alluvial-loess deposits of the Quaternary age, with nine main aquifers. The groundwater level in the river valleys is 3-5 m deep. The water confining layer is red-brown clay and the groundwater discharges mainly to the south-east into the Pliocene-Quaternary aquifer complex of the Lower Danube terrace plain, but also 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.

ii) Rivers

The physical features of the main watercourses entering the Lower Danube lakes and thus into the main floodplain are shown in Table 2. The rivers 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. The river catchments of the lower Danube region have been severely altered. Extensive modifications of the river drainage systems have taken place throughout the catchment areas in both Ukraine and 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. Inflows in Lakes Kagul and Yalpug are severely reduced by impoundments in the upper catchment and much of the sediment and effluents are contained by the upstream reservoirs.

The Yalpug river course is 114 km long and flows almost entirely through Moldova, entering Lake Yalpug close to the Moldova/Ukraine border. The hydrological system of the entire river valley has been increasingly disturbed since the early 1970s, resulting in its desiccation and pollution with calcium sulphate, which was used for over 15 years to combat salinity in the soil. The waters have also become enriched by fertiliser run-off from agricultural land. In 1966, a 33-km canal was completed in the Yalpug valley from Lake Yalpug (Ukraine) to a reservoir at Teraclea (Moldova) holding some 60 million m^3 of water (annual flow in the Yalpug river at the border section in 2001 was 8.67 m^3/s). As the drainage area is naturally saline, the River Yalpug itself was canalised and diverted around the reservoir (to prevent saline intrusion), rejoining the irrigation canal close to Lake Yalpug.

iii) Lower Danube Lakes

All of the main Lower Danube lakes – Kagul, Kartal, Kugurlui, Yalpug, Katlabugh and Kitai – are relatively shallow in relation to their area because they are actually limans (flooded river valleys) with one or more rivers flowing into them and comprising part of the natural Danube floodplain before it was embanked. Such limans are a characteristic feature of the coastal/riverine zone between the Danube and Dniester rivers.

Table 2: Main physical features of Lower Danube lakes and river systems
Source: Goriup (2003)

Parameter	Kagul	Yalpug and Kugurlui	Katlabugh	Kitai
Total length of main river (km)	71	142	117	146
Total length of tributaries (km)	80	283	114	176
Main rivers in catchment	Kagul, Chitron, Bolboka	Yalpug, Menzual, Karasulak, Dondorskaya	Bolshoi Katlabugh, Tashbunar, Yenika	Kirgizh-Kitai, Aliaga, Angokran
Catchment area (km^2)	807	3252	1144	1232
Average annual inflow volume (m^3)	1400	10700	3000	5900
No. of reservoirs/ponds in catchment	1	> 100	6	9
Total surface area of ponds (km^2)	0.05	14.5	1.54	1.32

The highest water temperature in the lakes occurs in July-August. On average the lakes freeze one winter in two. The earliest ice cover occurs during the second or third week of December and, typically, disappears by late February to mid-March; Lake Kagul normally becomes free of ice cover first and Lake Kitai last. Ice cover lasts, on average, from 56 days (Kagul) to 71 days (Katlabugh) although a maximum of 134 days was noted in Yalpug in the winter of 1953-1954. The average ice thickness ranges from lake to lake from 9-15 cm (Kagul) to 16-28 cm (Yalpug), with the maximum ice thickness observed during early January – early February.

Only Kagul has water of less than 0.5 g/l total minerals, the threshold level for irrigation. Mean biological oxygen demand (BOD) concentrations in the lakes are relatively low in all lakes, except Kitai. However, there is a strong linear relationship with chlorophyll a, suggesting that much of the variation in BOD, particularly at the highest BOD levels, result from high algal biomass. All the lakes can be characterised as eutrophic to hypertrophic (especially Lake Kitai), resulting from the introduction of excess nutrients, especially phosphorus.

The Lower Danube region soils (Table 3, Figures 3 – 5) are dominated by moist to wet alluvial types. They are almost entirely mineral in the western part (Reni – Izmail), with increasing amount of more organic peat-forming soils in the central and eastern parts. The western and central parts include a large area of drained wetlands which might be suitable for rewetting in future.

Table 3: Lower Danube soils
Source: ReedBASE project

Soil type	A. Reni	B. Izmail	C. Kiliya
Alluvial mixed organic & mineral soils	17,199.5	15,607.9	7,337.2
Alluvial mixed organic & mineral soils within reedbeds*	55.4	3,104.9	8,563.9
Non-alluvial mineral soils	0	0	9,106.9
Non-alluvial mineral soils within reedbeds*	0	0	841.7
Total	**17,254.9**	**18,712.8**	**25,849.7**

Figure 3: Lower Danube Region A, Reni to Izmail – Soils
Source: ReedBASE project

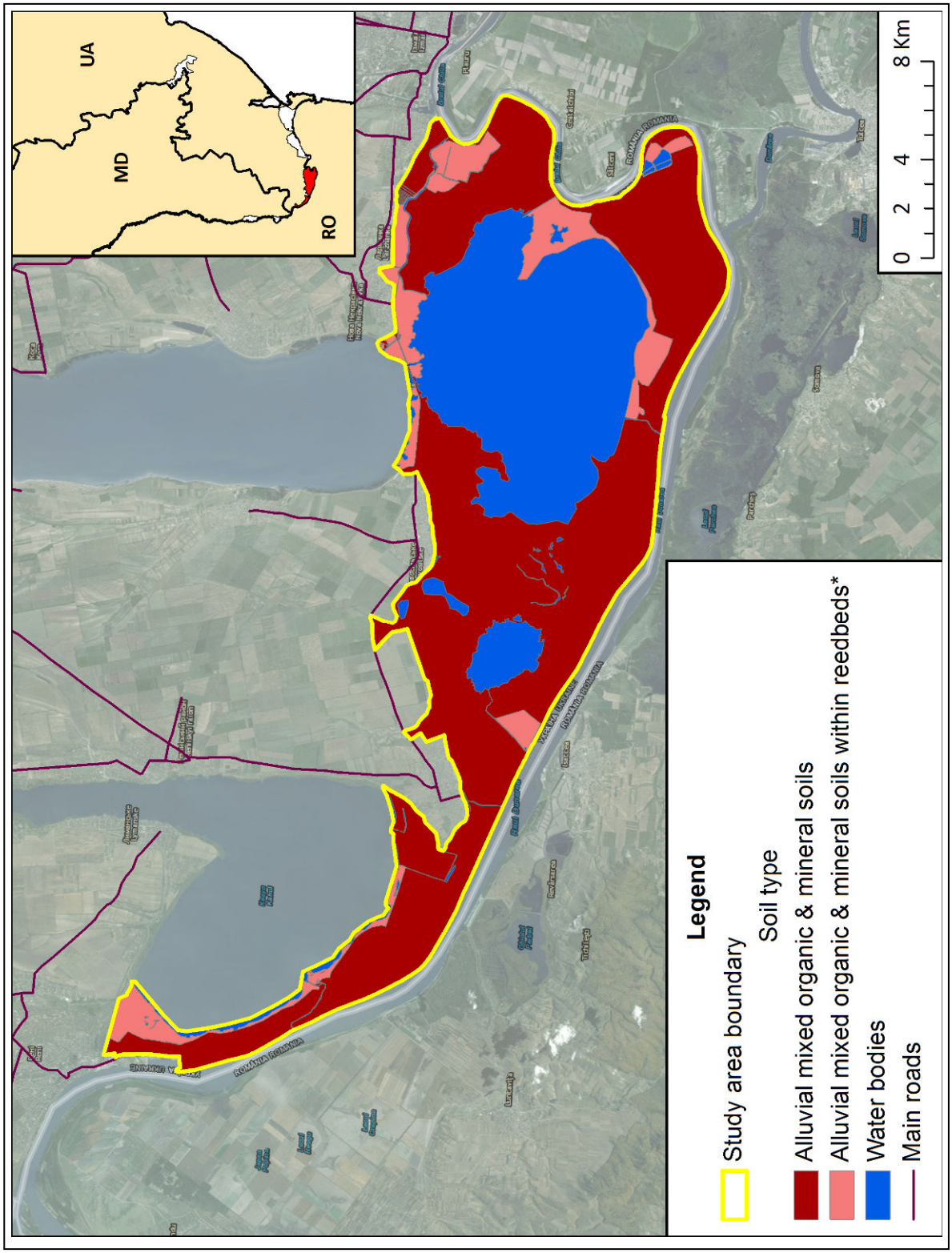


Figure 4: Lower Danube Region B, Izmail to Kiliya – Soils
Source: ReedBASE project

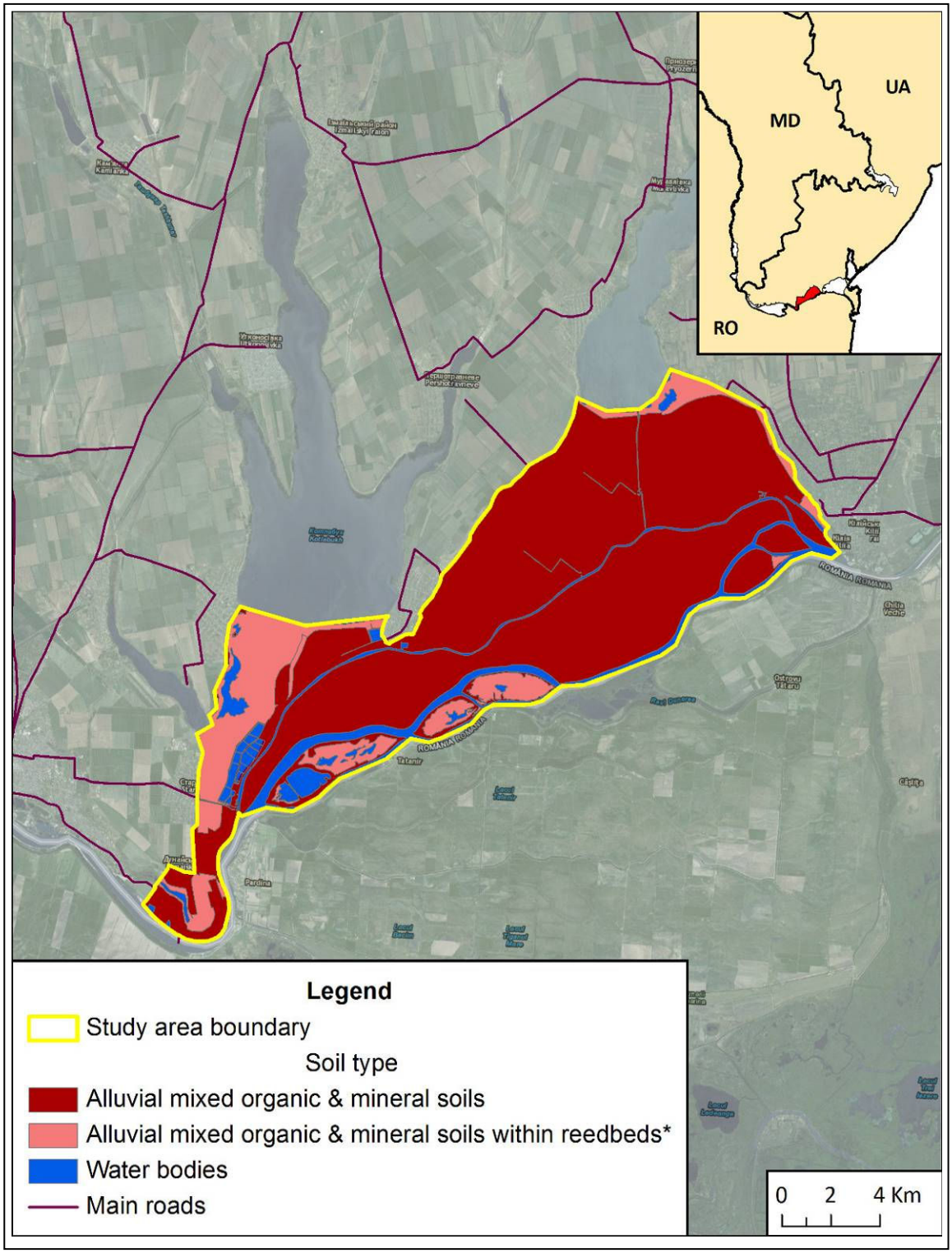
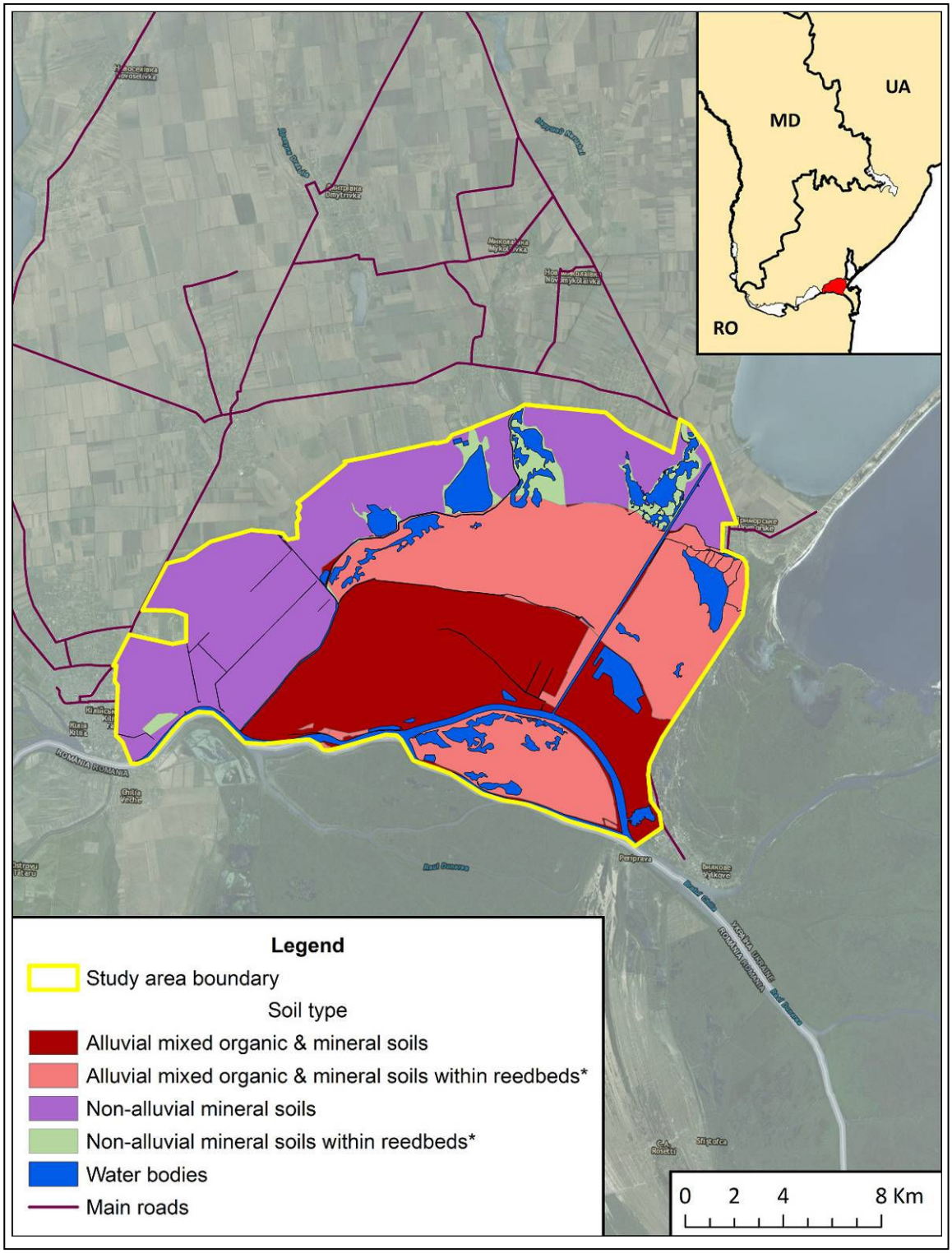
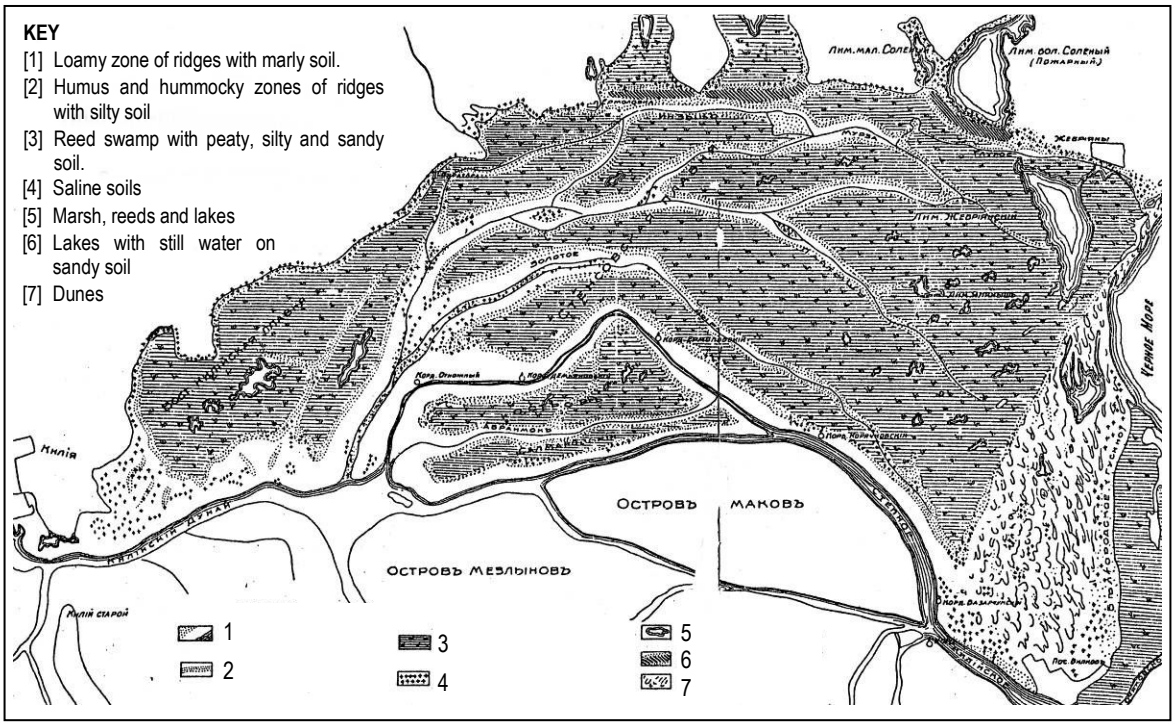


Figure 5: Lower Danube Region C, Kiliya to Vylkove – Soils
Source: ReedBASE project



It is interesting to compare the soil map in Figure 5 with that prepared in 1914 (Figure 6). The latter shows the compact and continuous extent of reedbeds (dark shading) west of Zhebryanski (now Primorski), and their drainage system, before the hydrological alterations of the mid-20th century.

Figure 6: Soils of the Danube Delta from Kiliya to Vylkove in 1914
Source: Nabokich, A. I. (1916) Carte schématic des sols du delta du Danube dans la region Kisliza – Kilia – Vilkovo. Proceedings of the Imperial Agricultural Society of Southern Russia, vol. 86.



2.1.3 Lower Dniester region

The Lower Dniester basin is located within the Black Sea lowland, consisting of steppe plains. The topography of this area is one of a gently dipping plain, which has promoted the development of extensive wetland area in the river floodplain, dissected by branches, and ancient river beds that are frequently flooded. However, the topography makes the area susceptible to sedimentation.

The River Dniester itself has a mean annual flow of 8.4 billion m^3, discharged at an average rate of 274 m^3/s through an internal delta, that discharges into a large liman largely separated from the Black Sea by a sandbar except for the exit point near to Zatoka.

The width of this section of the Dniester River is in the range 100 m to 200 m. The river valley slopes are asymmetrical: the altitudes of the right slope decrease from 150 m to 50 m, whereas the left slope altitudes fall from 70 m to 30 m in the downstream direction.

Near Ciobruci Village in Moldova (148 km from the mouth), the navigable channel of the Dniester River bifurcates to form the Turunchuk, or Novy (New) Dniester, which joins the main Dniester River channel further downstream, near Belyaivka Village (21 km from the mouth). The Turunchuk Branch is separated from Beloe Lake by a naturally developed sand levee, to flow directly into the Dniester River.

The Turunchuk Branch receives about 60% of the total Dniester flow. This area has an extensive system of lakes, which are located along the Dniester and Turunchuk channels, enveloping the Turunchuk Island. The largest of them include the Kuchurgan Liman, Beloe Lake, Putrino Lake, and Tudorovo Lake. The Hlyboki (Deep) Turunchuk splits from the main Dniester channel downstream of Mayaki Village, featuring an artificial channel, about 100 m wide and 9-10 m deep. The Dniester drains to the Dniester Estuary via its two branches, the Dniester and Hlyboki Turunchuk.

Wetland lakes represent a very important feature in the local landscape. There are about 100 of them, with 10-15 major lakes. Most of wetland lakes are in hydraulic continuity with the Dniester, being connected to its branches via small streams, cutting through the natural levee and running in the reed thickets. The largest of them are 15-20 m wide and up to 1.5 m deep. These streams are major suppliers of flow to the lakes, especially from the Turunchuk Branch, which provides flow to the upper part of the Dniester Wetlands, characterized by the significant variability of water levels, resulting in elevated discharge rates and velocities of incoming flow. The lakes (and wetlands as a whole) are also fed by water overflowing the natural riparian levee during significant flooding events. The whole wetland area floods in these periods

The Belhorod-Dniestrovsky irrigation system water intake is located along the main branch of the Dniester River 1 km downstream of the Moldovan/Ukrainian border. Further downstream, after the confluence of two river branches, the river flow is abstracted to supply water to the Dniester Drinking Water Treatment Plant, and to the Mayaki-Bilyaivka and Troitsko-Hradenytsia irrigation systems. The Dniester Drinking Water Treatment Plant itself abstracts over 300 million m^3 of river water per year at an estimated flow rate of 10 m^3/s, to provide drinking water to Odessa, Illychivsk, and Belhorod-Dniestrovsk.

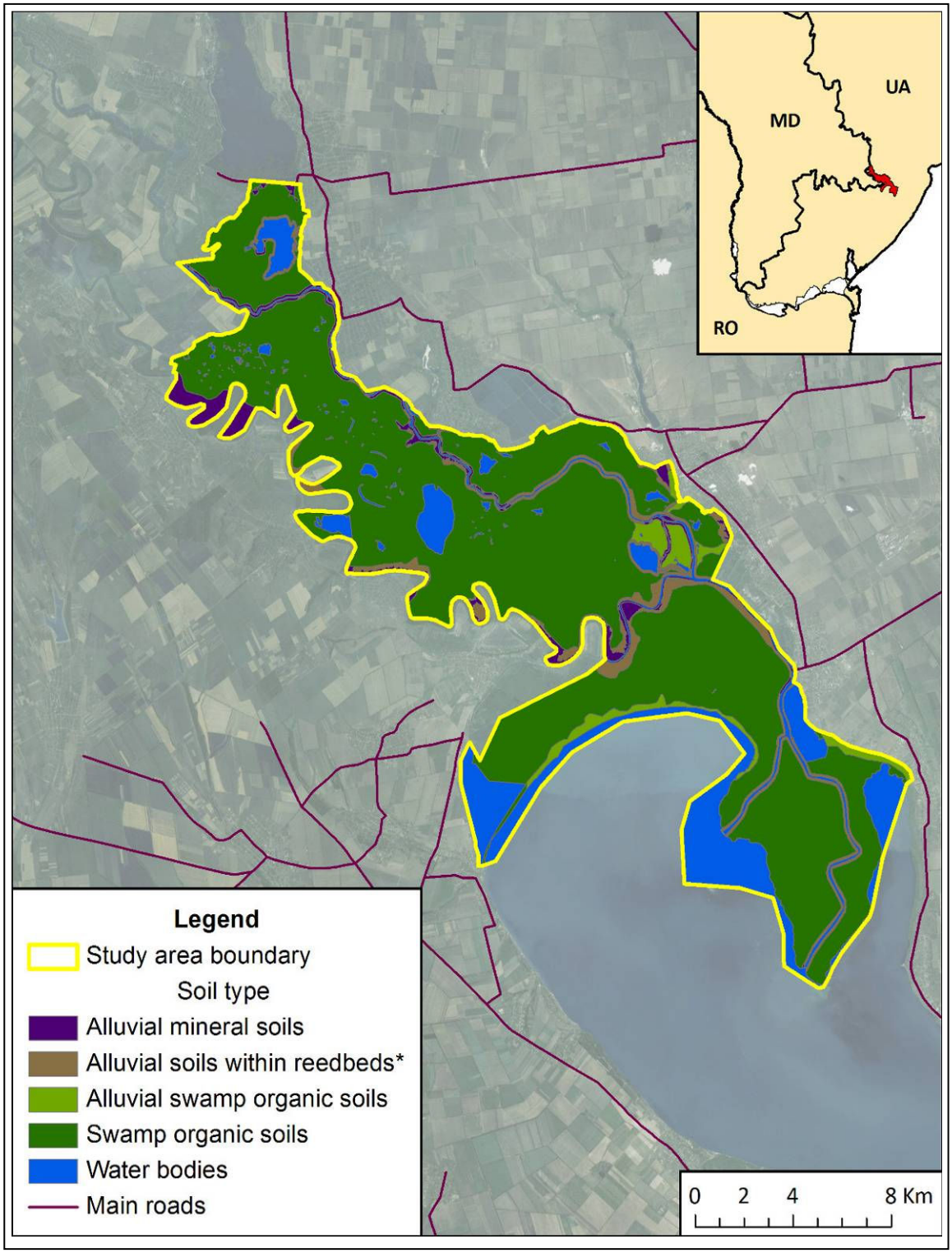
The Dniester basin has seen a progressive reduction in available river flow since 1957, largely due to the increasing anthropogenic pressures and large-scale land reclamation activities in the river catchment. Despite the reduced intensity of economic activity in the Basin since the 1990s, there has been no perceived improvement in river's flow regime. The construction and operation of reservoirs have had a profound impact on the ecological equilibrium and natural flow regime in the Basin, with the current rate of water exchange being several times lower than under natural conditions

The soils of the Lower Dniester area (Table 4, Figure 7) are predominantly moist or wet alluvial soils, including a significant area (up to 19,700 ha) of peat-forming soils. This area has the highest potential of the three study areas for carbon accumulation through peat formation as most of it is already wet.

Table 4: Lower Dniester soils
Source: ReedBASE project

Soil type	Area, ha
Alluvial mineral soils	1,118.8
Swamp organic soils	19,699.3
Alluvial swamp organic soils	766.6
Alluvial soils within reedbeds*	1,468.7
Total	**23,053.4**

Figure 7: Lower Dniester Region – Soils
Source: ReedBASE project



2.2 Land cover and water management

The current land cover in each of the three project regions was mapped according to the categories in the CORINE system[1]. CORINE means 'coordination of information on the environment' and was a project started in 1985 working on many different environmental issues, including an inventory of land cover in 44 main classes. This inventory was subsequently taken over and is now maintained by the European Environment Agency, which produces periodic updates available for most areas of Europe. Using the CORINE system allows use of a standard system of land use categories and integration of the ReedBASE inventory with the wider European data sets.

The results are shown in Table 5, and Figures 10 to 14. From Table 5, it can be seen that the total area of the project region is 117,920 ha and contains 33 land cover types at CORINE level 2. Out of the total area, two land cover types are the most common: 36,802 ha (31%) comprise arable land and 35,760 ha (30%) are pure reedbeds; a further 9,974 ha (8%) comprise reed mixed with other land cover types. The remaining area is largely represented by open water with 23,139 ha (20%). The maps also indicate the locations of water management structures (pumping stations and sluices) as well as bridges that can carry vehicles and are therefore large enough to influence water flow. As mentioned previously, all the project regions have been heavily impacted by various hydrological works, not only within them but also upstream and in the surrounding catchments.

A good example of the type of works and impacts is demonstrated by the lower Danube floodplain. From the mid-1950s, this region was embanked to improve access to Reni and ensure border security (with electric fences and guard towers). This led to a cessation of the seasonal inundation of the floodplain and associated lakes that naturally refreshed and flushed out the water held in the lakes. Similarly, the Lower Danube lakes basin as a whole was severely altered during the last seventy years. Extensive modification of the river drainage systems took place throughout the catchment areas in both Ukraine and Moldova through installation of barrages and other water storage schemes for irrigation of crops. The heavy use of pesticides and fertilisers for crop production, and the discharge of untreated effluents by villages situated in the valleys greatly affected the water quality of various rivers. Due to such impoundments, the inflows into Lakes Kagul and Yalpug are severely impeded and much of the sediment and effluents are contained by the upstream reservoirs.

Since the embankments were built the water exchange between the Danube and the lakes has been actively managed. Pumps are used to introduce Danube water into Lakes Katlabugh and Kitai in spring, and sluices and canals used to draw them down in autumn. During the high flood period of the Danube, from late March to early June, sluices are opened and river water flows into Lakes Kagul and Kugurlui (and from the latter to Yalpug) via a series of canals (Figure 8). The sluices are then closed until mid-September, when they are opened again and the lakes are drawn down, sometimes to the dead storage level, until November. From mid-December, when the Danube begins to rise again, the lakes are 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 (especially from River Yalpug into the northern part of Lake Yalpug). However, because of these changes, the fish catch has declined precipitously and significant amounts of sediments have built up in the lakes.

[1] https://www.eea.europa.eu/publications/COR0-landcover

Table 5: Land cover in the project area (figures in ha)
Source: ReedBASE project

Land cover category, level 1	Land cover category, level 2	Lower Prut	Lower Danube (A)	Lower Danube (B)	Lower Danube (C)	Lower Dniester	Total
Agricultural areas	Arable land	2,319	7,514	13,305	13,271	394	36,802
	Heterogeneous agricultural areas	99	1,447	202	739		2,487
	Pastures	30	92	54	84		260
	Permanent crops	2		131			133
Artificial surfaces	Green urban areas		61	45	359	62	526
	Industrial units	2	29	147	336	3	516
	Transport units		24		3		26
	Industrial & transport units			22			22
Forest & shrubs		1,099	1,166	1,543	418	2,709	6,935
Herbaceous vegetation	Natural grassland	108	58	12	44	107	328
	Natural grassland & moors	47					47
	Natural grassland & shrubs	31	148	73			252
	Natural grassland, moors, shrubs	181					181
Open spaces with little or no vegetation	Sparsely vegetated areas	14	24		3		41
Water bodies	Estuary					2,209	2,209
	Lakes	2,364	9,582	1,868	2,904	968	17,686
	Artificial	2					2
	Fish ponds	1,327		188	260	814	2,588
	Ponds	1					1
	River					654	654
Wetlands	Grassland				177		177
	Grassland & shrubs	165	147				312
	Reedbeds	1,744	2,106	2,941	9,187	19,781	35,760
	Reedbeds & fish ponds		524				524
	Reedbeds & forests	692					692
	Reedbeds & arable land				61		61
	Reedbeds & grassland			114	15		129
	Reedbeds & shrubs	56		56			112
	Reedbeds, grassland & shrubs				154		154
	Reedbeds, forest & shrubs	433					433
	Water & moors	3					3
	Water bodies & reedbeds	279	6,517	72	889		7,757
	Water bodies, reedbeds & shrubs				110		110
	Total	**10,997**	**29,438**	**20,773**	**29,013**	**27,700**	**117,920**

Another example of water management infrastructure comes from the Lower Dniester. During the research for this report, we found that a series of aerial photographs had been taken across the project area in 1944. Thus, Figures 9a and 9b show the drinking water intake at Bilyaivka in 1944 (being a strategic target) and 2014 – 70 years apart. In that time, the main change has been the construction of an additional channel below the main intake canal, consequent installed buildings and encroachment of the reedbed margins by willow scrub, suggesting a lowering of the average water levels.

Figure 8: Water management system for Lakes Kagul, Kartal, Kugurlui and Yalpug
Source: Goriup (2003)

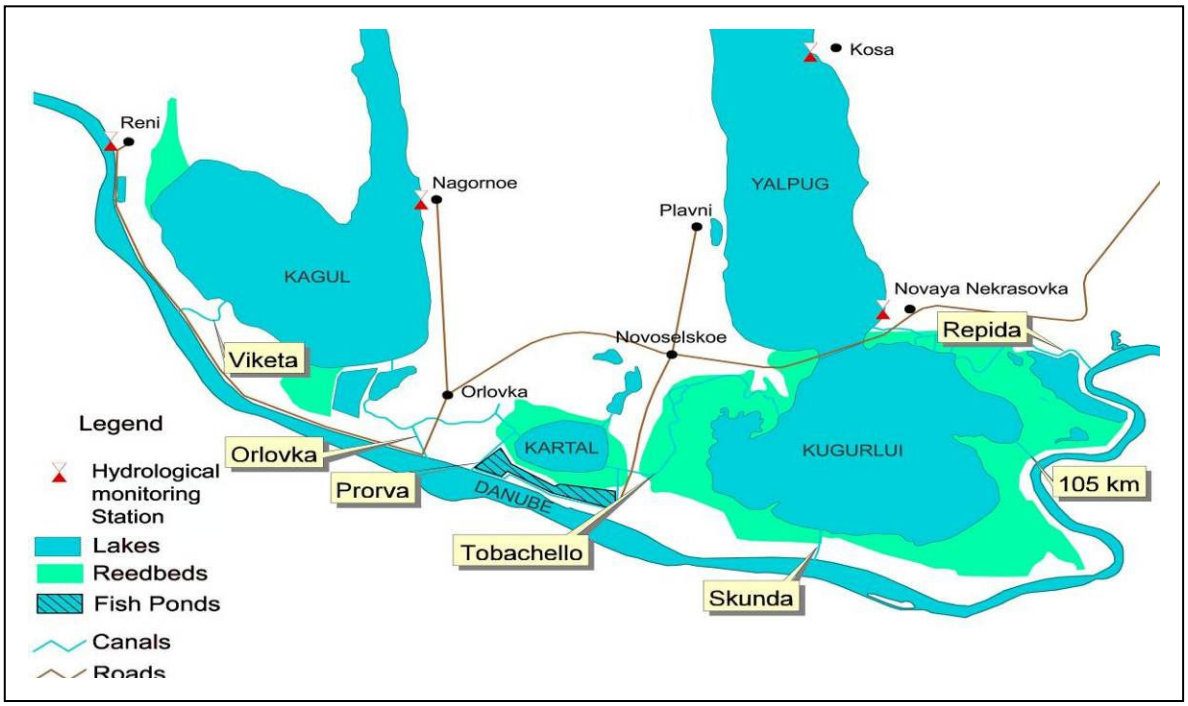


Figure 9a: Water intake at Bilyaivka, 17 July 1944
Source: http://wwii-photos-maps.com/

Figure 9b: Water intake at Bilyaivka, May 2014
Source: Google Earth screenshot

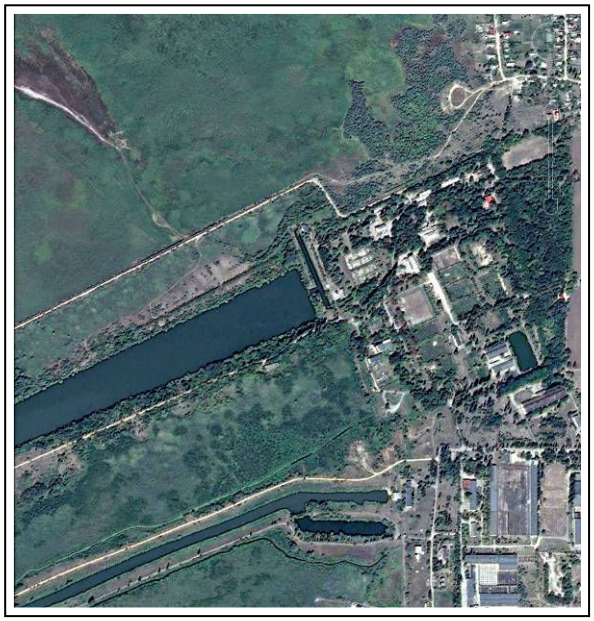


Figure 10: Lower Prut Region – Land Cover and Water Management
Source: ReedBASE project

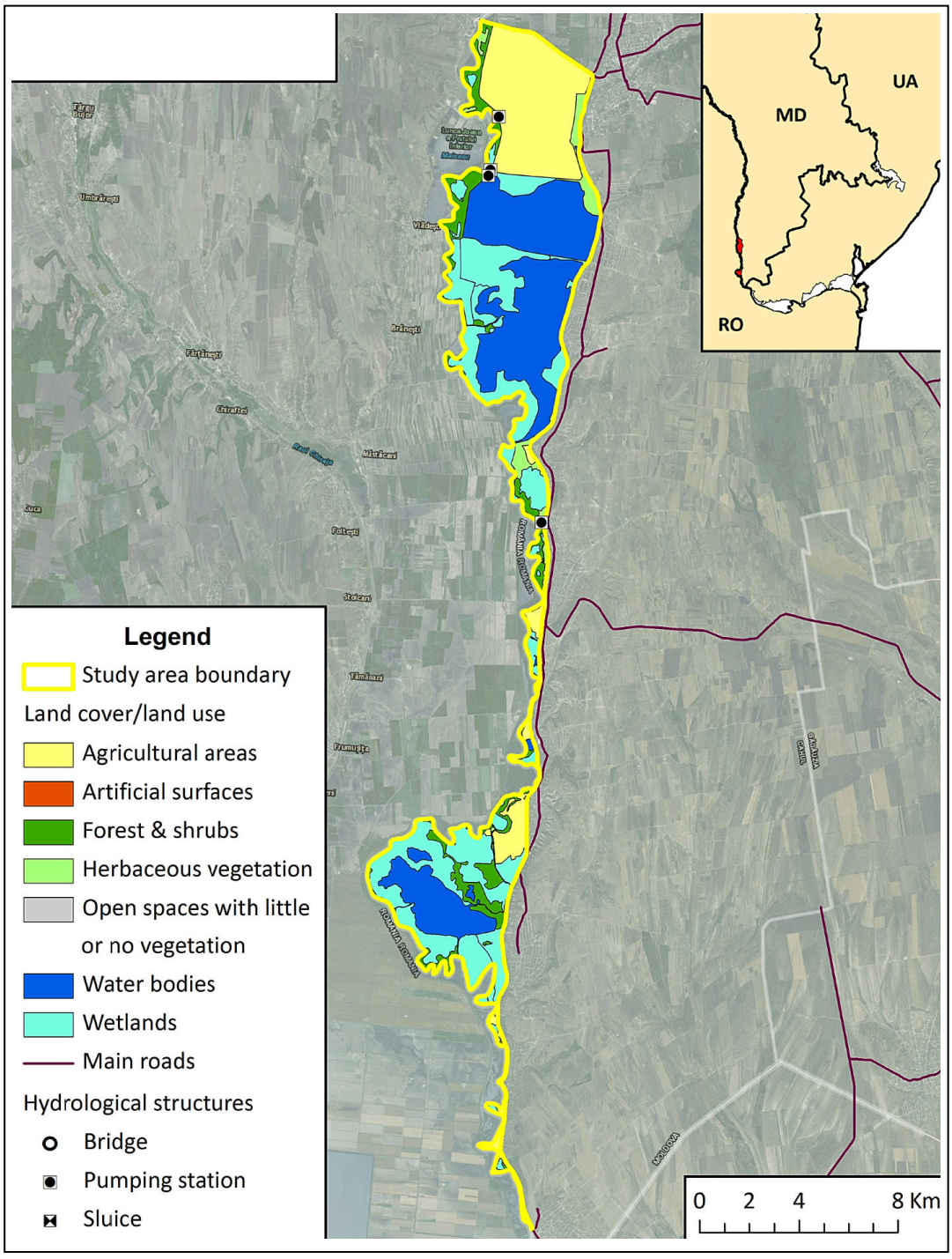


Figure 11: Lower Danube Region A, Reni to Izmail – Land Cover and Water Management
Source: ReedBASE project

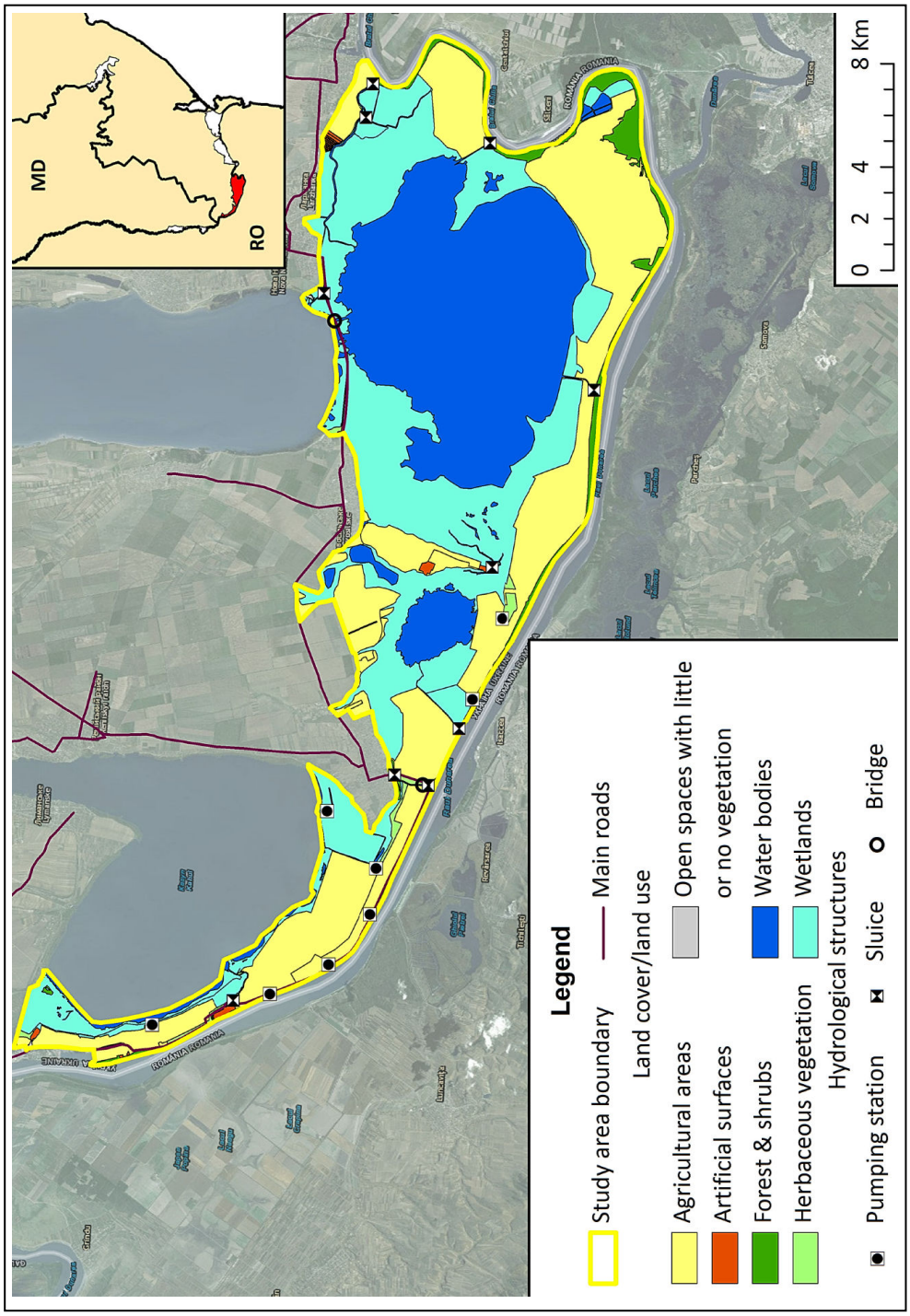


Figure 12: Lower Danube Region B, Izmail to Kiliya – Land Cover and Water Management
Source: ReedBASE project

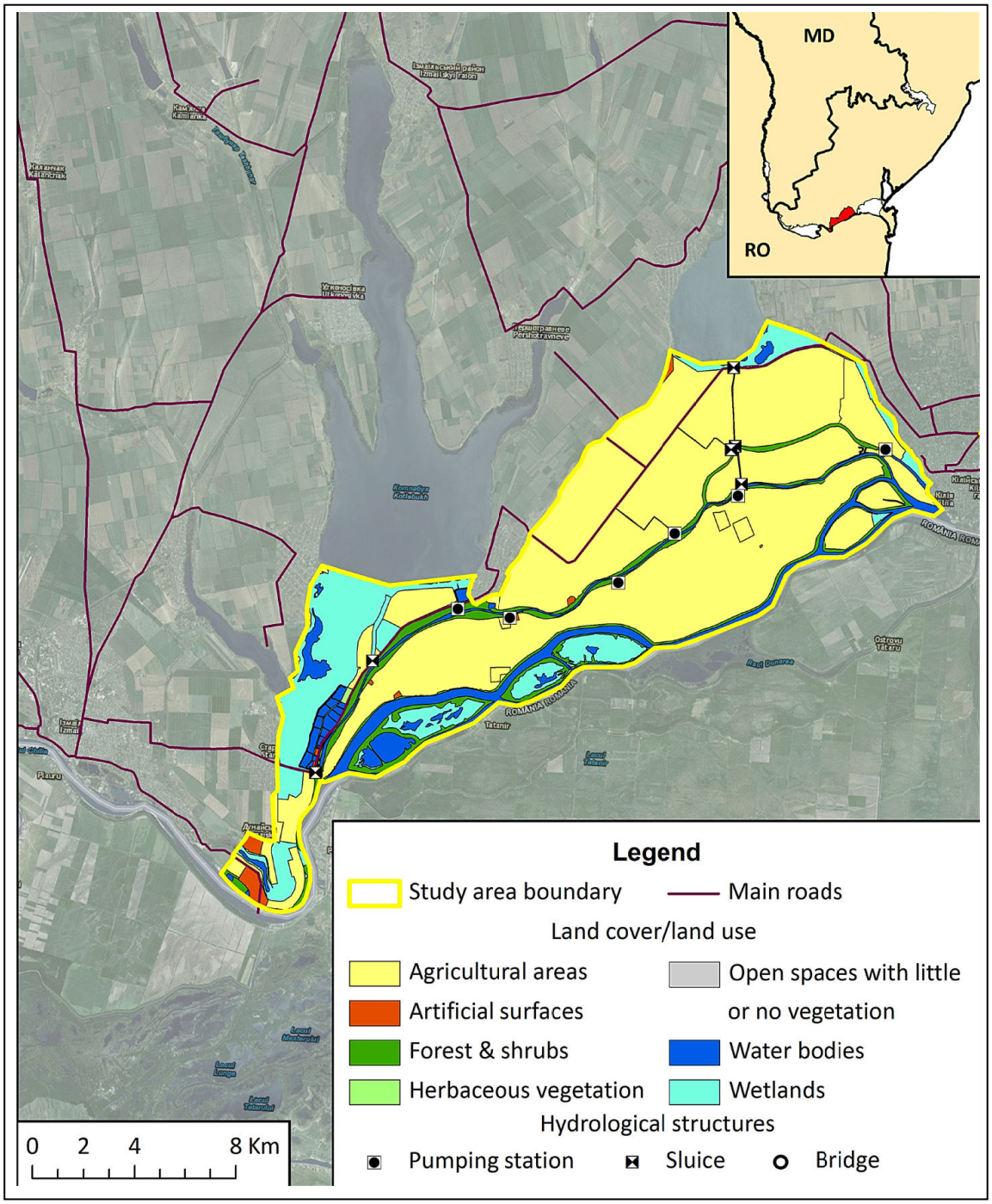


Figure 13: Lower Danube Region C, Kiliya to Vylkove – Land Cover and Water Management
Source: ReedBASE project

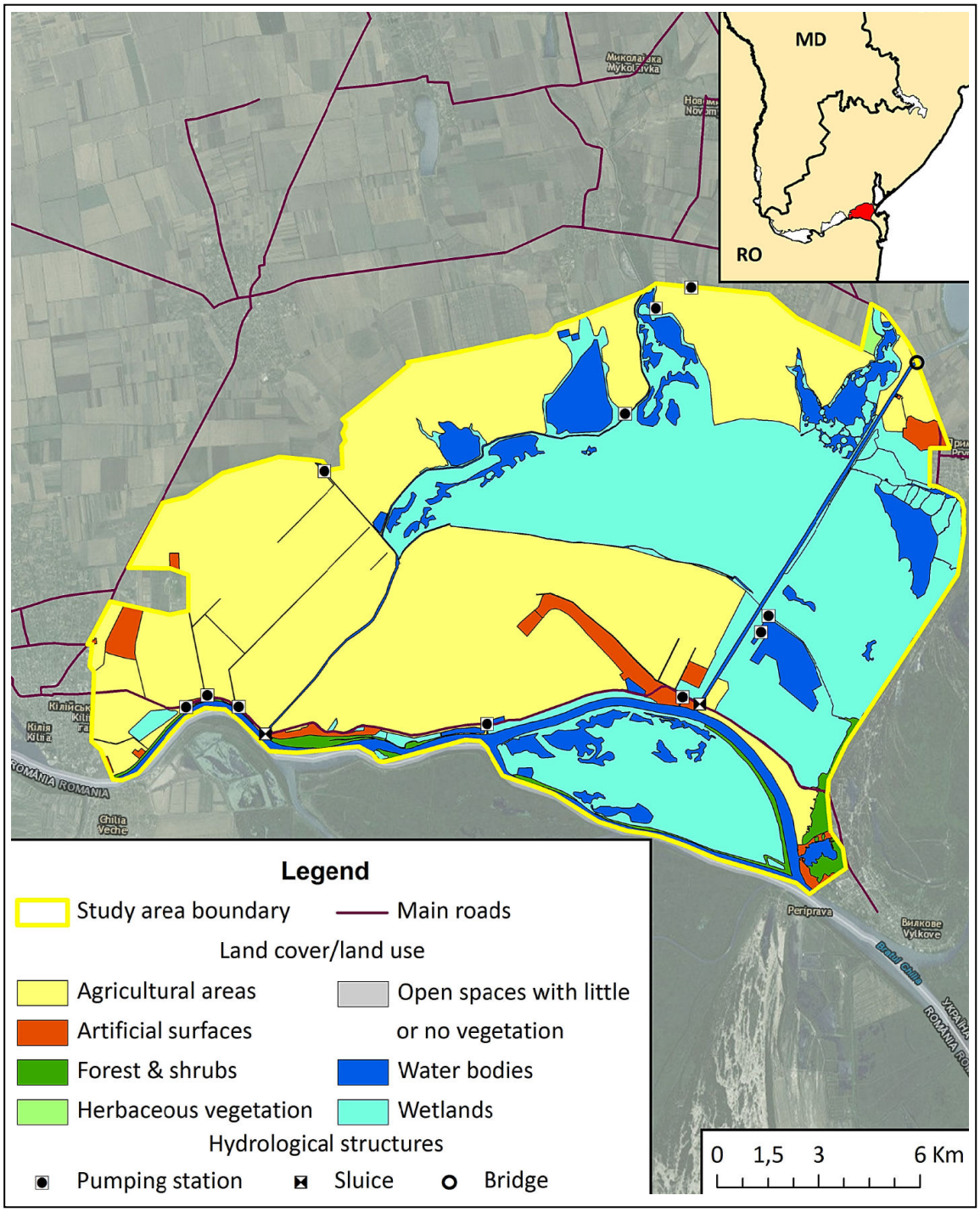
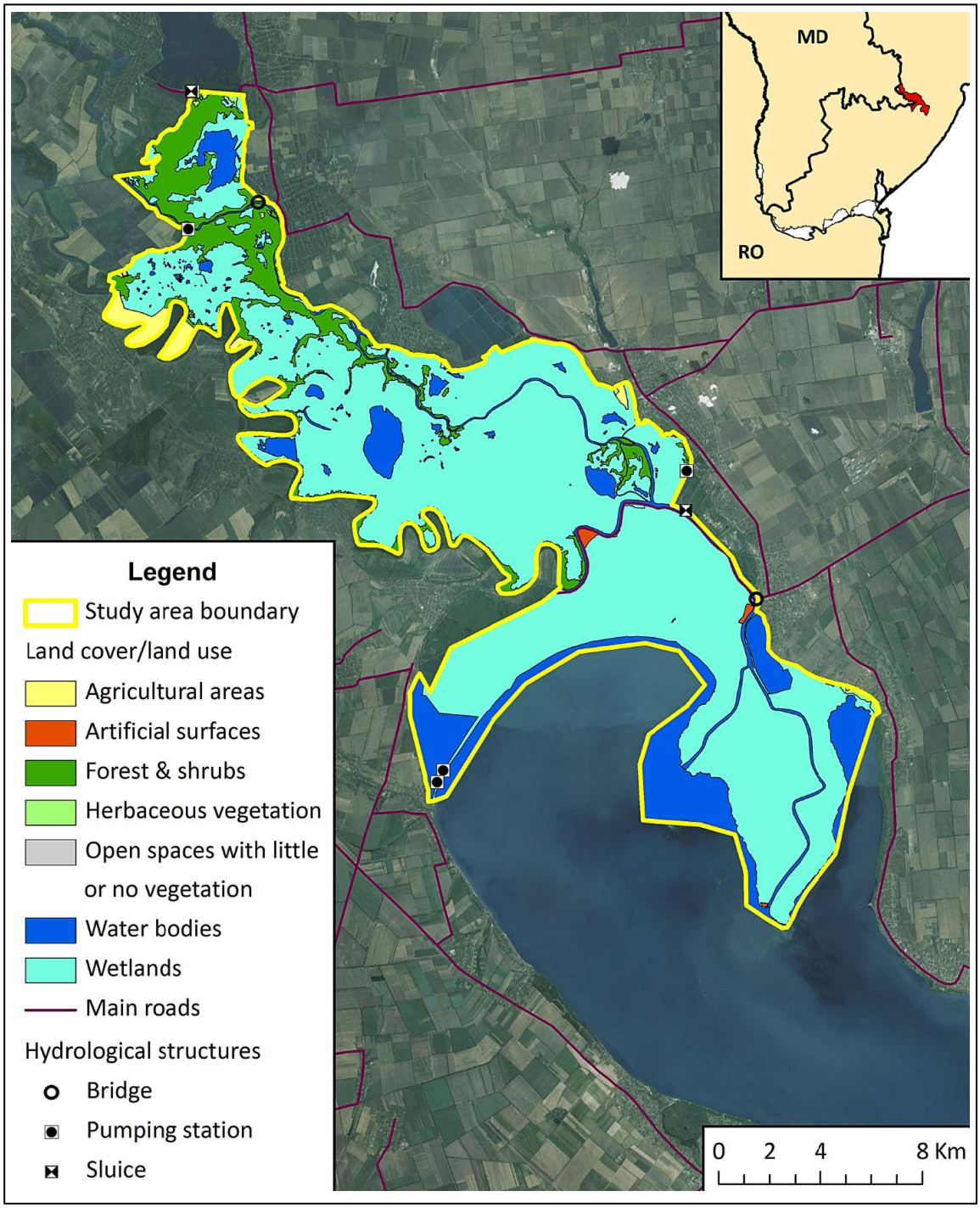


Figure 14: Lower Dniester Region – Land Cover and Water Management
Source: ReedBASE project



2.3 Land ownership

The registered ownership of the floodplain areas according to the national land cadastres is provided in Table 6 for the Lower Prut, and Table 7 for both the Lower Danube and Lower Dniester. The distribution of land ownership is mapped for each site in Figures 15 to 19.

These data indicate that the whole of the Lower Prut area has been cadestrated (compare total area with land cover in Table 5), with 74% of the area in state ownership.

In Ukraine, on the other hand, some 68,297 ha (36%) of the areas remain unregistered. However, the maps show that these lands are predominantly reedbeds and water bodies that are constitutionally under state ownership (including large portions of the Danube Biosphere Reserve and Dniester National Park).

Of the 38,626.5 ha of registered land in Ukraine, the majority (24,529 ha or 63.5%) is privately owned, almost entirely as household, family or market farming land.

Table 6: Lower Prut Land Ownership
Source: ReedBASE project

Ownership	Area, ha	%
Public	8,133.4	74.0
Private	2,863.3	26.0
Total	**10,996.7**	

Table 7: Lower Danube and Lower Dniester Land Ownership
Source: ReedBASE project

Ownership	Land category 1	Land category 2	Area, ha	%
Municipal	Agricultural	Household, family or market farming	65.0	
	Industrial	Water & gas supply	24.8	
	Water bodies	Fishery	66.6	
		Sub-total, Municipal	**156.4**	0.4
State	Agricultural	For research and education purposes	37.1	
		Haymaking	515.3	
		Household, family or market farming	6,278.6	
	Construction	Hydro-engineering facilities	8.0	
		Public buildings	169.2	
		Recreation_facilities	9.7	
	Forest		3,318.0	
	Industrial	River transport facilities	35.3	
		Solar power station	101.9	
		Water supply	7.5	
		Undefined	136.1	
	Reserve		456.2	
	Water bodies	Cultural and recreational purposes	0.4	
		Fishery	1,539.0	
		Undefined	1,119.1	
		Sub-total, State	13,731.4	35.5
Private	Agricultural	Gardening	43.2	
		Household, family or market farming	24,013.4	
	Construction	Roads	5.3	
	Residential		310.9	
	Residential & agricultural		155.0	
	Water bodies	Fishery	1.2	
		Sub-total, Private	**24,529.0**	63.5
State & Private	Industrial	Transport facilities	**66.9**	0.2
Undefined	Agricultural	Haymaking	61.5	
		Household, family or market farming	66.5	
	Industrial	Water & gas supply	14.8	
		Sub-total, Undefined	**142.8**	0.4
		Total	**38,626.5**	

Figure 15: Lower Prut Region – Land Ownership
Source: ReedBASE project

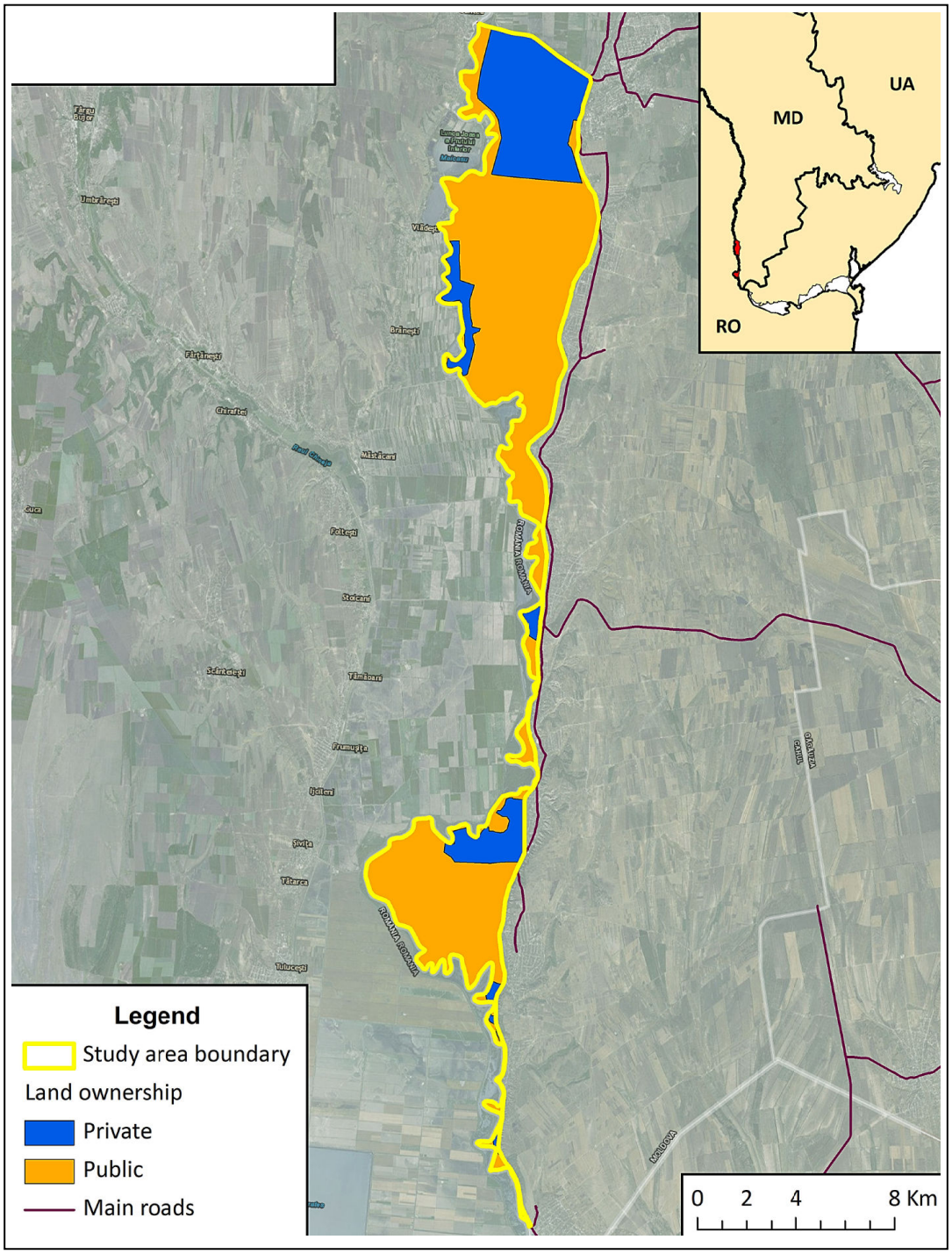


Figure 16: Lower Danube Region A, Reni to Izmail – Land Ownership
Source: ReedBASE project

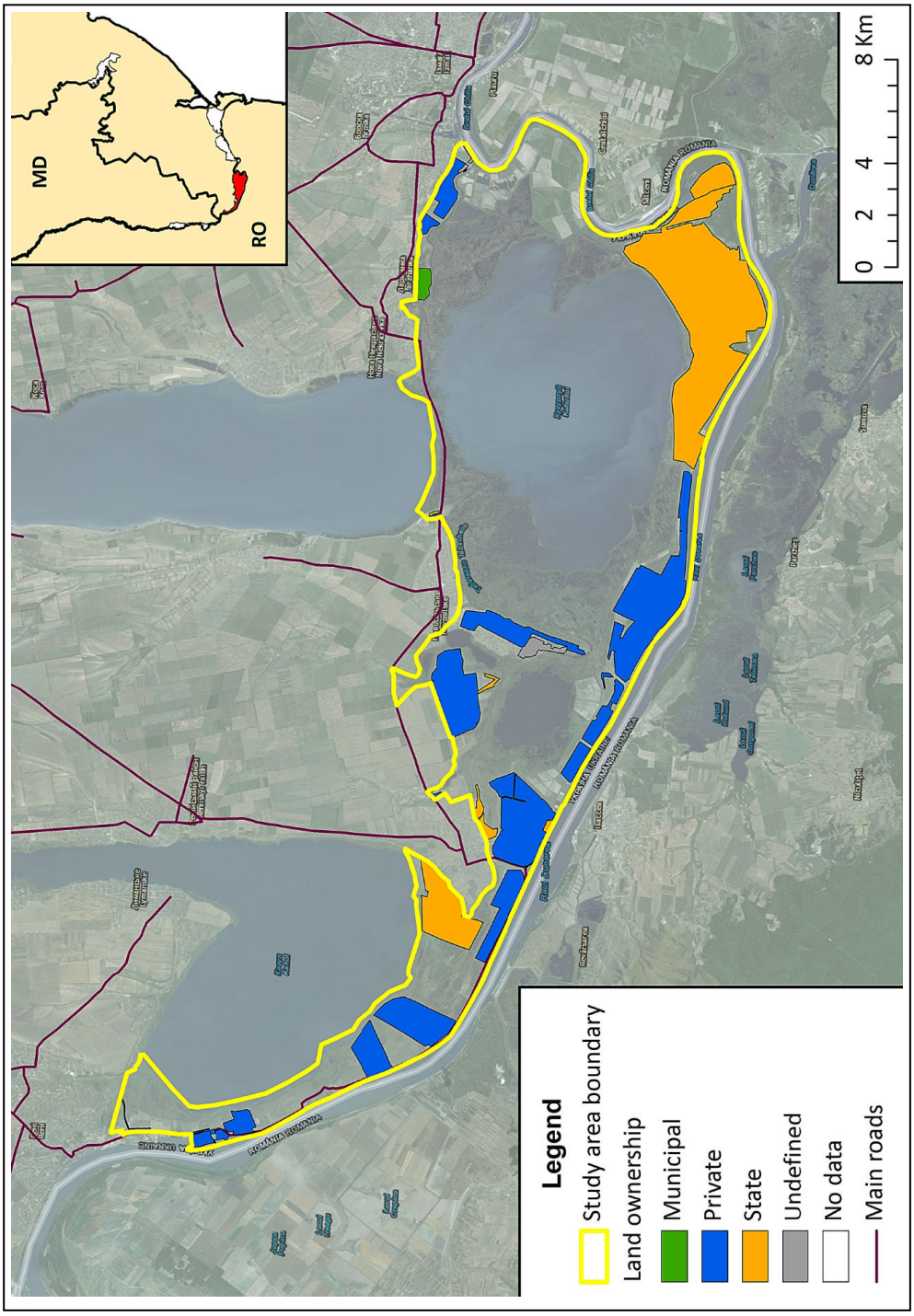


Figure 17: Lower Danube Region B, Izmail to Kiliya – Land Ownership
Source: ReedBASE project

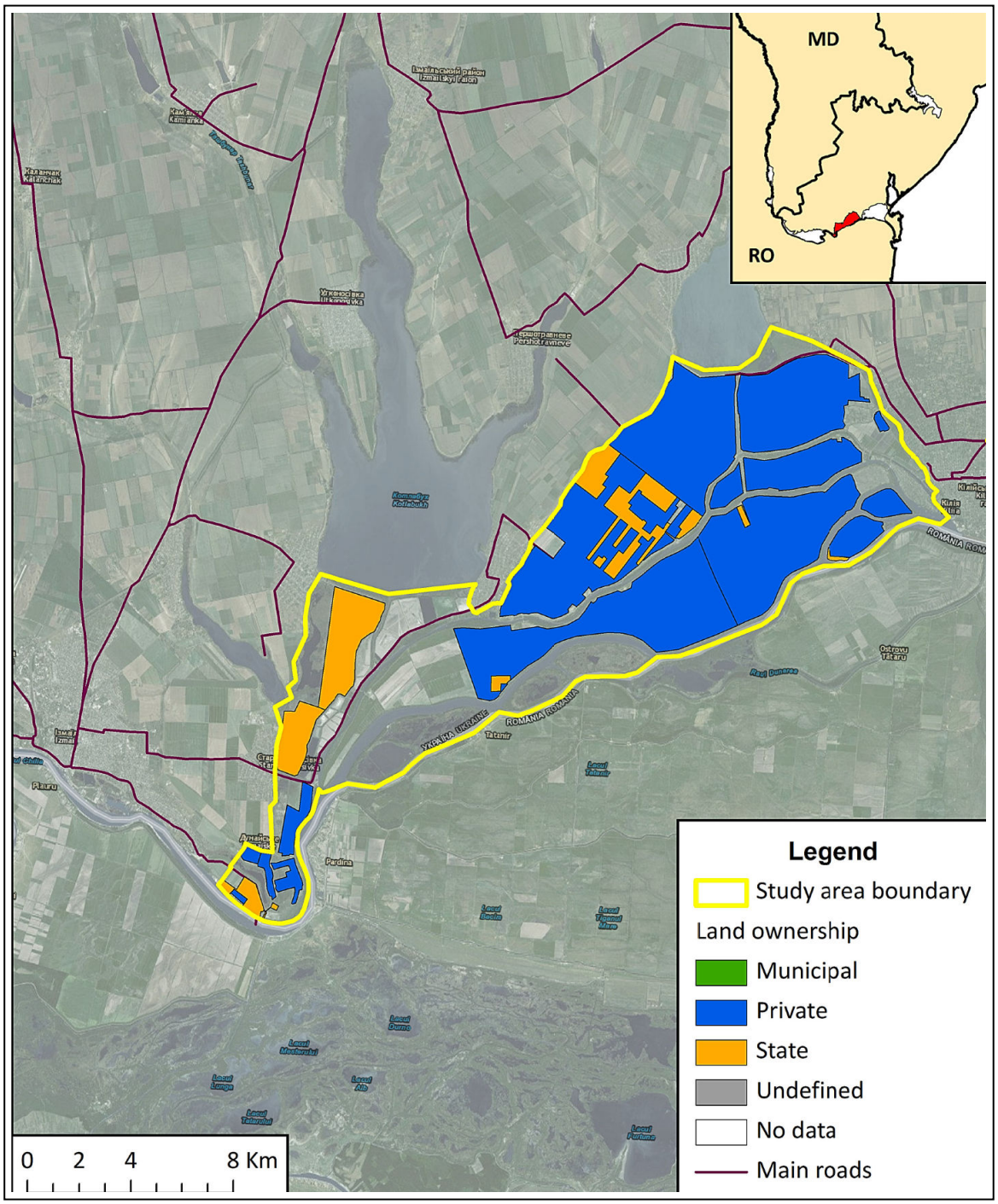


Figure 18: Lower Danube Region C, Kiliya to Vylkove – Land Ownership
Source: ReedBASE project

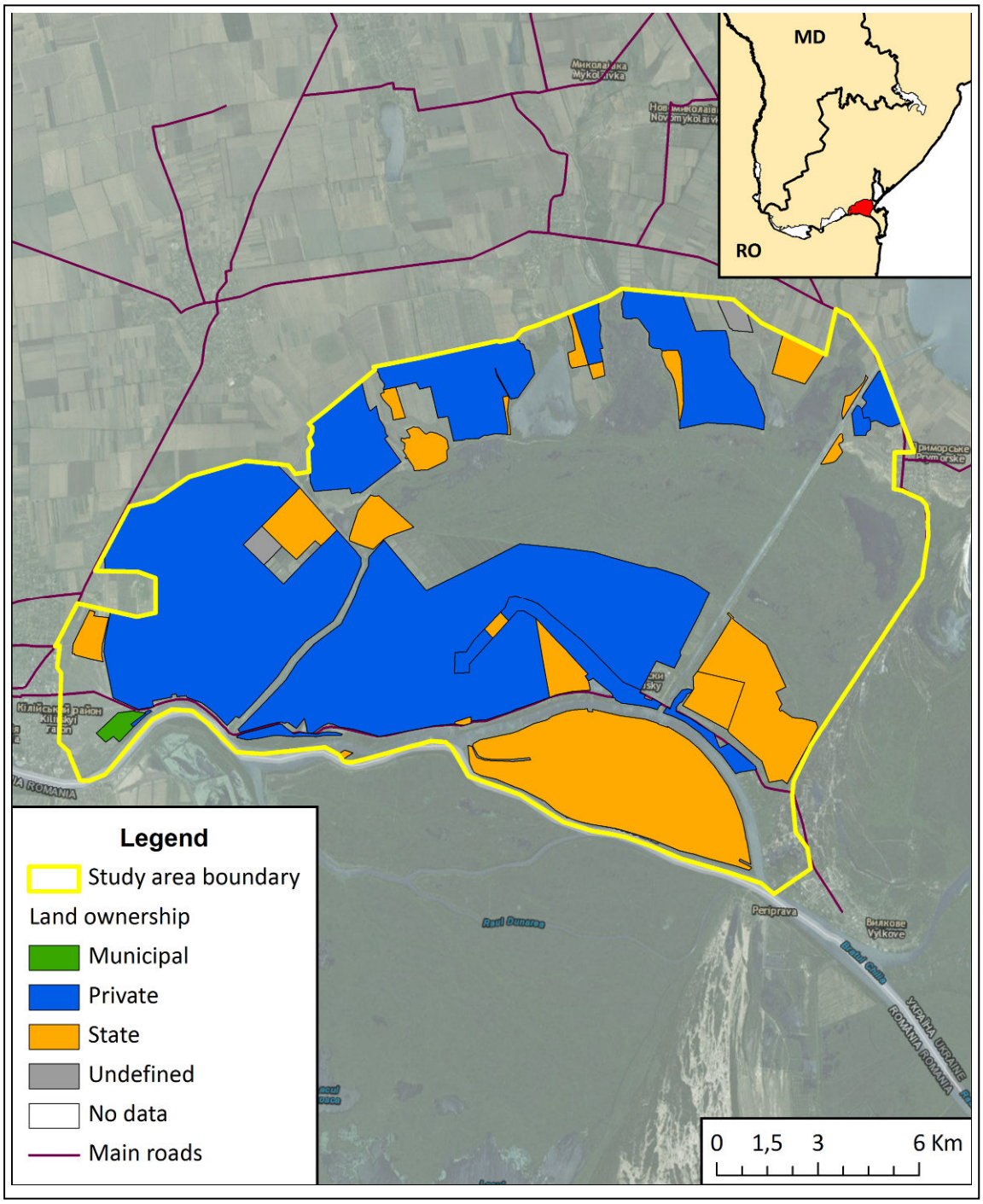
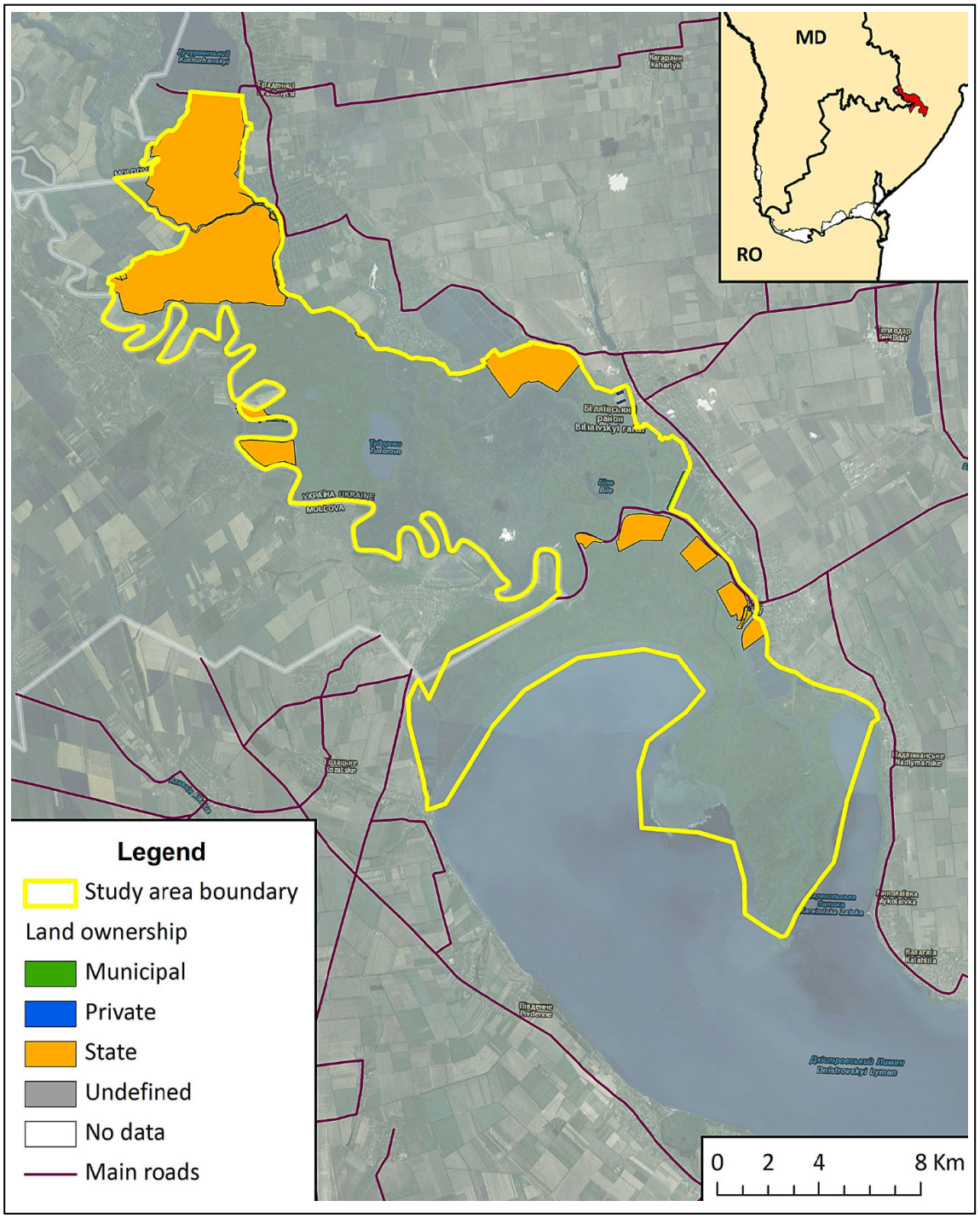


Figure 19: Lower Dniester Region – Land Ownership
Source: ReedBASE project



2.4 Protected areas

The protected areas situated in the study regions are listed in Table 8, and mapped in Figures 20 to 23. It should be noted that the Lower Danube (A) region (Reni to Izmail) has no protected areas at present. The overall cover of protected areas amounts to 22,580 ha, representing 19.1% of the study regions: this is a significantly higher level than the national averages for either Moldova or Ukraine and reflects the focus on protected areas in selecting the study regions.

Table 8: Protected areas in the study regions
Source: ReedBASE project

Status	Designation	Name	Study region	PA area, ha	Study area, ha	% cover
National	Scientific Reserve	Lower Prut	Lower Prut	1,691	10,997	15.4
National	National Nature Park	Lower Dniester	Lower Dniester	15,502	27,700	56.0
National	Protected Site (within NP)	Dniester reedbed	Lower Dniester	-7,620	27,700	27.5
National	Biosphere Reserve	Danube	Lower Danube (C)	10,821	29,013	37.3
Local	Regional Landscape Park	Izmail Islands	Lower Danube (B)	1,366	20,773	6.6
Local	Regional Landscape Park	Lake Lung	Lower Danube (B)	799	20,773	3.8
Local	Regional Landscape Park	Wet Oak Forest	Lower Dniester	21	27,700	0.1
			Total area protected	**22,580.0**		
			Total area of study regions	**117,920.0**		
			% protected cover	**19.1**		

2.4.1 Lower Prut Scientific Reserve

The Lower Prut" Scientific Reserve was established in 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. About 160 species of vascular plants have been recorded in the reserve, and the Prut River and its 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 here in recent years. Species included in the Red Book of Moldova include otter *Lutra lutra*, European mink *Mustela lutreola*, wild cat *Felis sylvestris*, whooper swan *Cygnus cygnus*, Dalmatian pelican *Pelecanus crispus*, 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*

2.4.2 Lower Dniester National Nature Park

The Lower Dniester National Nature Park was established in 2008 in order to conserve, restore and promote sustainable use of the diverse natural habitats of the lower reaches of the Dniester River which display ongoing natural geomorphological processes. The reedbeds, meadows and halophytic areas support many rare plant species including club-mosses, floating fern *Salvinia natans*, sedges and water chestnut *Trapa natans*. The park also has a rich fish fauna with sturgeon *Acipenser gueldenstaedtii*, Black Sea salmon *Salmo labrax*, Dnieper barbel *Barbus borysthenicus* and many others. The area has high importance for birds such as glossy ibis *Plegadis falcinellus*, Dalmatian pelican *Pelecanus crispus*, pygmy cormorant *Microcarbo pygmeus*

and white-tailed eagle *Haliaetus albicilla*. The wetlands and mudflats are used by a great number of migrating waders and waterfowl both in spring and autumn, and the open water provides a resting area for thousands of geese (including red-breasted goose *Branta ruficollis*) in March and April.

2.4.3 Danube Biosphere Reserve

In 1967, a 1 km-wide coastal strip of the Kilia delta in Ukraine was declared a reserve. Between 1973 and 1978, the reserve area was increased to 14,851 ha and then in 1998, the area became a biosphere reserve. In February 1999 UNESCO included the Danube Biosphere Reserve in the global network of biosphere reserves, when it also formed a component part of the Danube Delta Cross Border Biosphere Reserve between Romania and Ukraine. The delta today covers a total area of 4,178 km², shared by Romania (82% on the Saint George and Sulina branches of the Danube) and Ukraine (18%, on the Kilia branch). The delta continues to grow in to the Black Sea at a rate of about 75-80 metres per year due to the large volume of sediments that are deposited: the average load of suspended solids in the River Danube at Reni alone is about 1 ton per second. Because of the very active delta-forming processes and the nutrients brought by the river, the delta supports a flora and fauna of worldwide importance. For example, it is home to over 950 plant species and over 240 bird species, many of which are listed in national and international Red Data books.

2.4.4 Isles of Izmail Regional Landscape Park

The "Isles of Izmail" comprise three island lying in the main channel of the Danube: Daller, Little Daller and Tataru. These were designated as a Regional Landscape Park in 1993, and wetland restoration work was carried out on Daller by WWF in the early 2000s. They hold a range of rare aquatic plants such as floating fern *Salvinia natans*, fringed water-lily *Nymphoides peltata*, and white water-lily *Nymphaea alba*. The islands are fringed with exceptional examples of riverine forest, clad with vines. White-tailed eagle *Haliaetus albicilla* regularly breeds on the islands, and Dalmatian pelican *Pelecanus crispus* and pygmy cormorants *Microcarbo pygmeus* feed there. Mammals present include otter *Lutra lutra*, European mink *Mustela lutreola* and wild cat *Felis sylvestris*.

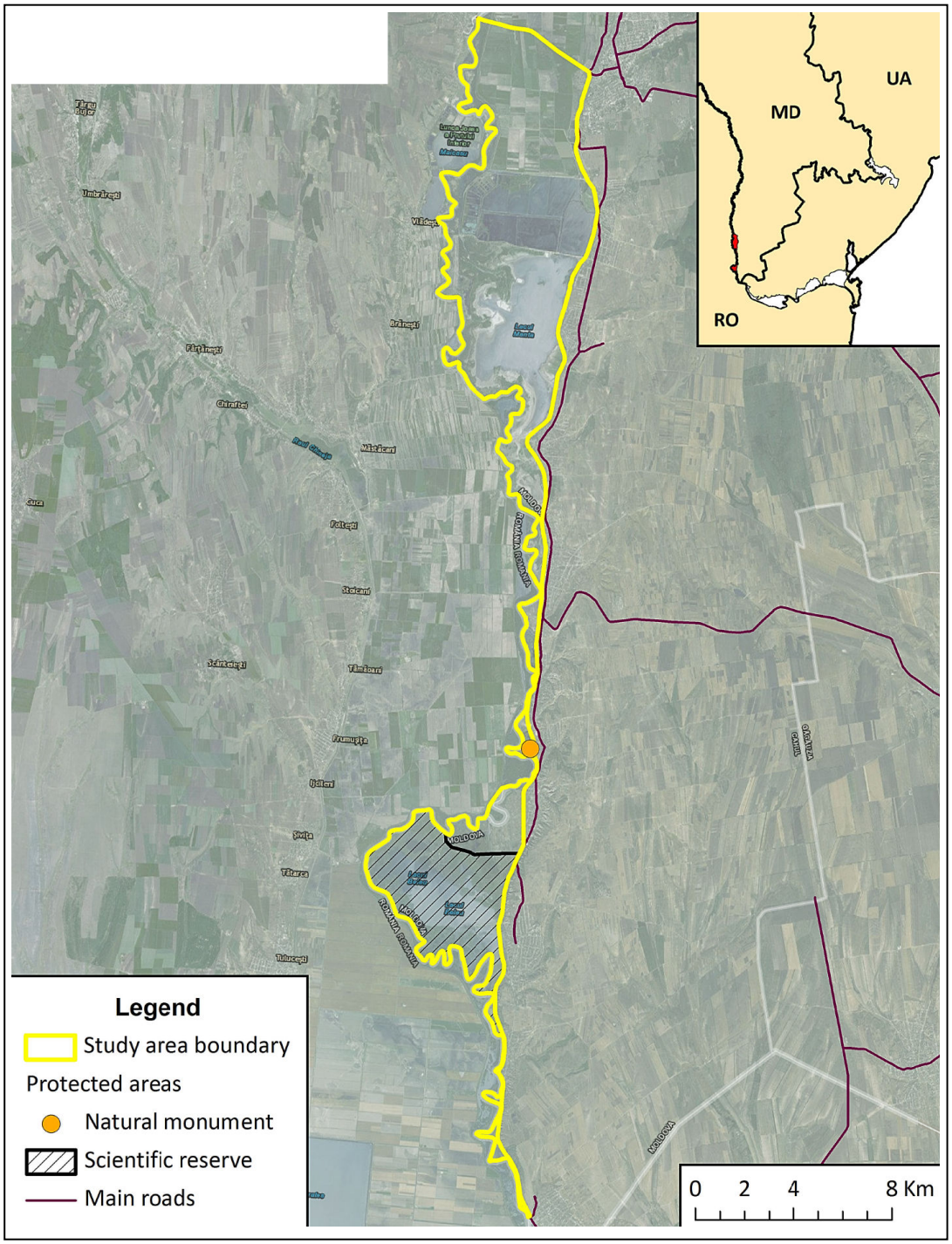
2.4.5 Lake Lung Regional Landscape Park

Designated in 2004, Lake Lung Regional Landscape Park (a part of the adjacent Lake Katlabugh) holds important populations of breeding waterfowl such as ferruginous duck *Aythya ferruginea* and red-crested pochard *Netta rufina*, and its shallow waters have a rich community of colourful charophytes, recalling coral beds. Floating fern *Salvinia natans*, fringed water-lily *Nymphoides peltata* and water chestnut *Trapa natans* also occur here.

2.4.6 Wet Oak Forest Regional Landscape Park

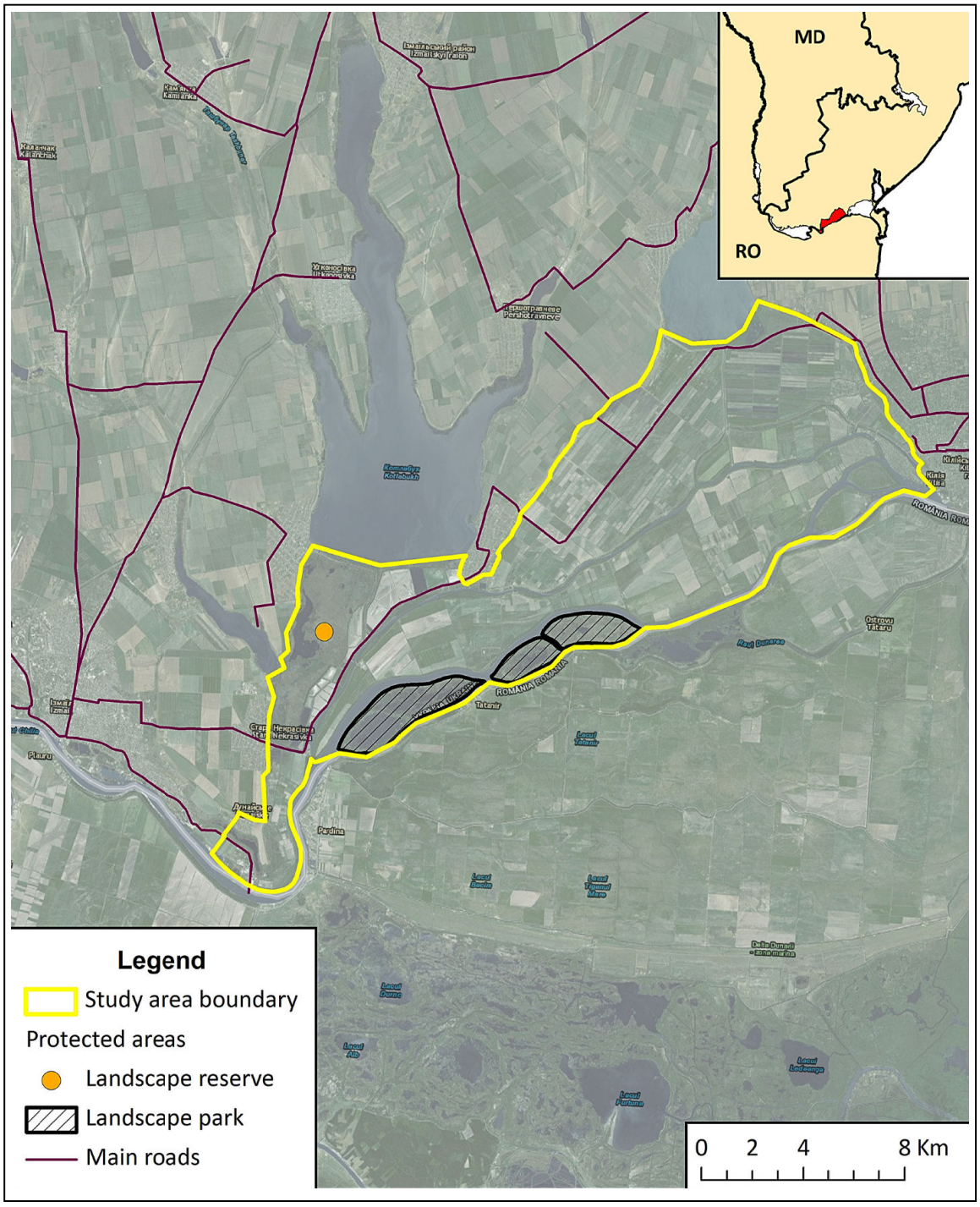
This Regional Landscape Park was designated in 1973. It comprises a plantation of oak *Quercus robur* situated in the Dniester floodplain. It holds a number of plant species of regional importance including vines and the May lily *Maianthemum bifolium.*

Figure 20: Lower Prut Region – Protected Areas
Source: ReedBASE project



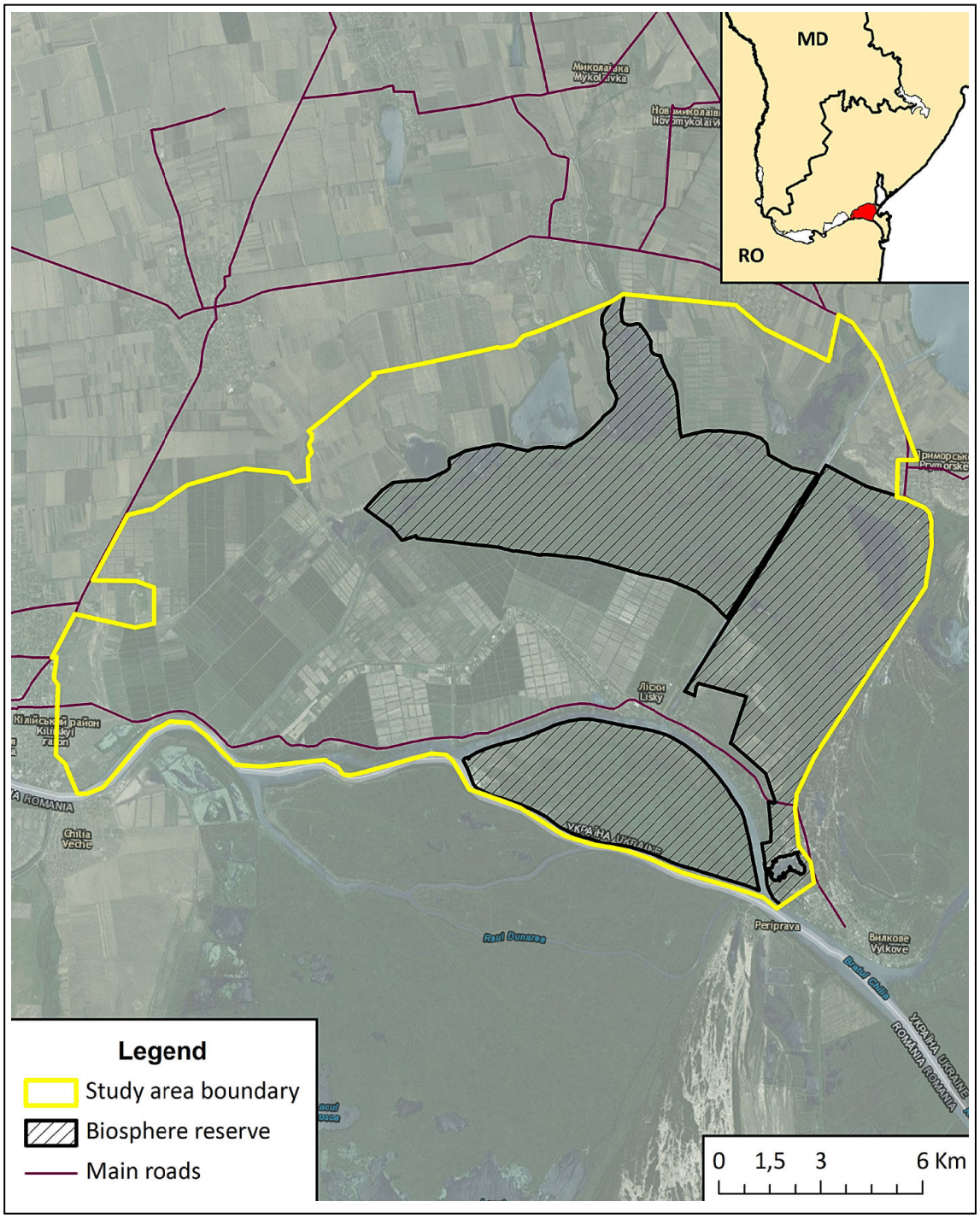
Lower Prut Scientific Reserve

Figure 21: Lower Danube Region B, Izmail to Kiliya – Protected Areas
Source: ReedBASE project



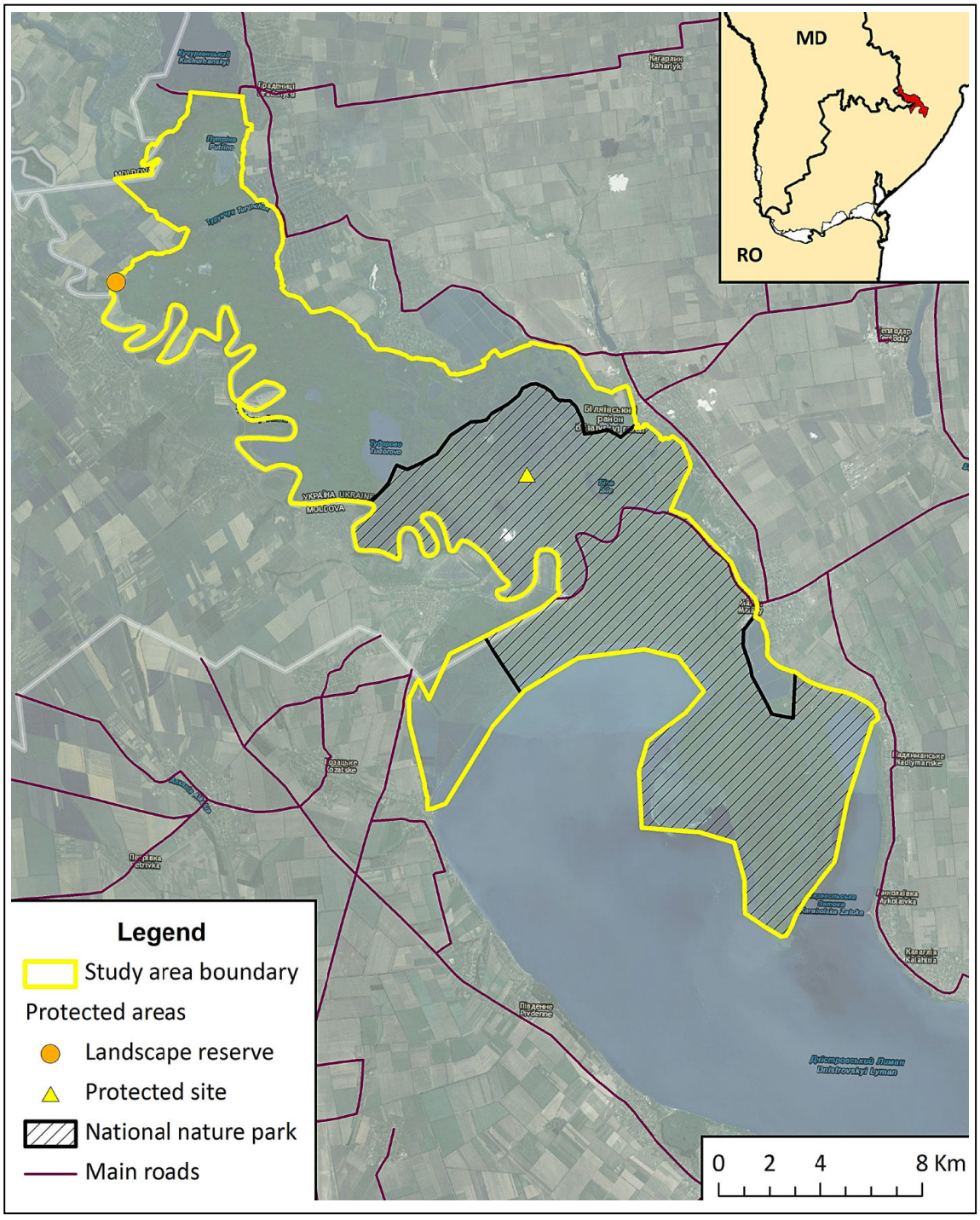
Isles of Izmail Regional Landscape Park

Figure 22: Lower Danube Region C, Kiliya to Vylkove – Protected Areas
Source: ReedBASE project



Danube Biosphere Reserve

Figure 23: Lower Dniester Region – Protected Areas
Source: ReedBASE project



Dniester National Park (includes Dniester reedbed protected site)

3. UTILISATION OF WETLAND BIOMASS

3.1 Review of current situation

Wetland biomass consists of a range of plant species that in a long tradition people use as a source of food; animal fodder; fibre; cellulose, polysaccharides and other chemicals (including pharmaceuticals such as salicylic acid, the active ingredient of aspirin); weaving and construction materials; and solid fuels in the form of peat, raw bulk or compressed in briquettes or pellets. They include willow (*Salix*), alder (*Alnus*), rush (*Juncus*), sedge (*Carex*), reedmace (*Typha*), bulrush (*Cyperus*), water chestnut (*Trapa*), yellow water-lily (*Nuphar*) and bog moss (*Sphagnum*).

Both energetic and material utilisation of renewable biomass sources hold manifold options for rural development in the in the lower Danube and Dniester regions. The combustion of reed briquettes or pellets is one of the most cost efficient ways as it goes along with existing management of reedbeds for developing renewable energy. The use of an existing resource of plant biomass of reed (and growing of willow on unused lands in the floodplain) creates conditions for the diversification of incomes for local people. It reduces the dependence of communities on fossil fuel supplies (first of all, on natural gas). Consequently savings from lowered heating costs for public facilities (schools, kindergartens, houses of culture, village councils, etc.) more public funds are free for rural and village development.

Within the project area, the main species of interest for sustainable biomass raw material production are reed and willow because of their wide distribution, abundance and high biomass concentration. Alder also has high potential for production of both high quality construction wood and fuel wood in short rotation under wet management that can contribute to formation of alder carr peat. In general, however, material utilisation is preferable to combustion for heat and energy for both ecological and economic reasons. Materials produced from renewable resources fix carbon for their lifetime cycle and substitute materials based on fossils. Due to the higher revenues for high quality products and materials under given opportune circumstances, material alternatives may be commercially more viable. It is best to design production schemes that feed different types of biomass to their respective appropriate and optimal uses.

Revival and modernisation of traditional biomass based construction materials in local and regional production will also add to rural income diversification. Such strengthened utilisation of renewable biomass resources will provide a reduction in greenhouse gas emissions by substituting fossil fuels (coal, gas, oil). In addition it will also help absorbing atmospherically carbon dioxide by fixation in biomass construction materials, enhancement of short term carbon cycling, and in case of otherwise degrading peat soils under drainage by restoration of natural carbon sequestration function in rewetted peat forming reedbeds.

In Moldova, the reed resource is rather limited: in the study area it amounted to just 1,744 ha. However, willow grown on a short rotation is a more suitable approach to biomass production. For example, in April 2016 one hectare of energy willow was planted at Cucuruzenii de Sus village, Orhei district, on farmland owned by a vocational school in Orhei town. The initiative is an alternative energy solution promoted by the Energy and Biomass Project in Moldova, with financial support of the European Union.

In Ukraine, reed is a substantial resource. Unfortunately, instead of use, large areas of reed are often simply set alight in situ by local people who hope to clear ground for grazing or market gardening (Figure 24). This leads to a large uncontrolled release of carbon, accidental

fires, and deposition of ash which can affect industrial processes.

Reed is most often harvested in the form of bunches for export to the Netherlands, Germany and Denmark for making thatched roofs (Figures 25 and 26), as well as mats for wall and insulation panels or fencing (Figure 27) and even some handicrafts (Figure 28). Such harvesting is prevalent in the lower Dniester and lower Danube region (C).

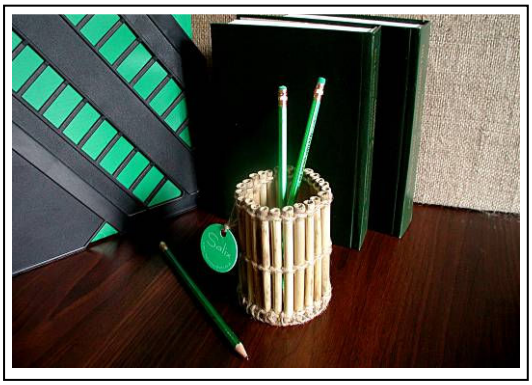
Figure 24: Reed burning in the Lower Dniester National Park, Ukraine *Photo: Paul Goriup*

Figure 25: Reed being prepared for thatch, Reni, Ukraine *Photo: Paul Goriup*

Figure 26: Houses with thatched roofs on Vilm Island, Germany *Photo: Paul Goriup*

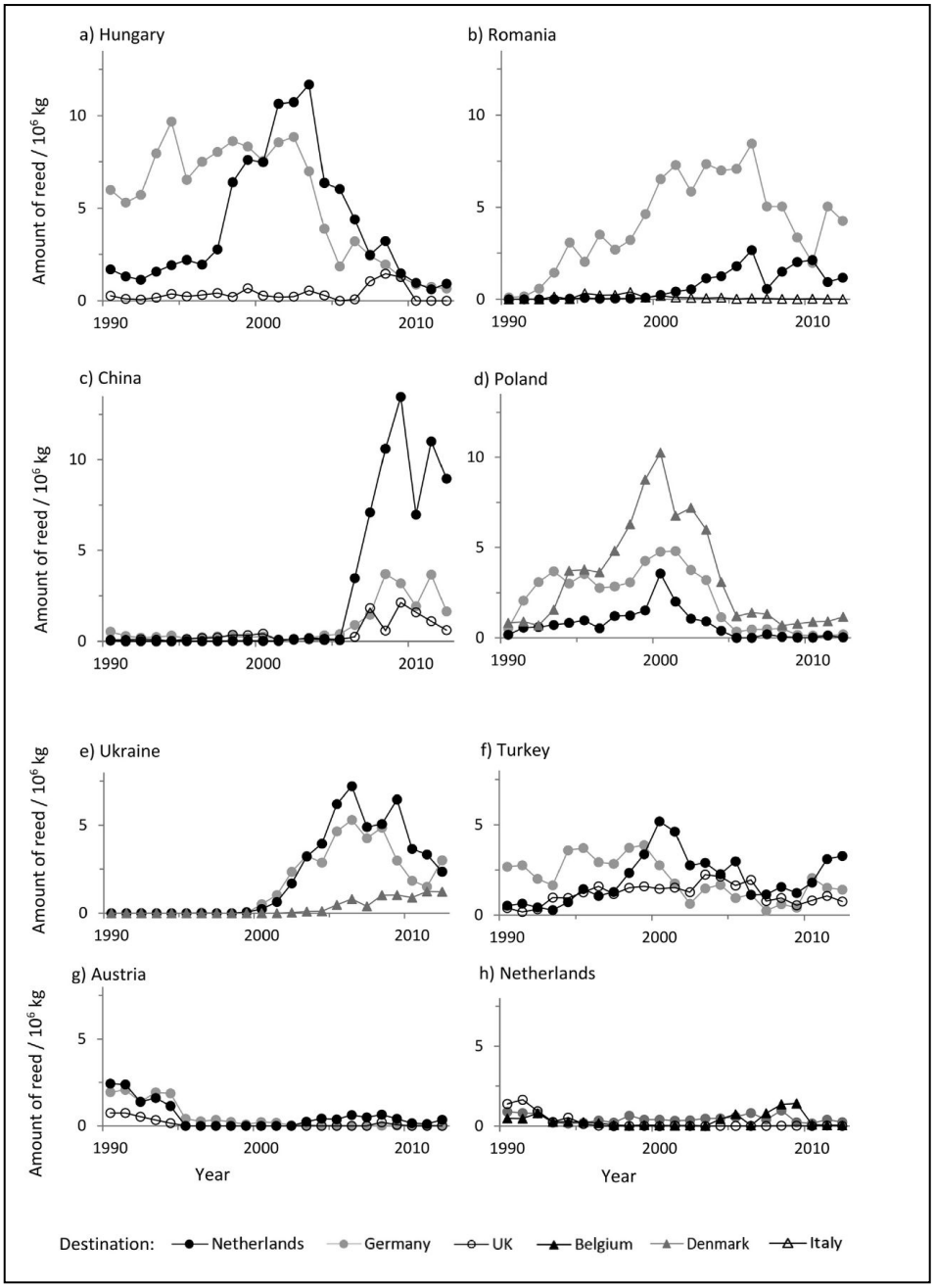
Figure 27: Fence made from reed mats, Vylkove, Ukraine *Photo: Paul Goriup*

Figure 28: Pencil holder made from reed by Salix Ltd, Odessa, Ukraine *Photo: Paul Goriup*



Recent market research shows that Europe is the largest market for thatching reed worldwide (Wichmann and Köbbing, 2015). The total consumption of at least 7 million bundles equals 29,400 tons of reed (assuming an average weight of 4.2 kg/bundle). The market generally increased from 1990 (Figure 29), but consumption dropped sharply after 2007 when the financial crisis caused a temporary drop in demand as homeowners postponed roof renovation. However, it is also notable that imports from China increased significantly about the same time, perhaps because early decay of reed thatch had been observed over recent decades. The reasons for early decay are not fully understood but may result from a combination of several factors such as poor construction, bad quality of reed, wetter climate in Europe and more aggressive fungi. Chinese reed seems not to be affected as yet, so many market participants are concerned that the domestic supply of reed will be further replaced by imports from China unless steps are taken to improve competitiveness and quality in Europe.

Figure 29: Annual exports of reeds to European countries from 1990 to 2013.
Source Wichmann and Köbbing, 2015



3.1.1 Reed harvesting methods

Most people mow reed in winter by hand using scythes (Figure 30), whether by foot or, if the reeds are in water, from boats (Figure 31). These reeds are mostly used for domestic purposes such as making mud bricks, roofing and fencing as well as animal bedding.

Commercial companies employ various types of mechanical harvesters usually fitted with tracks or very wide "balloon" tyres to reduce ground pressure on the soft earth and avoid damaging the reed rhizomes. There are also boat-mounted harvesters (Figure 32). Some harvesters, such as the Seiga-type built in Ukraine (Figure 33), can cut up to 4,000 bundles (around 6 tons) a day.

In the Danube Biosphere Reserve, some 13,000 tons of reed are harvested for thatch annually, using a fleet of these locally-built harvesters.

Figure 30: Harvesting reeds using a scythe, Reni, Ukraine *Photo: Paul Goriup*

Figure 31: Reed harvested in the Danube Biosphere Reserve, Vylkove, Ukraine

Photo: Paul Goriup

3.1.2 Regulation of reed harvesting in Ukraine

Manual mowing of reed by private persons has one of two purposes: either to use it for personal use or to sell. In the first case, it is expected that the volumes of the harvesting is minor, and their impact on natural systems is immaterial. This harvesting relates to the category of general use of natural plant resources and does not require registration permits. However, trade of reed and its products belongs to the category of special use of natural plant resources and requires permits, which are issued by local government authorities. To undertake reed harvesting, three documents are required:

1 – standard of special use of natural plant resources (established once in 3-5 years);

2 – limit of special use of natural resources (established annually);

3 – permit for special use of natural resources (issued annually).

Figure 32: A Belarussian boat mower ЛК-12 (LK-12) used in Ukraine

Figure 33: Seiga-type harvester with balloon tyres and twin mowing heads, Reni, Ukraine

Photo: Paul Goriup

When harvesting reed on the lands of state forest fund it is necessary in addition to draw up a forest permit. It is recommended to start drawing up documents a year before the start of harvesting.

In the case of special use of reed resources the collectors should:

- prevent the deterioration of other natural resources;
- not violate the rights of tenants, other temporary users, as well as the related users of plants;
- fulfil all the requirements of protection and sustainable use of plants, stipulated by the current legislation.

The payment for use of plant resources does not absolve a user from the implementation of measures for protection of flora and fauna objects, or their habitats, and is to liable to compensate for their losses.

To obtain permission for harvesting reed it is necessary to:

- Specify the approximate boundaries of the area where carrying out harvesting is planned, on planning and cartographic material.
- Determine in the district department of land resources whether the mentioned area is granted for ownership, permanent use, lease, etc.
- Clarify with the Ministry of Ecology and Natural Resources of Ukraine that:
    - harvesting of reed on the specified area is not prohibited according to state priorities for natural resource use;
    - the area is not within an environment reserve fund, on the lands of the state forest fund, etc.;
    - other legal or natural persons do not have permission to harvest reed on the specified area;

    the stocks of reed on the area do not belong to the resources of nationwide importance.

In accordance with the Water code of Ukraine, pollution and contamination of waters, including dumping of any waste and debris in waterways, during harvesting of reed is prohibited. It is also prohibited to carry out the harvesting of reed in fishery waters and on their shores without the consent of the authorities of fish protection and other relevant authorities. In case of violation of the requirements of the water legislation, the harvester is liable to pay mandatory compensation of the damages in the amounts established by the legislation of Ukraine.

3.1.3 Reed as a source of renewable energy

Durng the last decade or so, prompted by the concern over climate change and switch to low carbon fuels, interest has grown in reed as a source of renewable energy, using waste from preparing thatching reed, as well as a primary product from managed cutting to restore wetland biodiversity. The use of reed as a source of renewable energy for heating systems is possible over large territories in almost all regions of Ukraine, especially those where reed grows densely on large areas of moderate water-logging, because only a small proportion of reed grows on land, the rest in water.

At present, however, reed is rarely used in Ukraine for heating because a full cycle of logistics and processing specific for reeds is absent. On the other hand, pellets from agricultural residues (agri-pellets) such as sunflower husks, chaffs of flax, corn, straw, sawdust, etc. are familiar Ukraine. These are by-products of the main agricultural and forest production which businesses try to sell. These businesses are not directly related to the generation of heat. Also due to crop rotation and seasonal crop yield, the volume of production of these agri-pellets is limited, and it is difficult to monitor and contract future sales.

Therefore, there is an opportunity to process reed directly for heat generation through improved technologies. The high volumes of reed

available in Ukraine can ensure the reliable production of a large quantity of pellets. Today less than 30% of the limits allowed by the Ministry of Ecology and Natural Resources are used, and only in a few regions of the country. Basically, all volumes are unclaimed because there is neither equipment nor infrastructure for processing reed.

Within the project "Development and commercialization of bioenergy technologies in the municipal sector in Ukraine", implemented with the support of the UN Development programme, a study of the condition of Ukrainian market of pellets made of biomass for 2012-2015 was undertaken. The results of the study show that pellet production in Ukraine is very varied, according to the types of raw material: wood, straw, husk, peat, reed, bagasse, alfalfa, charcoal, rice, and waste from the processing of flour, corn, lignin, hydrolysis of the resin, etc.

Statistics on harvesting or production of pellets made of reed are not available: reed pellet production falls into the category of "others", comprising less popular types of raw materials. Thus, the total production of pellets in Ukraine in 2015 amounted to 1,319,465 tons from 494 enterprises (Table 9).

The main features of pellet production in Ukraine are the regional unevenness and relative dispersion of production, and a large number of small-scale businesses working with traders. Producers of wood and peat pellets are found mainly in the west of Ukraine and in small numbers in the industrial areas of the centre and east (up to 70% of the production of wood pellets are provided by 8 regions – Zakarpattia, Volyn, Chernihiv, Kyiv, Zhytomyr, Volyn, Lviv, Sumy). The manufacturers of husk pellets are mainly in the central and eastern regions where raw materials are derived from processing of sunflower seeds and there is a large concentration of oil extraction plants (for example, only four regions – Dnepropetrovsk, Zaporizhia, Odessa and Mykolaiv – produce up to 413,000 tons, i.e. more than half of all husk pellets made in Ukraine).

Table 9: Production of pellets in Ukraine by type of raw material
Source: Agency for European Integration

Raw material	Number of producers	Production in 2015 (tons)
Husk	110	632,800
Wood	254	359,030
Straw	24	82,700
Straw, husk	11	80,000
Wood, husk	29	50,000
Wood, straw, husk	19	41,700
Wood, straw	11	18,000
Peat	4	8,400
Other	32	51,835
Total	**494**	**1,324,465**

In any case, in Ukraine there is no large enterprise specialized solely on the production of pellets made from reed. According to German researchers, briquettes made of reed are economically viable for the supply of customers within a radius of 30 km and capacity of thermal power plants from 15 to 1000 kilowatts. As consumers of this new fuel source, experts see farms, garden associations, small businesses, and residential neighbourhoods consisting of up to 30 houses.

In terms of actual combustion, experience shows that the process of burning different types of fuel has different complexities depending on the fuel and mode of use. The main problems are melting of the ash, which causes locking of the movable elements of the furnace, the deposition of molten particles on the convective heat transfer surfaces, resulting in a worsening the terms of heat transfer and overheating of the tubes, and the actual chemical composition of the biomass which can lead to corrosion damage and even air pollution.

The chemical characteristics of reed compared with the German pellet DIN and European wood pellet standards standard and other biomass fuels from Ukraine and Germany are shown in Table 10. Parameters of reed pellets produced in Reni (see section 3.3) match quite well with pellets from reed tested in a project at Greifswald University, Germany and largely fulfil the criteria of the European wood pellet standard EN-plus as well as many parameters of the stricter German pellet DIN.

Table 10: Chemical properties of different biomass fuels
Source: ReedBASE project

Parameter	Pellets Reni	Fen biomass pellets Greifswald*			Pellets from various agricultural residues or energy crops						Wood			Wood pellet standards			
Species or Standard	Reed	Sedge	Canary grass	Reed	Sunflower	Wheat straw	Rape straw	Rice husk	Canary grass	Miscanthus	Willow	Pine	Hardwood	German DIN 51731	ENplus-A1	Enplus-A2	EN-B
Specific fuel characteristics																	
Ash content 550 °C [Ma.-%DM]	5.4	5.3	6.3	4.3	3.85	6.4	5	18	6.5	4	2	0.3	0.3	< 1.5	≤ 0.7	≤ 1.5	≤ 3,0
Moisture content [Ma.-%OS]	na	8			na	na	na	na	na	na	na	na	na	< 12	≤ 10		
Net calorific value [MJ/kgDM]	15	18.8	18.7	19	16.46	17.6	17.6	15	16.6	17.5	18.4	19.1	18.9	17.5-19.5	na		
Lower calorific value [MJ/kgDM]	na	17.6	17.4	17.7	na	na	na	na	na	na	na	na	na		16.5 ≤ Q ≤ 19	16.3 ≤ Q ≤ 19	16,0 ≤ Q ≤ 19
Total content																	
Sulfur [Ma.-%DM]	0.03	0.2	0.2	0.1	0.18	0.1	0.3	0.06	0.1	0.2	0.05	0.03	0.02	< 0.08	≤ 0.03		≤ 0.04
Nitrogen [Ma.-%DM]	0.24	≤ 1.0			1.15	0.5	0.8	0.45	1.3	0.7	0.5	0.3	0.1	< 0.3	≤ 0.3	≤ 0.5	≤ 1.0
Chlorine [Ma.-%DM]	0.21	0.5	0.8	0.08	0.08	0.4	0.5	2.1	0.5	0.2	0.03	0.01	0.01	< 0.03	≤ 0.02		≤ 0.03
Silicate silicon dioxide [g/kg]	43.5	na			na	10	10	na	12	8	0.5	0.2	0.2	na	na		
Trace metals																	
Arsenic [mg/kg]	0.45	na			na	0.1	0.1	na	0.1	1	0.1	0.1	0.1	0.8	na		
Cadmium [mg/kg]	0.45				na	0.1	0.1	na	0.04	1	2	0.1	0.1	0.5			
Chromium [mg/kg]	7.67				na	10	10	na	na	2	1	1	1	8			
Copper [mg/kg]	2.75				na	2	2	na	na	2	3	2	2	5			
Lead [mg/kg]	6.48				na	0.5	0.5	na	1	2	0.1	2	2	10			
Mercury [mg/kg]	0.02				na	0.02	0.02	na	0.03	2	0.03	0.02	0.02	0.05			
Zinc [mg/kg]	10.85				na	10	10	na		5	70	10	10	100			
Physical properties																	
Diameter [mm]	6.0	~8.00			na	na	na	na	na	na	na	na	na	na	6.00 or 8.00		
Length [mm]	8 - 15	8.5 ≤ L ≤ 22			na	na	na	na	na	na	na	na	na	na	3.15 ≤ L ≤ 40		
Bulk density [kg/m³]	~700	≥ 600			na	na	na	na	na	na	na	na	na	> 1000-1400	≥ 600		
Abrasion resistance [Ma.-%]		98.7	98.7	97.1	na	na	na	na	na	na	na	na	na	na	≥ 97.5		≥ 96.5
Ash melting properties (ox.) of ash at 550 °C																	
DT [°C]		1150	1200	1400	na	na	na	na	na	na	na	na	na	na	≥ 1200**	≥ 1100**	

*Project results Greifswald University (Oehmke et al 2015); ** Ash melting properties (ox.) of ash at 815 °C

According to Table 10, the net calorific value of reed pellet is some 15 GJ/t, which is equivalent to about 0.5 t of coal, 395 m^3 of gas, or 405 l of crude oil. This compares quite favourably with other agri-pellets. In terms of chemical composition, reed has no mineral content that exceed the standards for wood pellets, whereas wheat, rape and *Miscanthus* have problems. The ash content is about the same as for other agri-pellets; it is notable that rice husk has a very high ash content. In fact, 80% of reed ash is composed of amorphous silica (which is why reed is waterproof) that could be a useful feedstock for other industrial processes such as tyre manufacture. Overall, reed pellet properties are well within the limits for commercial (but not domestic) use in biomass boilers

3.2 Case study: reed briquette production in Vylkove, Ukraine

The WWF Danube-Carpathian Programme is acting at the Danube basin level to promote conservation that also embraces the sustainable use of natural resources. In this context, in 2012, WWF successfully submitted to the financial programme of the European Commission ENRTP ("Environment and Sustainable Management of Natural Resources including Energy") the project "Climate proofing Danube Delta through integrated water and land management" (contract no. DCI-ENV/2010 222 - 927). The aim of the project was to supports building a foundation for the adaptation of the Ukrainian, Moldovan and Romanian parts of the Danube Delta sub-basin to the modified climate conditions. It also helps increasing the cooperation between sub-basin countries. The project helped to increase cooperation between partner countries to develop and implement the regional trans-boundary Climate Change Adaptation Strategy for the Danube Delta sub-basin and Action plan.

3.2.1 Developing a local renewable energy business

The project activities were implemented in partnership with Danube Biosphere Reserve (Ukraine), Center for Regional Studies (Ukraine), NGO Ecospectr (Moldova). Scientific Engineering Centre "Biomass" (Ukraine), National Institute for Research and Development Danube Delta (Romania), and Danube Delta Biosphere Reserve Administration (Romania).

The Danube Delta is known for having the widest compact area of reeds in Europe, a valuable asset when it comes to adapting to climate change, though still not used to its full potential. Exporting reed as a building material to the countries of Western Europe is an expanding business in Ukraine. About 10 enterprises in the Vylkove region do business by harvesting and exporting reed. In 2012 alone, about 13,460 tons of reed were collected from 3,500 hectares of flooded areas. The business is very important for the local communities as the companies in Vylkove employ about 1,150 people, in other words almost one-sixth of the total population of the town. But these businesses also create an average of 1,000 – 2,000 tons of waste reed per year.

Through the “Climate proofing the Danube Delta through integrated land and water management” we wanted to help communities benefit from this opportunity. Given the lack of production of reed waste briquettes in Vylkove a local green business scheme was set up, to use the available reed waste and transform it into raw material.

The briquettes, produced on a briquetting line owned by the Municipal enterprise ‘Zmiinyi’, will be used for heating the local public building instead of using coal in the new boiler installed also through the project. The action reduced costs for heating arising from the use of fossil fuels, but has an impact on protecting the Delta. Green energy generated from reed briquettes

contributes to reducing the carbon footprint in the selected pilot areas, since biomass can successfully replace coal.

Furthermore it is planned that Danube Biosphere Reserve will provide verification that the entire amount of reed is harvested according to the established methodology and legislation regarding nature conservation.

The strategy implemented in the pilot area of Vylkove shows how the community and the area can adapt in a natural way to climate change. Using reed as a biomass source and restoring wetlands in the Danube Delta to have more space for reed, the source of green energy, also creates new opportunities for local people and entrepreneurs interested in sustaining their livelihoods.

3.2.2 Steps in setting-up the renewable business scheme in Vylkove

The project activities related to the reed-use implemented until 2014 have followed a special designed sequence necessary to cover all the crucial aspects for a proper decision regarding the feasibility and profitability of the green business scheme and also to provide benefits for local community. As a consequence, the following issues have been analysed before the implementation of the scheme started.

A. Assessment of the potential renewable energy sources in Ukrainian part of Danube delta

The Center for Regional Studies assessed the areas along the Danube considering biomass potential from reed (using remote sensing imagines), logging (energy willow, shrubs and special attention was paid to the invasive shrub *Amorpha fruticosa*), and rice straw and husks as biomass materials, as well as territories with potential for wetland restoration projects. The assessment of the embanked floodplain areas in the Ukrainian part of the Danube Delta identified four territories with high potential for demonstration of opportunities of wetland ecosystems restoration and sustainable production of biomass as an alternative energy source, namely: Orlovka polder (Zarzy); polder at Skunda channel; Yermakov Island and Leski polder.

B. Energy demand in relevant villages

Energy demand assessments were done for Orlovka village and Vylkove town. The study concluded that the main energy source in Orlovka village was natural gas. However, wood had a rather large share of the balance meaning that it was the most popular alternative energy source. The population was the major heat consumer, but the public sector was more attractive for implementation energy saving measures since this sector used only natural gas. In Vylkove, the main energy source was coal and the population dominated the heat consumption balance.

C. Existing and potential exploitation of reed biomass

The ownership of Zarzy polder (Orlovka) proved to be uncertain. Before 2002, the land belonged to the village council but according to some new land legislation, this area was to become the property of Reni district administration. Also, reed was manually harvested from Kartal lake by Orlovka people and used for building fences and sheds, for roofing and for combustion in ovens. The potential was theoretical since there was no harvester in the village for mechanical harvesting. In Vylkove, almost all the land primarily covered with reeds are part of Danube Biosphere Reserve. From this perspective, Vylkove was more attractive for a renewable energy scheme based on reed biomass.

D. Identify the public buildings to be included in the reed biomass scheme

For determining the supply chain regarding the final users, public buildings in Orlovka and Vylkove were assessed regarding their suitability to support new investment and the

potential effectiveness of installing a biomass boiler based on reed. The Svitliachok kindergarten in Orlovka was considered to be in the best physical condition among the public buildings there and the existing hot water pipe system could be supplied by reed-fired boilers. There was enough free space for installation of a biomass boiler using briquettes, wood logs or wood chips and to allow storage of wood logs. The "golden fish" kindergarten in Vylkove was also in a good condition after renovation works carried out the previous year, and had adequate space for a boiler and biomass storage.

E. Identify / design equipment for reed harvesting, producing pellets / briquettes, boiler

Harvesting and baling

The valuable examples from Finland and Estonia were explored during the implementation of the project "Reed strategy in Finland and Estonia" (financed through the INTERREG III3A programme) and are summarised into the project deliverable published in on the internet and could be downloaded from the following link: http://julkaisut.turkuamk.fi/isbn9789522160355 .pdf. This study identified the possible ways and issues of harvesting reed. As reed grows in very different places ranging from standing water to dryer shore areas, harvesting equipment varied according to different growth places and harvesting times (summer/winter). The defining factors are the technical requirements in harvesting and the overall cost-effectiveness.

The essential technical factor in the harvesting reed is the weight of the machine and the surface pressure it exerts on the ground and the ice. Machinery on wheels is the most cost-effective in the light of transportation between work sites, even though tracked harvesters have lower surface pressure. Using extra wide tires for tractors decreases the surface pressure. However, implementing the scheme in the Ukrainian part of the Danube delta did not involve harvesting as such, but just using waste reed and other possible raw materials resulting from rice production or forestry operations (brashing and removal of *Amorpha*).

Transporting and storage

The logistic chain also included consideration of the transporting and storage of biomass. All costs attached to the reed transport from the harvesting place to all possible production locations and to storage places of raw biomass and of the final products were analysed as part of the business plan in order to include them into the cost of the final product.

Analysis of possible reed biomass products

A detailed economic analysis of biomass production plants and solid fuel boilers that are available in Ukraine was carried out. While there are many suppliers of pelleting and briquetting lines, only a few companies had some real experience in processing reed to pellet or briquette.

The consultants had contacts with 15 companies and only two of them provided concrete commercial proposals for all ages f implementation of a biofuel production facility including project design, construction works, commissioning etc. One proposal was received for pelleting and two for briquetting.

The research revealed that Ukrainian suppliers of straw pelleting lines can rarely offer a complete set of equipment of their own manufacture. Therefore, new factories operating in Ukraine are mostly equipped with auxiliary equipment of Ukrainian production, but the pellet mills, coolers, and other basic equipment is mainly supplied by well-known manufacturers from Western Europe (Kahl, CPM, Andrits, Buhler, etc.).

The only local manufacturer of shredders, pellet mills and controls in Ukraine is GranTech Engineering, a part of the ICK Group in Kyiv. With respect to briquette machines, the most well-known producers: Pini Kay Mashinenfabrik GmBH, Austria; Asket, Poland-

press-extruders Biomasser; Weima, Germany; NESTRO Lufttechnik GmbH, Germany; C.F. Nielsen, Denmark; and RUF, Germany.

Briquette production line

After intensive market research and consultation with some suppliers, a contract was signed with "Genesis-Trade" engineering company, with the participation of "Bio-Alliance" for design, manufacture and supply of a complete line for the production of NESTRO type fuel briquettes from reed with output up to 350 kg/h.
This equipment can process different raw plant materials (reed, straw, vines, corn, sunflower and rice waste). The production line consisted of the following equipment (Figure 34):

- Multi-purpose shredder;
- Dispersant - dryer;
- Briquetting press type PBU-060-400, including:
  - cooling line;
  - hopper;
  - control box;
- 2-chamber rack for bags

Heat production

The calorific potential of the reed briquettes was analysed to achieve the best use in heating installations. It is known that the use of biomass as fuel is determined by different characteristics such as the heat of combustion, fractional composition, bulk density, ash-softening temperature, and the presence of chemical components which may lead to corrosion of the boiler.

The main producers of straw-burning equipment were investigated to identify a boiler with the most suitable technical characteristics for burning reed briquettes (e.g. Passat Energi (Denmark), Maskinfabrikken REKA (Denmark), LIN-KA Maskinfabrik (Dennark), Teisen Products (UK), Alcon ApS Ingeniorfirma (Denmark), Skeltek (Denmark), MetalERG (Poland), WEISS (Denmark), and JSC Moldagrotechnika (Moldova)).

Figure 34: Components of the briquetting line installed in Vylkove
Source: WWF DCP

Multi-purpose shredder


Dispersant dryer


Briquetting press PBU-060-400

The most popular models are able to work with any type of biomass fuel, mostly based on wood. Other types of biomass like sunflower husk, straw, meal are also quite popular for use in the form of pellets, briquettes and chips. The type of boilers which consume straw bales is almost absent in Ukraine. It was found that there is not much experience regarding use of reed in any form among local producers and suppliers of solid fuel boilers. Only four companies provided some real solutions: 2 for straw pellets and 3 for straw briquettes. Finally, the boiler model RETRA 3M (made in Rivne) was purchased and installed at the public building in Vylkove.

F. Determine a feasible and profitable scheme to produce reed fuel to benefit the local community

Before elaboration of equipment for biofuel production and solid fuel boilers, the demand among the local population and public bodies was clarified, as well as profitability of using biomass boilers in comparison with local fossil fuels namely natural gas in Orlovka and coal in Vylkove. It was decided to analyse the potential of biofuel production facilities in Vylkove only, since there were no means to harvest and transport reed in Orlovka. The waste from producing thatching reed were selected as the most likely source for biomass production.

It proved impossible to obtain real data from companies regarding implementation of biomass production based on reed for commercial reasons. This analysis was performed based on information provided by commercial proposals from companies that included technical specification of equipment, detailed description of technology, costs for services regarding project design, installation and construction works, commissioning, etc. Furthermore, the capital cost also included installation of an electrical substation of appropriate capacity that was absent at the project site. During analysis of potential solutions for boilers, it was found that a pellet boiler was not profitable in case of coal replacement: here is a real problem with pellet demand since it is almost impossible to provide total substitution of coal by pellets in Vylkove.

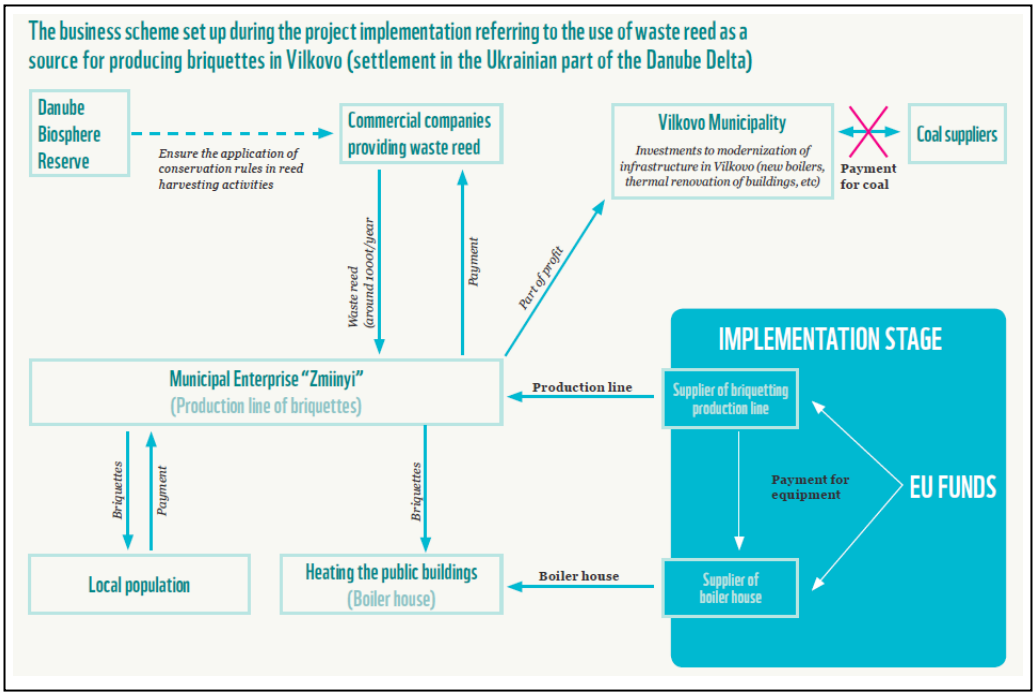
As the maximum amount of waste reed likely to be processed was 1,500 t/yr, the capacity of the briquetting machinery was calculated for 350 kg/h with a recommended price of 40 EUR/t.

G. Ownership and organizational structure

It was mentioned above that the success of biomass production is highly dependent on the demand and it was clear that for future market development, the renovation of public sector boiler houses will require a lot of funds. Accordingly, the boiler houses should be operated by a company that will provide a strong commitment on the use of local briquettes based on contracts and will invest in local heating systems. At the same time, the company producing briquettes should ensure supply and a stable price that would create the opportunity for boiler operators to make a return on the investments made in the local heating infrastructure.

The Danube Biosphere Reserve was one of the most important participants of the project and has a big responsibility during the permitting process for reed companies to establish the reed harvesting limits. A memorandum of cooperation in the framework of the project implementation has to be established between World Wild Fund for Nature (WWF), Municipality of Vylkove as a main stakeholder of the Communal Company “Zmiyinyi” and Danube Biosphere Reserve, according to the operating scheme shown in Figure 35.

Figure 35: Business scheme for sustainable use of reed biomass as a fuel in Vylkove
Source: WWF DCP



3.3 Case study: reed pellet production in Reni, Ukraine

The British company Fieldfare International Ecological Development plc harnesses ethical investment resources in Western Europe to promote ecologically sustainable development and wise use of natural resources in Eastern Europe. It is particularly active in the Danube Delta, a region of high biodiversity, where relatively modest innovative investment can generate large biodiversity benefits. Fieldfare fosters local businesses for such sustainable use of natural resources, using a cluster approach.

The innovation described here is the production of biomass fuel from overgrown, low biodiversity reed beds that have become widespread as a result of floodplain modification since the 1950s. Cutting is the only way to keep open water areas for wetland birds, but this is far too expensive to undertake for conservation purposes alone. Fieldfare's solution is to harvest and pelletize the reeds as a biomass source, initially for local markets. This innovation also assists business in tackling policy risks related to greenhouse gas emissions. The use of reed pellets as a fuel sources can help companies towards carbon neutrality. It should also be noted that reeds have high polysaccharide content so they would also form a suitable renewable feedstock for producing biofuels and other industrial organic chemicals, an avenue that is currently being researched intensively in China.

After forming a joint venture (called BioTop ltd) with a local reed harvesting company in Reni, three ears of pilot harvesting, production and sales trials were conducted at Reni in Odessa region. BioTop harvested about 30 ha of reed bed a year, some 100 ha altogether so far. This provided about 90 tons per year of biomass fuel for local homes and public buildings, created five new full time jobs, and prompted the establishment of a dealership in biomass boilers in Reni itself.

BioTop has been marketing reed pellets since January 2013 to local customers in lots of 100 kg to 20 tons, with an average price of EUR 65 per ton. The company is now scaling up its operations, using a pelleting line including equipment supplied by British and Ukrainian companies with a production rate of 500 kg/hr

(Figure 36). It is expected that operating profits and dividend payments will accrue over the longer-term as the country completes its transition to a full market economy, a process accelerated by the ratification of the EU Association Agreement in 2016.

Figure 36: BioTop reed pellet production line, Reni, Ukraine
Photo: Paul Goriup

Fieldfare has commissioned independent scientific monitoring of its reed harvesting in terms of plants and birds. The site has shown a positive response to reed bed harvesting from breeding birds in the harvesting areas. The harvested reed beds (total extent about 300 ha) support some 35 species of wetland birds, and around 80 bird species overall.

Among these are globally threatened species like ferruginous duck *Aythya nyroca* and pygmy cormorant *Microcarbo pygmeus*, as well as a growing heronry, a large colony of glossy ibis *Plegadis falcinellus*, recolonisation by spoonbills *Platalea leucorodia* and the largest population of moustached warblers *Acrocephalus melanopogon* in Ukraine. Reed harvesting, whether for roof thatch or for fuel pellets, is potentially one of the most specific and sustainable use of reed beds. It is considered beneficial in the long term by restraining the hydroseral (plant succession) process (which eventually leads to the loss of the wetland) but incompatible with some bird nesting activities in the short term. Management methods are currently to harvest every other year while maintaining a mosaic of patches harvested over a longer (7– 15 years) rotation, thereby maintaining a range of successional stages supportive for a wide variety of plant and animal species. However, different species will have specific requirements. For example, a study in the Carmargue found that bitterns *Botauris stellaris* benefit from cutting every second year. However, because second-year reed is often of lower yield, this management could represent high economic cost.

A good ecological/economic compromise for commercial cutting would consist of leaving 20% of a patch uncut at variable location each year. This scenario will also reduce the impact of reed harvest on arthropod availability for breeding passerines and ensure that some habitat remains for bird species wintering in reed beds. Obviously, the complete cutting of a site, especially if isolated, would be detrimental to many marsh birds and should be completely avoided. To prevent disruption of early breeding activity in spring, or autumn migration feeding and roosting, reed harvesting is limited to the period from November to March.

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4. TRIPLE HELIX APPROACH FOR BETTER WETLAND MANAGEMENT

4.1 "Triple Helix" Institutions and Renewable Energy Innovation

The "Triple Helix" approach is one in which the potential for innovation and economic development in a modern, knowledge-based society is enhanced by close, mutual interaction between universities, industry and government.

The interaction between these three institutional spheres generates new institutional and social formats for the production, transfer and application of knowledge.

The range of interactions and knowledge-sharing encompass many aspects from basic science to government policy, cluster formation among geographical and research groups, funding and product development (Figure 37).

Innovation in the sector of efficient and sustainable use of renewable resources is gaining global importance and needs transboundary efforts for optimisation. In 2009, the European Commission established the European Institute for Innovation and Technology (EIT) to connect and stimulate cooperation between top-level research and development of academic and industrial research institutions. The EIT has an international Board of 15 members representing expertise from the higher education, research, business and innovation fields. EIT currently administers five so-called Knowledge and Innovation Communities (KICs) from their headquarters in Budapest, Hungary (Table 11).

Table 11: Current EIT Knowledge and Innovation communities and issues addressed
Source: EIT

Name	Focus
Climate-KIC	Climate change mitigation and adaptation
EIT Digital	Information and Communication Technologies
KIC InnoEnergy	Sustainable energy
EIT Health	Healthy living and active ageing
EIT Raw Materials	Sustainable exploration, extraction, processing, recycling and substitution

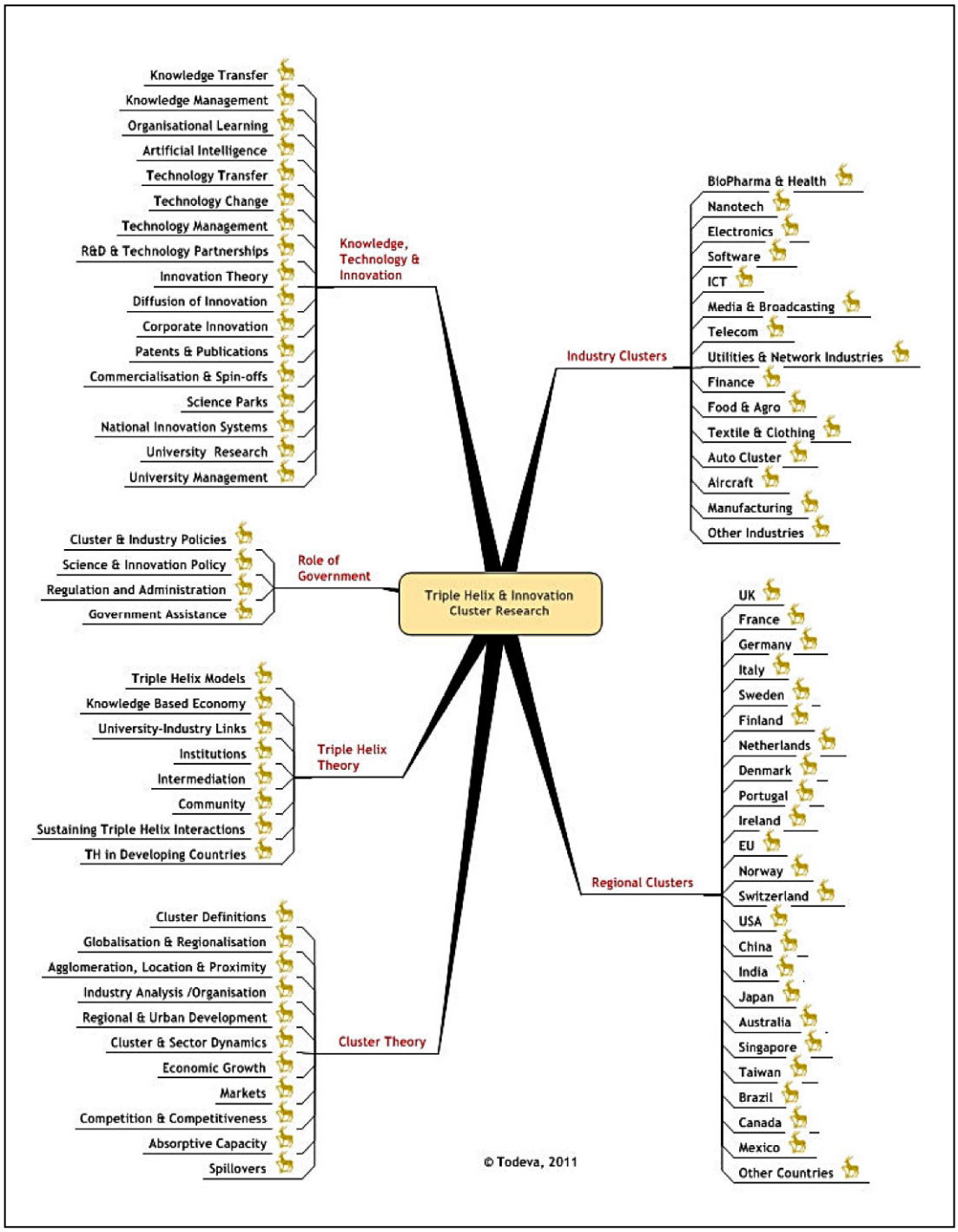
4.1.1 Climate-KIC

In respect to the potential for rewetting and restoration of drained floodplains in the ReedBASE project area and consequent sustainable reedbed management, the EIT Climate KIC could be of interest.

The sustainable management of reedbeds for materials and renewable energy production has a variety of aspects that address climate change adaptation, including:

- water regulation (water retention; flood control; water purification)
- CO_2 emission reduction (emission reduction from drained peatlands after rewetting; carbon storage in materials from renewables);
- decentralised renewable energy supply;
- substitution of fossil energy fuels by renewables.

Figure 37: Triple Helix Innovation Clusters
Source: www.triplehelixassociation.org/th-reading-databank



4.1.2 InnoEnergy

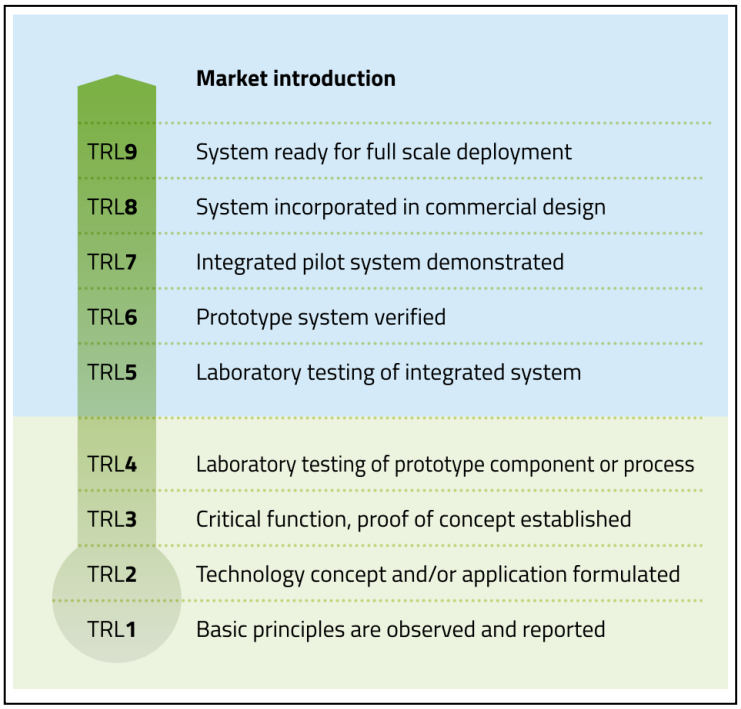
InnoEnergy focuses on the energy sector with eight thematic fields which are open for applications for innovation projects and start-ups:

- Clean coal and gas technologies
- Energy storage
- Energy efficiency
- Energy from chemical fuels
- Renewable energies
- Smart and efficient buildings and cities
- Smart electric grid
- Nuclear instrumentation

The Michael Succow Foundation contacted InnoEnergy Germany on behalf of the ReedBASE project to assess the potential for cooperation and support. According to InnoEnergy, the readiness for commercialisation of a new renewable

energy technology is evaluated according to a 10 level scale (Figure 38). To obtain funding and support from InnoEnergy, a proposed innovation project must rank at least on TRL 6-7 on the evaluation scale. Thus, for support of sustainable management of reedbeds for renewable energy, a project would need to demonstrate working pilots (e.g. in Vylkove and Reni) and have a high-level implementation project constellation and partner consortium in place.

Figure 38: InnoEnergy's 10 level evaluation scale for evaluating commercial readiness of innovations



4.2 Application of the Triple Helix Approach for Wetland Biomass Utilisation

In order to initiate the formation of a "Danube wetland biomass innovation cluster", as the first step for responding to calls for major EU funding proposals (such as Horizon 2020 and INTERREG Danube Transnational Programme), ReedBASE conducted a survey of relevant "Triple Helix" organisations. Those entities that are or might be interested in the sustainable use of biomass from reed beds within the study area were entered in a database. In addition to research institutions, industry and government, relevant civil society organisations were also included because of the need to disseminate accurate information among potential customers for wetland biomass products. The results of the survey so far cover 118 organisations (see Annex 1, and summary in Table 12). It is intended that future surveys will extend to other Danube range states, from Romania and Bulgaria, and then further upstream.

Table 12: Triple Helix organisations related to wetland biomass utilisation in the project area
Source: ReedBASE project

Sector	No. in UA	No. in MD	Total
Research / education	19	5	24
Industry	19	17	36
Government / PAs / IGOs*	32	7	39
Civil society	12	7	19
Total	82	36	118

*Includes protected area administrations and inter-governmental organisations

It is evident from Table 12 that there are many stakeholders relevant to the sustainable use of wetland biomass in Ukraine and Moldova. Accordingly, there is a high potential to form an interest group or cluster representing all Triple Helix (as well as civil society) organisations in order to identify, develop and implement innovative approaches for wetland biomass management and utilisation in the ReedBASE project area.

5. CONCLUSIONS and PROPOSALS

The main aim of the ReedBASE project is to develop a broad-based cross-border innovation group (covering Ukraine, Moldova and eventually Romania) concerning the sustainable use of wetland biomass. Based on a sustainable approach for peatland management (paludiculture), ReedBASE focuses on restoring drained and degraded wetlands and related ecosystem services to convert unproductive drained areas into productive wet sites in marginal rural areas. Wherever possible, paludiculture will be applied on degraded peatland areas to maximize the potential for the mitigation of greenhouse gas emissions from organic soils. Innovation in harvesting, processing techniques, and management schemes will be appropriate for soft organic and wet soils. The establishment of a ReedBASE innovation cluster will strengthen the conservation and wise use of peat- and wetlands around the north-west coast of the Black Sea and help to disseminate paludiculture innovations. Furthermore, this approach will contribute to the mitigation of and adaptation to climate change, by safeguarding and reactivating ecosystem services.

5.1 Potential wetland biomass resources in the project area

According to a recent survey of stakeholders within the bioeconomy value chains in a Triple-Helix perspective, Danubionet found that under-utilisation of existing natural assets was a high priority, demonstrating the early stage of development of an advanced Bioeconomy. In order to use these resources sustainably, considerable investments are needed to build biorefineries, trigger market demand for bio-based products and guarantee the security and sustainability of long-term biomass supply. (Danubionet Position Paper for the Development of Bioeconomy in the Danube Region, December, 2016. http://www.danube-inco.net/)

The respondents attributed the largest potential to agricultural residues, followed by industrial wastes/by-products, forestry residues and energy crops. Interestingly, the potential of the existing wetland biomass assets was not mentioned in the survey, which demonstrates the need for a throughout analysis of the present status of wetland degradation and reedbed management practices.

The total project study area in Ukraine and Moldova covers 117,920 ha (Table 5). 36,802 ha (31%) comprise low-lying arable land and 35,760 ha (30%) are pure reedbeds; a further 9,974 ha (8%) comprise reed mixed with other land cover types. The remaining area is largely represented by open water with 23,139 ha (20%). Assuming that about 70% of the reedbed area is accessible (excluding areas under strict protection or unsuitable for harvest), that a two-year harvest rotation is used, and that an average yield of 8 tons of dry reed per hectare is obtained, it is estimated that the project area could in time sustainably generate some 100,000 tons of biomass per year. This is equivalent to almost 50,000 tons of coal, or 39.5 million cubic metres of gas. Using reed biomass would not only provide a substantial amount of energy, but also avoid emitting some 79,000 tons of CO_2 from burning gas.

Furthermore, most of the arable land occurs in difficult areas for cultivation, with high likelihood of flooding in winter and needing irrigation in late spring and summer. In Ukraine, according to the Water Code, annual crops should not be grown close to main rivers and large waterbodies and this legislation is being increasingly enforced.

An alternative use could be the introduction of short rotation coppice based on willow and

alder species. These trees are well adapted to floodplain conditions and should produce at least 6 tons/ha dry biomass per year (https://www.researchgate.net/publication/259231834). Such plantations can produce wood for a variety of uses, apart from energy generation. Converting 5,000 ha of marginal (if not abandoned) arable land to short rotation coppice, combined with the reed biomass, would be sufficient to fuel a 10 MWh combined heat and power plant.

5.2 Use of reeds as a source of renewable energy

Of course, there is a big gap between the potential wetland biomass resource described above, and the current reality. The two case studies presented in Section 3 highlight the obstacles involved even in implementing relatively simple reed processing plants, and obtaining economic viability for such small-scale initiatives is difficult. This is further shown by a Strengths-Weaknesses-Opportunities-Threats (SWOT) analysis (Table 13), based on the information from this desk study, the Danubeionet survey mentioned above, as well as economic research carried out by the Greifswald Mire Centre (Wichmann,.2016).

Table 13: SWOT analysis of energy generation from harvesting reed

STRENGTHS	WEAKNESSES
Concentrated source of non-cultivated biomass	High ash, silica, chlorine content
Biomass properties similar to other crop residues / energy crops	Difficult and expensive to harvest (not a waste)
Relatively high polysaccharide content	Harvest unpredictable as weather dependent
Easy to store and dries passively	Current processing equipment not optimised for reed biomass
Contributes to restoration of wetland ecosystem functions	Availability usually far from infrastructure - roads, buildings, power supply - and markets
Superior qualities as animal litter and bedding	Low investor interest as a novel, not mature, product
Ash does not sinter and easily removed; can be used as a soil conditioner	
OPPORTUNITIES	**THREATS**
Rewetting drained floodplains for reliable cropping and carbon sequestration	Ecologically unsustainable harvesting
Use of amorphic silica by-product	Fire risk, incidental and arson
Increase market awareness of reed biomass advantages	Price volatility and market distortion from grants / subsidies
Set up research projects to improve harvesting and processing technologies	

5.3 Innovation to realise sustainable wetland biomass potential

As shown in Section 4, forming a Triple-Helix cluster is the best way to achieve innovation for sustainable use of wetland biomass, and obtain the inherent ecosystem benefits this approach entails. Such a cluster can cooperate and address the weaknesses and threats outlined in the SWOT analysis while building on the strengths and opportunities. Some examples of possible initiatives follow.

Policy Development

The government sector has a major role to play in facilitating the use of wetland biomass as a renewable source of energy, within its overall green energy policy. Topics to be addressed include:

- Enforcement of water protection zone management and rewetting floodplain areas where appropriate
- Promotion of short rotation coppice for materials and energy
- Designating reed as a recognised energy crop
- Incentive schemes for research and business creation at local level to initiate economic development based on short carbon cycles
- Certification of product quality (thatch, briquettes and pellets) according to European standards

Research Needs

Universities and research institutes in the region should engage with international networks and organisations in the relevant fields, as well as strengthen their investigations of, and train local expertise in, aspects such as:

- Long-term monitoring of impact on habitat diversity and quality
- Wetland management especially for carbon sequestration
- Paludiculture opportunities
- Biomass harvesting equipment and optimal harvesting regimes
- Innovative construction materials from wetland biomass
- Pelleting / briquetting production equipment
- End uses: boilers and CHP units
- Economics of wetland biomass utilisation
- Evaluation of ecosystem services improved by wetland restoration and wise management

Business Investment

The private sector is the main driver for the development and marketing of new products, resulting from appropriate wetland biomass policies and incorporating research results. Examples of cluster-based research and development projects carried out by businesses are the Loreen combined heat and power plant being developed in Sweden with grant support from KIC InnoEnergy, and the natural growing of furniture and sculptures supported by KIC Climate (see box).

Social Engagement

Civil society organisations, although not a formal part of the Triple Helix system, can still play an important role in promoting awareness, increasing acceptance of and raising demand for wetland biomass products:

- Creating awareness of wetland biomass value as a natural capital asset
- Promoting consumption of locally produced wetland biomass products
- Discouraging *ad hoc* burning of reed beds as anti-social behaviour and wasting resources
- Promote the role and value of ecosystem services especially in the climate change context.

Swedish Local Residue Energy (Loreen) Project

A Sweden-based combined heat and power (CHP) consortium formed by Meva Energy, the research institute of Sweden (RISE) and a leading international furniture manufacturer, has secured €2.9m worth of funding from KIC InnoEnergy. The process that the consortium has developed comprises a CHP plant fuelled by the gasification of unprocessed, dry biomass residues from agriculture and wood-based manufacturing. The initial feasibility studies showed that Meva Energy's gasification processes will be able to produce heat and power in the range below the commercial viability of existing steam-turbine technology – typically less than 10MWe. It could be the solution that expands the possibilities for cogeneration and for biomass.

Full Grown Ltd furniture and sculptures, UK

Using ancient techniques combined with modern technology, the British start-up company, Full grown Ltd, grows, grafts, nurtures then harvests living trees to produce unique items of furniture.

They are developing an elegant, simple art form that emits oxygen, absorbs CO_2 and whose by-products sustain wildlife. Each piece is an elegant cooperation between nature and craftsmen that could last for hundreds of years

5.4 Formation of a Wetland Biomass Innovation Cluster

The next stages of the ReedBASE project concern exploring the feasibility of establishing a broad-based cross-border innovation group (covering Ukraine and Moldova initially and Romania later) for the use of wetland biomass as a source of sustainable energy as well as other products. This will be done through two rounds of meetings with relevant Triple Helix organisations later in 2017.

A possible scenario for establishing such a cluster comprises the following steps:

- Informal "pre-cluster" formed under the leadership of IMPEER, in which various interested organisations express a desire to participate and share information;
- Screening of opportunities for relevant project grants e.g. EU Transnational Danube Programme, EU Horizon 2020 and national and bilateral programmes
- Forming consortia to bid for grants for research and development projects
- Joining the Triple Helix Association (https://www.triplehelixassociation.org/about-tha)
- Seeking collaboration with the European Institute of Innovation and Technology and relevant Knowledge and Innovation Communities.

REFERENCES

Bilanchyn, Ya., Usacheva, Ye., Gazetov, Ye., Medinets, V., 2014. Soil map of Lower Dniestrovskiy national natural park territory. *In*: Visnyk ONU, Geografichni ta geologichni nauky, Mechnikov National University in Odesa, p. 69-76.

Goriup, P. and Goriup, N. (2015) Evolution of Politics and Institutions for Conservation of the Ukrainian Danube Delta. pp 319 – 344 *in* Iordachi, C. and van Assche, K. (eds) The Bio-Politics of the Danube Delta: Nature, History, Policies. Lexington Books, London. ISBN 978-0-7391-9514-7

Goriup, P. D. (Ed.) (2003) Environmental Management Programme and Action Plan for Habitat Restoration and Sustainable Management of the Lower Danube Lakes area. Report of EU Tacis Project Ref. WW/SCRE1/No. 1 – CBC 1998

Marples, D. (1985) Problems persist in Ukraine's Land Improvement Program. *The Ukrainian Weekly* **18** (May 5): pp. 7 and 14.

Marushevsky, G. (ed) (2003) Directory of Azov-Black Sea Coastal Wetlands. Revised edition. 230 pp. Wetlands International, Wageningen.

Stagl, J.C. and Hattermann, F.F. (2016) Impacts of Climate Change on Riverine Ecosystems: Alterations of Ecologically Relevant Flow Dynamics in the Danube River and Its Major Tributaries. *Water* **8**: 566-591; doi:10.3390

Wichmann, S. (2016) Commercial viability of paludiculture: A comparison of harvesting reeds for biogas production, direct combustion, and thatching. *Ecological Engineering*, **9** pp. https://doi.org/10.1016/j.ecoleng.2016.03.018

Wichmann, S. and Köbbing, J.F. (2015) Common reed for thatching – A first review of the European market. *Industrial Crops and Products*, **77**: 1063–1073.

Wichtman, W., Schröder, C. and Joosten, J. (Eds) (2016) Paludiculture - productive use of wet peatlands: Climate protection - biodiversity - regional economic benefits. Schweizerbart Sche Vlgsb. ISBN 978-3510652839.

ANNEX 1

TRIPLE HELIX ORGANISATIONS IDENTIFIED IN THE PROJECT AREA

UKRAINE

Name	Registration place	Website	Interest	Responsibility	Recent activities relevant to biomass use
Civil Society					
Vernadsky Youth Ecological Centre	Odessa	https://www.facebook.com/groups/EcoTV.Odessa/?fref=ts	Education in sector of environmental awareness.	Carrying out of environmental actions, seminars and training. Conducting of educational programmes.	
Mama-86-Odessa	Odessa	http://www.mamaodessa.org/uk/	Ensuring of healthy environment. Adapting for the climate change. Increased public awareness in energy efficiency.	Environmental projects on adaptation to climate change. Training, seminars and conferences.	Project “Adaptation to climate change of the Dniester river basin through creation of planted areas and raising public awareness”
Centre for Democratic Development of Youth "Synergy"	Odessa	https://www.facebook.com/pg/cddy1synergy/about/?ref=page_internal	Empowering youth participation in national development processes of democracy and civil society in Ukraine. Implementation of scientific, artistic, political, institutional, environmental, social, educational and other potential young people. Protection of legitimate social, economic, environmental, cultural, legal and other interests of young people.	Environmental projects on adaptation to climate change. Training, seminars and conferences.	
Energetic country	Odessa		Implementation of energy efficient technologies in the national economy.	Measures that improve environment through energy efficiency	Implementation of the projects of transition to renewable energy sources and the use of pellets for heating in social buildings.

Name	Registration place	Website	Interest	Responsibility	Recent activities relevant to biomass use
Odessa Regional Organisation of Ukrainian Environmental League	Odessa	http://www.ecoleague.net/	Improving the environmental situation and formation of a new environmental mentality, environmental education and culture.	Organisation of public environmental monitoring of compliance of environmental legislation. Prevention of activities that threaten environmental safety, biodiversity and health. Expanding public participation in the formulation and implementation of state environmental policy. Promoting of the development and implementation of environmentally balanced, energy-saving technologies.	Ecological Forum "Prospects and Measures for Sustainable Environmental Management in Waters of the Dniester estuary." Organisation of the Youth Water Parliament of Ovidiopol raion. "Preservation of of the Dniester delta wetlands - the key of region environmental balance." Environmental Forum "Natural Resources of the Lower Dniester - Conservation and Sustainable Use."
Black Sea Branch of Ukrainian Environmental Academy of Sciences	Odessa	http://www.bsb-ueas.org/	Our mission is to strengthen scientific society partnership by enhancing participation and contributing to the policies in order to provide environmental safety of the Black Sea region.	Development of scientific bases of sustainable use of the Black Sea natural resources, including fundamentally new approaches to environmental monitoring and effective environmental management; Document and disseminate experience and best practice to address Black Sea environment issues and natural resources management; Greening of the economy, environmentally friendly approaches development and dissemination (alternative energy sources, green tourism).	n/a
Kray Children's Ecological Club	Berezany	http://dniester.info, http://www.eco-tiras.org	Informs the public about the social and environmental problems, organises and conducts seminars and workshops.	Development of environmental policy	Project "Education for sustainable development in action." Project "The democratisation of the Dniester River Basin Management".
Agricola	Reni	https://www.facebook.com/AgricolaNGO/?fref=ts	An NGO comprised of individual experts, organisations and SMEs who support sustainable development and livelihoods, protection of cultural heritage, and nature conservation.	Particularly active in: Establishing new natural protected areas Improving regional ecotourism infrastructure Utilisation of wetland biomass for renewable energy Developing drought-resistant organic farming systems Restoring fisheries based on native species.	Project "Promotion of Paludiculture in Black Sea Region Wetlands for Carbon Sequestration, Sustainable Development and Community-Based Renewable Energy" Visitor centre establishment in Reni and Vylkove
Vidrodgenya	Tatarbunary	http://ecosolar.org.ua/contacts/	Environmental protection, nature reserves, raising awareness of environmental lifestyle.	n/a	n/a

Name	Registration place	Website	Interest	Responsibility	Recent activities relevant to biomass use
National Ecological Centre of Ukraine	Kyiv	http://necu.org.ua/	NECU works to bring environmental considerations into the core of any decision, to save nature, by maintaining and creating new protected areas, and to decrease human impact on environment, through policy changes in energy and transport sectors.	Campaigning for new nature protection zones to keep animals and plants in their natural environment and that the existing protected territories remain untouched. Trying to redirect the energy policy of Ukraine to an energy efficient economy using alternative energy sources. Member of Ukrainian NGO Working Group on climate change that works to integrate climate change issues into Ukrainian government policies, and monitors the implementation of Kyoto protocol mechanisms in Ukraine.	n/a
Environment-People-Law	Lviv	http://www.epl.org.ua/	Increasing the environmental awareness of Ukrainians.	Improve Ukrainian legislation in the field of environment protection; Raise initiators of progressive change – environmental lawyers; Defend environmental rights of people; Develop progressive views on court proceedings among judges and lawyers; Protect nature from harmful impacts of the industrial sector.	Project "Promotion of Paludiculture in Black Sea Region Wetlands for Carbon Sequestration, Sustainable Development and Community-Based Renewable Energy"
Society and Environment Resource & Analysis Centre	Lviv	http://www.rac.org.ua/	Environment 3D — relevant and timely analysis for meaningful changes in society.	The interrelation of environmental protection and energy issues is evident, and development and implementation of energy policy should take into account current environmental challenges. Energy Community is legally guaranteed by the requirements to implement four EU environmental directives.	n/a
Business					
BioTop Ltd	Reni	n/a	Production of materials from reedbeds at Lake Kagul	Harvest permit holder	Production of reed pellets
Zmeiny Ltd	Vilkovye	n/a	Using waste reed from thatch harvest	Supply of heating fuel to schools	Production of reed briquette
GranTech Ltd	Kyiv	www.ick.ua/en/grantech	Farm equipment manufacture	Supplier of pelleting equipment	Development of specific machinery
Odessaribhosp Ltd	Bilyayivka	n/a	Freshwater fish farming	n/a	n/a
Agricultural Production Cooperative "Danube"	Kiliya	n/a	Agriculture	n/a	n/a

Name	Registration place	Website	Interest	Responsibility	Recent activities relevant to biomass use
Agricultural Production Cooperative "Lighthouse"	Kiliya	n/a	Agriculture	n/a	n/a
Dawn Ltd	Novoozerne, Izmail district	n/a	Agriculture	n/a	n/a
Farm "Larga"	Larzhanka Izmail	n/a	Agriculture	n/a	n/a
Farm "Dobryeva DD"	Izmail Danube	n/a	Agriculture	n/a	n/a
Farm "Muravlev AA"	Stara Nekrasivka Izmail district	n/a	Agriculture	n/a	n/a
Farm "Khrustalev Ivan G."	Izmail Danube region	n/a	Agriculture	n/a	n/a
Farm "Cheban PG"	Kyslytsya Izmail district	n/a	Agriculture	n/a	n/a
Izmail Pulp and Paper Works JSC	Izmail	n/a	Production of paper and cardboard	n/a	n/a
Multidisciplinary cooperative "Novo Nekrasov"	Novyi-Nekrasivka Izmail district	n/a	Mixed farming and freshwater fish farming	n/a	n/a
Multidisciplinary cooperative "Novo Nekrasov"	Kyslytsya Izmail district	n/a	Mixed farming and freshwater fish farming	n/a	n/a
Farm "Shevchenko NN"	Kyslytsya Izmail district	n/a	Agriculture.	n/a	n/a
Farm "Krokus"	Kyslytsya Izmail district	n/a	Agriculture.	n/a	n/a
Agricultural cooperative "Natalka"	Komyshivka Izmail district	n/a	Agriculture.	n/a	n/a
Farm “Debut-2005”	Kiliyskiy district	n/a	Agriculture.	n/a	n/a
Scientific Institutions					
State Regional Design-Research Institute "Ukrpivdendiprovodhosp"	Odessa	n/a	Design of water supply and sewerage, flood and reclamation activities, etc.	Operating in the field of engineering	Design of culverts in the delta of the Dniester.

Name	Registration place	Website	Interest	Responsibility	Recent activities relevant to biomass use
Odessa National University of Ilya Mechnikov	Odessa	http://onu.edu.ua intercollab.onu.edu.ua	Teaching and research	Various departments involvement in environmental research and monitoring	Project EUTACIS "Danube lakes: Improving CrossBorder Cooperation in Integrated Management of Water Resourses in the Lower Danube» (2000-2003); Project FP7 ÉCLAIRE "Effects of Climate Change on Air Pollution and Response Strategies for European Ecosystems" http://www.eclairefp7.eu/; Project; Project on developing management plan for Lower Dniester National Park.
Ukrainian Scientific Center of Ecology of Sea (UkrSCES)	Odessa	http://www.sea.gov.ua/	Performing complex tasks of environmental monitoring of the Black and Azov Seas	Conducting observations of the marine ecosystem components (water, bottom sediments and biota) and by major natural and man-made impacts; Creating and maintaining databases of environmental information and data bank; Scientific analysis of data for evaluation, diagnosis and prognosis of the state of marine ecosystems and develop scientifically based recommendations for management decisions; implementation of environmental expertise and environmental audit for industrial facilities in the coastal zone.	Project "Inventory, Assessment and Remediation of Anthropogenic Sources of Pollution in the Lower Danube Region of Ukraine, Romania and Republic of Moldova" (MIS-ETC Code 995)
Institute of Market Problems, Economic and Environmental Research, NAS of Ukraine	Odessa	http://www.impeer.od.ua/	Development of basic and applied research schools Institute aimed at solving urgent problems of optimisation of the national economy, strategy and tactics of sustainable, balanced socio-economic and economic-environmental development.	Development of economic policies and mechanisms to ensure sustainable development and economic competitiveness in Black Sea tourism and recreation industry.	Inventory, Assessment and Remediation of Anthropogenic Sources of Pollution in the Lower Danube Region of Ukraine, Romania and Republic of Moldova (MIS-ETC Code 995)
Institute of Marine Biology NAS of Ukraine	Odessa	http://www.nas.gov.ua/	Research on various aspects of biology and ecology of marine ecosystems.	The hydrobiological amelioration and restoration of damaged marine and coastal ecosystems. Creation of ecological data bases on the north-western Black Sea shelf, coastal areas, lagoons and estuaries of the Danube and Dniester.	Development of a common intraregional monitoring system for the environmental protection and preservation of the Black Sea – ECO-Satellite; Towards COast to COast NETworks of marine protected areas (from the shore to the high and deep sea), coupled with sea-based wind energy potential (CoCoNET)

Name	Registration place	Website	Interest	Responsibility	Recent activities relevant to biomass use
Southern Research Institute of Marine Fisheries and Oceanography (PivdenNIFO)	Odessa	n/a	Scientific support for development of marine fisheries in Ukraine through the development and implementation of comprehensive measures for long-term conservation and sustainable use of marine living resources.	Comprehensive study of biology industry, associated and dependent species of Black Sea and the oceans. Scientific rationale for long-term conservation and sustainable use of biological resources and ocean monitoring, marine ecosystems and lymans, develop forecasts and recommendations for the management of biological resources International scientific cooperation.	Pivden NIFO actively participates in international fisheries organisations and commissions
Ukrainian Scientific Research Institute of Ecological Problems	Kharkiv	http://www.niiep.kharkov.ua/	Scientific support of public policies on environmental protection, natural resource, environmental and radiation safety, as well as Ukraine's international commitments stemming from the signed conventions, treaties. Assessment of water quality, environmental hydrogeology, air quality protection, scientific support networks of natural areas under special protection, industrial waste management, cartographic methods for remote sensing.	Basic and applied research in the field of environmental protection, environmental management and environmental safety; perform research and development, design, design and exploration work, create and implement designs new technology, instrumentation and systems, including systems for environmental monitoring.	n/a
Ukrainian Centre of Environmental and Water Projects (UCEWP)	Kyiv	http://www.ucewp.kiev.ua/	UCEWP is a research organisation that undertakes computer modelling in water management.	n/a	n/a
Institute of Water Problems and Land Reclamation (IWPLR)	Kyiv	http://igim.org.ua	Conducting research, research and development, design engineering, process, search, and design and exploration work, scientific and technical expertise.	Research in: - scientific basis of technical and technological sustainable development and management of Reclamation Water Management and reclamation complexes; - scientific basis of rational water use in rural areas; - farming systems and technologies in agricultural production on irrigated land.	n/a

Name	Registration place	Website	Interest	Responsibility	Recent activities relevant to biomass use
Ukrainian Hydrometeorological Institute	Kyiv	http://uhmi.org.ua/	Development of geophysical science by carrying out fundamental and applied research in meteorology and basic environmental monitoring, coordination of research on meteorology in Ukraine.	Study of physical processes in the atmosphere, hydrosphere, hydrometeorological regime and agro-climatic conditions; development of new and improvement of existing methods of meteorological, hydrological and agrometeorological forecasts and their practical implementation; comprehensive study of the hydrometeorological regime and the pollution of the Black and Azov Seas.	Flood Monitoring and Forecast in Pripyat River Basin # 983516 (2009-2011)
Institute of Fisheries and Environment Sea (IFES)	Melitopol	http://irem.org.ua/	Study of water bioresources of the Black and Azov seas and scientific support of national aquaculture	Creation of commercial fish-breeding systems (sturgeon, mullet, perch, flounder). Development and implementation of artificial reefs, spawning reefs, and biofilters. Development and improvement of national legislation in the field of fisheries.	n/a
National University for Water and Environmental Management (NUWEM)	Rivne	http://start.nuwm.edu.ua	Trains highly qualified personnel for the water management sector	Teaching students in the following specialties: Agriculture; Water supply and drainage construction; Surveying and land management; Irrigation; Water bioresources and aquaculture; Hydropower	n/a
Education					
Odessa State Environmental University	Odessa	http://odeku.edu.ua/	Environmental education and research	Applied ecology, environmental economics, hydrology, oceanography, meteorology..	Integrated Hotspots Management and Saving the Living Black Sea Ecosystem – Hot Black Sea (Final HBS Project Booklet)
Odessa National University of Economics	Odessa	http://oneu.edu.ua/	Economic education and research	Regional development, environmental economics. Business economics. Business Information Centere of the European Union.	n/a
Odessa National Academy of Food Technologies	Odessa	www.onaft.edu.ua	Environmental education and research	Research in the field of ecological safety of the environment.	n/a
Odessa National Polytechnic University	Odessa	http://www.opu.ua	Polytechnic education and research	Energy audit. The development of new energy technologies. Improved use of natural resources.	Development production of briquettes and pellets. Transnational integrated management of water resources in agriculture for the EUropean WATER emergency control (EU-WATER) № AF/A/165/2.1/X
Centre for Warmth and Comfort	Odessa	www.ctk.center	Technology transfer	Energy audit. The development of new energy technologies.	Development production of briquettes and pellets

Name	Registration place	Website	Interest	Responsibility	Recent activities relevant to biomass use
State Environmental Academy of Postgraduate Education and Management	Kyiv	http://dea.gov.ua	Environmental education and research	Leading organisation in Ukraine for educational, scientific and technical work on environmental protection, natural resource management, environmental security, environmental assessment, implementation mechanisms for environmental management.	n/a
Interagency Azov-Black Sea Ornithological Station	Melitopol	http://www.mdpu.org.ua/	Monitoring of avifauna	Station coordinates monitoring wetland birds along the Black and Azov Sea coastal zone.	n/a
International Organisations					
United National Development Programme - UNDP	New York	http://www.undp.org/content/undp/en/home.html	UNDP works to eradicate poverty while protecting the planet. Helps countries develop strong policies, skills, partnerships and institutions so they can sustain their progress.	Disaster risk reduction; Climate change; Sustainable energy	Cba Project - Phase III The Project will empower citizens of villages and cities to assert themselves as drivers of local development leading to enhanced participatory governance, energy efficiency and employment opportunities at local level.
Ramsar Convention Secretariat	Gland	http://www.ramsar.org/	The Convention's mission is "the conservation and wise use of all wetlands through local and national actions and international cooperation, as a contribution towards achieving sustainable development throughout the world".	Under the "three pillars" of the Convention, the Contracting Parties commit to: work towards the wise use of all their wetlands; designate suitable wetlands for the list of Wetlands of International Importance (the "Ramsar List") and ensure their effective management; cooperate internationally on transboundary wetlands, shared wetland systems and shared species.	Regional Workshop on Challenges in addressing Climate Change and Eco-system Based Approach in Peatlands, 2015
International Commission for the Protection of the Danube River (ICPDR)	Vienna	www.icpdr.org	ICPDR works to ensure the sustainable and equitable use of waters and freshwater resources in the Danube River Basin.	The work of the ICPDR is based on the Danube River Protection Convention, the major legal instrument for cooperation and trans-boundary water management in the Danube River Basin.	Support for the development of the 2nd River Basin Management Plan and 1st Danube Flood Risk Management Plan.
Global Water Partnersheep - GWP	Stockholm	http://www.gwp.org/en/About/who/What-is-the-network/	The GWP is a global action network with over 3,000 Partner organisations in 183 countries. The network provides knowledge and builds capacity to improve water management at all levels: global, regional, national and local.	Support countries in better water management. GWP's comparative advantage is the combination of technical expertise and convening power to bring together diverse stakeholders who contribute to the change processes that help bring the vision of a water secure world closer to reality.	DriDanube project was launched on 1 January 2017 as a multi-partner cooperative initiative of 10 countries from the Danube region under the leadership of the Slovenian Environmental Agency (ARSO). The project's main objective is to increase the capacity of the Danube region to manage drought related risks. It aims at helping all stakeholders involved in drought management become more efficient during drought emergency response and prepare better for the next drought.

Name	Registration place	Website	Interest	Responsibility	Recent activities relevant to biomass use
World Wide Fund for Nature - Danube-Carpathian Programme	Vienna	http://wwf.panda.org/what_we_do/where_we_work/black_sea_basin/danube_carpathian/	The five most important features of The Green Heart of Europe: Wilderness; Forests; Rivers and wetlands; Large carnivores; Danube sturgeon.	To secure Europe's greatest natural treasures in the Southern Carpathians, Danube Delta and Maramures, and promote local livelihoods connected with them. Support implementation of the Lower Danube Green Corridor,the Mura-Drava-Danube Transboundary Biosphere Reserve and other Ramsar sites. Implement and support floodplain and wetland restoration projects across the Danube.	"Restoration of natural connection of Katlabuh lake with Kislitsky branch of the Danube River, Ukraine" "Restoration of the natural regime of the Lung-Safiany lakes, Ukraine" "Climate proofing Danube Delta through integrated water and land management"
Centre for Social Innovation (ZSI)	Vienna	https://www.zsi.at/en/about_zsi/profile	ZSI conducts research on the social embedding and impact of all types of innovations, and contributes to the design and diffusion of socially accepted and sustainable innovations to meet social challenges.	By deployment of innovative research, education, advisory services and co-ordination of networks, we create new knowledge, reflect and configure existing knowledge, evaluate measures, develop concepts and forward their implementation.	Danube-INCO.NET seeks to overcome obstacles hindering the social and economic development of the Danube region.
Protected Areas					
Lower Dniester National Park	Odessa	http://nnpp.org.ua / https://www.facebook.com/nizhnednestrovsky/	Conservation, restoration and management of natural habitats of the lower reaches of the River Dniester.	Preservation of biodiversity and restoration of natural resources of the Dniester. Monitoring of compliance with current legislation in the protected territory of the park, where traditional economic activities occur. Educational and scientific activities.	Active management of harvesting reed along Dniester channels.
Danube Biosphere Reserve	Vylkove	http://www.dbr.org.ua/	Conservation, restoration and management of natural habitats of the lower reaches of the River Danube	Conducting basic and applied research in the field of environment and protected areas. Development and implementation of management of natural systems, environmentally sustainable use of natural resources, taking into account the existing traditions of nature use based on relevant agreements. Environmental education and advocacy to raise awareness about the DBR and conservation. International cooperation in the framework of the UNESCO "Man and Biosphere" Programme.	Mnagement of reed bed harvesting and implementation of the pilot project for the production of briquettes.
Isles of Izmail	Izmail	http://branta.org.ua/ru/branta-issues/branta-4/4-04.html	Conservation, restoration and management of natural habitats of the lower reaches of the River Danube	Management of recreational activities to avoid damage to nature.	n/a

Name	Registration place	Website	Interest	Responsibility	Recent activities relevant to biomass use
Government Bodies					
Department of Ecology and Natural Resources of Odessa Regional State Administration	Odessa	http://ecology.odessa.gov.ua/	Regional implementation of state policy in the sphere of nature management.	Issuing permits for natural resource use, establishing regional protected areas, environmental impact assessments, pollution control.	n/a
Environmental Inspectorate of the Northwest Black Sea Region	Odessa	http://bsdei.gov.ua/	In the process of reform.	In the process of reform.	In the process of reform.
Hydrometeorological Centre of the Black and Azov Seas	Odessa	http://www.hmcbas.od.ua/	Agrometeorological surveys on the status and conditions of growth, development and formation of basic agricultural crops.	n/a	
Odessa Regional Forestry and Hunting	Odessa	http://ulmg.odessa.gov.ua/	Office engaged in inter-sectoral coordination, governance and control of forestry and hunting.	n/a	n/a
Odessa Regional Water Resources Management	Odessa	http://watermd.od.ua/uk/	Ensuring the needs of the people and economic sectors in the field of water resources	Implementation of public policy for the development of water management and land reclamation hydraulic engineering, management, use and reproduction of surface water resources. Implementation of activities related to the prevention of harmful effects of water and the elimination of its consequences, including flood protection of rural areas and farmland area; Capital and current repairs of reclamation network, reservoirs and other water management facilities owned by Odessa.	— Project "Emergency planning and flood protection in the Lower Danube Euroregion" — Project WWF "Restoration of natural connection of Katlabuh lake with Kislitsky branch of the Danube River, Ukraine" — Project Tacis "Improving cross-border cooperation in integrated management of water resources in the Lower Danube Euroregion" — Project WWF "Restoration of the natural regime of the Lung-Safiany lakes, Ukraine" — Project WWF "Ukrainian Danube Delta Wetlands Inventory" — Project "Cooperation in the management of water resources of the Odessa region"
Western Black Sea Basin protection, use and reproduction of aquatic biological resources and fishing authority	Odessa	www.fishnadzor.com.ua	Reproduction of aquatic resources	n/a	n/a

Name	Registration place	Website	Interest	Responsibility	Recent activities relevant to biomass use
Black Sea State Regional Geological Enterprise	Odessa	http://www.pgrgp.com.ua/	Exploration work on prospecting, exploration and industrial evaluation of mineral deposits. Assessment of state resources, reserves and quality of groundwater contamination, heavy metals and other hazardous compounds soils, sediments and groundwater	Integrated geological, hydro-geological and environmental geological mapping. Geological and economic examination of projects and business plans for the use of natural resources. Laboratory tests of samples of rocks and minerals, chemical analysis of water.	n/a
Department of State Sanitary and Epidemiological Service in Odessa region	Odessa	http://odses.gov.ua/	Provision of state policy in the sphere of sanitary and epidemiological management.	Ensuring quality of drinking water and protecting human health.	n/a
State Emergency Service of Ukraine	Odessa	http://www.dsns.gov.ua/ https://www.facebook.com/mns.gov.ua	SESU is coordinated by the Cabinet of Ministers through the Ministry of Internal affairs. It implements state policies in the domain of civil protection, protection of population and territories from emergencies.	Prevention of emergencies, rectification of emergency consequences, rescue work, fire extinguishing, fire safety, accident rescue service activities and hydrometeorologic activities.	n/a
Authority of Emergency Situations and Defence of Odessa Regional State Administration	Odessa	http://guns.odessa.gov.ua/		Coordination of activities of regional state administrations, local authorities, enterprises, institutions and organisations related to disaster relief	n/a
Bilyaivka District Administration	Biliaivka	http://bilyaivka-rda.odessa.gov.ua/	Local resource management (Dniester)	n/a	n/a
Ovidiopol's'ka District Administration	Ovidiopol	http://ovidiopol-rda.odessa.gov.ua/	Local resource management (Dniester)	n/a	n/a
Belgorod-Dniesterovskyi District Administration	Belgorod-Dniesterovskyi	http://b-dnistrov-rda.odessa.gov.ua/	Local resource management (Dniester)	n/a	n/a
State Enterprise "Odessa forestry"	Velyko-dolynske	http://ulmg.odessa.gov.ua/	Inter-sectoral coordination, governance and control of forestry and hunting.	n/a	n/a
Reni District Administration	Reni	http://reni-rda.odessa.gov.ua/	Local resource management (Danube)	n/a	n/a
Izmail District Administration	Izmail	http://izmail-rda.odessa.gov.ua/	Local resource management (Danube)	n/a	n/a

Name	Registration place	Website	Interest	Responsibility	Recent activities relevant to biomass use
Danube Hydrometeorological Observatory	Izmail	http://www.dhmo.org.ua/	Hydrometeorological observations.	n/a	n/a
Danube Basin Water Resources	Izmail	http://www.dbuvr.od.ua/	Provides within the basin of the Danube in the Odessa region the realization of state policy in the management, conservation and restoration of water resources.	Development of water management, maintenance of water facilities, waterworks. Decide together with the executive authorities and other organisations, institutions and enterprises issues of population and economic sectors of water resources.	NA
State Enterprise "Izmail forestry"	Izmail	http://ulmg.odessa.gov.ua/	Inter-sectoral coordination, governance and control of forestry and hunting.	n/a	n/a
Kiliya District Administration	Kiliia	http://kiliya-rda.odessa.gov.ua/	Local resource management (Danube)	n/a	n/a
Ministry of Ecology and Natural Resources of Ukraine	Kiev	http://eng.menr.gov.ua/	MENR of Ukraine is the main body within government for formulating and implementing state policy in the area of protection of environmental, ecological and, within its competence, biological, genetic and radiation safety.	Treatment of waste, pesticides and agricultural chemicals. Efficient usage, restoration and protection of natural resources. Development of water economy. Restoration and protection of lands and waters (freshwater and marine). Preservation, restoration and sustainable use of bio- and landscape diversity. Creation, preservation and use of ecological network. Regulation of negative anthropogenic influence upon change of climate and adaptation to its changes.	n/a
The State Agency of Ukraine for Fisheries	Kiev	http://darg.gov.ua/	Implementation of state policy concerning fisheries and the fishing industry.	Protection, use and reproduction of aquatic biological resources. Regulation of fisheries and maritime safety of fishing fleet vessels.	n/a

Name	Registration place	Website	Interest	Responsibility	Recent activities relevant to biomass use
Dniester-Prut Basin Water Management Resources Authority	Chernovtsy	dpbuvr.gov.ua https://www.facebook.com/dpbuvr.gov.ua/?ref=ts&fref=ts&qsefr=1	State management in the use, conservation and restoration of water resources, the needs of the population and industries on water resources in the basins of the Dniester, Prut and Siret.	Maintenance of the system of monitoring water in the basins of the Dniester, Prut and Siret and implementation of state monitoring program within Chernivtsi region. Organisation of the long-term programmes for land reclamation and environmental improvement of reclaimed land, providing priority to rural areas using imported water, centralized water supply, protection against harmful effects of water villages and farmland within Chernivtsi region. Ensuring reliable operation of water systems, hydraulic structures and individual objects of engineering infrastructure owned by the state. Implementation of conservation measures related to the prevention of harmful effects of water within rural areas and agricultural land and the elimination of its consequences, including flood protection of areas within Chernivtsi region.	NA

MOLDOVA

Name	Place of registration	Website	Interest	Responsibility	Recent activities relevant to biomass use
Civil Society					
A.O. „Perspectiva”	Cahul	https://aoperspectiva.wordpress.com/contacte/	Youth related activities.	n/a	n/a
Cahul Sustainable Community Development	Cahul	https://www.facebook.com/pg/fcddc/about/?ref=page_internal	Sustainable development of local communities.	Create a competitive business environment and environment protection.	n/a
Cahul "Contact" Center	Cahul	www.contact-cahul.md	Promote the economic development of Cahul district.	n/a	n/a
Ecological Counseling Center Cahul	Cahul	n/a	Environment protection.	n/a	n/a
Eco-Tiras	Chisinau	http://www.eco-tiras.org	Help and advice authorities and population to manage the river in sustainable way.	n/a	n/a
Terra Nostra AO	Chisinau	n/a	NGO aiming to promote ecological education and awareness.	n/a	n/a
Business					
Tomșa Mihail GT	r. Leova, s. Cneazevca	n/a	Production of briquettes from various materials, including straw and reed	n/a	Production of reed briquettes. Equipment origin Moldova and Ukraine.
GT Sava Igor	Țiganca vill., Cantemir District	n/a	Production of briquettesl from various materials, including sunflower and reed	n/a	Production of reed briquettes (400 kg/h). Equipment origin Poland.
Trans Oil Refinery SA	Ciadîr-Lunga	www.transoil-moldova.com	Production of pellets from sunflower.	n/a	Production - 6000 t/year Equipment origin Ukraine
Agro Andor SRL	Cimislia	n/a	Production of briquettes from straw	n/a	Production of briquettes (500 kg/h). Equipment origin Russia.
Teaca Igor ÎI	Tigheci vill., Leova District	n/a	Production of briquettes and pellets from sunflower and wood	n/a	Production of briquettesl (500 kg/h) and production of pellets (1000 kg/h). Equipment origin Czech Republic
Azur-Com SRL	Taraclia	n/a	Production of pellets from wood	n/a	Production of pellets. Equipment origin China.
Biocimenerg SRL	Cimislia	n/a	Production of pellets from straw and wood	n/a	Production of pellets (400kg/h). Equipment origin Moldova and Czechia
Culiget SRL	Cantemir	n/a	Production of pellets from straw and wood	n/a	Production of pellets (400 kg/h). Equipment origin Ukraine

Name	Place of registration	Website	Interest	Responsibility	Recent activities relevant to biomass use
Cereale-Cim SA	Mihailovca vill, Cimislia	n/a	Production of briquettes from straw	n/a	Production of pellets (240 kg/h). Equipment origin Poland
Biocarbune LLC	Cimislia	n/a	Production of briquettes from wood, straw, sunflower	n/a	Production of pellets (290 kg/h). Equipment origin Ukraine
Scientific Institutions					
Academy of Sciences of Moldova Institute of Energy	Chisinau	http://www.ie.asm.md/ro/home/publications	Research on energy related topics	n/a	n/a
Technical University of Moldova	Chisinau	utm.md	Research on energy related topics	n/a	n/a
Education					
Orhei professional school	Orhei	http://sporhei.educ.md	Education related to biomass energy sector	n/a	n/a
Professional School - Cuhurestii de Sus	Cuhurestii de Sus, Floresti District	n/a	Education related to biomass energy sector	n/a	n/a
Professional School no. 3 Chisinau	Chisinau	http://sp3chisinau.si.md/contacte-2/	Education related to biomass energy sector	n/a	n/a
International Organisations					
UNDP Moldova	Chisinau	http://www.md.undp.org	Implementation of Energy and Biomass project (co-funded by the EU)	n/a	n/a
Protected Areas					
Lower Prut State Natural Reserve	Slobozia Mare	n/a	Protection of flora and fauna in the Lower Prut area and Beleu Lake	n/a	n/a
Government Bodies					
"Manta-V" Forestry Cynegetics State Enterprise	http://mantav.silvicultura.md	n/a	Ensure biodiversity in protected areas.	Protection of natural resources (flora and fauna) and also of water and wetland areas.	n/a
Forestry enterprise "Silva-South"	http://cahul.silvicultura.md	n/a	Ensure biodiversity in protected areas.	Protection of natural resources (flora and fauna) and also of water and wetland areas.	n/a
Moldova's Waters Agency	http://www.apelemoldovei.gov.md	n/a	Water management	n/a	n/a

Name	Place of registration	Website	Interest	Responsibility	Recent activities relevant to biomass use
Environmental Pollution Prevention Office Ministry of Environment	www.eppo.md	n/a	Preventing water pollution. Introducing new antipollution methods including for wetlands.	n/a	n/a
Ministry of Environment	mediu.gov.md	n/a	Environment protection	Ensuring sustainable use of natural resources	n/a