Climate proofing the Danube Delta through integrated land and water management

Draft 2

REPORT

Strategic assessment of the Ukrainian Danube Delta's potential for renewable energy sources including guidelines for sustainable biomass production

Odessa – 2012

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CONTENTS

INTRODUCTION

This report is prepared within the Activity 3.1 of the project «Climate proofing the Danube Delta through integrated land and water management». The report contains the description of data and information collected in field, results of assessment of potential of reedbeds biomass as well as recommendations for its sustainable production, harvesting and utilisation as an renewable energy source.

This report is based on the series of field studies, conducted in the Ukrainian part of the Danube Delta in August 2011 with additional studies in August 2012. The main objective of the field studies was collection of data and information for development of a strategic assessment of the Danube Delta potential for green energy sources.

The studies carried out were aimed at linking wetland and floodplain restoration/sustainable management and production of biomass with the needs of the local communities for improved livelihoods and access to green energy sources. The report clearly shows that wetland restoration in the Danube Delta Region not only provides benefits for nature (increasing biodiversity) but could be a valuable source of income for the local economy as well.

By using biomass provided by natural and restored wetlands in the Danube Delta as a source of green energy, new opportunities will be offered to local people, interested entrepreneurs (tourism, reed harvesting, fishery and agriculture) to sustain their livelihoods. Green energy generation will also contribute to reducing costs for heating arising from the use of fossil fuels as well as reducing carbon footprint.

At present reed in the Danube Delta is mainly used for roof thatching, fences, as a food source for animals but less as an energy source. The present strategic assessment was conducted to document the potential of the Danube Delta for renewable energy sources. The assessment took into consideration the biodiversity conservation priorities of the Danube Delta and investigated the impact of restoring wetlands to enhance the quality of the habitats and to provide sustainable energy sources for the local communities.

Up to now the reed harvesting (for export to other European countries for roofing materials) had been an increasing economic activity in the Danube Delta. It could become unsustainable in the absence of accurate reliable information about the resources availability and management rules. The appearance of reed from China on the European market leads to a drop in demand for Ukrainian reed and some reduction of harvests. Under these conditions, the introduction of technologies of reed biomass utilization for renewable energy production will be very important for maintaining and developing this sector of the local economy.

The results of this study will help the managers of the Danube Biosphere Reserve and Izmail Forestry in the decision-making process for the management of biomass resources.

CHAPTER 1. GENERAL ASSESSMENT OF THE UKRAINIAN DANUBE DELTA'S POTENTIAL OF VEGETATION BIOMASS FOR RENEWABLE ENERGY PRODUCTION

Ukrainian part of the Danube Delta region has significant biomass resources, which can be successfully used as a local source of renewable energy.

The main source of renewable biomass in the Danube Delta region is wetland grasses, especially reed. The most perspective energy crops in terms of their cultivation are: several species of willows and amorpha *(Amorpha fruticosa)* on waterlogged delta lands and silverberry (*Elaeagnus commutata*) on the salt meadows. Post-harvest crop residues, especially rice, are of certain interest.

In this study, the energy potential of biomass in the Ukrainian part of the Danube Delta was assessed in three directions: the use of reed communities; the use of false indigo-bush (*Amorpha fruticosa*), and the possibility of establishing energy plantations of white willow (*Salix alba*) on restored floodplain areas of the Danube.

In order to visualize the results of studies maps of landuse, biomass production, restoration proposals and others were designed. For this purpose the remote sensing data from LandSat 5TM and LISS satellites was collected and analysed. In some cases Google Earth service was additionally used to determine shapes and location of certain objects.

Reed

The largest reedbeds in Europe are located In the Danube delta. The annual biomass growth (based on the dry matter) is up to 15 tons/ha. Reasonable fall-winter withdrawal of natural dead organic reedbed vegetation from delta ecosystems, primarily reed, will have a positive impact on natural delta complexes themselves. This is connected to the significant increase of nutrient pollution of the Danube water in the last 50 years and global warming, which led to an increased productivity of reedbed ecosystems. As a result, annual fall of dying grass vegetation increased significantly. This leads to unwanted acceleration of succession, secondary eutrophication and accelerated degradation of reedbed ecosystems.

Overall assessment based on field studies of 2011, analysis of satellite images and data of field studies of recent years has allowed making a preliminary assessment of the total phytomass resources of the Ukrainian part of the floodplain and the Danube Delta, which is 1.3 million tons.

The analysis allowed identifying two of the most promising area for harvesting reed in the Ukrainian part of the Danube Delta (see fig 1.1. and 1.2). They are reedbeds of lakes Kartal and Kugurlui and reedbed ecosystems around Vilkovo town: Stentsovsko-Zhebriyanskie plavni (SZHP), Ermakov Island and the delta of Kiliya branch of the Danube (Kiliya Delta). The results of field studies in 2012 and a detailed assessment of phytomass potential for these areas are presented in Chapters 2 and 3.

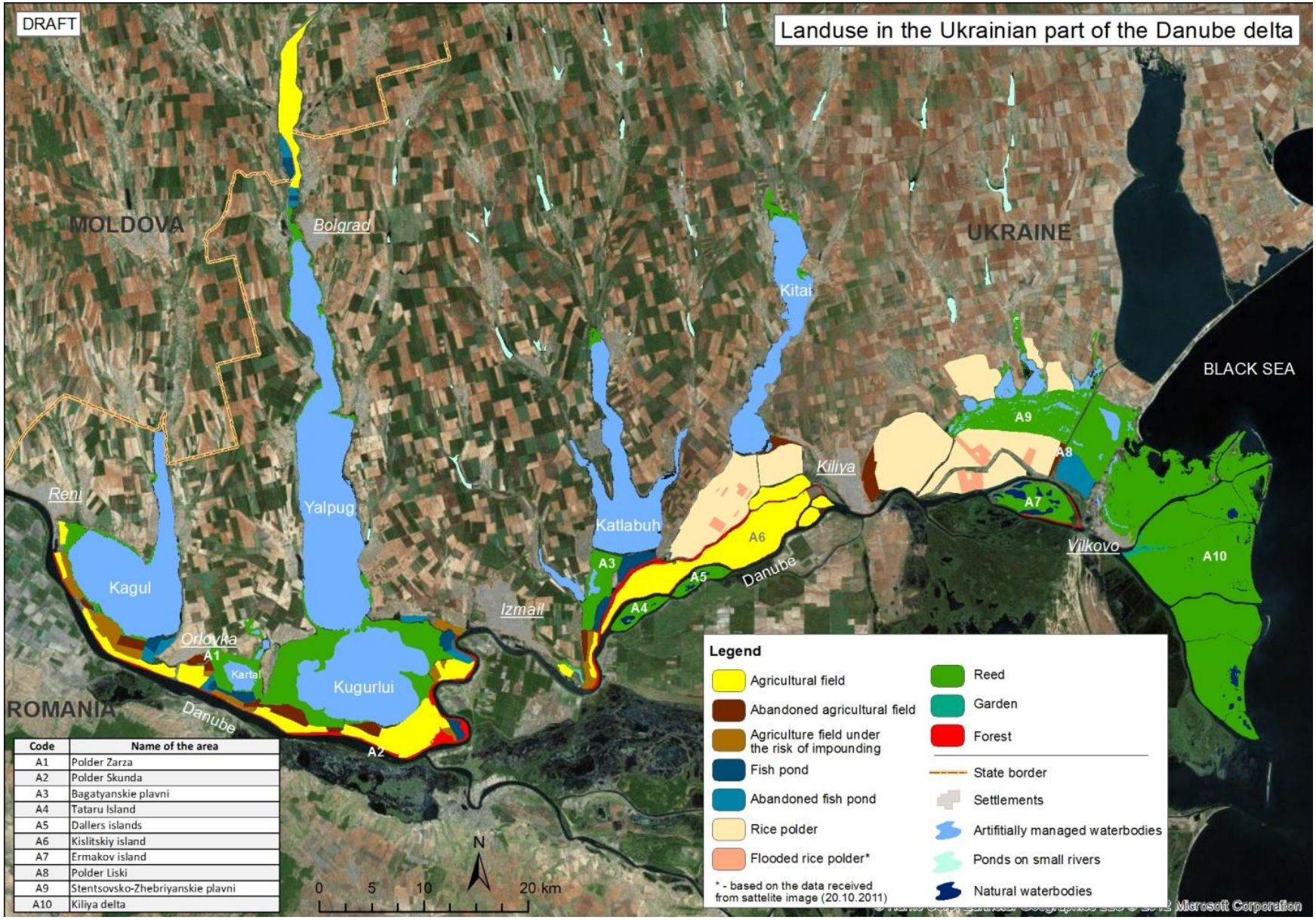


Fig. 1.1. Zoning of the Ukrainian part of the Danube Delta Region

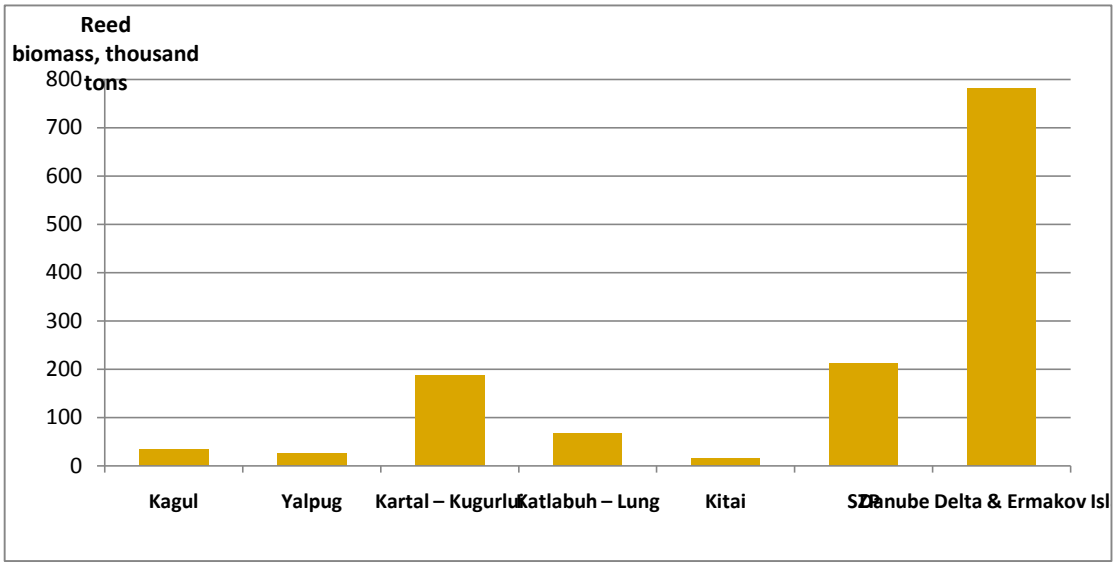


Fig. 1.2. Distribution of reed resources within areas

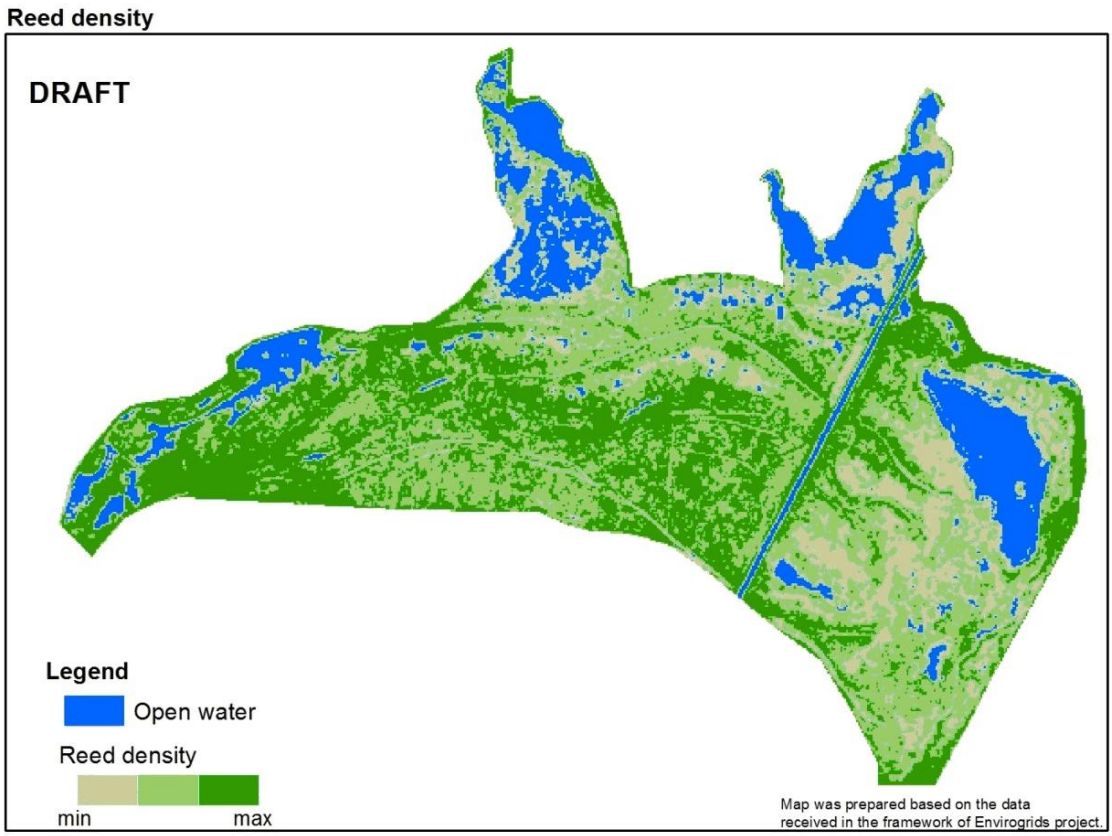
Some interest as an additional energy source for Viklovo town and surrounding villages may be living reed rhizome and detritus of SZP. Due to regulation of water regime and irresponsible management they currently covered (replaced), about 40% of the water body. For the purpose of environmental restoration of the water body their immediate withdrawal is needed. The rhizomes can be processed into biogas and organic fertilizer. Their resource is huge – about 25 million m^3. But there are many organizational and legal problems to the use of this very promising resource in modern Ukraine.

Identification of reed density and mosaic

In addition to the main goal of the biomass assessment a pilot study was made to determine main characteristics of reed-beds using remote sensing data. The aim of the study was to evaluate the ratio of open water and reed-beds, and preliminary evaluation of reed density.

For this task SZP was chosen as a pilot area because of mosaic structure and presence of different types of objects in one area: open water, small channels, dense and sparse reed-beds (see fig. 1.3).

This evaluation was done based on the remote sensing data (LandSat5TM, 2011-10-28), which was classified as 15 classes using ERDAS IMAGINE software. For better visualization and to improve opportunities for further analysis, reclassification of results was done in ArcGIS software. Finally 4 classes were obtained: open water and 3 reed-bed classes of different density.



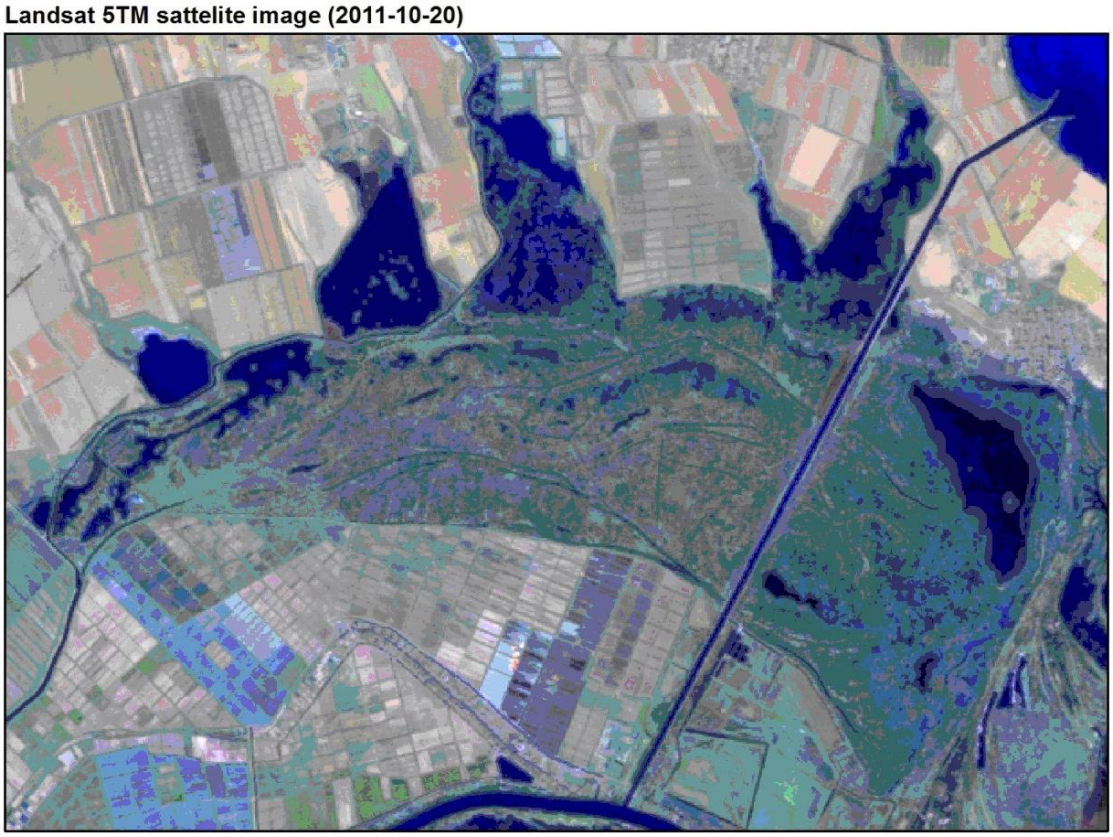


Fig. 1.3. Evaluation of reed density based on remote sensing data

Comparing the results of such evaluation (fig 1.4) with the results of a series of field studies in SZP revealed that this method provides rather rough results and can not be used for exact determination of reed-beds' characteristics without additional identification of reference conditions in the field. Still this is the on-going activity and its methodologies and approaches are being refined.

Wood biomass. Energy trees and shrubs

Forest resources in the Ukrainian part of the Danube Delta region are limited and do not have commercial value. They are represented by riverine (gallery) and ravine forests and forest plantations. Forest covers about 3% of the territory in the region, and in coastal protection strips forest resources percentage reaches 12%. The total area covered with forest vegetation in the Ukrainian part of the Danube Delta region (Reni, Bolgrad, Izmail and Kiliya districts of Odessa region) is 4812 hectares. Gallery and floodplain forest cover 1,600 ha: around 700 ha are located along the main channel of the Danube and over 890 ha on the islands (including Tabachello channel and Kugurlui Lake (see Fig 1.1 and 1.4).

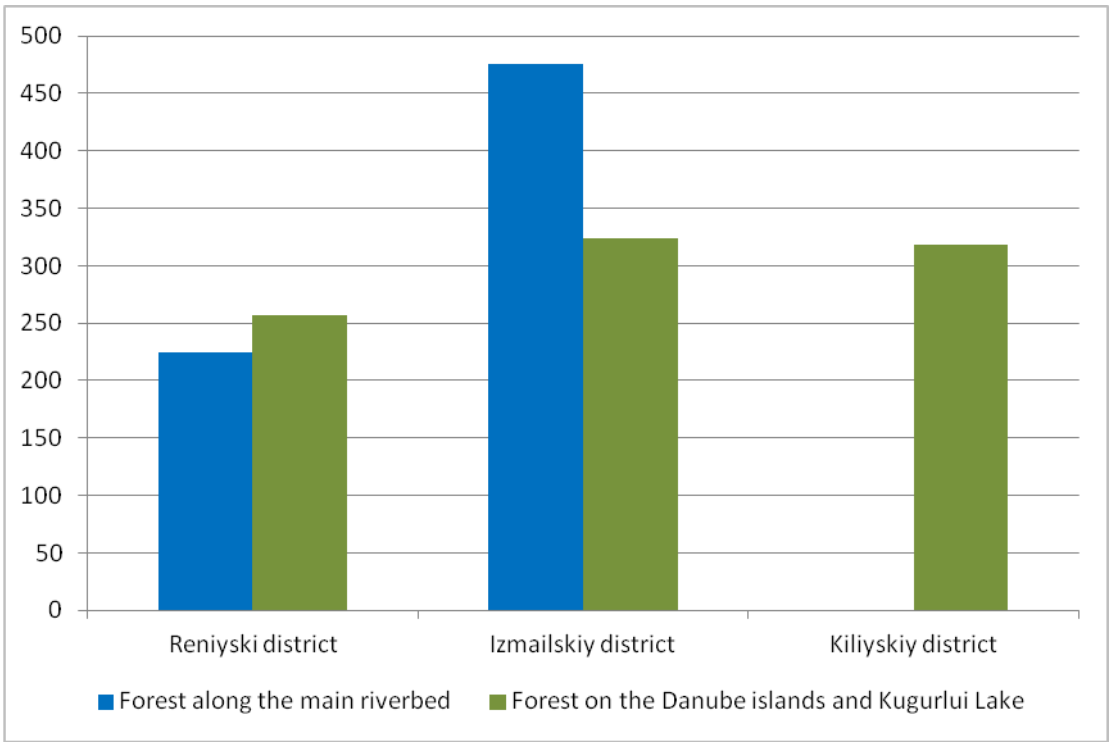


Fig. 1.4. Area of gallery and floodplain forests

Natural forests and most of forest plantations have nature conservation and agroforestry value and cannot be actively used for woody biomass harvesting as an energy source. In this regard, the most appropriate is the creation and subsequent exploitation of dedicated energy trees plantations on abandoned or on ineffectively used agricultural polders (see Chapter 4). In case of an interest in this area special field and analytical study is required.

Forest resources management is a responsibility of the State Enterprise "Izmail State Forestry", located in the south-west part of Odessa Region within 6 administrative districts: Izmail, Bolgrad, Renii, Kiliya, Tarutino, Artsyz.

Table 1.1. – distribution of the forest areas within the forest departments of the Izmail Forestry

Forestry Department (FD)	Administrative district Total area	Forest area		Area without forest	
		Total, ha	Including covered with forest	Total, ha	Including mires
Izmail FD	Izmailskiy, 5475 ha	2673	2132	2802	1963
Bolgrad FD	Bolgradskiy, 2457 ha	2065	1255	392	92
Vikovo FD	Kiliyskiy, 11909 ha	1360	1085	10549	9684
Reni FD	Reniyski, 2444 ha	515	340	1929	1844
Nove Ivanivske FD	Artsyzskiy, 552 ha	536	482	16	-
	Tarutinskiy, 432 ha	426	365	6	-
Total	23269	7575	5659	15694	13583

It is important to note that more than half of the total area under the jurisdiction of Izmail State Forestry (13,583 ha) is occupied by reedbed vegetation, which makes the Forestry one of the major stakeholders for the implementation of projects in the field of biomass reed use as renewable energy resource in the Ukrainian part of the Danube Delta region.

Amorpha (Amorpha fruticosa)

In this study, separate evaluation of amorpha resources on the pilot areas and determination of the possibility of its use as a renewable biomass resource was made.

Amorpha is an invasive species, which spreads actively along the Ukrainian part of the Danube and in the Delta during last few years. Particularly active distribution of this species appears along the main channel of the Danube and on the islands where is no cattle grazing. At these sites, amorpha forms mono dominant tangles with low biodiversity, thus inhibiting the development of native tree species. On the sea edge of Kiliya Delta distribution of amorpha is limited by the poor sandy soils and groundwater salinity.

Sites for harvesting were selected in August 2011; the works on the definition of amorpha reserves were done in 2012. Intense, almost mono dominant thickets of amorpha were noted instead of riverine forests, which didn't have the upper tree layer for various reasons (human activities, natural fall because of the age of mature poplar and white willow trees, fire, etc.). With good lighting and a lack of competition with other tree species, amorpha forms thickets, which make natural renewal of native tree species impossible under their canopy.

Grass cover at sites selected for determining amorpha stock and its harvesting is almost dry. Here occur sporadically birthwort (*Aristolochia clematitis*), ground-ivy (*Glechoma hederacea*), common reed.

Height of amorpha is 350-400 cm. Dry shoots that happen in the bush bottom were not taken into account for stock assessment. Evaluation was made on a basis of live shoots only, they were cleaned of leaves and thin lateral branches (Fig. 1.5.).

Fig. 1.5. Clean trunks of amorpha, prepared for weighing

Determination of amorpha wood stock was held at cutting sites of 25 square meters (5x5 m). The wood stock at selected sites was 15,5 tons/ha (1,55 kg/m^2). Location of sites for logging and wood stocks is shown in Fig.1.6.

– Sites with amorpha thickets in place of degraded riverine forests.

Fig. 1.6. Location of sites for logging and wood stocks.

It should be noted that due to the lack of natural renewal in riverine forests, new sites with amorpha domination will occur regularly all the way along the Ukrainian part of the Danube.

Together with economic profitability (as described above) amorpha harvesting will have important ecological impact. As the experience of WWF Hungary within the project “Experiences of nature business project with local communities on Tisza floodplain” has shown, removing of a part of oveground phytomass of the bush will allow freeing space for energy trees cultivation as

well as initiating the processes of natural restoration of native tree species (white poplar, white willow), which were previously constrained by the amorpha spinneys.

Rice straw and husks

Large-scale systems of rice polders located in the Ukrainian part of the Danube Delta occupy the total area of 138,64 km^2 (see fig. 1.1), of which only about 10 % are used for rice cultivation.

There are 3 rice production farms in the Vilkovo area, the largest of which is the Leski rice farm. Straw and husks produced during the process of rice processing practically are not utilized due to the total degradation of large-scale livestock farming. Preliminary assessment shows that rice farms can produce up to 5-7 thousands of tons of green biomass. There is additional potential of utilizing stubble residues from cultivation of crops such as wheat, barley, corn and sunflower

Opportunities for utilization of rice straw and husks as a source of energy phytomass in the Danube Delta region require separate detailed examination.

CHAPTER 2. ASSESSMENT OF RESOURCES OF THE REEDBED VEGETATION BIOMASS OF THE KARTAL–KUGURLUI–YALPUG GROUP OF LAKES FOR RENEWABLE ENERGY PRODUCTION

In accordance with general assessment of reedbed vegetation biomass in the Ukrainian part of the Danube Delta the reedbeds of the group of lakes: Kartal, Kugurlui and Yalpug have been identified as one of the most perspective places for reed harvesting for renewable energy production.

Commercial harvesting of a reedbed vegetation biomass in this part of the Ukrainian Danube Delta region is not conducted. Reed and reed mace are harvested in small quantities for needs of local people mainly from Orlovka and Novoselskoye villages: for cattle fodder, fences, roofs for shelters and sheep pens.

Data collection for reed biomass resources assessment

During the field visits in August 2011 and 2012 water areas of the lakes Kartal, Yalpug and Kugurlui as well as adjacent lands were examined and reed-bed storage was assessed. Reed-bed phytomass was defined at the mowing sites 1 by 1 meter.

Yalpug Lake

Reed phytocenoses in the lower, middle and upper part of the lake consist of monodominant belt spinneys with productivity 0.85-1.29 kg/m^2 air dry phytomass (Fig. 2.1).

In the upper part of the lake belt spinneys as well as solid arrays with the productivity of 0.49-1.29 kg/m^2 air dry phytomass (Fig. 2.1).

On the right sloping bank of the lake a tendency of increase of area of reed beds is registered due to their progression towards the bank. For the moment this process is impeded with cattle grazing. In the conditions of absence of grazing reed 'aggression' can be predicted on the sloping parts of the right bank.

Reed harvesting on the Yalpug Lake is not reasonable because of important bank protection function of belt spinneys and high importance of solid reed arrays in the upper part as natural biofilters.

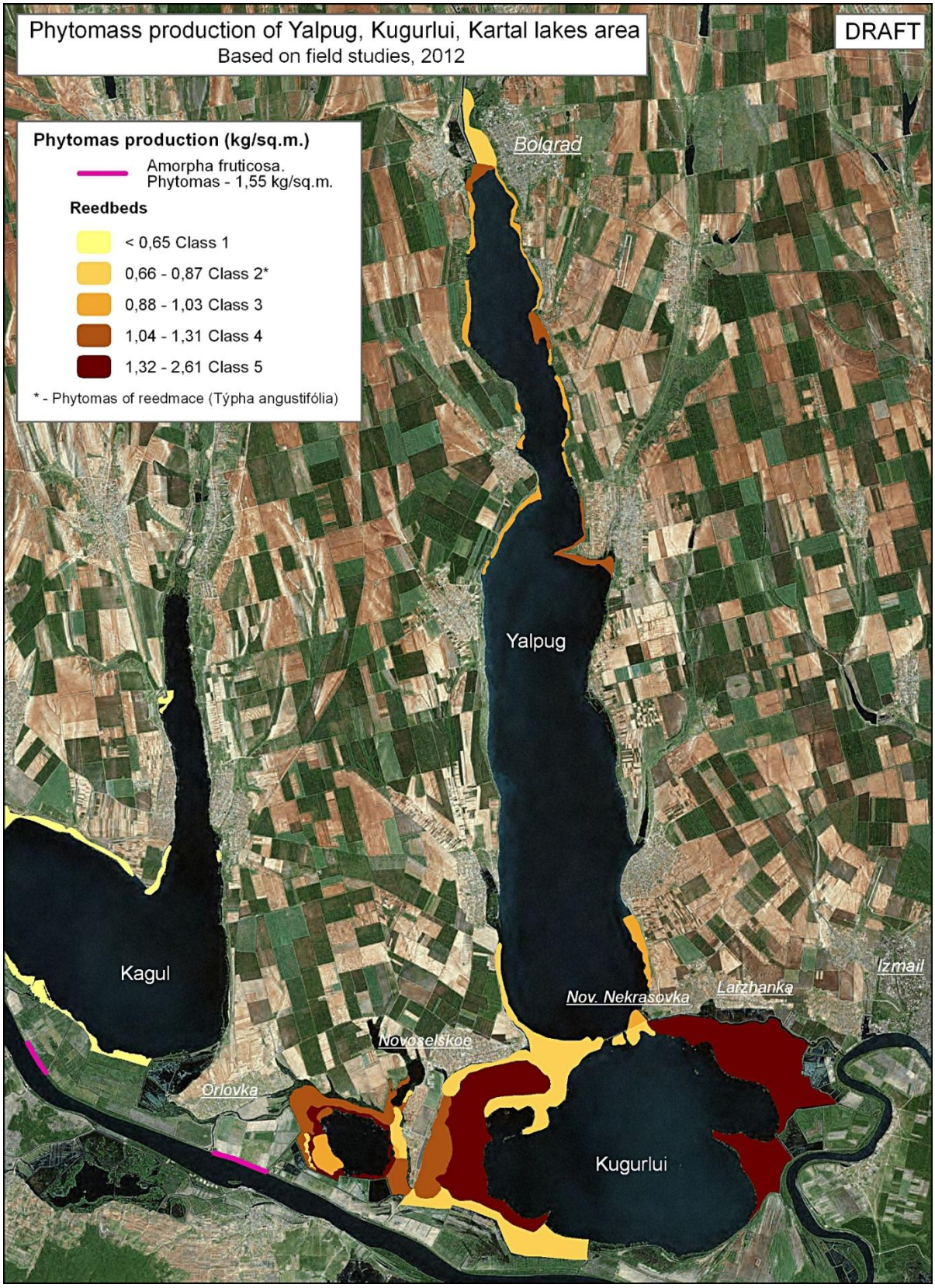


Fig. 2.1. Assessment of reedbed vegetation biomass productivity for Kartal, Kugurlui and Yalpug lakes

Kugurlui Lake

Reed phytocenoses consist of solid arrays all around the lake's periphery with the productivity of 0.81-2.44 kg/m^2 air dry phytomass (Fig. 2.1). In the north-western part of the lake, adjacent to the Yalpug Lake, curtain spinneys of reed mace were registered. The tendency of decrease of reed mace phytocenoses and their substitution with the solid reed arrays is recorded. The locals evidenced that 5-10 years ago a 'tongue' of the Repida consisted entirely of reed mace with a system of flat-water. Now it is a solid reed spinney. The similar situation is registered in the western part of the lake and at the Skunda Channel. Reed mace occurs as single low specimen without generative organs. Additionally a number of reed mace spinneys with the height of only 3-10 cm registered here.

The reasons for such substitution have to be studied in detail. One of them can be stable low water level (even drying in some periods) in these areas. In these conditions reed has significant advantages comparing with reed mace. The latter is adapted to stable watercut and deeper habitats.

For the increase of biological and ecotopic diversity of the solid reed beds reed harvesting sections with the total area of 11.13 km^2 are proposed on the Kugurlui Lake (Fig. 2.2). The volumes of reed biomass which can be harvested annually in the Kugurlui Lake reed-beds are estimated from 125,5 to 229,7 tons (77,9-154,0 tons at Larzhanka village and 47,6-75,7 tons at Novoselskoe village)

- places for reed harvesting

Fig. 2.2. Reed harvesting sections are proposed for the Kartal Lake

Kartal Lake

Reed phytocenoses here are of various type – belt, solid and curtain. Their productivity varies from 0.82 to 2.61 kg/m^2 air dry phytomass (Fig. 2.1). Only in the eastern part of the lake curtain spinneys of reed mace occur. Here their trend to reduce and being substituted with solid reed arrays is also registered.

Similar to Skunda, in the north-western part of the lake, adjacent to the Orlovka village, reed mace occurs as single low specimen without generative organs. A number of reed mace spinneys with the height of only 3-10 cm registered here.

In order to increase biological and ecotopic diversity of the solid reed beds and to improve water flow on some areas reed harvesting sections with the total area of 1.66 km^2 are proposed on the Kartal Lake (Fig. 2.3). The estimated volumes of reed biomass which can be harvested annually in the Kartal Lake reed-beds (at Orlovka village) are from 16,9 to 21,4 tons

– places for reed harvesting

Fig.2.3. Reed harvesting sections are proposed for the Kartal Lake

It should be noted that in the north-western part of the lake, adjacent to the Orlovka village, formation of meadow cenoses was recorded instead of mowed reed. Probably it was mowed in the early summer because of the lack of green fodder due to dry period. In the end of summer well formed meadows were observed.

CHAPTER 3. ASSESSMENT OF RESOURCES OF THE VEGETATION BIOMASS OF REEDBEDS NEAR VILKOVO TOWN

The Ukrainian part of the Danube delta is contingently divided into 3 sections: the upper, the middle and the lower. The last one is the most interesting and extensive. It includes mainly the delta of advance of the Kiliya arm of the Danube located downstream Vilkovo town, Stentsovsko-Zhebriyanskie plavni (reedbeds), Ermakov Island, as well as some less significant lands. Almost all of these areas are part of the Danube Delta Biosphere Reserve (the DDBR). They are primarily covered with reedbed vegetation. These sites were surveyed for assessment of potential of renewable biomass of reedbed vegetation, mainly reed.

Reedbed vegetation of the study area consists almost exclusively of rhizome perennial plants, especially reeds, Lesser Reedmace (cattail), bulrush and several species of sedge. Other species are only a few percents in the biomass, so may be considered as not relevant to mention.

A feature of rhizome perennial plants of reedbeds is the annual death of their green aboveground (emerged) part at the end of vegetation season with preliminary "transfer" of nutrients in the underground rhizome. Due to this, vegetation process restarts in spring. The dead aboveground (emerged) part of the reedbed vegetation, mainly composed of cellulose, can be successfully used as a source of alternative energy.

Under the natural conditions, stems of reedbed plants are preserved in a non-fallen state from 2 (cattail) to 5 years (reed), but in the end they fall up into a litter. The increase of vegetation season as a result of climate change and eutrophication of the Danube water increase productivity of reedbed vegetation and, respectively, the annual litter. Mineralization of the increasing amount of litter leads to secondary eutrophication, which further exacerbates the ecological situation in reedbeds and causes the loss of valuable oligotrophic habitats. Therefore the partial withdrawal of the annual reedbed vegetation biomass may have both economic and positive environmental effects. Besides this, the inevitably increasing mosaic structure of sites will also have a positive effect on the ecosystem with a proper harvesting of reedbed vegetation.

Fires, that partially fulfill the mineralizing role in the growth of the biomass, are not always acceptable to the economic, environmental and legal point of view, especially on the protected areas, which are the main sites of a study. Fire in reedbeds is particularly damaging in the summer-autumn period. In addition to the harm caused to the animal biota, fires undermine the very reedbed vegetation resources. It happens, because at this time the nutrients are still largely found in green shoots and are completely destroyed by fire. Additionally, during this low water season in the Danube delta fire damages surface layers of rhizomes with growing points of the first order, which also has a negative impact on the productivity of biomass. The early spring fires are no less devastating for reedbeds. Therefore, the annual partial strictly regulated removal of the annual biomass growth will be an important fire prevention measure.

Reedbed vegetation has its own features at every separate site of the study that significantly affect their productivity, including in terms of biomass. However, such an environmentally and geomorphologically separated territorial units as the delta of Kiliya arm of the Danube, Stentsovsko-Zhebriyanskie reedbeds and Ermakov Island can be considered as more or less of

the same type for our preliminary definition of annually renewable biomass resources of reedbed vegetation.

Ermakov Island

After the ecological restoration of the island in 2010, the essence of which was mainly to restore natural inundation and hydrological regime, an active succession of reedbeds has appeared. It is a bit similar to the overgrowth of shallow bays (lagoons) at the front edge of the delta with a substantial supply of fresh Danube water.

The area of the island covered with reedbed vegetation today is about 65%, namely about 1500 ha. Reedbed vegetation of the island is represented mainly by bulrush and bulrush – cattail communities; significantly less by reed – bulrush and reed communities. Their average productivity is relatively low, since the density of thickets is small. The annual increase of phytomass of dying plants here is in range of 0.2 – 3.2 kg; the average is about 0.9 kg/m^2 of air dry phytomass. Thus, about 13.5 thousand tons of phytomass is produced on the island annually for winter.

Despite the relatively impressive volumes of phytomass growth and the existing legitimacy of its collection (the island is located in the buffer zone and the zone of anthropogenic landscapes) the use is currently impractical due to the fact that reedbeds of the island are now in the active stage of succession and plant litter is necessary for their further development. In addition, the phytomass density in these plots is minimal for the area of study and is represented by bulrush which is difficult to collect and it has extremely low density per volume unit due to the spongy structure of its shoots. The last time reed was harvested on the island for commercial purposes was in 2002.

Stentsovsko-Zhebriyanskie plavni (SZP)

The SZP are extremely important in terms of phytomass production and especially reed harvesting in Danube delta. The total area of reedbed vegetation is about 6,500 ha here. However, it consists mainly of reed with an average productivity of about 2.3 kg/m^2 of air dry phytomass. Moreover, it is higher along the inland waterways and along the periphery areas.

Thus, about 150 tons of phytomass which dies in the end of vegetation period is produced on the area annually. Due to the location of the SZP within the zone of regulated conservation and some of its part beyond the Danube Delta Biosphere Reserve (DBR), it allows legal reed harvesting all across the territory in compliance with recommendations regarding environmental conservation of 25% of vegetation.

However, SZP is one of the main areas of the commercial harvesting of so-called "roofing" reed (fig. 3.1). About 1,450 ha of reeds are used for this purpose. Thus, about 5,000 ha are left for phytomass harvesting; reed can be harvested of 75% of this area (3,750 ha). The annual reed production is about 86,000 tons of phytomass, but about half of the area is physically unavailable for harvesting because of its remoteness, deep water, presence of floaters, etc., as well as the inevitable losses during collection and transportation of raw materials, only about 40,000 tons of phytomass of reedbed vegetation can be harvested annually.

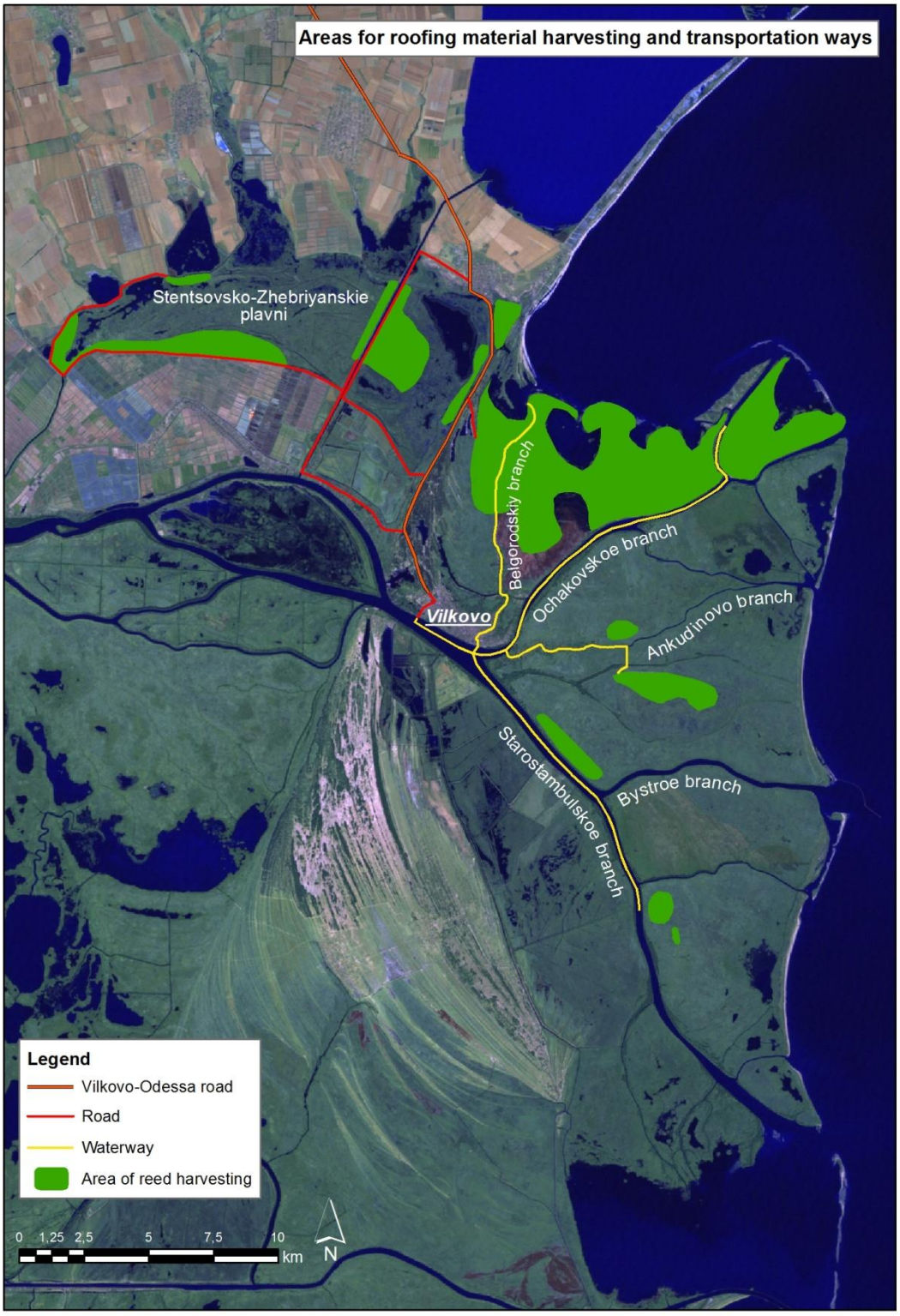


Fig. 3.1. Places for commercial harvesting of "roofing" reed

Reedbeds of the Kiliya delta of the Danube (Kiliya Delta)

The main areas of reedbed vegetation of the lower (coastal) part of the Ukrainian part of Danube Delta are located in the delta of advance of the Kiliya arm of the Danube. Total area of reedbed vegetation is about 27,000 ha and is represented mainly by reed-sedge associations and only in the northern part of the site reed associations predominate. Reed-reed mace and reed mace associations are represented in a much smaller amount. The latter are located in the areas of the former depressions mainly.

To study the productivity of the site a special survey was made to the inland of 5 big islands in different sectors of the Kiliya delta with the use of special equipment – reed harvesters. The two islands Belogorodskiy and Polunochnyy were surveyed on 04.09.2012 (fig. 3.2); Ochakovskiy Island – on 24.09.2012 (fig. 3.3); central delta islands Kubanu and Kubanskiy – on 25.09.2012 (fig. 3.4). Surveys have shown a relatively low productivity of sites in the central parts of the islands and increased productivity at the periphery, around inland waters and waterways, and in coastal areas. At the areas of the 2011 summer fires, especially on the Belogorodskiy Island, the phytomass productivity was significantly lower than the year before.

The average productivity for the whole Kiliya Delta area is about 1.8 kg/m^2 of air dry phytomass of fresh growth. About 0.3 kg/m^2 on average was the non-fallen phytomass of previous years. However, it was almost absent where summer and winter fires had happened, as well as in the areas of "roofing" reed commercial harvesting.

Fig. 3.2. The itinerary according to tracker data on the Islands Belogorodskiy and Polunochnyy (04.09.2012).

Fig. 3.3. The itinerary according to tracker data on the Ochakovskiy Island (24.09.2012).

Fig. 3.4. The itinerary according to tracker data on the islands Kubanu and Kubanskiy (25.09.2012).

Thus, 27 thousand ha of Kiliya Delta reedbeds annually produce about 0.5 million tons of fresh growth of air dry phytomass. However, reed harvesting is prohibited on the legal level in a conservation zone of the DBR, which has about 6.5 thousand ha of reedbeds. About 2.5 thousand ha are allocated for commercial harvesting of "roofing" reed.

The phytomass harvesting is only possible in Kiliya Delta in about 18 thousand ha of reedbeds and for the environmental reasons can be harvested at 75% (approx. 13.5 thousand ha) of the area only. About 250 thousand tons of phytomass in the air dry weight are produced here annually, but about two thirds of the site area are physically unavailable for harvesting due to their remoteness, the presence of quagmire, lots of tussocks and the lack of convenient places to exit delta sleeves (especially at Ochakovskiy Island), etc., as well as the inevitable losses during collection and transportation of raw materials, only about 80 thousand tons of phytomass of reedbed vegetation can be removed annually.

Assessment of potential resources of the reedbed vegetation biomass for Vilkovo town

Thus, in the study area (the Kiliya Delta, the SZP and Ermakov Island) annually produce about 660 thousand tons of phytomass of reedbed vegetation in air dry weight, of which only 120 thousand tons could be removed annually for alternative energy. In addition, on the area of about 4 thousand ha of reedbeds, allocated for commercial harvesting of "roofing" reed (a schematic map of harvesting places is included), only 6 – 12 thousand tons of phytomass are harvested, of which about 3 – 7 thousand tons are waste (in commercial sense). They can be successfully used for alternative energy first of all. Moreover, half of the waste is sorted during the final sorting in Vilkovo and is ready for use as energy phytomass. It should be noted that in the season of 2011-2012 only 1,5 – 2 thousand tons of such waste was delivered to Vilkovo due to low total volumes of harvested reed caused by large-scale fires in the reed-beds and adverse conditions for harvesting. But nevertheless this is a good starting amount of reedbed phytomass to set its use for alternative energy within this project.

Thus, the total amount of available "energy" phytomass in the study area, according to a preliminary estimate, is about 125 thousand tons annually (fig. 3.5).

The town of Vilkovo with the population of 7000 inhabitants consumes about 1000 tons of coal and up to 400 tons of firewood for heating annually. With the actual market prices for these types of fuel the total costs for heating in the entire town are estimated at 1,37 mln. UAH annually.

Assessing the expedience of introduction of reed biomass as an energy source for heating, 2 prior factors should be taken into consideration: quantity of reed biomass necessary to produce enough energy for heating and costs of raw reed biomass which can be utilised:

1. To produce the amount of energy equal to the one, produced in existing conditions (with the utilisation of above mentioned volumes of coal and firewood) about 2000 tons of air-dry reed biomass have to be burned. The above mentioned waste from production of “roofing” reed can be used for these purposes, moreover, only its amount can be quite enough for heating purposes in the entire town of Vilkovo.

2. The estimated price of raw "roofing" reed waste is 0,5 UAH/kg. With this price costs for production of the amount of energy necessary for heating in the town of Vilkovo are estimated at 1 mln. UAH annually, which is cheaper comparing to the currently used 'traditional' fuel.

This assessment of additional energy resource shows that it is possible to use reed biomass instead of currently used coal and firewood and it can reduce costs for energy resources. But to burn waste from reed harvesting as they are special types of furnaces and heaters may be required. The process of modernisation of heating systems for the use of renewable energy sources should be realised with the administrative, institutional and financial support on the regional/state level through national programmes and environmental subsidies.

Harvesting of the available amount of the renewable "energy" phytomass in Vilkovo town area will require significant financial and organizational costs due to remoteness and legal specifics of the studied sites. The cost of its production will consist of obtaining permits (scientific studies, forest tickets, etc.), harvesting, transportation and storage in places of further use. Besides this, phytomass from SZP will be significantly cheaper than the same from Kiliya Delta due to water transportation of the last mentioned.

According to preliminary estimates, the cost of 1 kg of air dry phytomass harvested and delivered to energy consumption points will be about 1.0 – 1.25 UAH for the sites available for land transport and 1.50 – 1.75 UAH for sites with the need for both water and land transport (the whole territory of Kiliya Delta).

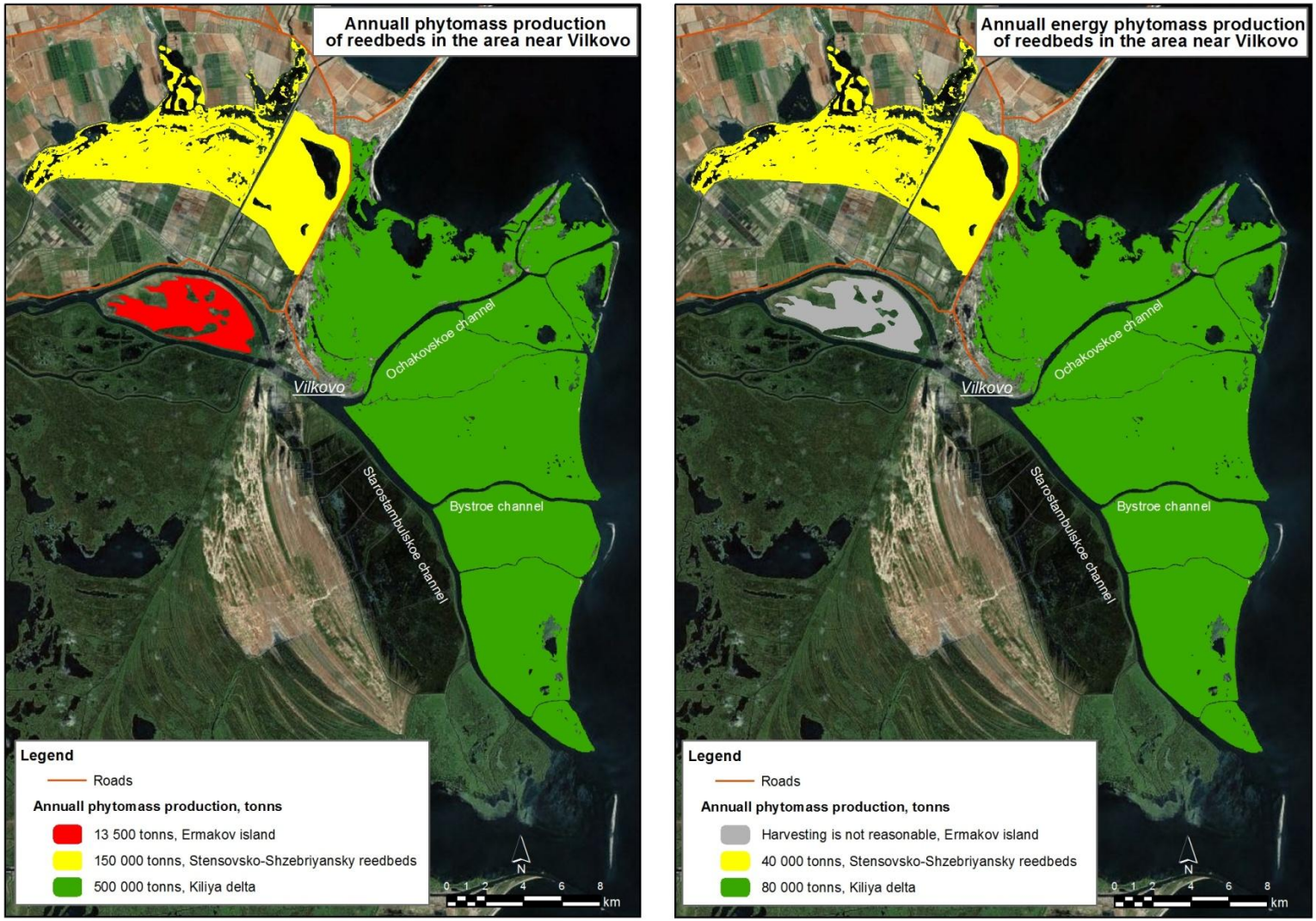


Fig. 3.5. Annual reedbed phytomass production and annual energy reedbed phytomass production of reedbeds near Vilkovo.

CHAPTER 4. RECOMMENDATION FOR SUSTAINABLE REEDBED VEGETATION BIOMASS PRODUCTION IN THE UKRAINIAN DANUBE DELTA

Comprehensive assessment of the wetland restoration potential (Project Activity 2.4 Conduct an assessment to evaluate restoration potential within the Danube Delta sub-basin and develop a Danube Delta Wetland Restoration Action Plan), including a series of field studies and analysis of remote sensing data resulted in identification of territories which are potentially suitable for restoration of floodplain ecosystems and production of green biomass as an alternative (renewable) energy source for local communities.

The analysis revealed above 23 km^2 of abandoned agricultural polders on the previously dyked and dried floodplain along the Ukrainian section of the Danube River (fig. 4.1). The processes of degradation, subsidence, soil inundation and salinization develop rapidly on these territories. The wettest of them are grown actively with reed, the driest – with silverberry. Recently a tendency of significant intensification of colonization of non-plowed floodplain areas (including pastures) with silverberry has been recorded. This decreases their value and practically makes them not suitable for agricultural use.

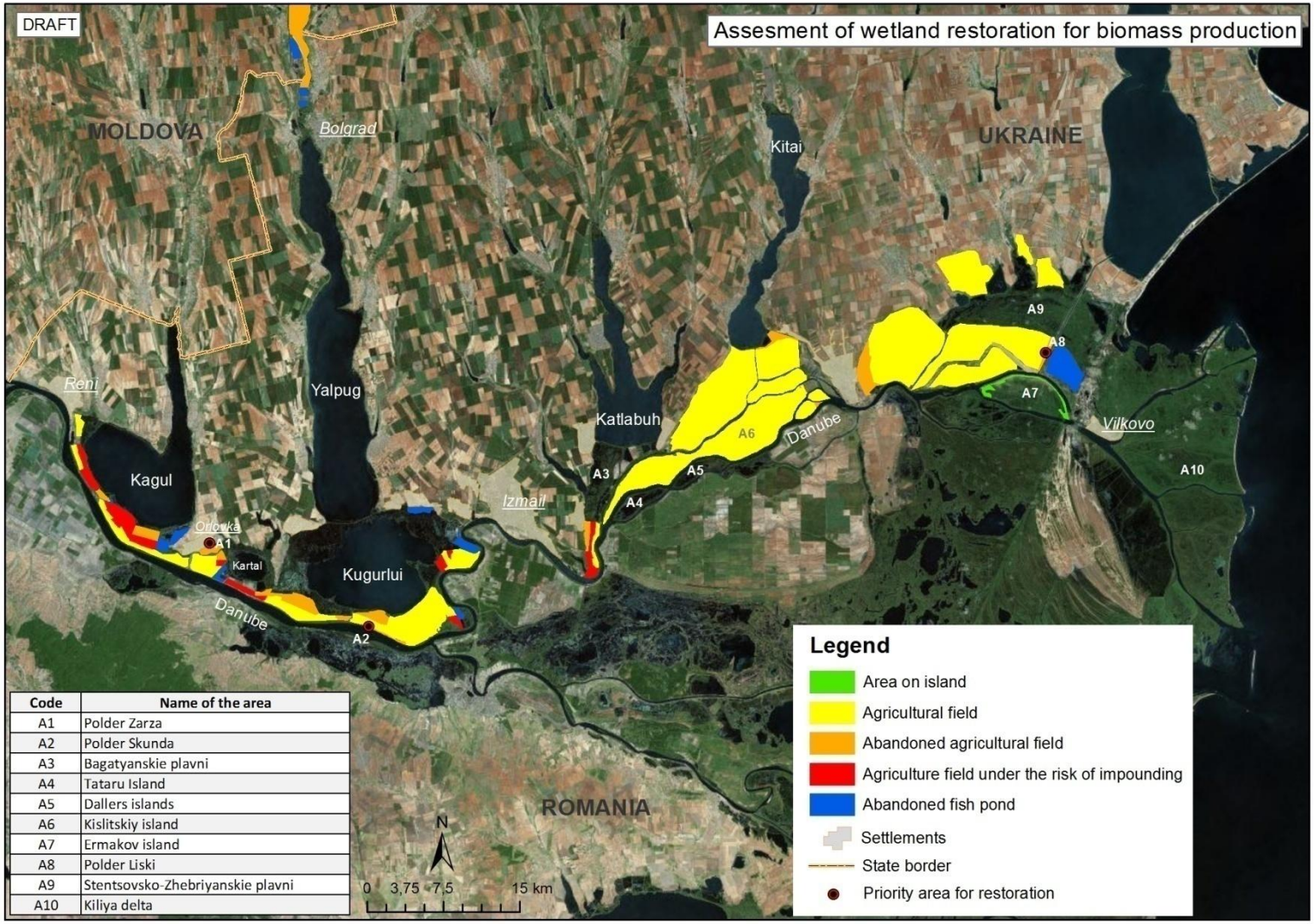
Total area of the fields which are periodically used for crops cultivation is above 18 km^2 (fig. 4.1). Decision on use/not use of agricultural lands is determined by the water regime of the Danube River and, as a consequence, by the intensity of waterlogging. Several years with high yields on these territories are often followed by years with total loss of the yield due to its overmoistening and/or significant rate of reed among the crops. Crop cultivation on these territories is risky and land owners and local communities are interested in new profitable, low-cost and environmentally friendly options of land use related to the traditional economic activities.

In addition to this, agricultural polders located remotely from the settlements or on the islands can be recommended for production of green biomass (willow), e.g. south-eastern part of the Kislitskiy Island.

Another type of lands, suitable for green biomass production are not used or inefficiently used fish ponds, which currently cover the area above 10 km^2. Total area of fishponds in the Ukrainian Danube floodplain is about 36 km^2.

An important factor in the implementation of projects on wetlands restoration for energy phytomass production on former agricultural lands is the status of land and land ownership.

Optimal for the implementation of such projects are 'reserve' lands that belong to the forest fund or the water fund, and are located within the protected area (outside the strict protection zone). Lands with the status of pastures and hay fields can also be recommended for the implementation of projects on wetlands restoration and phytomass production.



Code	Name of the area
A1	Polder Zarza
A2	Polder Skunda
A3	Bagatyanskie plavni
A4	Tataru Island
A5	Dallers islands
A6	Kislitskiy island
A7	Ermakov island
A8	Polder Liski
A9	Stentsovsko-Zhebriyanskie plavni
A10	Kiliya delta

Fig. 4.1. Wetland restoration potential for phytomass production.

The most problematic are lands with a status 'arable'. When restoring these wetlands a question about changing the land status and land use arises. Decision on withdrawal of lands from the arable lands fund is made at the state level and it makes the implementation of the project more complicated.

In terms of ownership, areas in common (collective) ownership of local community or in a long-term lease (25-49 years) of one or few land users are optimal for projects on wetlands restoration.

The most difficult are 'shared' lands with a big number of owners (shareholders).

Thus, the main obstacle to the widespread implementation of projects on wetlands restoration on previously dyked areas of the Danube floodplain and the Danube lakes is lack of positive examples of economic benefits of phytomass growth on the territory of restored wetlands in the Ukrainian part of Danube region.

Proposed territories for biomass production and assessment of their perspectives

Comprehensive assessment of the dyked floodplain areas in the Ukrainian part of the Danube Delta resulted in determination of 4 territories of the highest potential for demonstration of opportunities of wetland ecosystems restoration and production of green biomass as an alternative energy source:

1. A1. Zarzy polder
2. A2. Polder at Skunda channel
3. A7. Ermakov Island
4. A8. Leski polder

A1. Zarzy polder

Location

Odessa oblast, Reniyskiy district, Orlovka village council (fig. 4.1)

Land owner

Orlovka village council

Status

Reserve land

Stakeholders

Local community (Orlovka), DRBMD, fish farmers, hunters

Supposed land use (purpose of transformation)

Agricultural use

Sort of green biomass proposed for production

Willow, reed

Current state of the territory:

Zarzy polder – is a dried polder without systematic water regime control. During high water partially underflooded. Occasionally flooded through the downstream opening in the dyke. Permanently dried by the means of drainage canal on the north-west of the territory. The area is partially saline and overgrazed. Eastern part is overgrown with silverberry. Used mainly for grazing of gees, horses, cattle and sheep. Land use is spontaneous. Parts of the village adjacent to the polder is traditionally used by the local residents for willow cultivation for the purposes of heating and basket weaving.

Preliminary consultations with stakeholders:

Consultations with the head of the village, presentation of the idea of restoration at the general meeting of the village. General support from the key stakeholders.Interest: willow cultivation; improving quality of meadows; enhancing of the village attractiveness and creation preconditions for ecotourism and recreation development.

Preliminary examination

Botanical and ecological surveys during the field studies of 2009, 2011, 2012. Brief data on the earlier state of the territory is available at the DRBMD and Orlovka village council.

Proposed restoration measures

Restoration of regulated water regime and its approximation to the natural state is proposed. The works should include resumption of operation of the Luzarsa sluice and reopening of the Zarza channel. This will allow short-time filling the territory with water during high levels.

Benefits from restoration

Ecological: restoration of meadow biotopes, creation of spawning places, improvement of feeding conditions for birds, increased area of the forest biotope, improving natural connectivity, initiative stage of a larger project – restoration of the Kartal Lake; social & economic: energy biomass cultivation, hay production, rational grazing, promotion of traditional crafts, creation of preconditions for ecotourism and recreation development, additional opportunities for employment for local residents.

Risks

No risk of flooding of local infrastructure; small decreasing of meadows.

A2. Polder at Skunda channel

Location

Odessa oblast, Izmailskiy district (fig. 4.1)

Land owner

Izmail Forestry

Status

Land reserved for afforestation

Stakeholders

Izmail Forestry, DRBMD, hunters, border guards

Supposed land use (purpose of transformation)

Forestry activities, wood production

Sort of green biomass proposed for production

Willow

Current state of the territory:

Polder at Skunda channel is a territory between two flood protection dykes, old and duplicating ones. During severe Danube floods of 2006 and 2010 the main dyke was overflowed and now during high water levels the lower part of the territory is flooded. Due to absence of natural discharge of water from the territory, some parts of it can be flooded all around the year. Plantation created on the polder consisted mainly of false acacia (*Robinia pseudoacacia*), which has dried out due to changed hydrological conditions. The area is partially overgrown with reed, shrubs and meadow plant species. Currently it is not used for artificial forestation due to its remote location.

Preliminary consultations with stakeholders:

Consultations with the main stakeholder and actual land user – Izmail Forestry. General support from the key stakeholders. Interest: willow cultivation, flood protection.

Preliminary examination

Botanical and ecological surveys during the field studies of 2009, 2011, 2012. Brief data on the earlier state of the territory is available at the Izmail Forestry. Levelling survey of the area is necessary.

Proposed restoration measures

Restoration of natural hydrological regime, typical for floodplain forest is proposed. To achieve this the main dyke should be cut till the elevation of the natural levee to allow free water flowing to and discharge from the territory in accordance with the Danube river regime.

Benefits from restoration

Ecological: restoration of floodplain forest, restoration of valuable habitats, improved conditions for nesting and feeding for birds, creation of spawning places, improving natural connectivity; social & economic: energy biomass cultivation, hunting.

Risks

No risks for infrastructure and/or ecosystems

A7. Ermakov Island

Location

Odessa oblast, Kiliyskiy district, Vilkovo town council (fig. 4.1)

Land owner

Private business

Status

Buffer zone of DBR

Stakeholders

Local community and entrepreneurs, DBR

Supposed land use (purpose of transformation)

Reed cultivation

Sort of green biomass proposed for production

Willow, poplar, reed

Current state of the territory:

Hydrological regime of the Ermakov Island was restored within WWF activities in 2009-2010 and currently fully depends on the regime of the Danube River. Generally, in the existing conditions the island is a natural territory. High banks, surrounding the island are currently used for horse and cattle grazing. The inner part is permanently flooded and overgrown with reedbed vegetation. The upstream part of the island is a dumping site for silt, produced during dredging of deep navigation canal. Additionally, there is a part of floodplain forest belt extant in this part of the island, while in the northern part it was significantly deforested. Land and natural resources use at the island are regulated and controlled by the DBR.

Preliminary consultations with stakeholders:

Consultations with the DBR as a key stakeholder and with actual land user. General support from the key stakeholders. Interest: increase of area with forest biotope; willow cultivation; developing ecotourism; improving quality of meadows; renaturalization of a dumping site (dredging of the Bystroye navigable canal); reed harvesting (in future).

Preliminary examination

Long-term data series on the state of the island is available at DBR within the "Nature records". Further investigation of possibilities for forest restoration is necessary.

Proposed restoration measures

Natural hydrological regime is already restored. Further measures for restoration of floodplain forest within the island are proposed.

Benefits from restoration

Ecological: restoration of meadow/reedbed/forest biotopes, restoration of valuable habitats, improved conditions for nesting and feeding for birds, and for spawning for fish, improving natural connectivity, purification of the Danube water; social & economic: energy biomass cultivation, grazing, hunting, raised tourist attraction, additional employment opportunities for local residents.

Risks

No risk of flooding of local infrastructure; meadows area decreased.

A8. Leski polder

Location

Odessa oblast, Kiliyskiy district, Leski village council (fig. 4.1)

Land owner

Private business

Status

Land reserved for silt dumping

Stakeholders

Local community and entrepreneurs, DRBMD, DBR

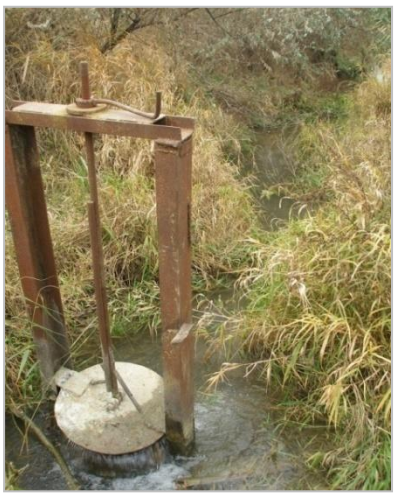
Supposed land use (purpose of transformation)

Dumping of silt from dredging of the Danube-Sasyk canal

Sort of green biomass proposed for production

Silverberry (in the beginning), willow

Current state of the territory:



Leski polder is a territory between the Danube-Sasyk canal and Leski Rice System, surrounded and crossed by a network of drainage canals. Major part of the territory is densely grown with trees and shrubs. A little southern part of the territory is currently used for herbs cultivation and cattle grazing. The area is partially saline and overgrown with willow and poplar along drainage canals, and silverberry. The area is partially inundated from the Danube-Sasyk canal through water intake pipe.

Preliminary consultations with stakeholders:

Consultations with the land user and representatives of local authorities. General and financial support from the key stakeholders. Interest: creation system of multipurpose utilization of the polder; willow cultivation; improving quality of meadows; improving quality of soil for herb cultivation; creation of conditions and infrastructure for ecotourism and recreation development; decrease overgrowing with shrubs etc.

Preliminary examination

Botanical and ecological surveys during the field studies of 2009, 2011, 2012. Levelling survey of the area as well as elaboration of technical options of restoration of hydrological regime is necessary.

Proposed restoration measures

Restoration of regulated water regime and its approximation to the natural state is proposed. Restoration should include creation of 3 additional hydrotechnical constructions to allow water flow from the Danube-Sasyk canal into the territory during high levels, and construction of wind-powered pumps for water discharge from the lowest part of the territory.

Benefits from restoration

Ecological: restoration of meadow/forest biotopes, restoration of valuable habitats, improved conditions for nesting and feeding for birds, improving natural connectivity; social & economic: energy biomass cultivation (silverberry and willow), herbs cultivation, promotion of traditional crafts, creation of preconditions for ecotourism and recreation development, additional opportunities for employment for local residents, grazing, hunting.

Risks

No risks for infrastructure and/or ecosystems.

Table 4.1. – Prioritisation* of the proposed territories

Territory	Area, ha	**EV**	OS	OFS	TP	AP	PE	Total mark
Zarzy polder	189,93	**4**	4	1	4	3	5	21
Polder at Skunda channel	38,22	**4**	4	2	4	4	3	21
Leski polder	112,82	**4**	5	4	3	4	5	25
Ermakov Island	2371,08	**5**	3	2	5	5	2	22

*The prioritisation process consisted of expert assessment of the following factors:

EV – ecological value of the territory assessed based on at least 3 factors – ornithological, botanical and entomological value. This assessment was the result of the EU/WWF DCP funded project "Supplement to the inventory of wetlands of the Ukrainian part of the Danube Delta" (2009). 1 – lowest, 5 – highest.

OS – land **owner** (user) **support** and enthusiasm to conduct restoration works on the territory and to sustain the further integrated use of natural resources. 1 – not supported, 5 – fully supported.

OFS – land **owner** (user) **financial support** and readiness to take certain risks related to the restoration works. 1 – no co-funding provided, 5 – all costs covered by land owner.

TP –**technical possibilities** for restoration works, which included accessibility of the site, necessity of new infrastructure, complexity of works, critical infrastructure that can be damaged etc. 1 – crucial technical constraints, 5 – no technical constraints.

AP – **administrative possibilities** for restoration, including necessity of approvals and permits from local/regional authorities, necessity of conducting public hearings, land owner's lobby etc. 1 – crucial administrative/bureaucratic constraints, 5 – no administrative/bureaucratic constraints.

PE – **'pilot effect'** – value of the area's restoration as a means for promotion of idea of wetland restoration and using biomass as a renewable energy source, and multiplication of this experience along the Ukrainian part of the Danube River floodplain.

Proposed territories for management of invasive species in the Ukrainian Danube Delta Region

Taking into consideration sparseness, narrowness and low ecological value of the wood plantings between the flood protection dyke and the Danube River bank along the section of 20.6 km from Reni Town to Orlovka village and considering its overgrowing with false indigo-bush, creation of energy plantations of white willow may be recommended. Additional advantage of this area is the availability of a road along the whole section and existence of wire fencing on the flood protection dyke, which can allow arranging horses and cattle grazing here. The additional value of willow plantations on this narrow stripe is anti-erosion protection of the dyke.

A part of this section between Orlovskiy and Prorva canals with the length of 2.4 km and width of 60-100 meters can be proposed for creation of a pilot plantation (fig. 4.2).

Currently white willow, white poplar and European ash dominate in the top level here. Crown density in the top level is 0.5. Dense tangles of amorpha form on open areas without trees and in undergrowth. The height of amorpha bush is 3-4 meters, sometimes it is up to 5 meters. The estimated wood stock of amorpha is 15,5 t/ha. Biodiversity level is low.

Fig. 4.2. Location of an area with amorpha spinneys

CONCLUSIONS

1. The Ukrainian part of the Danube Delta Region possesses significant renewable biomass resources, first of all reed. The total area of reed-beds is 439 km^2, 185 km^2 of which can be used in various ways.

2. Main reed sources are accumulated on the areas adjacent to the Kartal and Kugurlui Lakes system (186,9 thousand tons) and to the Vilkovo town, including reed-beds of Kiliya Delta and SZP (about 660 thousand tons).

3. In the existing conditions reed resources of air dry phytomass available annually for harvesting are: for Kartal and Kugurlui Lakes – up to 100-200 thousand tons (depending on logistics), for Kiliya Delta and SZP – up to 125 thousand tons. Reed harvesting on the Ermakov Island is not recommended due to the current active processes of restoration of the wetland ecosystem.

4. Currently organized reed harvesting ('roofing' reed) is conducted only in the Vilkovo area for export purposes. The volume of such production is about 6-12 thousand tons annually. 3-7 thousand tons of them is waste forming during sorting of harvested reed. This volume is a potential source of renewable energy of high priority. Its use will also improve the conditions for 'roofing' reed harvesters as now they do not have possibilities for waste reed utilization.

5. Considering that there are large areas with reed-bed vegetation in the Ukrainian part of the Danube Delta, wetland restoration projects with elements of biomass use should focus on creation of forest plantations and extension of forest and meadow biotopes, which were harmed more than others after dyking and drying of floodplain along the Ukrainian section of the Danube River in the middle of the 20th century.

6. Comprehensive analysis and zoning of the territory of the delta and floodplain of the Danube River and Danube Lakes revealed over 23 km^2 of abandoned agricultural polders as well as 10 km^2 of abandoned fish ponds, which can be used for restoration of meadow biotopes and approximation of hydrological regime of water bodies of the Ukrainian part of the Danube floodplain to natural conditions. These territories can be used for promotion of integrated use of natural resources of the floodplain ecosystems.

7. About 18 km^2 of remote and practically not used agricultural fields can be recommended for further restoration with the use of biomass if the real economic effective restoration examples exist in the region.

8. 4 territories examined within the studies can be recommended for restoration in the nearest future. Two of them (Lesky and Zarzy polder) are of higher priority in the context of 'pilot effect', meaning that they can be effectively used for promotion of the ideas of floodplain restoration and integrated use of natural resources of the floodplain ecosystems. At the same time two other territories (polder at the Skunda channel and Ermakov Island) are more preferable due to less technical and administrative constraints for restoration.