A Vision for the Danube Delta, Ukraine

Background document

A LIVING DANUBE DELTA
A HOME FOR WILDLIFE AND
WELFARE FOR PEOPLE

partners & for wetlands

background document
september 15th, 2003

COMMISSIONED BY
WWF-Danube Carpathian Programme Office, Vienna
and WWF-Project Office Odessa, Ukraine
in collaboration with WWF-Netherlands

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Blue Heron

Summary

THE GOAL OF THE VISION IS TO describe a desirable future for people and nature in the Ukrainian part of the Danube Delta on the basis of an understanding of the driving forces behind both the natural system and its human use.

The report identifies the importance of the Ukrainian part of the Danube Delta within the context of the whole Danube basin which covers an area of 817,00 square kilometres, in which 17 countries are located with a combined population of 80 million people. There are several recent agreements covering governments' wishes to preserve the natural values of the Danube and several projects under way. Taking its cue from such agreements and on-going initiatives, the Vision launches a way forward for the Ukrainian Delta.

The Delta lies at the end of the 2,800 km long Danube river. The Ukrainian part, about one-fifth of the total Delta area, covers 125,000 ha of which 75,000 ha are land and 50,000 ha are water. Its importance for nature conservation lies in the richness of its wildlife (some 4,318 species of flora and fauna) and its role as a refuge for several globally threatened species (e.g. Pygmy Cormorant, Ferruginous duck, Red-Breasted Goose). The Delta as a whole has the largest extent of reedbeds in Europe (over 280,000 ha).

WWF has been deeply involved in helping to protect the Danubian landscape through its Danube-Carpathian Programme. In partnership with all interests, WWF's role in the Ukraine Delta is to:

1 Develop the Vision
2 Establish model sites to show the implications of the Vision
3 Communicate the Vision and results from the model sites

THE FOUNDATION OF THE VISION IS AN UNDERSTANDING OF THE DANUBE DELTA SYSTEM AND STRUCTURE. THESE ARE DESCRIBED IN THE MAIN BODY OF THE REPORT AND IN THE EXTENSIVE TECHNICAL APPENDICES. THE KEY FEATURES ARE:

- The landscape of the Delta is shaped by the river and the sea dynamics: rising and falling water levels, erosion and sedimentation processes.
- Sedimentation is key to the vertical growth of the Delta, necessary in preventing the sea from drowning it and to its horizontal growth including into the Black Sea.

- A mosaic of immense reed beds and lakes forms the basic structure of the Delta.
- Gallery forests along the river branches form the main contrast to the reedbeds and lakes.
- The ecological functions of the Delta are:
  - Natural fertilization of the floodplain by floods;
  - Refreshment of water in the limans by rising and falling water levels;
  - Creation of natural biotopes for plants and animals, including refugia for relict and endemic species;
  - Filtering of silt, nutrients and pollutants in the Danube waters.

THE TRADITIONAL, RECENT AND CONTEMPORARY USES OF THE DANUBE DELTA ECOSYSTEMS AND THEIR IMPACTS ARE EXAMINED IN THE REPORT AND ANNEXES. THE KEY OBSERVATIONS ARE that while small-scale traditional hunting and fishing, reed-harvesting, horticulture, bee-keeping, grazing and the collection of medicinal plants, cause little damage. It should also be noted that, despite the construction of the dykes, generally there has not been building in the floodplain (with very small exceptions). Settlements are located on the elevated areas. The main negative impacts of industrial-scale production and activities have been:

- The disappearance of large herbivores due to habitat destruction and hunting has led to the collapse of the dynamic balance between plant growth and consumption, and has deprived the landscape of its structural variations.
- Overgrazing by domestic cattle and horses has led to the disappearance of the alluvial forests and the shallow parts of the reed beds, the appearance of pioneer communities and overall simplification of the ecosystem.
- The entire floodplain of the Ukrainian part of the Delta, including all but two islands, has been embanked, with dykes very near to the river (100-150m). There are numerous impacts:
  - Natural habitats have collapsed or become fragmented;
  - A large part of the ecosystem is turning into a saline steppe;
  - Key geomorphological processes such as sedimentation have come to a halt (also affected by other activities such as dredging, and the Iron Gates Dam);
  - Filtering of nutrients and sediments has stopped;
  - The annual refreshment of large part of the limans has ended;
  - Fisheries have collapsed;
  - There has been heavy salinisation of agricultural polders;
- Dredging of the canals of the Outer Delta for shipping has had severe impacts on the river functions, leading to the free flow of water carrying sediments and nutrients directly into the sea through only one, deepened, channel. Dredging has stopped in recent years but will be resumed once the economic situation improves, together with increased pressure to build harbours.
- The health of the Delta depends on conditions in the Danube basin, such as run-off regulationand man-made catastrophes, as well as conditions in the catchment basins of small rivers on the Budzhak plateau

THE VISION REPORT ASKS WHAT THE FUTURE HOLDS IF PRESENT AND RECENT TRENDS CONTINUE. THE ANSWER GIVEN IS:

- Further degradation of the Delta ecosystems;
- Further decline of soil fertility;
- Further decline of water quality in limans;
- Increased risk of flooding;
- Horizontal growth of the Delta without corresponding vertical growth, leading to its 'drowning' by the sea;
- Ever decreasing nutrient reduction capacity.

THE QUESTION THEN ARISES: WHAT KIND OF APPROACH SHOULD BE ADOPTED? WHAT ARE THE OPTIONS?

The report discusses two alternative approaches:

a) Further technical solutions vs. natural restoration
   Conclusion: although some problems can be solved over the short term with high investments but also a high risk of low returns, intensive management and constant human intervention, there is no long-term technical solution for the main ecological, systemic problems of the Danube Delta.
b) Modification of the system to meet growing demands vs. sustainable use
   Conclusion: the Vision opts for moderate use of the natural resources within the limits of the ecosystem, rather closely following traditional approaches but improved with modern practices.

The report opts for the second solution which constitutes THE VISION.

KEY ELEMENTS OF THE VISION

The Vision looks to large-scale restoration of the natural system of the Danube Delta in order to provide new opportunities for socio-economic development, conservation and sustainable use of the natural resources. The Vision is directed to a more natural system commensurate with modern life.

The proposed approach of the Vision is to start with restoration of model sites which would demonstrate application of the Vision, provide valuable information and experience (learning by doing), help to attract strategic partnerships, and can be communicated in order to generate enthusiasm and follow-up. Activities in these model sites need to start as soon as possible, designed in a modular way if funding is not available for full-scale implementation.

PROPOSED MEASURES

- RESTORATION of the Delta natural morphological and ecological systems and processes through the removal of river dykes within scientifically, economically and socially reasonable limits. Restoration should be gradual, starting with selected MODEL SITES.
- CONVERSION OF OVER-EXPLOITATIVE AGRICULTURAL TECHNIQUES to human use that is restricted to the gathering of plants, animals and materials within the limits, products and resources of the natural system.

- RE-ESTABLISHMENT OF NATURAL GRAZING by wild herds of large herbivores.
- MORATORIUM ON CONSTRUCTION OF NEW DYKES and on investment in the repair of existing ones, unless they protect objects of strategic importance for the society.
- RECONSTRUCTION OF PART OF THE BORDER CONTROL SYSTEM if the dykes' integrity is broken.
- REDIRECTION OF GOVERNMENT FUNDS earmarked for construction and maintenance of river regulation infrastructure. This infrastructure has to be located at sites where it does not frustrate the restoration plans proposed in the Vision, e.g. not in the floodplain of the river, but on the higher situated plateaus. Bridges are preferred, while they do not obstruct the water flow.
- MAINTENANCE OF LAND IN PUBLIC OWNERSHIP, but privatise various sustainable use activities in the form of licenses.
- Obtaining a political decision among the governments of the neighbouring Danube countries to exercise more strict ENVIRONMENTAL CONTROLS on industries situated along the river and to provide for legally enforceable compensation for the costs of clean-up.

BENEFITS FOR THE (LOCAL) POPULATION

- IMPROVED WATER QUALITY of the Danube Delta and the Black Sea; while the system will function more naturally and floods are allowed to occur, the filtering capacity of the system (e.g. of reed beds) will be restored.
- SHIPPING can be maintained as long as future activities will function within the limits of the ecosystem and do not pollute the Black Sea. When smaller ships are used, dredging won't be necessary and facilities such as harbours has to be located in the less vulnerable areas.
- ECOTOURISM: starting with small entrepreneurs offering Bed and Breakfast accommodation, campsites, boat hire or organised excursions. Later, a detailed study of the options, infrastructure and skills is needed.
- REED HARVESTING: the export market is being explored; the quality of reed offered for construction purposes is important. Further investigation is needed and probably a strategy.
- AGRICULTURE: intensive crop cultivation should be removed from the area. Indigenous large herbivores need to be reintroduced, and used in a sustainable way through the control of their number within the limits of the ecosystem. Market gardening (horticulture, grape vines resistant to flooding) could continue in some areas. Rice fields that are unprofitable would best be returned to the floodplain.
- FISHING: the return to natural processes will greatly improve fish yields. Over-fishing and poaching will need to be seriously addressed through better regulation, licensing and enforcement.
- GATHERING: sustainable harvesting of medical plants, herbs, honey and trapping of small animals for food (or fur, such as the muskrat).
- HUNTING: limited to the regulation of wild herbivore populations within the ecosystem capacity, in ways which would prevent animals from associating humans with danger (for nature tourism).

- FLOOD PROTECTION: the Danube Delta dykes have very low safety standards and create a false feeling of safety. They would not withstand the hundred-year exceptional flood (which has not taken place in the last 90 years). The best protection is to remove the dykes completely, and use water levels as a guiding principle in planning. Some small dams/dykes near settlements may be needed to protect several buildings in the floodplain.
- PREVENT BLACK SEA POLLUTION: through the restored filtering capacity of the Delta (silt, nutrients and pollutants).

THE FIRST STEPS IN IMPLEMENTING THE VISION: THE MODEL SITES

Selection of the model sites took into account their suitability for fulfilling the following aims to:

- Demonstrate the approaches described in the Vision document;
- Learn in practice and by experience to improve the proposed solutions
- Restore or revive major dormant or disturbed natural processes;
- Forge links between restoration of natural processes and other interests in the region and in synergy with the interests of strategic partners;
- Develop solutions that fit within the socio-economic context of the Ukrainian Danube Delta;
- Address wetland systems and issues that are representative of the Ukrainian Danube Delta and that are identified in the Vision document;
- Be easy to communicate to broad groups in society and stimulate other partners and parties to buy in to the Vision and help implement it on a larger scale;
- Be able to start within a year and show major results within 2-3 years.

Potential model sites:

- Izmail grazed alluvial gallery forest
- Liman shores: transition from delta to plateau
- Tataru and Daller islands
- Katlabuh Liman
- Communication project; Izmail Wetland Park
- Ermakov Island
- Stensovsko-Zhebriansky Plavni
- Zhebriansky ridge
- Natural grazing in the Outer Delta

The objective of the Vision is to describe a desirable future for people together with nature. The WWF would like to start, together with the stakeholders and partners co-operating in the project, on a short term with some of the demonstrating projects, the model sites, to illustrate the implications of the Vision

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White Pelicans in the Danube Delta

Foreword

The Danube has been a focus of WWF activity for many years. The initiative of concern to us here is part of the WWF International Danube-Carpathian Programme (DCP) and Lower Danube Green Corridor international agreement. Its specific approach also qualifies it as a project within the (global) Partners for Wetlands Programme.
The conservation of freshwater and marine habitats are two of the six global priorities for WWF. Within these priorities the Danube Delta is of special importance. Not only is it one of the largest river deltas in western Eurasia, it also features on WWF's 'Global 200' which means that it is among the 200 most important ecoregions in the world.
Over time WWF has taken on various roles in the conservation of this magnificent area, varying from actively campaigning against imminent threats (e.g. against dam building near Hainau and Cabsikovo), to implementing field projects for conservation and habitat restoration. So far, much of the focus has been on the Romanian part of the delta. But in the Ukrainian part too, there are great opportunities for ecosystem restoration and economic rehabilitation. Through its support for the creation of the Vision for the Ukranian part of the Danube Delta described here, WWF aims to take on yet another role: that of active broker between the requirements of a healthy Danube ecosystem and those of the local and national stakeholders in Ukrainian society.
In its capacity as active broker WWF has already helped to build good working relations and even formal partnerships with various stakeholders and institutions in the Odessa region, especially the Danube Delta Biosphere Reserve Authority, Odessa Oblast Administration, the local councils of Izmail and Reni, Odessa Oblast Water Management Committee, Fisheries and Forestry organisations, tour operators and local businesses.
Most of these institutions have taken part in the development of the Vision through several workshops, field excursions or written contributions. WWF is very grateful for these and would much appreciate continued and even closer ties in the implementation of the Vision.

To conclude: the role WWF offers to play in the Danube in partnership with all interests is threefold:

- Developing a shared VISION for the Danube Delta;
- Establishing MODEL SITES to show the implications of the Vision;
- COMMUNICATING the Vision and the results from the model sites, to magnify to other parts of the Danube River Basin and the Black Sea Region.

How should this report be used?

This Vision report document is intended for interested experts and decision-makers at all levels in Ukraine and elsewhere.

The report contains extensive technical and scientific information on the Ukrainian Danube Delta system, an approach to wetland restoration initiatives in the area, and suggestions for sustainable use of the natural resources which will help to support the nature values, as well as offer income-earning opportunities for the Delta population.

The Vision takes into account current programmes on developing the near Danube region. The main proposals compliment the project activities of other organisations in the region, including those developed by the Tacis programme such as the 'Management Programme' and 'Action Plan'. The Vision proposed in this report therefore sets out a technical and scientific framework for an approach to wetland conservation in the Ukrainian Danube Delta, and examines what the implications may be for management of different types of habitats and economic activities. The Vision is not a programme of implementation; this would be the next step (drawing on the experience of the model projects) and would need to be accompanied by specific action plans and detailed projects.

This report is intended to be used as a source of ideas which could be integrated into existing and forthcoming development plans and initiatives, as well as a basis for development of the partnership with WWF and\or other organizations and initiatives that aim to implement the ideas of the Vision.

Further economic and environmental feasibility studies may be needed for implementation of the Vision in different areas of the Danube Delta. This Vision does not intend to answer all the questions or solve all the problems in the area or those which arise out of implementation of the Vision itself; it proposes a direction for further efforts in order to guarantee the long-term solution of the environmental problems of the Ukrainian Danube Delta, and the sustainable economic development of the region.

How was the Vision developed?

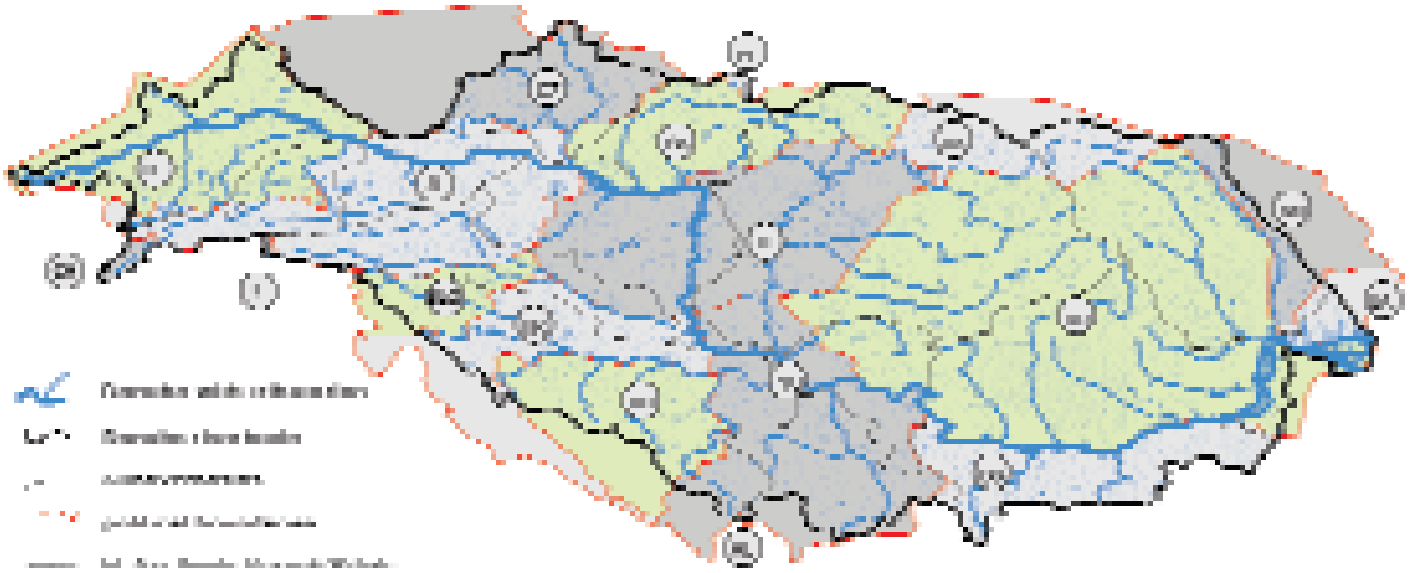
The initiative to develop a common Vision arose in 2001. The intention was to understand the natural system of the Ukrainian Danube Delta and formulate a common approach to wetland restoration as well as to sustainable economic use. Partners were sought for implementation of the Vision on the ground.

The Visioning process started in November 2001 at a meeting in Biesbosch, the Netherlands. All the key Ukrainian partners and stakeholders, representing various sectors and decision-making institutions, attended the meeting. Participants had a chance to visit several wetland areas where restoration and sustainable use practices were being developed on the basis of a Vision.

The meeting ended with agreed terms of reference for the development of the Vision as well as an outline of the visioning process that included:

- A core visioning Group of Ukrainian and Dutch experts as well as a representative of the WWF project in Ukraine which has been responsible for drafting the report with inputs from Ukrainian experts, stakeholders from different sectors and an Advisory Group.
- The Advisory Group consisted of key interests (institutions) in the Ukrainian Danube Delta who met several times to comment on the drafts of the Vision and consulted on various issues in the process of the Vision development.

The final draft of the Vision was ready by the end of 2002.



Countries of the Danube Basin

1 Why a Vision for the Danube Delta, Ukraine

1.1 THE IMPORTANCE OF THE DANUBE DELTA

The Danube is the second largest river in Europe. Its total catchment area is 817,000 km² and lies in the territory of seventeen countries. The river itself flows through ten countries. Some 2,860 km from its source the river divides into several branches flowing towards the Black Sea through a vast delta 564,000 ha in area stretching over 100 km in both length and breadth. The Delta of this immense river system hosts a variety of natural habitats; the most celebrated of these are the largest reedbeds in Europe stretching over some 280,000 ha.

In the Ukrainian part of the Danube Delta there are some 4,318 species of plants and animals, among them: 950 – higher plants; 717 - planktonic single-cell algae; 277 - aquatic invertebrates; 91 - fish species; 5 - reptiles; 10 - amphibia; 252 - birds and 39 mammals. In comparison, 3569 species are registered in Romanian part of the Danube Delta. The number of breeding birds in the Danube Delta as a whole is twice as high as in the Rhône and Guadalquivir deltas taken together.

Some of the bird species are rare on a European scale and some are globally threatened, for example, it holds the majority of the world population of Pygmy Cormorant, Ferruginous Duck and Red-Breasted Goose at certain times of the year. It has 5% of the breeding population of the Dalmatian Pelican and is a breeding area of the White-Tailed Eagle; visitors on migration include the Slender-Billed Curlew and the Lesser White-Fronted Goose, globally threatened species.

The Delta could be treated as the waste disposal reservoir of much of central Europe or it could be seen as an opportunity to work together to preserve and enhance a shared natural heritage and the skills required to manage and restore it. The Vision described here hopes to take a further step in the second direction.

1.2 GOALS AND OBJECTIVES OF THE VISION

The history of human interaction with the Danube Delta dates back many centuries during most of which people lived in harmony with the natural environment. Even now, the Danube Delta's multi-ethnic population retains a rich tradition of sustainable use of the exceptional wildlife. Unfortunately during the Soviet period much of the natural wealth was lost as a result of unwise and aggressive economic development and water management. Far from bringing prosperity they brought a decline in living conditions for many communities.

Now, however, local people, together with the government and international institutions, are trying to restore the Danube Delta ecosystem. Using the momentum generated by a common understanding of the benefits for both local people and nature, WWF initiated the development of a common Vision on how and where the natural processes and values may be restored, as well as how traditional and new sustainable practices may be (re-)introduced.
The goal of this Vision for the Ukranian part of the Danube Delta is to describe a desirable future for people and nature on the basis of an understanding of the driving forces behind both the natural system and its human use. Ideas flowing from the Vision will be demonstrated in model sites. The subtitle of the report is thus derived from the Vision:

'A Living Danube Delta: a home for wildlife and welfare for people'

The Vision should serve as an inspiration and point of reference for further nature conservation and economic initiatives in the area, through demonstrating how the economy and nature conservation can support each other ensuring long-term sustainable use of the Ukrainian Delta region. By stressing the need for economic development through wise use, it is hoped that the Vision will encourage key stakeholders including local communities, and interested third parties to work together as partners in its implementation.

To summarise: the OBJECTIVE of the Vision for the Ukrainian Danube Delta is to describe a *desirable future for people together with nature*.

The APPROACH by which it seeks to achieve the objective includes the following components:

- explaining the physical processes and phenomena underlying the evolution and current status of the natural system;
- describing the human impact on the evolution and current status of the Delta;
- identifying which natural processes have become dormant because of unwise human activities;
- evaluating how, where and to what extent these processes may be 'awakened' or restored;
- describing the benefits of restoration activities for local and regional economies;
- demonstrating the natural and practical economic benefits of restoration through projects in selected model sites which apply sustainable resource use practice;
- generating enthusiasm and cooperation amongst local people, the corporate sector and government using communication to encourage identification with the Vision and partnerships for its implementation.

Reed, willows and boats

1.3 TIME HORIZON AND IMPLEMENTATION OF THE VISION

Formulation of the Vision for the Danube Delta has taken almost a year of study and discussion in 2002. These involved many scientific and economic experts and institutions that are well familiar with the Ukrainian Danube Delta and represented the interests and sectors in the region. WWF brought in expertise on the dynamics of natural systems and experience of working with partners and establishing model sites.

The temporal scope of the Vision is estimated at 15 - 20 years. This means that implementation should be completed before 2020. A few sites can already be established in 2003 and in 2004 more can be started. However, such a rate of implementation will only be possible if the various stakeholders continue to support the Vision.

During the lifespan of the Vision, its implications will become clear. Insights will deepen and the opportunities for nature restoration and sustainable economic use will become visible. In other words, the Vision will change over time. It will be enriched by the experiences at the model sites and through the contributions of partners.

Shared effort and cooperation, and growing knowledge from the model sites will ensure that the hopes expressed in this Vision are fulfilled on the ground for the sake of preservation of the unique ecosystem of the Ukrainian Danube Delta as well as for the welfare of future generations of its inhabitants.

1.4 THE VISION WITHIN THE DANUBE RIVER BASIN

GENERAL DESCRIPTION OF THE DANUBE RIVER BASIN

The Danube is more than Europe's second longest river extending 2,800 km from its source in Germany to its delta at the Black Sea. It is more than a line on a map and a political boundary for 10 countries experiencing vastly different political, economic and historical contexts. It is an immense basin that drains water from 817,000 square kilometres of lands within 17 European countries. The Danube is the most international river basin in the world and is home to 80 million people.

Several major European rivers drain into the Danube River. From the Inn River in Germany to the Morava River in the Czech Republic, Austria and Slovakia; from the Tisza in Hungary and Romania to the Sava through Slovenia, Croatia, Bosnia & Herzegovina, and the former Yugoslavia, to the Prut River in Romania and Moldova.

THREATS AND PRESSURES TO FRESHWATER ECOSYSTEMS

In this immense area of 17 countries, people, cities and industries impact the natural environment of the basin and the Black Sea into which the Danube flows. Pollution remains a very serious problem. The volume of nutrients, mainly from agricultural fertilizers, household products and urban sewage, entering the river is too high. This is one of the main reasons why the ecosystems of the Black Sea are seriously at risk. Toxic substances are also a key threat, made worse by mining accidents or floods that spill or flush toxins directly into the watercourses. The quality of drinking water for tens of millions of people depends on the health of the Danube and its tributaries.

Most recently, the August 2002 floods that raged through Central Europe and the Danube basin were in part the result of past decisions that led to deforestation and the destruction of natural floodplains in the Danube.

A recent study, financed by the Global Environment Facility (GEF) and carried out by WWF, showed that over 80% of the Danube River Basin's wetlands and floodplains have been destroyed since the beginning of the 20th century despite their values and benefits. Destruction of wetland habitats and increased pollution threaten many species such as the Sturgeon, Dalmatian Pelican, Great White Egret and White-tailed Eagle which are all now struggling for space in which to survive.

The remaining floodplains are often mere islands of green. Cut off from a network, they are slowly losing the capacity to perform their natural functions.

RESPONSES TO THREATS AND PRESSURES

In 1998, the DANUBE RIVER PROTECTION CONVENTION (DRPC) came into force after being ratified by 8 Danube states and the European Commission.

The INTERNATIONAL COMMISSION FOR THEPROTECTION OF THE DANUBE RIVER (ICPDR) was created to coordinate the implementation of the convention. Since its creation, the ICPDR has been effective in

reaching agreed policy among countries on priorities and strategies for improving the Danube and implementing the DRPC.
A number of countries in the basin are actively pursuing membership of the European Union. As part of the Accession Process, the countries are required to adopt European environmental legislation. This includes the development of a RIVER BASIN MANAGEMENT PLAN in line with the EU WATER FRAMEWORK DIRECTIVE, a legislative tool that enhances water resource management and pollution control by valuing the ecological integrity of rivers as living and dynamic entities.

On June 5, 2000 the government of Ukraine together with the governments of Romania, Bulgaria and Moldova signed an agreement to create a protected area system along the lower Danube, including the Danube Delta: THE LOWER DANUBE GREEN CORRIDOR (LDCG). The largest international, cross-border wetland restoration and protection initiative in Europe, this green lifeline will include wetlands, lakes and temporarily flooded areas with floodplain forests and meadows. The initiative will connect existing protected areas, new areas to come under protection, and floodplain habitats to be restored. Management of the floodplains will aim to optimise socio-economic benefits to local communities.
The countries will further work to develop economic instruments to reduce pollution and promote wetland conservation.

The funded projects in the Ukrainian part of the Danube Delta are working to stop further man-made damage, to restore the natural functioning and values of the damaged wetlands where possible, and to use the restoration activities as the basis for further sustainable economic development strategies. The projects can be linked to Romanian pilot sites that have been very successful in restoring wetlands and improving fish stocks. Trans-boundary cooperation will aim INTER ALIA at improving water supply and other water services, strengthening sustainable agricultural policy, providing river basin management tools and protecting wetlands.

Echoing the approach along the Danube, the Danube Delta Vision will help to mobilize support and enthusiasm for wetland conservation and restoration throughout the BLACK SEA region. Recent funding from the United Nations Development Program/GEF for improving ecological conditions in the BLACK SEA has created a further basis for actions to restore wetland functions and values, notably, a commitment to address issues related to wetlands and land use. The lessons learned in Ukraine will be communicated and incorporated as appropriate into this basin-wide effort.

THE EU TACIS PROGRAMME 1

Over the last decade several Tacis projects have been implemented in the Danube region. In particular, following a request to Tacis from the Odessa Regional Council, the 'Danube lakes: sustainable restoration and conservation of natural condition of ecosystems' project was carried out between 2000 and 2003. The result is the '*Programme of Environmental Management and Action Plan for Conservation of Natural Condition and Sustainable Management of the Near Danube Lakes Region*'.

As it is implemented, the Programme will provide the framework necessary for implementation of the Vision and for larger-scale development and restoration of the lower Danube floodplain. For example, it includes measures for pollution reduction, the sustainability of economic activities within the catchment area of lakes, improved transboundary cooperation to limit pollution in the Danube basin, and application of the 'polluter pays principle'.

Further development and application of the proposed ecological monitoring programme of lakes within the Programme, will help to guide and build experience for both small- and large-scale restoration projects.

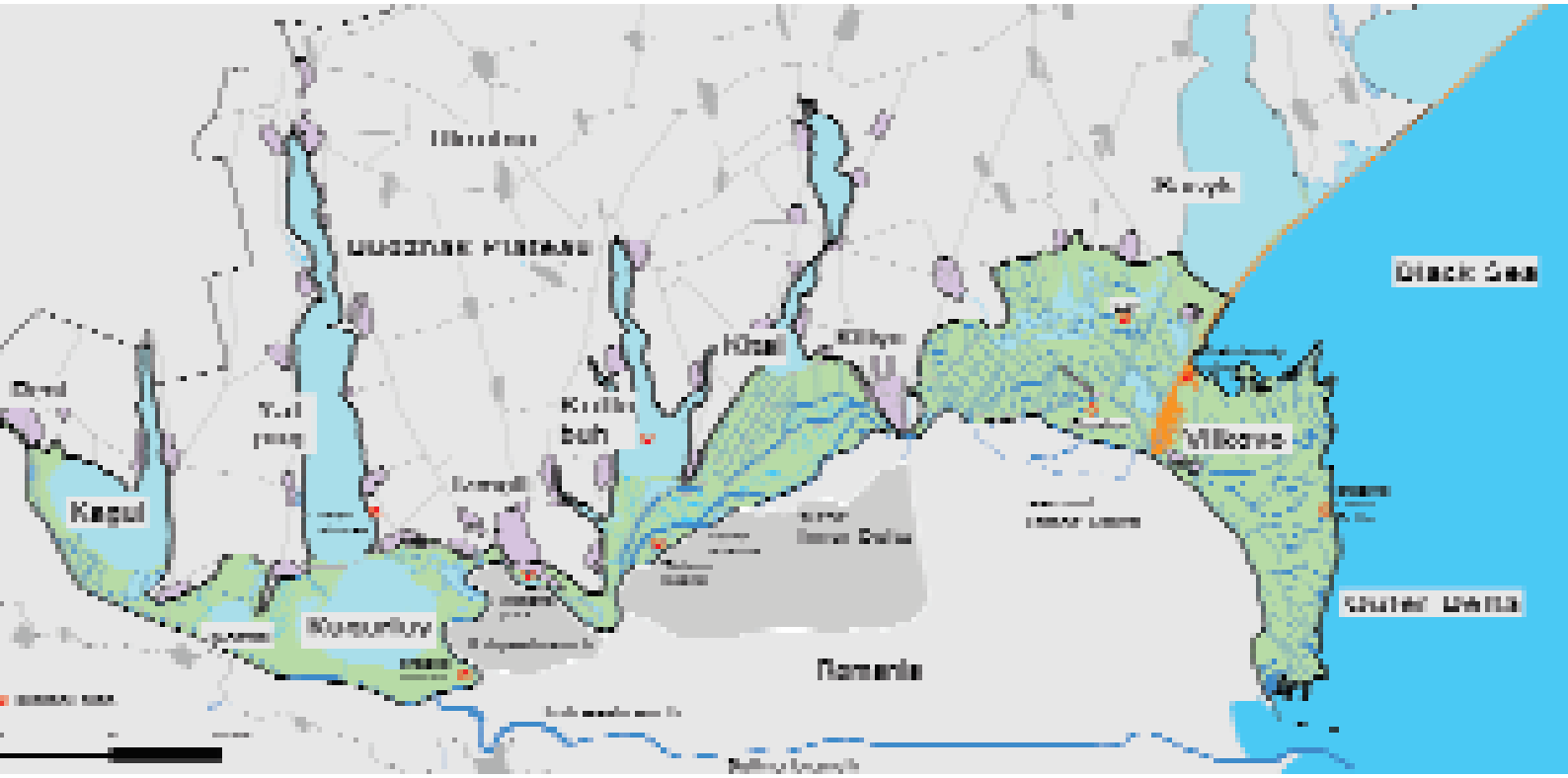
Transboundary cooperation, harmonisation of legislation and implementation of some elements of European Union law regarding water policy, as well as planned institutional reforms, will also assist project initiatives for restoration of the floodplain ecosystems in the near Danube area.

The Tacis programme proposes the establishment of a tripartite transboundary Biosphere Reserve between Ukraine, Romania and Moldova. As the Delta is a semi-natural system which does not recognise man-made boundaries, this initiative will be of immense help in supporting long-term conservation and harmonious sustainable management in the region. It will also provide an opportunity to offer more favourable terms for investment in sustainable use of the natural resources.

The first investments under the Tacis Programme, in sustainable agriculture, more efficient water use and development of ecotourism, are proving to be an important step not only for environmental improvement, but also for the provision of models of sustainable use of natural resources. These should encourage further investments in sustainable management of the region.

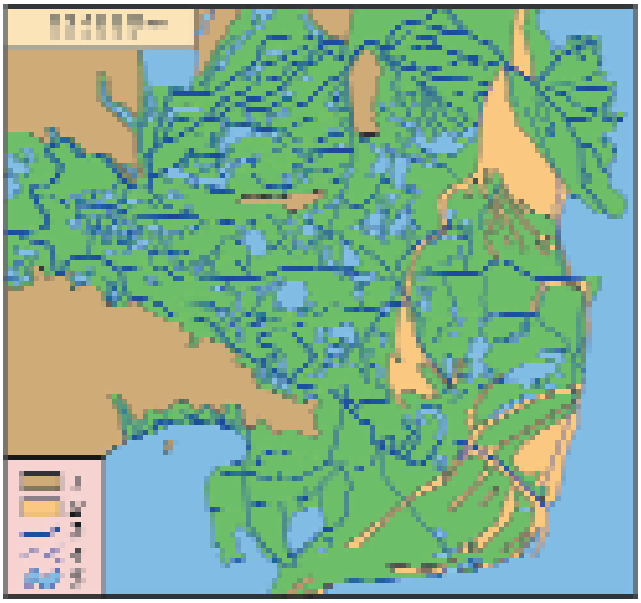
Successful approaches to sustainable use of natural resources and restoration of nature has provided the inspiration for proposing and activating the Vision. It is hoped that WWF, local authorities and the Tacis programme will cooperate to jointly and creatively apply the ideas contained in the Vision.

1 The EU's programme of technical assistance to the countries of Eastern Europe and Central Asia (EECA). The Programme supports the process of transition to market economies and democratic societies in the EECA countries. Amongst other activities it promotes environmental protection and management of natural resources.



TOP

Project area and model sites.



RIGHT

Scheme of the morphohydrographic net of the Danube Delta

1 forms of primary relief, surrounding the deltas
2 marine sand spits, once blocked the lagoon or formed under swelling on the delta periphery
3 branches
4 creeks
5 delta and near delta lakes

2 Understanding the Danube Delta system

2.1 THE DANUBE AND ITS DELTA IN UKRAINE

The Danube washes the south-west part of Ukraine for a distance of 170.6 km from the Moldavian border to the Black Sea. It flows through the Reni, Izmail and Kiliya districts of Odessa region forming part of the state boundary between Ukraine and Romania. About one-fifth of the total area of the Delta, that is 125,000 ha, is situated within Ukraine, of which 75,000 ha are land and 50,000 ha water. Conservation and restoration must take into account the different biotopes and their associated resource-use systems. To do this, it is necessary to understand how the systems function.

From the mouth of the Prut river to Izmailsky Chatal (the bifurcation point of the branches, and thus the head of the Delta) the Danube flows as one course with a general width of 600 - 700 m but in some places up to 1600 m, and a depth of up to 20 m. The length of this section is 55 km. Near the Izmailsky Chatal the river bifurcates into the Kiliya and the Tulchea branches. The latter flows into Romania and divides again after 17 km into the Sulina and St George branches.
The 116 km Kiliya branch has the highest discharge: about 60% of the total. For 55 km from the bifurcation point to the first Inner Delta near Izmail, it flows as one channel without islands but with five distinct bends. On this section the average width of the branch is 300-400 m but on bends it decreases to 250 m. The depth fluctuates from 14 m to 18 m.

On the Izmail-Kiliya-Vilkovo section, the Kiliya branch bifurcates twice, each branch turning into one stream again forming two inner deltas. The width of the main channel in this section is 300 m - 600 m, and that of secondary branches is 100 m - 300 m. The depth is 5 m -19 m.
Downstream of the city of Vilkovo, the Kiliya branch flows into the Outer Delta. The river bifurcates to the left into the Ochakovsky branch and to the right into the Starostambulsky branch. Downstream of this main bifurcation point the two main branches fork into numerous channels, with reedbeds stretching between them, and flow into the Black Sea over a length of 54 km. The Starostambulsky branch is the main channel. It is 23 km in length, 150 m - 400 m wide, and from 4 m to 8 m deep.

Scheme of the Kiliya branch

On the sea margin a sandbar has formed. Depth on the bar fluctuates from 1.2 m to 1.8 m. The length of the Ochakovsky branch is 15 km, it is 180-400 m wide and its depth fluctuates from 5.2 m to 1.5 m at the sandbar in the mouth of the river.

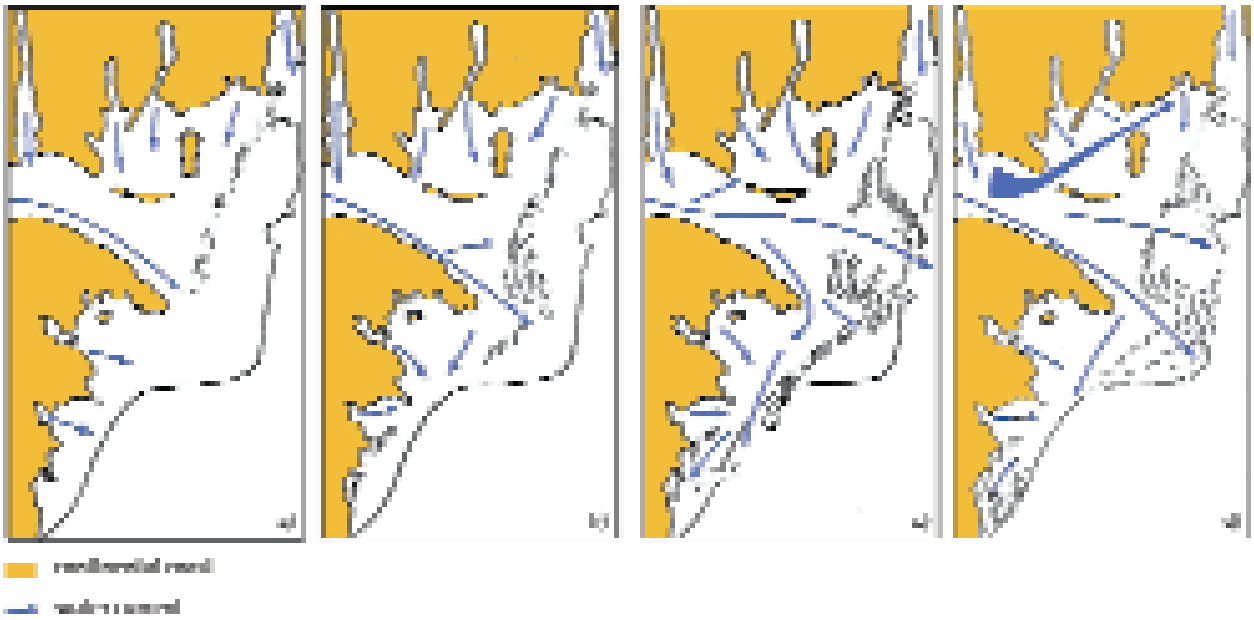
North of the Danube there is a series of lakes. They were formed when the Danube permanently flooded the lower parts of the valleys of tributary rivers. These large lakes or 'limans' form a distinctive feature of the Ukrainian part of the Danube Delta. Before the embankment of the Kiliya branch more than 10 smaller lakes could be found on the left bank of the Danube. The lakes now cover a total area of nearly 50,000 ha.

Skunda Canal between the Danube and Kugurluy Lake

Side channels are important parts of the waterway system of the Ukrainian part of the Danube Delta. They connect the main river with the limans. Before regulation of the lakes in the mid-1960s these were natural channels of varying length, periodically cleaned by fishermen. Now they are canals with sluices which serve to direct water to the lakes or to the river depending on the water level in the Danube and in the lakes.
It follows from the forgoing description that the Danube Delta is a diverse landscape. It is a complex hydrological network of natural branches, gullies, channels and artificial waterways such as canals. It also includes a great number of water bodies such as lakes (limans), lagoons and bays. The forces of the river and the sea formed the land in the Delta: islands, riverbanks and marine ridges, dunes, depressions, underwater bars and sandbanks. Man-made constructions are numerous as well: flood protection dams, rice fields, ponds, dykes, sluices, irrigation systems and other hydro technical constructions.

2.2 ORIGIN OF THE DANUBE DELTA

The Danube Delta is the result of interaction between dynamic processes in the transition zone between river and sea. It is located in a large bay which formed thousands of years ago when the rising sea flooded the river valley between the Budzak plateau in the north, and the Dobrudzha hills in the south. The bay is roughly triangular in form extending from Reni in the west towards the Black Sea.
The north-south sea current formed a long and narrow sandbar which closed off the bay. From that time until now, on the eastern or sea side of the sandbar the processes that govern the natural development of the Outer Deltas are dominated by the influence of the Black Sea, that is, by winds, storms and currents.



Scheme of the Danube Delta formation in prehistoric times
a) formation of a marine wave-cut wall Zhebriyany-Letya-Karaorman in the period of post-glacial climatic optium
b) formation of Karaorman ridge and beginning of forming Krasnikol, lupilor, Istriya and Stipok rigfes in the first half of the period between post-glacial climatic optimum and beginning of our era
c) formation of Letya ridge, a triangle delta of Sulinsky branch, such ridges as Krasnikol, lupilor and Istriya and beginning of forming a triangle delta in the mouth of Portitsa in the second half of post-glacial climatic optmum and beginning of our era
d) formation of triangle delta of Georgievsky branch and Kituk ridge, beginning of forming a northern branch (Kilysky branch)

On the western side of the sandbar a lagoon developed, sheltered from the influence of the sea. River flows, sedimentation and the drowning of some small river valleys shaped the so-called transition zone of the Delta. In subsequent interactions over thousands of years between the sea and the river, influenced also by tectonic movements, the Sulina and Kiliya branches and the structure of the Delta as we know it today was formed. Of the three main branches of the Danube, the youngest and most northerly one, the Kiliya branch, is currently the most active, carrying more than 60 % of the water and sediment to the sea. The Outer Delta, east of Vilkovo, was formed from about 1770 onwards.

2.3 CURRENT STATUS OF THE UKRAINIAN PART OF THE DANUBE DELTA

Aspects of the importance, often on a global scale, of the biodiversity of the Danube Delta were presented in Chapter 1.1 above. There can be no higher accolade than the presence of a World Heritage Site in the Romanian part of the Delta. UNESCO Biosphere Reserves on both sides of the border also attests to the region's international values as does its inclusion in WWF's Global 200 list of exceptional sites.
Though the delta territory is unique from ecological point of view, it lost many natural components, and lots of species are endangered. In the Danube delta there are 32 bird species, 21 species of higher plants, 17 fish species and 7 species of mammals listed in the Red Data Book of Ukraine. 7 fish species are included in the European Red List. 8 bird species, one species of the dragonfly and one amphibian species are in the International Red List of IUCN. The text below describes the most typical and unique features of wild nature in Ukrainian Danube delta

THE DELTA AS A REFUGE FOR ANCIENT SPECIES

The Danube water bodies are a refuge for many Pontocaspian relict species, mainly distributed in limans and the less saline parts of the Black Sea basin where conditions remain comparable to those in the ancient Tertiary basin. Some of these species are endemic, meaning that they are found nowhere else and rely on very specific ecological niches. If there were to be a decrease in the river discharge to only a little below 2000 levels, the salinity of the water in the limans is expected to rise possibly provoking the loss of some relict species.
Pontocaspian fish species are represented by 5 Sturgeon species and 5 species of goby (gudgeon). Between the 1956 to 1959 and 1995 to 1997 period, average annual sturgeon catches (3 species) dwindled from over 47 tons to 0.7 tons.

A FUNCTIONALLY IMPORTANT CENTRE AS A MIGRATORY CORRIDOR AND WINTERING AREA FOR THE WESTERN COAST OF THE BLACK SEA AND EAST EUROPE

The Delta lies on one of the main migratory routes for birds, the Eastern Mediterranean flyway, who use the abundance of varied habitats at the junction between the river valleys and coast for stopovers before they depart to North Africa, Southern Europe and the Near East.

AN ECOLOGICAL NETWORK THAT IS STILL LARGELY INTACT

The steppe, floodplain and coastal biotopes of the Danube Delta are still linked through branches or corridors that allow genetic exchange between individuals of species of low population size.

AN OUTSTANDING EXAMPLE OF LIVING DELTAIC PROCESSES

Although muchimpaired by hydraulic works in the Delta and up-stream on the Danube, there are probably enough functions left to be able to carry out restoration which will have a significantly favourable impact on the habitats, wildlife and processes of the Delta (see 2.4). The Vision takes this as a working hypothesis and will test it and its articulation with local communities and their economic and social welfare as part of the proposed model projects.

AN ECONOMIC RESOURCE

In addition to its importance for water supply, the Ukrainian part of the Danube Delta is used for fishing and fish-breeding. Although the catch of many fish species has decreased tenfold over the last three decades, the importance of this resource in the economy remains large. Reed harvesting for building and industry, haymaking and cattle grazing in the floodplain, hunting and collecting for commercial use (for example, frogs and introduced species such as the Muskrat) also make an important contribution to livelihoods. An increase in biological resource use after World War II raised the incomes of local residents and the population of the Delta.

2.4 LANDSCAPE FORMING NATURAL PROCESSES

Natural processes in the Danube Delta are dominated by the river and the sea. River dynamics in the form of rising and falling water accompanied by erosion and sedimentation, shape the landscape. At the coast, the sea gains the upper hand by re-shuffling the sediments originating from both the sea and the river.

Plant growth responds to abiotic processes by producing immense reedbeds and gallery forests along the rivers. Large herbivores make an impact on the landscape by changing the composition of the vegetation and they too change their behaviour according to the impact of changing water levels and weather conditions. As everywhere in Europe, natural grazing has almost disappeared, and will be described in its former role.

While all these processes are inter-dependent and therefore difficult to separate, the description that follows first reviews the functions of the river which tend to be most influential in the inner areas of the Delta, and then the influence of the sea which is strongest in the Outer Delta and, finally, the formation of vegetation and influence of grazing animals upon it.

THE INFLUENCE OF THE RIVER

INUNDATION OF THE FLOODPLAIN AND THE LIMANS

In times of flooding the Danube used to inundate its entire floodplain. In the Ukrainian part of the river, all the land between the river and the edges of the Budzhak plateau were flooded including the islands in the river. In the north the limans had open connections to the river and their water levels rose and fell according to the river levels. This cycle reached as far as 40 km inland along Yalpug liman. The impact of this regular flooding was important for the following reasons:

- *Natural fertilization of the floodplain*
  The waters of the Danube have always carried enormous quantities of nutrients now intermingled with components of artificial fertilizers and various other pollutants. Year after year nutrients were carried into the Delta nourishing the vast reedbeds, the underwater vegetation and the imposing gallery forests alongside the rivers.
  In the hot and arid climate of the Black Sea basin, the Danube Delta was, and still is, an oasis of abundance and lush vegetation compared with the dry steppe landscape around it.

- *Desalinisation of the floodplain*
  In a region where evaporation is far greater than precipitation, salts from the groundwater tend to concentrate in the upper layers of the soil. The long and regular floods counteract this process by flushing out the salts. The system itself moderated the negative impact of the dry climate.

- *Refreshment of the water in the limans*
  The long and narrow limans or lakes in the drowned river valleys in the north have a tendency to accumulate nutrients and other salts even under natural conditions of evaporation, contributions from

tributary rivers and rainwater flowing directly from the surroundings. In modern times, salts from artificial fertilizers used in agriculture have been present.
During floods, water from the Danube enters the limans, pushing levels up to 5m in the western limans, and up to 2.5m in the limans between Izmail and Kiliya. In times of low water, the shallow limans almost completely emptied into the Danube. The rhythm of the regular inflow and outflow of the water can be seen as the 'breathing' of the lakes whereby fresh water is brought into the limans and accumulated salts are carried away.
The Danube Delta therefore was a self-fertilizing and self-cleaning natural system

- *Creation of natural biotopes for plants and animals*
  The abundance of water, fertility and the scale of the Delta laid the basis for the richness of the ecosystem and attracted a great diversity of flora and fauna. As will be indicated in the chapter on Human Impact, the consequences of the embankment of the floodplain have been disastrous: the very core of the natural system has been corrupted.

TRANSPORT OF SEDIMENTS AND NUTRIENTS

Over the course of thousands of years, the lagoon between Reni and the sandbar at Vilkovo on the coast was gradually filled by sediment from the river in a complex history of falling and rising sea levels. Today, the area is still extremely flat. The western part, at Reni, lies only 2m higher than the eastern part at Vilkovo, 150 km away.
The branches of the Danube are relatively narrow and very deep. For an annual discharge of 16,000 m^3/sec, the width of not more than 300-500m in many places must be compensated for by depth. Thus the river is often more than 15-20m deep. This means that even at 150 km from the sea the bed of the river is 12-15m below sea level. As a consequence, the capacity of the river to deliver water to the sea is very large. In times of low water, all the water, silt, sand and nutrients ssimply pass to the sea along the main channel through the eastern part of the delta without contact with the floodplain.
In the past the Delta became almost completely inundated during flood seasons and some nutrients and silts entered into the floodplain. The capacity of the deep main river channel, however, was so large that even then most of the water, with most of the silt and nutrients and all of the sand, went directly to the sea. After the construction of embankments over the last 40 years, however, almost no water, sediments or nutrients enter into the floodplain. This has far-reaching consequences for several key processes in the Delta as a whole:

- *Slow growth of the inner parts of the Delta*
  As most of the sediments passed through the Delta towards the sea, there was not much available for increasing the height of the Delta. Thus growth of the Deltaic plain between Reni and Vilkovo was slow and the area remained flat. These circumstances account for the existence of the very extensive plains with reedbeds and lakes both on the Romanian and the Ukrainian side. Had there been more sedimentation, these lakes would have filled up long ago.

The embankment of large parts of the floodplain and most of the islands in recent times have completely stopped the process of growth.

- *Filtering of the river water*
  When the waters of the Danube entered into the immense reedbeds and lakes of the vast floodplain over an annual four-month period, at least part of the water was filtered by the floodplain: silt particles were removed and nutrients supported luxuriant reed growth. Even then, the main discharge of water went through the deep main branches of the river, without entering the floodplain. In the present situation, the floodplain is embanked and in the Ukrainian part of the Delta almost no water flows through the reedbeds. The filtering capacity of the Delta between Reni and Vilkovo was always weak but the embankment now prevents all filtering in the reedbeds.

- *Formation of riverbanks*
  The Danube carries enormous quantities of silt and sand, but only a fraction of it is available for the build-up of the western part of the Delta between Reni and Vilkovo. As already mentioned, most of the sediments remain in the deep river channel and simply by-pass this part of the Delta on their passage towards the Outer Delta.
  During flooding some of the silt particles in the river water were, nevertheless, deposited on the riverbanks and in the adjacent stretches of reedbeds but only low ridges developed in the section between Reni and Vilkovo. So, sedimentation was low, and the growth of the riverbanks as a consequence was slow. In the present embanked situation, sedimentation is almost absent, except for the narrow strips of land not encircled by dykes.
  Being the highest places in the Delta, the riverbanks were populated by alluvial forests in high and narrow galleries tracing the lines of the rivers and creeks through the expanses of reed.

- *Growing with the sea*
  Over the last two centuries, the oceans and related seas have risen by about 40cm. Apparently, the siltation rate of the Danube floodplain, even though it is quite slow, kept pace with the water level rise in the Black Sea. At least the riverbanks remained dry while the main surface of the Delta, the extensive reedbeds and shallow lakes of the Romanian part never received enough sediment to become completely dry, neither was it flooded by the sea.
  In the near future it is estimated that sea level rise, including the Black Sea, will be stronger - an estimated 50cm - 90cm during this century alone. In order not to be completely drowned, the area must be allowed to receive the available sediment and thus to keep pace with the level of the sea. The future existence of the Delta depends on the interaction between two forces: the inevitable rise of sea level, and the ability of the Delta to accumulate enough sediment to grow with the sea.

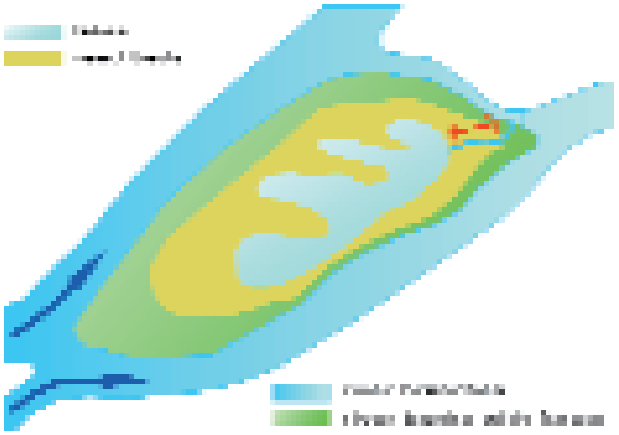
TOP
Inner lakes and reedbeds of Daller Island

BOTTOM
Daller Island from the air

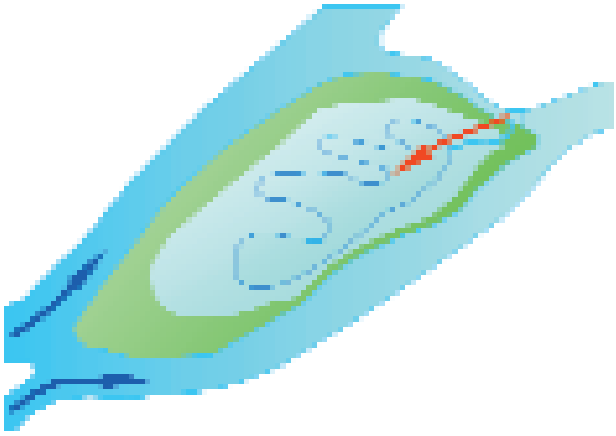
ISLANDS

Islands can be found at several places in the river. They developed in the same way as the riverbanks, but in a distinctive form. The riverbanks developed around the island hence their saucer-like shape, high at the outer edges and lower in the middle. On the outer ridges forests developed and the inner side of the island is covered with reedbeds and lakes. On the two Daller Islands in the First Inner Delta the characteristic shape and vegetation is still visible.

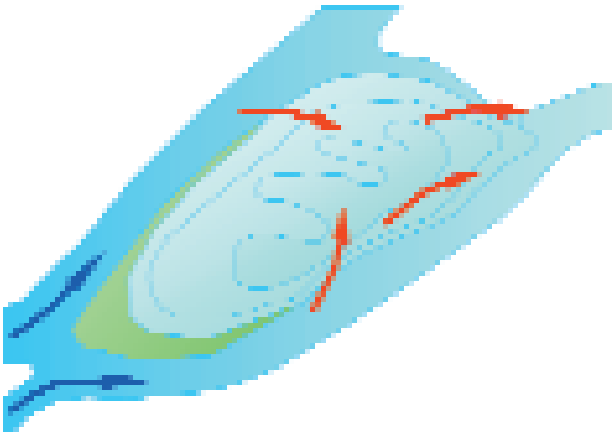
The figures on the next page show the geomorphological processes in the river which produce islands formations.



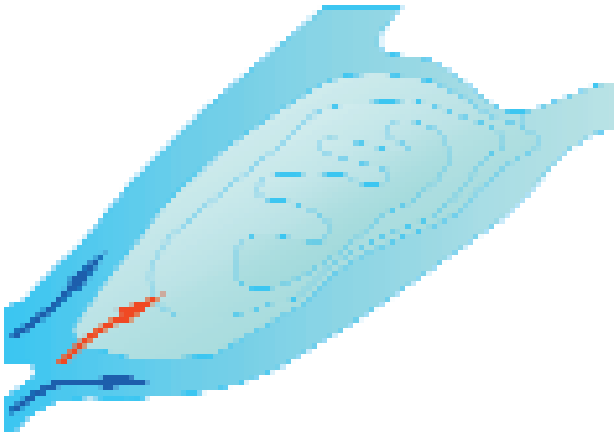
a) An island in the Danube Inner Delta during low water. The highest parts form a ring around the island, covered with alluvial forest. The inner parts are lower and consist of reed beds and lakes.
Often, exchange of water and fish is possible through a creek at the downstream end of the island



b) When the river rises, water flows in through the creek filling the inner part of the island. Because of the reversed direction of the current relatively little silt is brought into the middle of the island



c) When the water rises even higher, the lowest parts of the outer ring start to overflow. Water flows through the vegetation on the river banks where silt is filtered out and hence concentrated



d) Eventually even the highest point of the island is flooded. The island then becomes a part of the river. During high floods, sedimentation is concentrated at the top of the island

THE INFLUENCE OF THE SEA

OLD DELTAS AND MOVING DUNES

The original sandbar that thousands of years ago closed the lagoon from the sea developed over time into a long and wide area of sand and dunes. Dune formation is still going on but for various reasons, they are not as high as the ancient sand barrier. In the Ukrainian part of the Delta, the Zhebriansky ridge near Vilkovo is the only representative feature of the barrier. Under the prevailing climate the dunes are hot and dry much like deserts although they are surrounded by water. The extreme, dry conditions adds to the richness and diversity of the natural biotopes in the Delta.

To the east, the Zhebriansky ridge gradually slopes down into a shallow

TOP
Zhebriansky ridge

LEFT
Vilkovo and Zhebriansky ridge about 1780: no Outer Delta has yet formed
(National Archives, Vienna, detail)

wetland area where the soil is mainly sand, in contrast to other parts of the Delta where it is mostly heavy clay. The wetland area at the foot of the ridge gradually turns into the reedbeds and creeks of the Outer Delta.

TRANSPORT OF SAND, SILT AND NUTRIENTS TO THE OUTER DELTA

The main discharge of water, sediments and nutrients of the Danube (60-70%) is carried through the Kiliya branch. The form of the narrow and deep river bed causes most of the sand, silt and nutrients to pass through the western part of the Delta towards the Outer Delta, as was shown in the previous sections. The Outer Delta developed from the 1780s onwards and thus is very young. Apparently, before the 1780s the sediments were deposited in the Delta west of Vilkovo.

Sandbar in sea at the outlet of a river branch

The quantity of sediment that reaches the Outer Delta is very important for the growth of this most dynamic part of the whole system. During the 19th century, the quantity of sediment increased because a more extensive area of land in the catchment basin was brought into cultivation. On the other hand, the influx of sediment decreased sharply after the construction of the Iron Gate dams in the middle of the 20th century. The amputation of the floodplain by the embankment of the entire Delta has further decreased the influx of sediments.

PROCESSES IN THE OUTER DELTA

- *Formation of sandbars*
  The sediment brought by the river to the sea together with sand that originates from the sea, is acted upon by waves and currents. The force of the waves continually creates sandbars in the coastal area.
  The sandbars develop parallel, north - south, to the coastline and thus perpendicular to the west-east course of the river. The north-south current transports the sand towards the south, hence the asymmetric fan-like form of the Outer Delta. Locally the sandbar develops into dunes.

- *Numerous outlets, reedbeds and the filtering of silt and nutrients.*
  The sandbars block the river mouths. The main branches of the Danube in the Outer Delta, often more than 10m deep, suddenly become very shallow, only 1.50m, at the point where the river meets the sea. Behind the sandbars, the dunes and the shallow river mouths, the water stag-

nates. Silt is deposited and, in the shallow waters, reedbeds develop. The discharge of the Kiliya branch flows through many small river arms towards the sea and along one stretch seeps through the reedbeds. The Outer Delta therefore has a bowl-like shape: a series of ever-renewing sandbars at the outer edges of the Delta and behind those an area where silt deposits, reedbeds develop and many branches bifurcate.

The bowl-like form of the Outer Kiliya Delta creates a huge filtering capacity, which takes vast quantities of sand, silt and nutrients out of the river.
Neither dykes nor embankments have been constructed in the Outer Delta so the area retains many of its natural qualities. Some of the larger river branches, however, used to be dredged for shipping which provided an artificially easy outlet for water, sediment and nutrients. Both the filtering capacity and the growth of the Delta have been negatively affected by the dredging.

VEGETATION PROCESSES: FORESTS, REEDBEDS AND GRAZING

The physical circumstances in the Delta are such that in the shallow waters reedbeds predominate. Where riverbanks have developed, the land is high and dry enough for the development of alluvial forests. The lakes, smaller channels and canals are hosts to a range of aquatic plants. The strong tendency to develop reedbeds and forests can be considered as a landscape forming process. Intricate interactions and counter-forces cause the development of a mosaic of these main vegetation types.

GALLERY FORESTS

As the banks of the river are relatively high there is a strong tendency towards forest formation. On the drier lands forests of willow, black and white poplar, ash and occasionally elm, hawthorn, blackthorn and wild pear are found. WILD GRAPE grows as lianas in the tree canopies. Where the soil is wetter only willow remains. As the highest elevations border the rivers, monumental ridges of tall forests trace the river courses across the landscape (Gallery forests).

Without any interference, the high banks along the river(s) would be completely covered by forest. There are processes that do interfere, however, including erosion by the river itself, ice flows and storms. Even biotic forces make an effort to eliminate the forests: bird excrement, especially that of cormorant and heron colonies, may damage forests locally. Large grazers also restrict the development of forests. Where there are sufficient countervailing forces to forest development, a mosaic of larger and smaller thickets develops. The characteristic forest landscape is thus the result of a dynamic balance between maturity and a range of stages and variations in the development of the woodland.

TOP
Natural gallery forest at Tataru Island

BOTTOM
Overgrazed willow forest along Kislitsky branch

A corridor of willow forest in unbroken stretches of reedbed in the Outer Delta

REED

The terrain becomes gradually wetter in the direction of the lakes that lie behind the riverbanks. There the soil is too wet for forest and reed becomes the dominant vegetation. The limits of reed growth are determined by inter alia the intensity of shade at the forest-reed interface while at the same time water determines to which point trees can grow This interaction often causes complicated transitions from forest to reed.

Young reeds are very vulnerable to grazers especially in places where the forest has disappeared and reed growth could be expected. Cattle will continue to graze reed even at water depths up to their knees; in such cases they create zones with open, shallow water between the dry land and the deeper reed beds. Here, too, there is thus a dynamic balance between the grazers' influence and the inclination of reed to spread from the water to colonise the banks.

Reed cannot develop if its stalks are completely flooded in the growing season and this occurs quite frequently during the spring floods. In exceptional cases, lengthy inundations (ecological 'disasters' that define the limits of the system) mean that vast reed expanses die back locally and temporarily.

GRAZING

Under natural conditions, the habitat mosaic of water bodies and their aquatic flora, lush gallery forests along the river branches and extensive reedbeds, attract plant-eating animals of all kinds. The small ones, from caterpillars to hares, only occasionally act as landscape-forming agents.

Large herbivores have, however, a significant influence on the vegetation structure of an area, and literally eat a subtle mosaic out of otherwise monotonous vegetation. In the case of the Danube Delta, this applies especially to the higher parts of the area, that is the sand ridges, dunes and riverbanks.

- *Agricultural grazing and natural grazing*
  Domestic herds in the Delta tend to operate in densities of 1 - 5 animals per hectare whereas natural grazing densities are around 1 animal on 5 - 50 per ha depending on the climate and the fertility of the soil. Under domestic regimes, reedbeds disappear or are forced back into deeper water. Similarly, forest is damaged through the loss of young trees. First, wooded meadows develop (*page 23*), and gradually, as the trees age and die, almost treeless meadows are left. Domestic grazing leads towards impoverishment of the landscape by diminishing the variation in vegetation types.
  Extensive grazing, that is where indigenous animals, living in feral conditions, are able to maintain themselves over a long period, is in far lower densities. Only experiences in model sites will show the optimal densities for survival of the different species, and the exact influence on the landscape.

- *Grazing on riverbanks outside the forests*
  Several of the large herbivores, especially horses and feral cattle, prefer to live in open spaces outside forests and shrub, although they may enter the forest for protection against wind, sun, cold and snow.
  The availability of food in winter, and especially in early spring, largely determines the number of animals that an area can support without degradation occurring. This means, that in late spring and early summer, there is more vegetation available than the animals can eat. Herbs grow high and flower freely. In the rougher vegetation some young wild trees are protected and are able to grow. As willows and poplar germinate only on open land, these may be ash, elm and wild apples and pears. Some of those will be eaten in winter, others will survive and form solitary trees or bushes.

- *Grazing in the alluvial forests*
  Roe deer, Red deer and Fallow deer prefer woodland habitat, feeding on shrubs, branches of trees, and young buds. Occasionally they leave the cover of the forest and enter into the surrounding meadows. The influence of the animals on the trees and bushes is considerable. Cropped branches encourage new more bushy growth thus augmenting the productivity of the woodland. A forest without browsers offers a less bountiful food store. With browsers present, there is plenty of food even for the occasional visits of horses and cattle. In a rich natural environment the results of browsing can be found at different heights: low levels for Roe deer, middle range for the Red deer. Browser marks high in the shrubs mark the presence of elk.
  The influence of browsers in the forest can become more extreme for example in times of famine when the bark of adult trees can be completely removed.

Browsing in a forest improves the variation in habitats and the availability of food.

- *Grazing in the reedbeds*
  Boar, Elk and to some extent Roe deer and Red deer graze in the reedbeds. Hare and cattle will enter dry or shallow reedbeds to eat the young shoots.
  As was mentioned above: where intensive grazing can devastate reedbeds on dry ground or in shallow water, grazing in natural densities enlarges the spatial variation and the structure of the vegetation.

- *Introduction of natural grazing and browsing by large herbivores*
  Every landscape has its own characteristics. The conditions required for the survival of large herbivores and their precise impact can only be determined by trials in model sites.
  In the Ukrainian Danube Delta a few of the original indigenous herbivores are still present: Wild Boar is numerous all over the area, Roe deer live in small numbers in the forests and Fallow deer are found on Tataru Island. Exploiting the beneficial effects for conservation of grazing by these animals requires managing their populations so that they are in balance with the capacity of their environment.
  As the optimum populations are unknown, the first step in the model sites will be to stop hunting at least temporarily. This will change the behaviour of the animals making them less wary of humans and therefore more visible in the landscape. Numbers will grow. The density at which significant migration of animals out of the site occurs, indicating growing social tension, is the point at which population management, if necessary at all, can be introduced.
  The Danube Delta is one of the rare places in Europe where a group of feral cattle have managed to survive independently in a natural environment. The process of adaptation has taken more than 40 years. Groups of these animals could be brought to model sites. If hunting (regulation of numbers) is stopped, a natural dispersion through the Outer Delta could be expected. At some locations, dispersal of the population could be helped by making low hills above high tide level.
  Other species must be re-introduced. They are indicated in the list below, and in the chapters on model sites the topic of herbivores will be revisited.
  As most of the Delta is (or should be) flooded periodically, the animals can only survive if they are able to reach higher areas. At the coast, the dunes provide such an opportunity. In other places, such as on the Kugurluy riverbank, Tataru and Ermakov islands, low artificial hills will have to be constructed. In time, the animals will learn what to do during flooding.

- *Large herbivores of the region*
  Roaming species such as HORSES, AUROCH, ELK and DEER would have followed the network of rivers to and from the Danube Delta and, of course, the Danube itself has its own enormous hinterland. The large herbivore species identified below are mentioned in the literature; many would have used the corridors offered by the rivers and been attracted by the 'green lungs' of the Delta within the vast dry steppe

areas surrounding it. The list offers the basis for further discussion on potential introductions.

SAIGA ANTELOPE and KULAN ASSES, inhabitants of the semi-deserts and steppes as far west as the Prutt River, would in prehistoric times have come to the Delta to feed during drought. Kulans inhabited the steppes of Ukraine until the 12th century. As these species were simply guests in the Delta, it is unlikely that a good site for them could be found now.

Although thought to be a forest species EUROPEAN BISON inhabited the steppe zone as well and will have visited and used the higher ridges of the Delta. As Bison avoid muddy areas the clayey parts of the Delta are not suitable for them leaving only the sandy slope from Zhebriansky ridge towards the Outer Delta.

WILD HORSES and AUROCHS will have grazed on the ridges along the river branches, that is, on in the transition zone towards the extensive Budzhak loess plateau. As feral cattle already exist in some locations in the Delta, they can be brought, or allowed to migrate, to other areas. As for horses, their domestication history is more recent than for cattle, although hardy animals from local races would soon behave as wild horses.

RED DEER, ROE DEER and FALLOW DEER will have inhabited the alluvial forests and the shallow parts of the reedbeds, as the last two still do. Red deer could be re-introduced into several locations.

The distribution of ELK, now restricted to northern parts of Europe and America, used to include the shores of the Black Sea and this species will have grazed the gallery forests and the marshes of the Danube Delta. The Elk could be re-introduced especially where large shallow reedbeds, forests and dunes come together.

The BEAVER had an even wider distribution than the elk, including the Black Sea area and Turkey. It could easily be re-introduced.

Large populations of WILD BOAR are present in the reedbeds. GEESE will have used the grazed meadows on the riverbanks and they still have an important influence on the grasslands and the reedbeds.

INTERDEPENDENCY AND FACILITATION

Different species have different needs and behaviour and the interaction between them has a very complex impact on the landscape. Where the riverbanks are high enough, a mosaic of grassland, areas with rough vegetation, solitary trees, bushes and forest develops. In this mosaic landscape competition for food between the different species is not the only process at work. Facilitation is as common: horses eat the low grass that only exists because cattle have eaten the rough vegetation. Roe deer leave the forest for periods and graze the grass left by horses and cattle. The latter enter the forest on hot summer days and graze on twigs and young leaves.

The impact on the landscape is large and varied, fashioning the biotopes for a rich ecosystem.

TOP
Grey heron

MIDDLE
Spoonbills

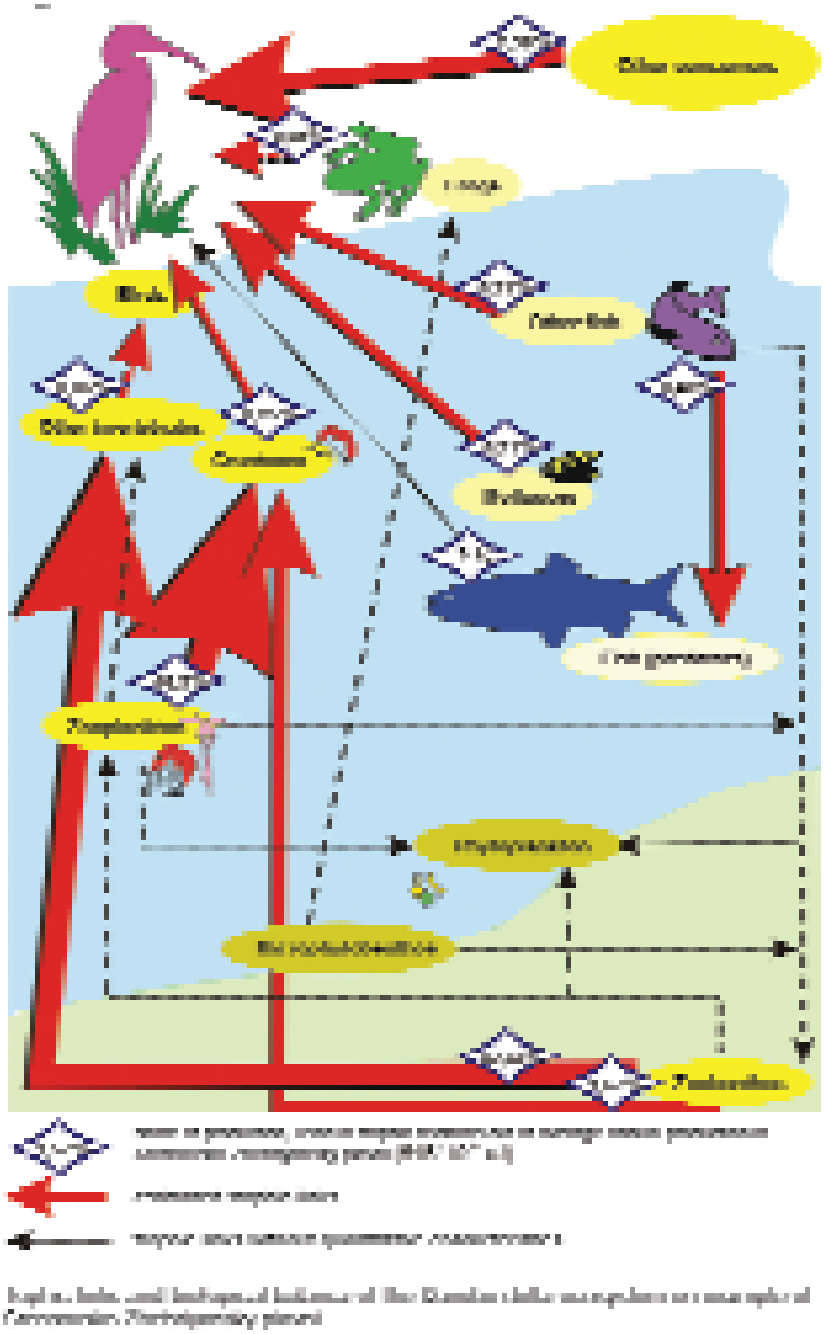
BOTTOM
Reed: a key species

Mosaic of water, reed and waterplants

VARIATION IN TIME AND SPACE AS A BASIS FOR BIODIVERSITY

The processes of the river and the sea form the basis of the ecosystem of the Danube Delta, an ever-changing mosaic of flowing or still standing water which may be rich or poor in nutrients, loaded with silt or crystal clear, deep or shallow, with an endless alternation of reedbeds and lakes. This mosaic landscape with its countless gradients and forms, further sculpted by herbivores is, in its turn, the basis for an endless variation in biotopes supporting great species richness.

Relatively few areas are dry in this landscape although the riverbanks are dry enough to develop riverine forests. Here large herbivores might add even more variation and structure.
The dry climate of the region tends to generate vast stretches of monotonousness: the largest reedbeds as well as the most extensive steppes in Europe are part of or adjacent to the Danube Delta. The contrast to the intricate, complicated mosaic-structure of the higher parts of the Delta have contributed to the natural richness of the region.
This green lung within the dry steppe area was (and is) a refugium for many species, both inhabitants of the Delta itself or migratory species.



Food chain in the Danube Delta

The key plant species in the Danube Delta is certainly Reed *Phragmites australis* covering a total area of 284,000 ha which is the largest extent in Europe. Mass growth of some algae species belong to the basis of the ecosystem as well.

Key species among birds are colonial breeding birds as Grey Heron, Night Heron, Glossy Ibis, Spoonboll, Pygmy Cormorant, Ferroginous Duck, Pochard, Red-crested Pochard, Coot and Greylag Goose.

Boys fishing

3 Human impact on the natural landscape

People have used the resources of the Danube Delta for many thousands of years. First as nomadic hunters and gatherers notably of the fish resources, later applying agricultural techniques as well. From the 19th century onwards dredging and canalisation for shipping changed the course and the behaviour of the river branches but the most important processes were still almost natural until the middle of the 20th century. In the second half of the last century, the Ukrainian, and large parts of the Romanian Delta were embanked or converted into polders.
Most of the towns and villages of the Ukrainian Delta are not located in the floodplain itself. With the exception of Vilkovo, settlements are on the slopes of the Budzhak Plateau, high above the floodplain including the homes of farmers who work on land in the floodplain. Even after 40 years of embankment, only a few houses have been built in the floodplain near Izmail, and in some villages.
Vilkovo was built in the floodplain at a point where the variation in river levels is relatively low: less than one meter. Occasional flooding by the sea or the river is, however, a threat. Many of the small gardens around the town are regularly flooded.

3.1 TRADITIONAL USE OF THE DANUBE DELTA ECOSYSTEM

Traditional uses of the natural resources of the Danube Delta are:

- small-scale hunting, trapping and fishing for their own consumption by the local population;
- reed-harvesting for fuel and building material;
- collection of medicinal herbs for folk as well as for conventional and homoeopathic medicine;
- around some villages, especially Vilkovo, small-scale horticulture for home and local markets is practised;
- bee keeping for honey production in spring and autumn.

These activities have traditionally taken place within the ecological capacity of the system. Some of them, such as fishing and, more recently, reed harvesting have also developed at industrial scales in parallel with traditional use.

3.2 CHANGING LAND USE AND ITS INFLUENCE ON THE NATURAL PROCESSES

THE DISAPPEARANCE OF THE LARGE HERBIVORES

Most of the species that once played a part in forming the landscape (see chapter 2.3) disappeared long ago in a process stretching over thousands of years. People had altered habitats to such an extent that their survival was no longer possible. They had also been hunted to local extinction or to unnaturally low population densities, or they came to be domesticated in unnaturally large populations.

With the disappearance of the herbivores, the dynamic balance between plant growth and plant consumption collapsed. The landscape was deprived of the richness of the endless variations in structure caused by natural grazing in natural densities, although we have seen that some remnants of large herbivore grazing have survived in the Delta in the form of feral cattle and some deer species.

OVERGRAZING WITH DOMESTICATED CATTLE AND HORSES

Domesticated cattle and horses are abundant in the Delta area. Stocking densities are 10-30 times higher than natural conditions allow. Overgrazing causes quite the opposite of natural grazing: it damages the natural vegetation and causes the disappearance of the alluvial forests and the shallow parts of the reedbeds. Plant communities disappear and simpler, pioneer communities return. Human impact by allowing overgrazing causes the degradation of important landscape elements and the simplification of the ecosystem.

FORESTS DESTRUCTION BY FIRE

Setting fire to reedbeds during the Christmas period is one of the traditions of the inhabitants of the Delta. It is believed that this practice keeps the reed healthy. At the very least, solitary trees and groups of trees that grow along the river branches, or on the rare elevated spots in-between the reedbeds, die and cannot re-establish themselves. This flattens the vertical structure of the area and takes away one of the very characteristic elements of the Delta: alluvial forests. Neither the steppes to the north nor the reedbeds in the Delta support forests, so the riverine and island forests along the Danube are the only ones in the region. Of course over-intensive timber harvesting has also contributed to the disappearance of the forests.

SEMI-NATURAL FOREST ON THE RIVERBANKS AND ISLANDS

The 'Iron Curtain' between the former Soviet Union and Romania brought benefits for the forest. In the 100-1,250m wide strip between the electrified fence on the dyke and the Danube and on several islands in the border zone, a semi-natural alluvial forest developed which is now about 35 years old.

EMBANKMENT OF THE FLOODPLAIN

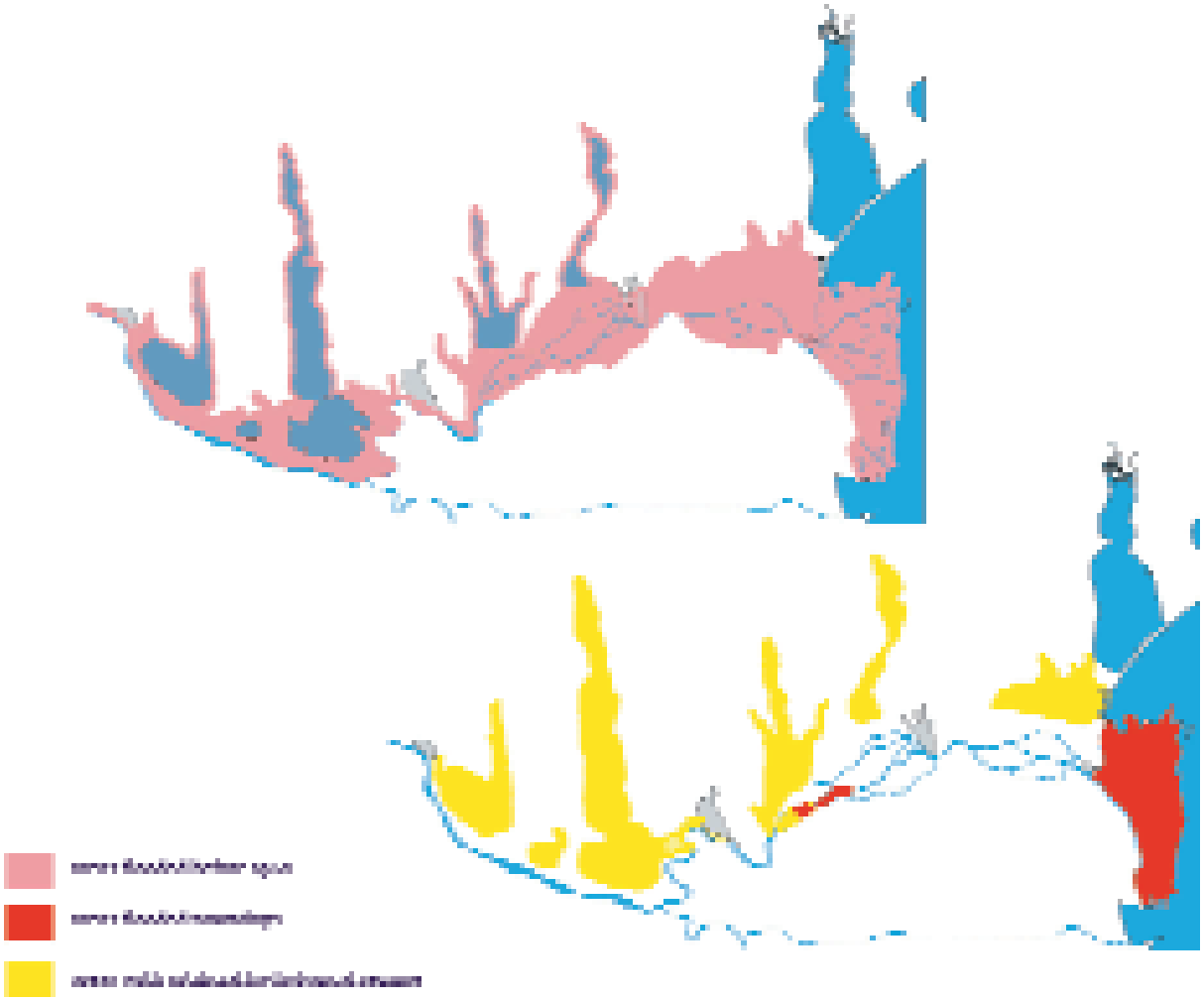
The whole floodplain of the Ukrainian part of the Danube Delta was embanked between 1955 and 1970. The dykes were built very near to the river at a distance of 100-150m. Only three islands escaped this fate: Tataru and both the Daller islands. The Outer Delta was not embanked. The shallow lakes or limans were cut off from the river. At first, a stable

Results of fire: young sprouts of reed and dying trees

water level in the lakes was maintained with sluices and canals, later more dynamic water management was introduced. During the earth-works for the construction of the dykes and canals, many natural side channels and gullies were filled up, trees were removed and higher areas levelled out. Much of the pasture was turned into arable land including rice growing.

The impact of the embankment has been dramatic:

- The intricate, interdependent network of biotopes collapsed. Forests, natural meadows, spawning places, slopes of all kinds, disappeared. Natural habitats became fragmented.
- Geomorphological processes that fashioned the floodplain have come to a halt. Ridges no longer grow, gullies are non-existent and the relief is flat. The Delta no longer keeps pace with the rise in sea level.
- Filtering of sediments and nutrients in the Danube water by the immense reedbeds has stopped. All sediments and nutrients are delivered directly to the Outer Delta and eventually to the Black Sea.
- The ecosystem that depended on this hydrological network and on these processes collapsed and is transforming into saline steppe.
- In the dry climate, large-scale salinisation of the floodplain has occurred. This has brought a dramatic loss of fertility for agriculture as well as for the natural vegetation, and a trend towards an extreme salt and brackish ecosystem in the midst of a freshwater environment.
- The annual refreshment of large parts of the limans has ended; their use as drinking water or even for irrigation has become impossible.
- Expecting great profits from higher water tables in the shallow limans, the fisheries found instead that natural fish propagation came to a



Floodplain of the Ukrainian Danube, before and after embankment

halt. After moving on to artificial fish breeding, the growth in harvests of the exotic fish species which were introduced stopped after a few years. Catches are now only 1/3 of those that used to be harvested under natural conditions.

- Locally, as in the Kugurluy and Kartal lakes and in the Stensovsko-Zhebriansky-marshes, new and different ecosystems developed. These have valuable characteristics of their own but they do not fit into the larger framework of the Delta.

3.3 TOWARDS A TECHNOCRATIC LANDSCAPE

The embankment of the floodplain and most of the islands in the two inner deltas marked the change from a natural or semi-natural landscape into a technocratic one. In the natural landscape the river ruled and human use had to follow the rhythm of the floods and gained by the natural riches they brought.

In the first years after embankment agricultural yields on the fertile soils were very high. Wheat cultivation and grazing were very profitable. Gradually, however, salinisation caused a decrease in fertility. To prevent further salinisation and maintain agriculture behind the dykes, the accumulated salts will need to be washed out by regulated flooding. However, the financing required to build and maintain the sluices and

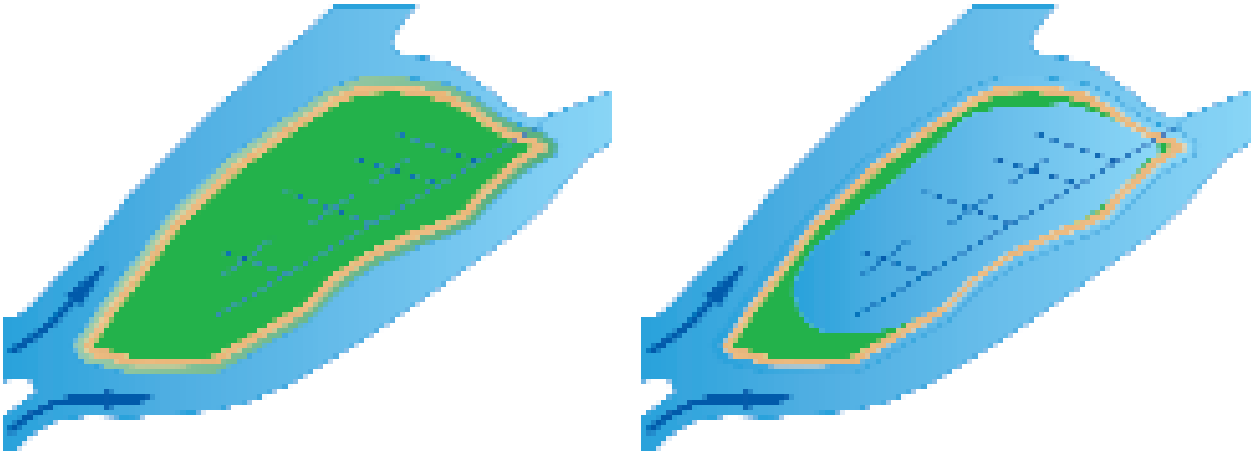
canals necessary to do this is lacking, and the cost of the electricity required to pump water into the fields is very high. The question therefore arises as to whether such investments on a tiny piece of land on the edge of the immense and fertile plains of Ukraine are economically sensible.

On the Romanian side of the Delta, several huge polders were constructed and several islands were embanked on the southern side of the Kiliya branch. Not only did these areas suffer the same fate as the embanked floodplain on the Ukrainian side of the river, the polders also blocked the exchange of water through the southern part of the Delta as a whole with grave consequences for the growth of the Delta and filtering of the water.

Floodplain restoration so far has tended to concentrate on isolated biotopes in this heavily damaged system. The well-meant but inadequate inundation of grasslands for fish spawning, reproduction of amphibia and food for birds, cannot restore the complex contribution of natural flooding. Trying to improve fish productivity and water visibility in the limans does not address the root causes of the problems. Building more sluices for such objectives leads towards an ever more technocratic landscape.

Opening dykes in a few places instead of removing the dykes completely has certainly a positive effect on the inundation of grasslands, but does not restore the geomorphological processes which are necessary for habitat variety, ecological functioning and the further development and growth of the Delta:

- As most of the dykes remain in place, most of the ridges on which the dykes are built do not receive the same quantities of sediment as under natural conditions during which the water flows in a thin layer over the surface of the riverbank. After only a few meters of flow the vegetation on the riverbank will have filtered out the sediment. This natural concentration of sediment on the parts of the banks nearest to the river is responsible for the characteristic build-up of this part of the Delta landscape.
- The amount of water and sediment allowed to flow through an island or the floodplain is less than in the situation where the ridges are inundated over the total length. Less sediment is available for the growth of the Delta, fewer nutrients are used for the growth of the vegetation, and greater quantities of the sediments and nutrients are deposited into the Black Sea.
- As the influx of water is more concentrated, the sediment is directed towards the lowest parts of the floodplain or the islands, so the pattern of sedimentation is reversed. In the natural situation the zones near the river filtered out most of the sediment with the inner parts receiving less. Where there are only a few openings, the ridges do not catch sediments and the lower parts of the floodplain and the lakes on the islands will start to fill up.
- Under natural conditions gullies develop on the riverbanks for the in- and outflow of water. They connect the river with the lower lands and lakes behind the riverbanks even in times of low water levels.
- The natural watercourses show distinctive processes (erosion and sedimentation), with small-scale typical elements such as vertically eroded banks, large variations in flow velocity, freshly sedimented open soils, undermined trees and small deltas.



A B

- On the islands, the natural sequence of inundation has changed. In natural conditions, the influx of water starts at the lower end of the islands; with the rising waters the outer edges of the islands gradually become inundated. This causes a gully to develop at the lowest part of the island. As the waters fall, the same creek is used to empty the lower inner part of the island. This creek is very important for the ecological connection between the inner reedbeds and lakes on the islands and the river offering a habitat for fish and fish spawning for example.

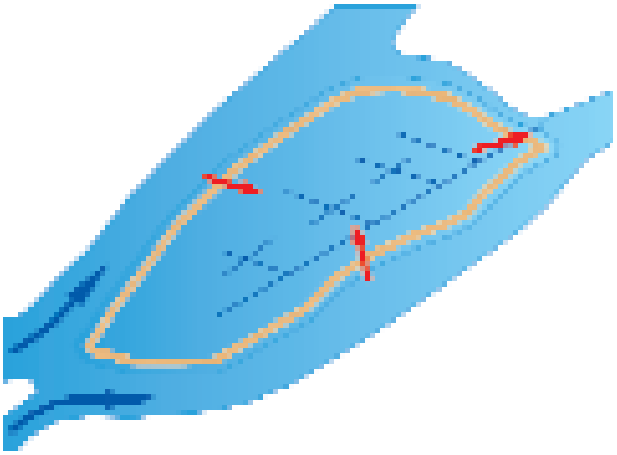
CANALISATION, SHIPPING AND DREDGING

One of the most significant activities in recent decades in the Delta has been the artificial extension of the natural canal network doubling its length to a total of 3,400 km between 1910 and 1990. Between 1857 and 1902, the TULCEA-SULINA branch was completely canalised with all former meanders and side channels cut off, reducing its length from 85 to 62 km.

Canalisation work has often been done to improve navigation, waterway transport and shipping. Shipping has been, and continues to be, a key economic activity in the Ukraine part of the Delta as well as for the entire Danube region. At the same time, the shipping industry has the potential to cause significant ecological harm.

Aside from the need to create engineered river regulations that dramatically alter the natural riverine landscape, shipping also often requires dredging activities. In the Outer Delta, several channels leading to the sea have been dredged for shipping. For example, the 80-meter wide TULCEA-SULINA navigation route has to be permanently dredged.

The impact of dredging is severe, especially in reedbed areas. Reeds tend to grow where water flow is slow, as in the contact zone where smaller branches of the river meet the sea. Here, reeds colonise shallow areas and islets that have been created through the accumulation of heavy silt particles settling in the bottom of the slow and shallow river branch. New reeds slow the water even further and sedimentation becomes progressively stronger. The reeds then begin to process nutrients and pollutants



C

A Islands (and riverbanks) were embanked to keep the water out during floods. The inner islands could be used for grazing, or even as arable land

B Water is controlled by a dyke and a sluice. Even at high water levels, large parts of the island remain dry

C Breaching the dykes restores flooding but not the original geomorphological processes. The outer ring of riverbanks does not grow in the same characteristic way as in a natural situation. As the flow of water and silt is directed towards the middle of the island, the relief will become inverted

from the water. If dredging, deepening or the construction of a new canal occurs in such shallow reedbed areas, the result will be significantly increased loads of silt, nutrients, and pollution flowing directly to the sea. The river will then gradually rebuild the shallow sandbars at the entrance to the sea – thereby requiring never-ending dredging to keep the canal deep enough at the river mouth.
Most international shipping along the Danube was abruptly stopped during the 1999 war in Yugoslavia when bombed bridges fell into the river and blocked traffic. With the bridges soon to be finally cleared, shipping is expected to increase along the entire Danube, including in Ukraine. This will likely include pressure to build new channels and ports and to increase the size of the shipping fleet.

There are various proposed development plans for shipping and navigation all along the Danube River, many of which are a direct threat to the last remaining natural areas of the Danube as well as to the region's freshwater, states the WWF report 'WATERWAY TRANSPORT ON EUROPE'S LIFELINE, THE DANUBE'. Many of the plans are also economically unsound, failing to respect current economic trends related to transport within Europe. In response, WWF has called for an immediate halt to the implementation of the plans followed by their comprehensive review and alteration.

This includes plans to build a ship canal through the Delta from the Black Sea to the town of Vilkovo. The plans entail dredging the BYSTROYE channel in the lower part of the KILIYA branch to improve navigational conditions and access to the Black Sea. This would cause significant damage to the most valuable part of this strictly protected UNESCO Biosphere Reserve and Ramsar site. More information can be found in the WWF report.

It is crucial that any future shipping activities in the Delta should be assessed for their ability to function within the limits of the ecosystem and without polluting the Black Sea.

POLLUTION OF THE BLACK SEA

As we have seen in previous parts of this report, the filtering capacity of the Delta has almost completely disappeared as a result of the construction of embankments.
The restoration of the filtering capacity of the Danube Delta is of great importance and is a major way in which international interest in preventing pollution of the Black Sea can be addressed.

APPROPRIATE USE OF PROTECTION WORK

The only positive motive for embankment in the Delta ecosystems should be protection of water bodies against catastrophic pollution episodes which periodically happen upstream in the basin. Removing the dams, however, has far more advantages than disadvantages.
Other measures, as we shall see below, can protect infrastructure and the small numbers of dwellings that maybe at risk.

3.4 THE FUTURE OF THE TECHNOCRATIC LANDSCAPE

The dykes and polders in the Danube Delta were built only a few decades ago but the first signs of degradation have already become evident. In the long term, the effects will become ever more severe.

The benefits of using fertile lands in the floodplain after the embankments are temporary. It has become evident that agricultural land use in the polders is not economically viable as fertility decreases. Over time soil compaction and salinisation will further increase if high-priced flushing technologies are not used.

The state of the dykes is deteriorating and their reconstruction needs considerable investment. This needs to be assessed in the light of the lack of any guarantee that the dykes will protect the floodplain from a catastrophic flood which happens on average once in a hundred years according to statistical data. According to current data there has not been such a flood for the last 90 years.

Hundreds of kilometres of dykes and canals; tens of powerful sluices; and hundreds of pumping plants extracting water from the polders or filling fish-breeding ponds and irrigation canals; all of this hardware will need huge financial investment and labour forces every year. The annual costs of repairs to the hydrotechnical constructions were estimated at 100-700,000 Ukrainian grivnas. It was evidently not enough. Delta dynamics and the constant deformation of channels will demand a constant increase in the maintenance costs of artificial landscape elements. It will fundamentally reduce the profitability of the Delta economies. For instance, in 2002 the cost of dyke repairs was 3.5 million grivna whereas only 720,000 grivna had been budgeted; similarly, sluice repairs amounted to 2.7 million of grivnas while only 648,000 grivna had been planned. Improvement of water quality requires investment of not less than 900,000 grivna. The regional budget does not have such sums and they could only be acquired if there were to be a considerable improvement in the profitability of economic activities in the Delta.

The floodplain, separated from the riverbed, has been deprived of the biogenes and nutrients needed for vegetation growth. It causes degradation of the ecosystem and loss of its unique biological diversity, as well as impairing the role of the Delta in the biosphere. The disappearance of natural spawning grounds has already resulted in a decrease of fish productivity in the Delta water bodies and in the Danube itself.

One consequence of the loss of the primary filtration capacity of the floodplain is that water quality in floodplain lakes and limans is sharply declining as is the supply of drinking water, and the Black Sea shelf zone is subjected to more contamination from Danube run-off.

The horizontal growth of the Delta is not now synchronised with its vertical growth. Such a morphological deformation will cause growth of the riverbank walls in front of the dykes, increasing the height of the protective dykes while the compacted and lowered floodplain remains on the same level at best. A high flood would thereby pass over an artificially low floodplain with ever increasing risks especially if houses are to be built there in the future.

Over the last four decades there has been a steady rise in Black Sea levels. Apart from the direct influence of maximum floods, this will also result in intensification of certain dynamic coastal processes such as sediment redistribution, breaching of low banks and bank erosion. Even without taking into consideration a cessation in vertical growth of the former Danube floodplain, the protection of infrastructure and settlements will call for the construction of high sea walls that will be a further drain on the local economy.

There is a gradual loss of ecological integrity and succession between the inner and intensively growing outer deltas.

Kugurluy Lake

4 A Vision for the Danube Delta

To avoid future threats, a clear Vision of the processes required for restoration of the Delta is needed. The building blocks towards restoration should be gradual, socially and economically justified and in tune with the aims of the administrative and economic structures.

It is evident that the key measure for achieving restoration must be the removal of river dykes within scientifically, economically and socially reasonable limits.

Before large-scale restorative activities in the Danube Delta are undertaken, a political decision is necessary. There must be an agreement between the heads of the neighbouring Danube states to exercise more strict environmental controls on industries situated along the river and to provide for legally enforceable compensation for the costs of clean-up incurred by downstream countries in cases of pollution disasters. If this is not done, the Danube Delta will turn into a filtration field for the effluent of central and eastern parts of Europe.

Restoration work in the Ukrainian part of the Danube Delta must be linked with the general cross-border (Romanian-Ukrainian) water management of the river.

Immediate implementation of restoration work across the whole of even the Ukrainian part of the Delta is unrealistic. It is therefore proposed to start on a limited number of model sites, gradually expanding the project areas over the years. In the process, it is expected that new partners will be encouraged to join, building on the results of the first phases which will have been stringently monitored.

Even restauration at model sites should proceed through several stages. In the transition stage from a technocratic to a natural landscape, reconstruction of some water regulation infrastructure should be carried out in order to provide an ecologically balanced restoration process as outlined in the Vision. This is also important for signalling to the local population the types of measures and the coherence of the objective being sought: the reconstruction of a natural delta.

4.1 CHOICES TO MAKE

In order to restore the ecology and functioning of the Delta, two sets of choices need to be made.

First, whether the problems in the area should be solved in a technocratic way or by returning as far as possible to the natural processes. Second, whether human use of the resources of the Delta should take place within the limits of the natural system or should change and shape the system to one devoted exclusively to human development.

It is obvious from the forgoing chapters what choice the Vision presented here has made, but the arguments for the two are reviewed below for the sake of completeness.

THE TECHNICAL SOLUTION

Fish-spawning grounds can be built and managed to restore fish populations. Salinisation might be reduced by controlled flooding through in- and outlet works. Refreshment of the lakes can be achieved by building larger canals and sluices. Through these methods certain biotopes might be restored. Some problems, however, would be too large for technical solutions; for example, filtration of the water of the Danube, sedimentation on riverbanks and in the reedbeds at a rate which would allow the Delta as a whole to grow with the expected sea-level rise. This method thus involves numerous technical solutions for isolated problems.

Therefore, although some problems can be solved over the short term with high investment but also a high risk of low returns, intensive management and constant human intervention, there is no long-term technical solution for the main ecological, systemic problems of the Danube Delta.

RETURN TO THE NATURAL SYSTEM

The second method implies restoration of the natural system as a whole. The removal – as far as possible – of dykes and polders will solve many of the problems the Delta now confronts. At the same time, morphological processes such as keeping pace with sea-level rise, filtration of the water and refreshment of the lakes, will be restored; soil salinisation and the mineralisation of the limans will be cured.

The natural system is considered to be a freshwater ecosystem with numerous river branches, lakes, immense reedbeds and narrow strips of alluvial forest along the streams. Near the sea, a transition zone from river to sea, from freshwater to salt, from clay to sand is found. This is the system that has proved to maintain itself in a rich and healthy state for thousands of years. It is changing continuously in time and space, and will follow the major climatic changes of our era, i.e. the rising of the level of the Black Sea.

Because of the embankment, almost the entire natural system is hibernating. Although only the first symptoms are visible, the effects on both the natural system and the economic and social use are disastrous, as described above.

In the Vision, restoration of the Danube Delta as a natural river system is the option chosen for a number of reasons:

- Removal of dykes and polders solves many of the problems at once;
- The root causes and not the symptoms are addressed leading to a more structural and lasting result;
- It is much cheaper to remove dykes (which are simple earth works) than to maintain them. Restoration of the natural system will in general be more cost-effective than developing many (new) technical solutions for existing and expected problems;
- Restoration of the natural system does not depend on continuous human intervention and management;
- The restoration of the system is more sustainable both in economic and ecological terms;
- The natural system is more able to respond to changes over time as it has proved for thousands of years; in other words, its resilience will be restored.

HUMAN USE OF THE LANDSCAPE AND THE NATURAL RESOURCES: EXPLOITATION OR SUSTAINABLE USE ?

People use the natural landscape in many ways. As a hunter and as a fisherman to collect meat and fish; as a harvester to collect fruits and herbs or building materials such as wood and reed. There may be over-exploitation but such activities can be regulated to become sustainable. The activities cited do not change the natural system.
But it is quite different with arable and grassland farming. These activities tend to change the landscape and place important natural processes in a dormant mode. As overgrazing and ploughing remove the tree component completely, the rich mosaic-like landscape disappears, and a treeless one emerges. In former times the floodplain was used for grazing cattle and some small-scale horticulture as is still the case around Vilkovo. These activities influenced the landscape considerably but did not disrupt the natural system.
So the second choice has to be made: what level and intensity of human use can be combined with the choice for a more natural landscape? The Vision opts for moderate use of the natural resources within the limits of the ecosystem, rather closely following traditional approaches but improved with modern practices. The choice is for sustainable use of the products the natural system provides. This translates into no crop cultivation. In the next chapters this will be explained in more detail.

For different activities this means different things. The main points are:

- SHIPPING: use of the Danube as a main shipping route can be maintained as long as future shipping activities function within the limits of the ecosystem and without polluting the Black Sea. It is recognized that the transport of goods and tourists through an international waterway has immense potential for improving the economic status of the region.
  However, there needs to be a dramatic shift in how shipping is conducted on the river away from a system dependent on large ships requiring deepening and dredging, to one focusing on a more flexible

system of small ships adapted to the natural characteristics of the river. In other words, the ships should be adapted to the river; the river should not be adapted to the ships.
As far as maritime shipping is concerned, the first consideration for accommodating the ships in a harbour is that the location of the harbour must give easy access both to marine and river vessels and there must be ample space for accompanying industrial developments.
Vilkovo lies in the middle of the most important natural delta in Europe: concentrating harbour facilities and industrial development on that vulnerable point will inevitably result in serious damage to the Delta, and its natural processes.
A study for an alternative location between the northern part of the Outer Delta and the Sasyk dam is recommended.

- FISHING: the return to natural processes will greatly improve the yield from natural resources. Fishing within the limits of the ecosystem is also a win-win situation.
- AGRICULTURE: in its intensive form, crop cultivation should be removed from the area. In a new sense, harvesting of meat from excess populations of wild herds of different species will evolve from a very old to newer and more modern methods.
- ECO-TOURISM: this activity has little impact on the natural system, and should be welcomed as a new economic activity which will be stimulated by restoration.
- GATHERING PLANTS AND ANIMALS: within strict rules, the gathering of reed, honey, medicinal herbs and wood. Hunting, within this concept and with different methods, can keep an important place in this approach.

Nature development and the dormant system

Human impact often restricts or even stops vital natural processes. The construction of dykes stops the natural growth of riverbanks and islands. The ploughing of arable land stops the life cycle of riverine forests. Over-grazing stops the growth of forests and reedbeds in shallow water. Changed water management causes the disappearance of many of the natural spawning places. Salinisation and mineralisation undermines the natural fertility of land and water.
Detecting and restoring the natural processes that have been completely or partially stopped, is called 'nature development' which, in the case of the Danube Delta, could be seen as the process of awakening a dormant giant. Hence knowledge of the local ecosystem can best be used to detect the underlying natural processes. Once they are known, the landscape can be revitalised by letting these basic processes do their work again.
Of course, dykes cannot be removed without careful assessment of consequences to human populations. Fortunately, it is known that there are often winning combinations frequently on the basis of surprisingly easy measures.
The approach encapsulated in the Vision asks for a different attitude from humans compared to the recent past: less intervention, less ego regarding the pre-eminence of technological solutions and, in exchange, more respect for nature, more trust in the resilience of the system and its capacity to continue into the future what it has already accomplished for millennia.

4.2 KEY ELEMENTS OF THE VISION

The Vision looks to large-scale restoration of the natural system of the Danube Delta in order to provide new opportunities for socio-economic development, conservation and sustainable use of the natural resources. Restoration does not mean going back in time, however. Although the analysis of the natural system and traditional economic use needs to refer to historical sources, this does not imply an attempt to return to a carbon-copy of a previous natural or socio-economic system.
The Vision is directed to a more natural system commensurate with modern life, with an open eye for the future. In the Vision a number of restoration opportunities or themes are identified.

FROM DORMANT TO ACTIVE

The following measures are proposed in the Vision:

- Re-establishment of the natural morphological system by re-connecting the floodplain and the islands to the river, and by removing the embankments and dykes. This will solve many of the problems that were caused by the embankment and will restore the most important natural processes in the area including:
  - natural, regular flooding
  - natural fertility
  - growth of the Delta
  - filtering of sediments and nutrients
  - refreshment of the water in the limans
  - spawning places of indigenous fish species
- Conversion of over-exploitative agricultural techniques to human use that is restricted to the gathering of plants, animals and materials within the limits, products and resources of the natural system.
- Re-establishment of natural grazing as a major landscape-forming process

MEASURES TO TAKE

Measures must be carefully designed and implemented with a view to the social and economic situation:

- Combination of restoration of the natural system with economic activities which, if implemented with care, do not harm each other but, on the contrary, give each other new openings such as for fishing, shipping and eco-tourism.
- Moratorium on construction of new dykes and on new investment for the repair of existing ones should be agreed if they do not protect objects which are strategically important for society.
- Reconstruction of part of the border control system would be necessary if the integrity of the dykes is broken.
- Funds set aside by the government for repairing and building new water management equipment, would be better used for reconstruction of bridges and other communications links across the territory of the Delta. This would be an opportunity to meet the needs of local communities and support new economic activities including eco-tourism while allowing for more natural functioning of the Delta.

Kugurluy Lake

LAND POLICY

Ukraine is in transition from collective to private ownership. Parts of the floodplain are already privatised in one form or another. Other areas within the Delta are not yet privatised.
Private ownership will need to be looked at in light of the goals of the Vision. As in other natural areas, the processes to be managed or revitalised (flooding, grazing) often occur over large areas and depend on consistent and stable management.

For the proposed forms of sustainable use, based on gathering within the limits of the ecosystem, it is better to keep the land in public ownership. The different forms of sustainable use, however, can be privatised in the form of licenses to fish, trap, gather herbs, mow reed, establish and manage a campsite or other activities in certain locations. The activities that are permitted can be described precisely, defined in time and space, and adjustment will be possible and needed (see annex H).

The Genius of the Place

Certain locations on this planet have certain characteristics. Glaciers are found in high mountains, mangroves along the Pacific. The specific processes and the circumstances that characterise a location were named in eighteenth-century England as the 'Genius of the Place'. For the Danube between Reni and Izmail, the Genius of the Place means: a rather dry climate, very hot in summer, rather cold in winter. A river with high and low water with a heavy load of silt. Extensive reedbeds and lakes. Along the river branches gallery forests.
Some events, such as flooding, influence the landscape every year; some events take place only once in a century. Some processes take less than one hour; other processes need thousands of years to complete. The things that happen naturally in a delta region form the basis of the natural system. Nature reacts on the infinitely complex and concerted actions of water, sand, mud, deep and shallow lakes, alluvial and marine deposits by producing a profusion of flora and fauna: an exuberance of species and specimens.
They are used by birds of passage and animals that live in the place throughout the year. In the above philosophy, nature conservationists should not design carefully researched biotopes for (groups of) plants and animals. The idea is that natural processes, in which the plants and animals have a shared evolution, are given free play so that the related animals and plants will themselves create their respective roles. Biodiversity itself is not the objective of the planning described here, but the natural processes that form the bases of the creation and survival of biodiversity. Biodiversity not as the objective, but as a result. It is impossible to describe the full complexity of biological relations still less to adopt a technological approach taking all inter-relations and mutual dependencies into account.

The Genius of the Place of the Danube Delta is determined by:

- THE CLIMATE:
  - cold winters, hot summers
  - more evaporation than precipitation

- THE ACTIVITY OF THE RIVER:
  - periodic floods
  - periodic droughts
  - erosion
  - sedimentation
  - seepage water from the river or from the hinterland
  - drifting dunes
  - the water in all its manifestations: flowing, stagnant, tepid, cold, clear, muddy, deep, shallow, permanent, periodical.

- IMPORTANT BIOTIC PROCESSES THAT SHAPE THE LANDSCAPE, SUCH AS:
  - the natural formation of forests,
  - the growth and accumulation of reed,
  - natural grazing.

- THE SCALE, OR BETTER, THE SHEER IMMENSITY OF THE MOSAIC OF WATER AND REED

Ecotourists in a bird observatory in the Outer Delta

5 Benefits for the (local) population

People use the landscape and its ecosystem to earn a living. In times of low population densities and fertile ecosystems, people can take everything they need out of the ecosystem without damaging it. As populations and standards of living tend to grow, however, the limits of the productivity of the natural situation are breached. People then resort to manipulation of the system: it starts with cultivation, livestock breeding and the burning and cutting of forests. It often ends in a completely changed landscape with a different ecosystem.
Sustainable use entails the introduction and application of methods and processes designed to prevent the long-term decline of biodiversity and to maintain its potential to meet current and future human needs and aspirations. Fertility and productivity has to be maintained over the long term without further deterioration of the natural system underlying human use.
In the previous section, the option of implementing more technical solutions, greater investment in control technologies and increased costs for maintenance is rejected. Opting for a return towards the natural system raises the question: what, in this particular case, does sustainable use mean?

USE OF WATER

Ninety percent of total water use in the near Danube area is of surface water, 70% of which is used for irrigation, although the latter has fallen sharply over the last decade. Use of underground water sources is more typical for continental parts of the Reni, Izmail and Tarutin regions.

Drinking water in eight administrative regions adjacent to the Danube, is drawn from groundwater (70%: main depths are up to 30 m) and 30% from surface water. Salinity of the groundwater is worse than that of surface water but the bacteriological characteristics are better. In localities with large populations such as Izmail, mixed sources are used for drinking water, so the number of people using lake water can only be estimated. Estimates suggest that not less than 80,000 of 215,000 people, most of them living close to the lakes, use the water from surface water bodies. Restoration of the hydrological regime will be of great value for the health of these people. Restoration will, however, require adaptation of the intake points and other infrastructure to deal with new and variable water levels.

In addition, there is a direct connection between the quality of lake water and the ground water in coastal zones. Thus benefits can be expected for a large number of people as a result of future restoration initiatives. Finally, such initiatives would meet the demands of the EU Water Framework Directive.

SHIPPING

Shipping made a very important contribution to the region in the past. The economic collapse over the last decade, aggravated by the wars in the Balkan, brought this activity almost to a halt. In time it will, however, recover. This will likely include pressure to build new channels and ports and to increase the size of the shipping fleet. Continued shipping activities are acceptable and encouraged if they function in the proper place and within the limits of the ecosystem, that is, that they do not modify the fluvial morphological and ecological processes and do not pollute the Black Sea. A good start would be to observe, and benefit from, new economic realities and trends within the international transport sector in Europe.

ECOTOURISM

Recreation and tourism are now the most important economic sectors in the European countryside and it is expected that tourism will double by the year 2020. Because of the low starting threshold in Ukraine, it will be easy for entrepreneurs to enter the sector. People could start Bed and Breakfast accommodation, a campsite, boat hire or organise excursions in natural areas. A tourism sector can therefore start to function relatively quickly and contribute to the development of the rural economy.

Before beginning to develop the sector, however, some aspects need to be taken into consideration. Tourists are not a homogeneous group, they have a variety of needs. To develop recreation and tourism in the Danube Delta in a way that caters for most of them and also ensures wide and equitable distribution of the benefits to the local population, a serious study of the options, infrastructure and skills/training needed is necessary. In the following only some initial thoughts and recommendations are offered.

Since Ukraine lies outside the current major tourist destinations, the question is how it can become a holiday destination and benefit from the income from tourism and expected future growth. A wise strategy could be to start with attracting local tourists from Ukraine and Russia and, after some years when facilities have improved, begin promoting the area in western markets. Ukrainians and Russians already visit the Black Sea coast during the summer. Day trips by bus or boat to the Delta could be organised. Local tour operators in Vilkovo, along the Black sea coast or in Odessa could initiate such visits. WWF can play a role by supporting the Biosphere Reserve in developing the ecotourist infrastructure in the Outer Delta and in the most beautiful spots along the river. Contacts have already been made with a view to organizing excursions from Odessa.

By building small and inexpensive holiday resorts in or near the natural part of the river floodplain between Reni and Vilkovo and here and there

along the lakes, Ukrainian and Russian holiday-makers could be attracted to the region. They could enjoy swimming and fishing on the banks of the river and the lakes. Tataru island especially or one of the other islands in the Danube are potentially appropriate for such activities. Only fifteen minutes by boat from Izmail, people can enjoy the wilderness. A number of small wooden lodges which are already in place could accommodate tourists. Built by the State Forestry department, a local tour operator could hire them out and manage them; mostly catering to the Ukrainian market for now.

The church of Vilkovo

At the moment the number of foreign tourists travelling to Ukraine and the Danube region is very small. Ukraine is not well known and much effort should be undertaken to promote the country as a whole. Natural richness could be an important selling point. The outer Danube Delta, which is in pristine condition, has the potential to attract people. National tourist authorities should be strongly encouraged to promote Ukraine as a country not only of interesting cultural heritage and beach resorts, but one which also offers rich nature. It will, however, be a long time before foreign tour operators introduce the Ukrainian Danube Delta region in their brochures. At the moment the number of luxury hotels, good quality restaurants and tourist attractions is far too low. Only tour operators offering special-interest tours (e.g. bird watching) might be tempted; a partnership with WWF would be of considerable help in this sector notably in contacting European tour operators and with promotion.

A complication for Ukraine is that most Europeans associate the Danube Delta with Romania and, because Romania is easier and cheaper to reach, far more foreign tourists visit that country. It will be difficult to change that. A solution might be to look for partnerships with Romania. It could be made easy for foreign tourists visiting Romania to visit the Ukraine Danube Delta (comparable with tourists on Greek islands who can easily hop over to the Turkish mainland for a short visit). The fact that the Kilia branch, lying in Ukraine, is the most vivid part of the Delta, where all the deltaic processes still take place, is likely to be one of the points of interest for foreign tourists in Romania. Another interesting aspect is that tourists are always eager to visit a nearby country during their holiday.

The Ukrainian Outer Delta has the potential to attract national and international tourists. Besides Ukrainians themselves, a small number of international tourists will eventually find their way to the Ukrainian Delta. Such tourist pioneers do not usually pay a great deal of attention to the quality of transport, accommodation or the tourist infrastructure

in a country. They are in search of a unique experience and are content to stay in simple bed and breakfast accommodation, in campsites or in farmhouses. A tourist guide with basic information about the places to stay, to eat and to visit is enough for them to plan their trip. Most pioneer tourists are looking for a mix of attractions. Besides natural areas they come to visit cultural and historic sites and scenic landscapes. A good tourist guide of the Danube region should therefore also give information about the natural richness, bird-watching places, places with the major colonies of birds, boat trips, walking possibilities and so on. When these pioneers return home satisfied with their stay, they will inform friends and relatives. This is the best way of advertising and will help tourism to the Danube region slowly grow.

Despite the richness of the Outer Delta, it has not much to offer most visitors for any longer than a two-to four-day stay. Combinations with a visit to one of the lakes, especially Kartal and Kugurlui, an island in the Danube near Izmail, the Black sea coast and Odessa can prolong the stay and make a ten-to fourteen-day holiday possible. To sell the inner Delta to international tourists is even more difficult than the Outer Delta. Between Reni and Izmail, the riverbanks are so far removed from their natural condition that it will take many years to bring them to the stage in wich they would be attractive. Even then the landscape will not be so unique that people from far away will visit it. Some foreign travellers could possibly visit the region on their way from one of the lakes to Izmail, but their number will be small.
Special attention must be paid to river cruises. A large number of cruises follow the Danube to the Black Sea each year. Cruise customers expect high quality services on board and during trips on land. Some of the new nature reserves along the Danube might be interesting enough for them to visit. Special day trips and excursions can be organised on request. The tour operators who organise the cruises should be informed about these programs so that they can include them in the cruise.

Large parts of the natural areas along the Danube will never become an important destination for foreign nor Ukrainian tourists. They can, however, offer recreation sites for the people living in the villages and smaller towns along the floodplain. There they can learn to enjoy their natural surroundings. A bar or café will attract more people and can generate some income for the owner. This will also attract young people to the riverbanks. Special facilities for schoolchildren could be built in the natural areas where they could enjoy summer camps and learn about Ukrainian nature. The opportunity could be taken to educate local people in the values and management of protected areas by, for example, offering ecological trails and practical instruction about wise management.

REED HARVESTING

Reed harvesting for local use still exists and has a long tradition. It can develop into an important economic activity both on the local as well as on an international scale. The export market is already being explored. Harvesting improves the filtering and purification functions of the reedbeds as the reed uses nutrients from the river water as it grows. At the same time, cutting and harvesting prevents the return of nutrients into the water through decayed plant material. Reed quality however

varies widely and only certain qualities can be used for roofing purposes. In theory, the places where reedbeds are frequently in contact with river water are where most of the nutrients from the river are filtered. Whether these areas produce the appropriate quality of reed, and whether large-scale reed cutting is possible, needs further investigation and the development of a strategy. The strategy should take the employment aspects of reed harvesting into account. In the Vilkovo area about 1,000 people are involved duringDecember-February with several hundres more taking part in processing.

AGRICULTURE IN THE DANUBE FLOODPLAIN

- *The past*

  Before the embankment of the floodplain, agriculture depended on the fertility brought by the floods whereby the water brought nutrients and flushed out the salts. Only the high ridges along the river could be used and grazing was the most common practice. After the floods, when the green ridges reappeared above the water, the animals were brought by boat to the meadows. Almost no farms were built in the actual floodplain. The lands were used by villagers from the high and dry Budzhak Plateau.

  Apart from grazing, some horticulture was practised, especially near Izmail, on Kislitsky Island, and near Vilkovo where it is still present. Fruit trees such as apples, pears, plums, nuts, red and black currant and grapevines, which can withstand flooding very well as their wild ancestors originated from alluvial forests, were, and are, cultivated. The name 'Kislitsky' means 'fruits from the forest'. Also some vegetables were grown, all for home use or to sell at the local market.

  After the embankment was contructed, land-use changed to large-scale cereal cultivation or grazing. Only around Vilkovo the old small-scale horticulture in regularly flooded gardens continued to exist.

  Behind the dykes, cereal farming and grazing suffer greatly from salinisation of the soil and the situation is still getting worse. Although new areas continue to be taken into cultivation, those which have been cultivated for some years, start to loose their fertility. Only if large-scale investment in technical equipment for regular flooding is made can fertility over the long term be restored. This seems, however, a perverse use of scarce resources in a country where thousands of kilometres of fertile land are available which are perfectly and permanently fit for cereal production. Artificial flooding practices are currently directed towards short-term profit: earn as much as possible in the fertile years and then abandon the land. The same applies to livestock, where lands have been overgrazed and support ever diminishing numbers of cattle or horses.

- *The future*

  The future for agriculture looks bleak as investment needed to continue current practices is too costly. After restoration of the floodplain, as described in this Vision, there is no future for agriculture either as only limited use can be made of the highest parts of the riverbanks. Large-scale production of cereals and intensive grazing now takes place on the higher ground of the Budzak Plateau, outside the floodplain. It is an immense area which is suitable for such land use but it should not be extended to the Delta.

Traditional fishery in the Outer Delta

Abandonment of cultivation in the floodplain opens an opportunity to reintroduce a number of indigenous large herbivores. In densities of up to 20 times lower than domestic livestock, different species can form a mosaic landscape of great richness in intricate inter-dependency. However large, the floodplain has a limited area and eventually the number of animals may increase beyond the local environment's carrying capacity. Sustainable use in this context means control of the number of wild herbivores to within the limits of the ecosystem. The products will be meat, skins and trophies from a spectacular range of animals.

Near Vilkovo, market gardening will continue to be practised, and perhaps the same will happen near other villages if fertility of the floodplain returns.

The rice polders are not suffering from salinisation as regular flooding with water from the river washes away the salts. However, at this moment rice cultivation is not profitable. If the situation remains the same, return of the rice fields to the river could be considered. The fields are relatively low-lying and they will change into shallow lakes with reedbeds. This will greatly improve the general quality of the ecosystem and the connection between the Katlabuh and Kitai limans, and the Shebriansky Plavni with the Danube.

FISHERIES

Fishing has always been and still is an important economic activity, both on a local as well as on an industrial scale. About 1,100 fisherman are currently working in the sector and up to 5,000 people are dependent upon it. In addition, many people in the villages fish for personal use.

- *The past*
  Before the dykes were built, the catch was taken from populations of indigenous species that spawned naturally. The species were Carp, Crucian carp, Bream, Pike-perch, Sheat-fish, Vimba, Danube herring and several types of Sturgeon.
  In the lakes and limans of the floodplain, these and other, non-commercial, species could reproduce freely. There was abundant space for spawning and the juveniles found food, space and cover during development. Catches were good; in times of low water large areas in the lakes turned into mudflats and the fish had to survive in deep hollows where they were easily caught.

  Together with the embankment, sluices and canals were built to regulate the in- and outflow of water to and from the lakes and limans. In the beginning a stable level was maintained while a more dynamic water level was used later.
  The stable water level in the lakes since the embankment of 30,000 ha of the floodplain in the period 1955-1960, is the main limiting factor in the life cycle of the regional fish fauna. Spawning places disappeared on a large scale and the fish population collapsed.
  To compensate for decreased catches, fish breeding was started using exotic species such as Silver carp and Bighead carp. Fish were hatched artificially and then used to seed the lakes.
  This system of fish breeding has been nearly completely abandoned as the yield decreased due to pollution of the water in the lakes. Also, the cost of the electricity needed for breeding young fish is too high to make the enterprise profitable.
  Fish production in artificial ponds was practised as well but was also abandoned, again because the cost of electricity was too high.

- *The future*
  Studies are being undertaken to investigate the exact conditions required for natural spawning of indigenous specious in the lakes in order to allow the fish population to regenerate. This means that techniques are being considered which would encourage the fish to spawn in the unnatural conditions of isolated, polluted lakes.

  On the basis of the choices made in chapter 5.1, this Vision looks in another direction. As in the situation before the embankment, spawning grounds were ample and regeneration of fish populations was stable. Restoration of the natural system is the best way to restore the natural fertility of the lakes. In the Danube itself and in the Outer Delta, over-fishing is ubiquitous. Some species, for example several species of Sturgeon, have become rare. Over-fishing and poaching are two reasons and, in the case of migratory species, the Iron Gate Dam in Serbia presents an insurmountable barrier to fish trying to reach their spawning grounds.
  To prevent over-fishing and poaching, better regulation through licensing is needed.

GATHERING

In the Danube Delta a number of gathering activities continue a very long tradition.

Harvesting of medical herbs, honey and trapping small animals for food, or for fur such as the Muskrat are among them.
These activities are sustainable and of importance in local economy; they would benefit greatly from the restoration of the floodplain.

HUNTING

- *The present*
  In the Delta region itself the number of hunters is not large (about 1,500). Most of the 12-15,000 people who hunt in the Delta come from elsewhere. Waterfowl, Hare, Fox are hunted and Roe deer and Wild boar hunting is popular. There is a need for better regulation of the hunting season and the numbers to be taken. Hunting is a historic and important activity in the region.

- *The future*
  When natural grazing is introduced both the number of species as well as the number of individuals within each species will increase. As space is limited and migration to other places has its limitations as well, the populations of wild herbivores will have to be regulated. Visibility of the large herbivores will be a great attraction to eco-tourists. However, with conventional methods the animals soon associate the sight of people with hunting and will remain under cover. This suggests that practices must be changed to meet new standards and different goals.
  The model sites, where natural grazing is one of the issues, are the ideal places to experiment with these new techniques and approaches to population management.
  The first step is to allow Boar, Roe deer and Fallow deer, as well as reintroduced species of herbivores, to grow to natural population densities which will be determined through monitoring a range of parameters. After that, new hunting techniques should observe the following principles:
  - Natural development of the density of herbivores, including migration and dispersion, is predominant
  - Hunting is a means of regulating the number of animals only if other means of regulation, including natural migration and natural death, are exhausted or have failed
  - Traditional hunting methods which involve noise and disturbance should be abandoned
  - Hunting methods through which the animals associate people with danger should be abandoned
  - New hunting methods should be invented or used: noiseless, sudden, without disturbing the herds.

FLOOD PROTECTION

The embankment of the Ukrainian Danube floodplain took place between 1955 - 1970. Since then development of housing, harbours and industry has taken place in Reni, Izmail and several villages. Fortunately, this has only been on a limited scale.
The Danube Delta dykes have a very low safety standard. An exceptional flood, which is expected to occur once in a hundred years (a 1% flood), will break through the dykes. People living in the area therefore have a

Fishing by the local population through holes in the ice of Yalpug Lake

roughly 3:4 chance of experiencing such an event in a lifetime.
Dykes always give a false feeling of safety. After a dyke is constructed, development in the floodplain follows. As soon as the inevitable disaster occurs, people ask for higher and better dykes: the false feeling of safety is reinforced once again. The period to the next catastrophe is lengthened. The investment in unsafe areas grows and the catastrophe will repeat itself. Holland is the key example of this cycle towards greater insecurity and greater risk which has been accumulating since the middle ages.
In some cases, there is no choice but to build dykes to defend investments in the hinterland, as in the case of harbours near to the river. In the Danube Delta floodplain, however, most towns and villages are still built on the edges of the Budzhak plateau in places that are safe.
The best flood protection is to remove the dykes almost completely. Opening the floodplain to the river will enable people to see for themselves the risks inherent in living in a floodplain. People will see the floods every year and, in some years, at unusually high levels. The water level will become the guiding principle in planning.
The dykes are low and dangerous. Development in the floodplain is also low. If in some locations relatively small dams are built to protect the few houses and industrial premises that have been built since the embankment was constructed, the opening of the floodplain will prevent future damage through flooding.

PREVENTING POLLUTION OF THE BLACK SEA

Opening the floodplain will restore the natural capacity of the Danube Delta to prevent nutrients and sediments from polluting the Black Sea. This capacity is limited, but in the perspective of the Green Corridor along the Danube, it plays an important role. It is obvious that opening cannot take place only in the Ukrainian part of the Danube Delta as it may cause artificially high floods.The best course is cooperation between Ukraine and Romania and all the countries of the middle and lower Danube.

6 The Model sites: learning and communicating

6.1 MODEL SITES

Model sites will take the first steps in implementation of the Vision. The requirements for a successful model project are reviewed below.

DEMONSTRATION OF THE VISION

A model project should illustrate, in the field, how the Vision – or essential parts of it – can be implemented in practice. Therefore the model site should be of direct relevance to the recommendations, approaches and perspectives outlined in the Vision.

The model site should always be presented as a small scale practical demonstration of the Danube Vision. The link between model site and Vision should be as accurate as possible and easy to explain.

Because the 'genius of place' varies across a large region such as the Danube Delta, several model sites are needed, each demonstrating how the Vision can be put into practice in different ecological and social settings.

The aim is not to implement the Vision through the model sites themselves, but to inspire others to pick up similar activities (with or without the guidance of WWF), so that the combined efforts of a range of actors, with their own projects and funding, eventually achieve full implementation.

STRATEGIC PARTNERSHIPS

Since working with strategic partners is a key element in implementing the Vision, model projects should from the beginning include cooperation (and in many cases, co-design at the early stages) with one or more strategic partners. Since a country's development path is not determined by conservation organisations, strategic partnerships should involve other social and economic interests.

COMMUNICATION

Communicating the Vision and its (partial) implementation in model sites is essential to generate the necessary enthusiasm and follow-up. Communication should target both WWF audiences and the people working and living in the Danube Delta, young and old and including high-level politicians.

The purpose is not to show how WWF is helping to implement the Vision, but to inspire and invite others to join. Communication should therefore give full credit to the strategic partners involved and should be inviting and stimulating. It should take place in situ, that is, in the field where the activities are taking place.

QUICK START/MODULAR DESIGN

Activities in the field should start as soon as the Vision for the area as a whole has been published and accepted by the present partners. Communicating a Vision can only be done effectively if reference can be made to model sites in the field where WWF in cooperation with other parties is working to implement it. Without field activities, the Vision will soon lose its relevance for the people in Ukraine.
As full funding may not be available right from the start, a model site and its budget can be designed in a modular way, that is, specific activities within an overall project can be identified. As soon as funding for a given module is available field activities can begin. As additional funding becomes available, other modules can easily be activated as well.

LEARNING BY DOING

The Vision document does not explain in detail how each of the model sites has to be developed thus joint design of a model site together with the partners is an important step towards implementation.

The development and design phase is by and large a matter of experiment whereby the partners, together with WWF and/or other parties, develop and decide between options and measures. These may be modified later as a result of experience in the course of implementation.

Whereas the Vision document provides general guidance, the field tests should aim at ecosystem conservation or restoration supported by sustainable economic use, and should demonstrate how to achieve this. In other words, the Vision suggests the 'what' for a particular site while the partners together with WWF look at the 'how' to achieve it on a 'learning by doing' basis. Experience elsewhere has shown that 'learning by doing' is more effective for restoration projects than developing theoretical scenarios to guide implementation in the field.

6.2 CRITERIA FOR SELECTION OF MODEL SITES

To demonstrate what the Vision means in reality, a number of model projects will be developed. In order to decide which project(s) could serve as model(s), a set of criteria can be helpful.

In a general sense, all the projects should apply the highest standards in all aspects (design, management, operation, budgeting, monitoring) and serve as outstanding examples of wetland conservation, as well as demonstrating the WWF approach in this field. These preconditions are essential for communication aspects, to involve non-conservation parties and encourage them to duplicate the WWF approach in other areas (magnification).

CRITERIA

The model projects should:

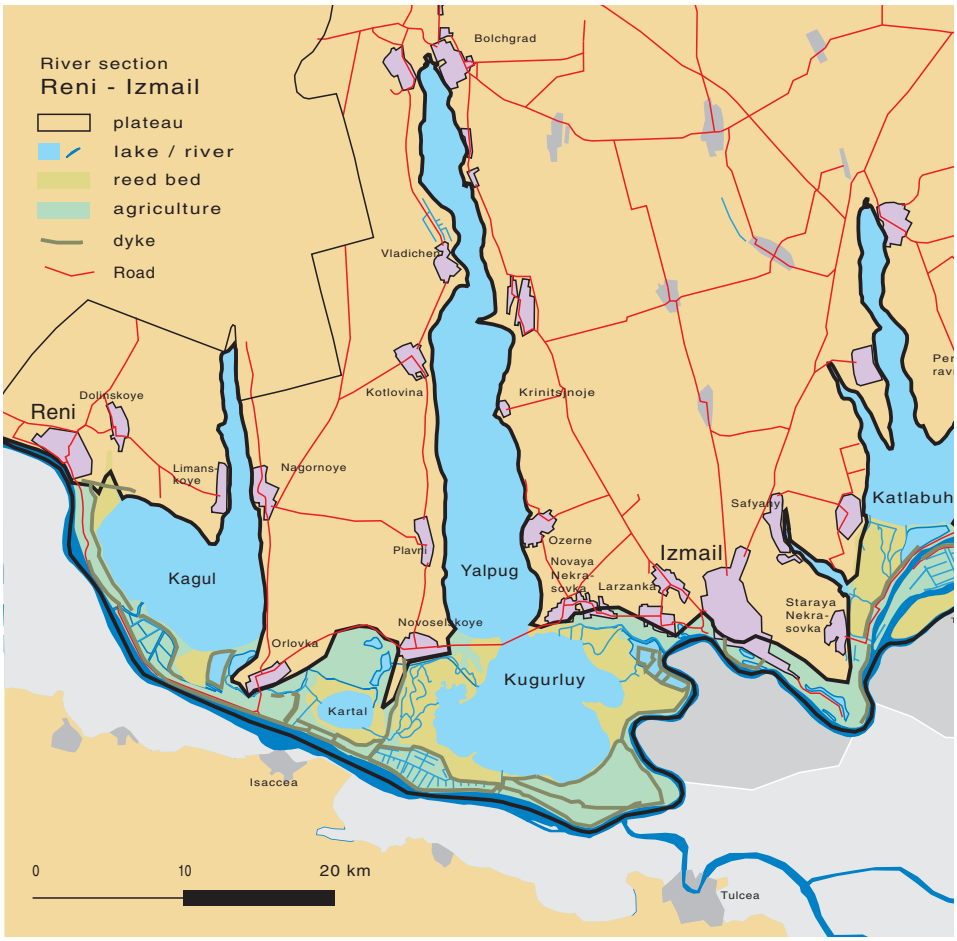
- demonstrate the approaches described in the Vision document;
- restore or revive major natural processes that have been dormant or have been disturbed;
- forge links between restoration of natural processes and other interests in the region (e.g. improving water quality) and in synergy with the concerns of strategic partners;
- develop solutions that fit within the socio-economic context of the Ukrainian Danube Delta (e.g. private land, state-owned land, co-ownership); obtain the consent of landowners and land users for restoration works.
- address wetland systems and issues that are representative for the Ukrainian Danube Delta and that are identified in the Vision document; in other words, several model projects will be necessary to demonstrate approaches for islands, lakes, floodplains and so on;
- be easy to communicate to broad groups in society and stimulate other partners and parties to buy in to the Vision and help implement it on a larger scale;
- be able to start within a year from the moment the Vision document is completed and show major results within 2-3 years. Projects may continue further as long as progress and results are sound and the best of them should offer long-term ecological, social and economic sustainability.

6.3 MODEL SITES: SUMMARY AND PRIORITIES

In the next sections, the following model sites are presented in geographical order from Reni eastward to the Black Sea. An explanation of the assignment of priority is given with each site description.

	Priority
Izmail grazed alluvial gallery forest	LOW
Transition from the Delta to the dry Budzhak Plateau	LOW
Tataru and Daller Islands	HIGH
Katlabuh Liman	HIGH
Communication project: Izmail Wetland Park	HIGH
Ermakov Island	MEDIUM
Stensovsko-Zhebriyansky Plavni	HIGH
Zhebriansky Ridge	MEDIUM
Natural grazing in the Outer Delta	HIGH

The Danube Delta ecosystem is not uniform because formation of the separate parts and the corresponding drainage redistribution occurred at different times. In fact the Delta can be divided into 4 sections according to period of formation: these are the areas between Reni and- Izmail, Izmail and- Kiliya, Kiliya and- Vilkovo, and the Outer Delta. They are differentiated by different fluctuation ranges, the presence or absence of drainage redistribution, and the presence or absence of islands. To demonstrate the Vision ideas model sites were selected for each of these sections."



Map of the Danube between Reni and Izmail

7 Model sites: from Reni to Izmail

The most extensive river banks of the Ukrainian Danube Delta are in this river section. North of the river a series of reed-fringed lakes and large limans are found. The difference between high and low water of the Danube is still significant: up to 5m. An continuous embankment, situated almost on the shore of the Danube, cuts the river off from the former floodplain.

7.1 REVIVING DORMANT FEATURES

After reviving the dormant features, what changes might be seen in the area?

- BREATHING LAKES: after removal of most of the dykes, the waters of the limans and the river will be connected again in times of flooding. Water will be exchanged and refreshed, spawning grounds will function again. The indigenous fish population will form the basis of both the natural system and the fishery.
- GRAZED RIVER BANK: the extensive river bank, more than 50 km long and several kilometres wide, will provide up to 100 km² or 10,000 ha of open areas grazed by large herbivores and interspersed with patches of woodland.
- To the north, an even larger area of REEDBEDS than is now the case, will gradually turn into several shallow lakes full of aquatic plants. Between land and reed, and between reed and lakes, there will be gradual transitions.
- From the lakes two large LIMANS run northwards, surrounded by steep hillsides and even cliffs. Here the wetlands of the Delta will meet the higher lands of the Budzhak loess plateau. A subtle ring of salty and brackish ground will mark the spot were these two extremes meet. Around the limans on 60 km² of reclaimed former steppe, the large herbivores will find a completely different environment.
- On an area of about 250 km² (or 25,000 ha) of fertile river banks, reedbeds that are accessible at least in some seasons, and dry former steppe lands, the complete range of indigenous large herbivores, from the semi-aquatic Beaver and elk, to steppe-loving Bison, feral cattle and horses will be able to form HEALTHY POPULATIONS.

Artist's impression of the future of Kugurluy Lake, with mosaic landscape on the river banks

7.2. MODEL SITES IN THE RENI - IZMAIL SECTION

For three distinctive parts of the landscape, model sites will be useful in obtaining a preview of the results of awakening Delta processes that are now quiescent:

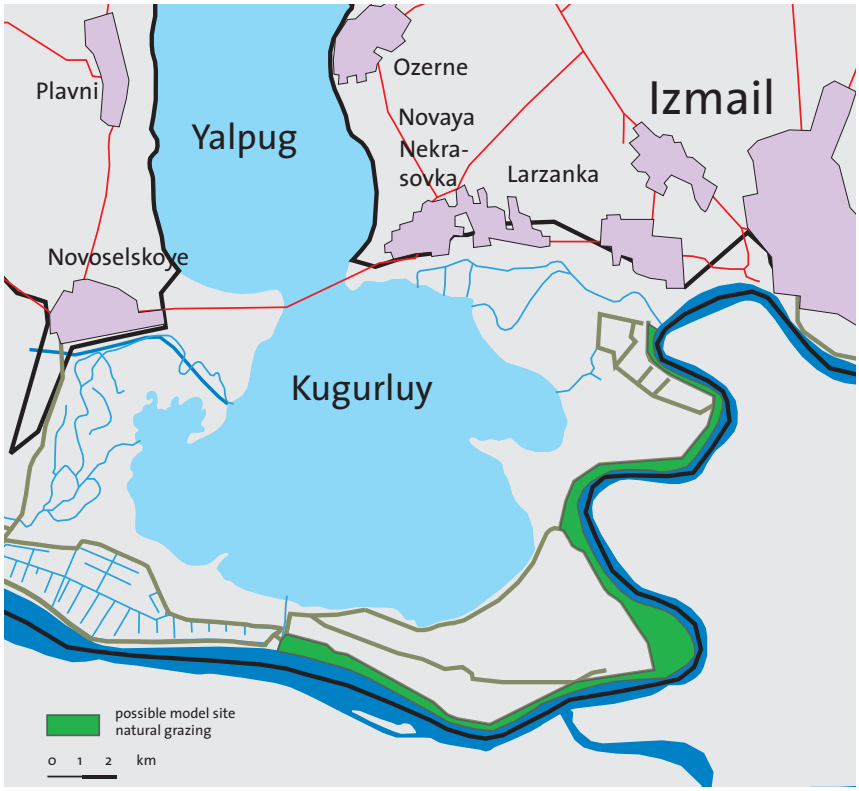
- A regularly flooded and grazed river bank with alluvial forest : Izmail grazed alluvial forest.
- A regularly flooded and refreshed system of lakes, reedbeds and limans. A model site for this aspect of the Vision will be found in the next section and at Katlabuh Liman.
- A connection-zone between the dry former steppe and the limans.

7.3 MODEL SITE: IZMAIL GRAZED ALLUVIAL GALLERY FOREST

THE SITE

A model site to demonstrate natural grazing in a woodland on a flooded part of the riverbank is perfectly possible in this section. Over a length of about 60 km a strip between the dyke and the Danube is still subject to flooding. This strip, 100 m - 300 m wide, is covered with almost natural forest. This is really the prototype of the landscape on the river banks except that it is not grazed.

A model site could be established between the Sunda channel downstream of Kugurluy polder to the buildings of the fisheries company near Izmail. It is about 850 ha in area and the strip of land is at its widest, about 1200 m, near to the bifurcation point.



Izmail grazed alluvial forest

AIM

To show, after a short period of grazing, the natural look and functioning of the alluvial forests on the flooded riverbanks of the Danube at their best.

The effects of grazing will gradually become clear. Boar and Roe deer probably already live in the area and the populations must be allowed to grow. To begin with, only a few of the wild Delta-cattle and horses can be brought in as the extent of grassland is still limited. It is a very good place for the re-introduction of Beavers.

The project is easy to visit as a (rather primitive) road on the dyke runs alongside. The people from Izmail and surrounding villages will be able to see the results of wild grazing. The site is large and interesting enough for tourists to see from the riverside as well as the road, with enormous Lianas (*Vitis sylvestris*) growing to the top of full-grown poplars hosting colonies of Cormorants.

POTENTIAL PARTNERS

- Border control administration
- Military administration
- Water Management administration
- Izmail forest service
- Izmail city council
- Tourism companies

PRIORITY

Low. Contacts must be made; partners must still be found.

Alluvial forest with Wild Grape and a colony of Cormorants near Skunda Canal

7.4 MODEL SITE: TRANSITION FROM THE DELTA TO THE DRY BUDZHAK PLATEAU

THE SITE

The shores of the long lakes or limans, the steep, often eroded slopes to the Budzhak Plateau, and the upper ridge of the plateau towards the road. This is the transition zone from very wet to very dry. The exact site of a model site in this transition zone has yet to be determined.

AIMS

- To show the transition zone from the Delta to the steppe plains
- To integrate the surrounding dry zone with the Delta restoration project
- To show the characteristics of the natural steppe zone
- To experiment with migration of animals between two completely different biotopes

POTENTIAL PARTNERS

Still to be found.

PRIORITY

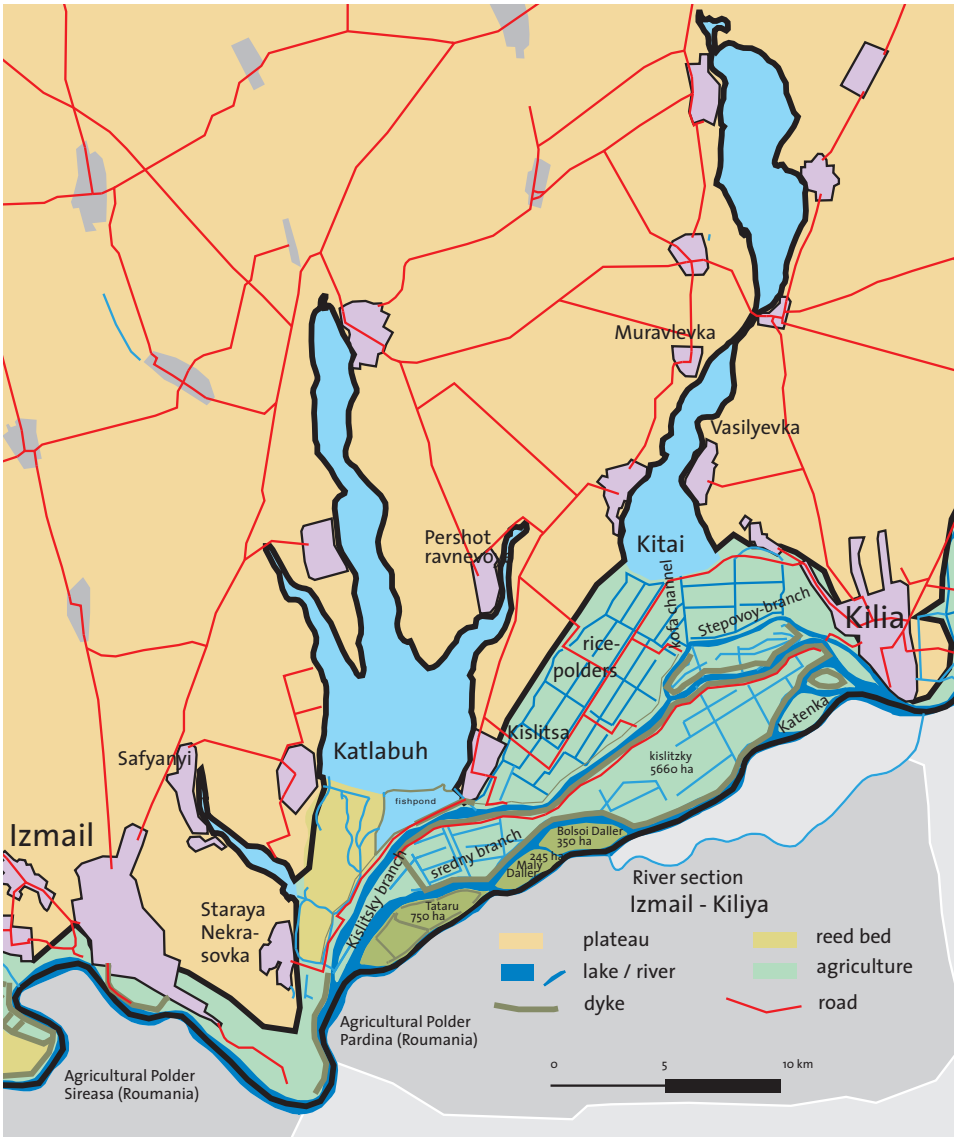
Low. Contacts must be made, partners remain to be found.

Slopes from the Budzhak Plateau towards Kagul liman near Orlovka

7.5 MODEL SITE: KUGURLUY POLDER

Kugurluy Polder is not a good site for demonstrating the restoration of natural processes in the floodplain.

- The project is only one step away from transformation towards a technocratic landscape;
- The sluices can (and will) be used to restore natural fertility for intensive agricultural use; the exact opposite of what is intended in the Vision;
- The project aims at the reconstruction of only a part of one of the many biotopes of the floodplain. Inundation with stagnant water is being considered; flowing water and morphological aspects have not been taken into consideration.



The Kiliya branch of the Danube between Izmail and Kiliya

8 Model sites: from Izmail to Kiliya

In this section, the first in the Inner Delta, there is a labyrinth of river branches and islands. Most of them are embanked and the land is in agricultural use. Three small islands belong to the few places along the river that are not yet completely embanked and still show their natural features. To the north, there are two large limans, cut off from the Danube branches by a dyke, and rice polders.

8.1 REVIVING THE DORMANT FEATURES

After reviving the dormant features, what changes might be seen in the area?

- The Katlabuh and Kitai limans will be opened to the Danube and thus rejuvenated: waters will be exchanged and refreshed; spawning grounds will function again; the indigenous fish population will form the basis of both the natural system and the fishery.
- An Inner Delta of natural islands surrounded by forests and with reedbeds and lakes in the interior.
- Natural grazing on the higher banks of the islands.

8.2 POSSIBLE MODEL SITES IN THE IZMAIL - RENI SECTION

In this section, two model sites could be developed:

- Tataru Island and the Daller islands as models for natural islands where a start could be made with ecotourism;
- Katlabuh Liman opened to the Danube as an example of the effects of dynamic and natural water management on the quality of the lakes and limans.

In addition, near to the city and harbour of Izmail, a wetland park is currently being developed through which the population can see aspects of the natural landscape around the city.

Natural forest on Daller Island

8.3 MODEL SITE: TATARU AND DALLER ISLANDS

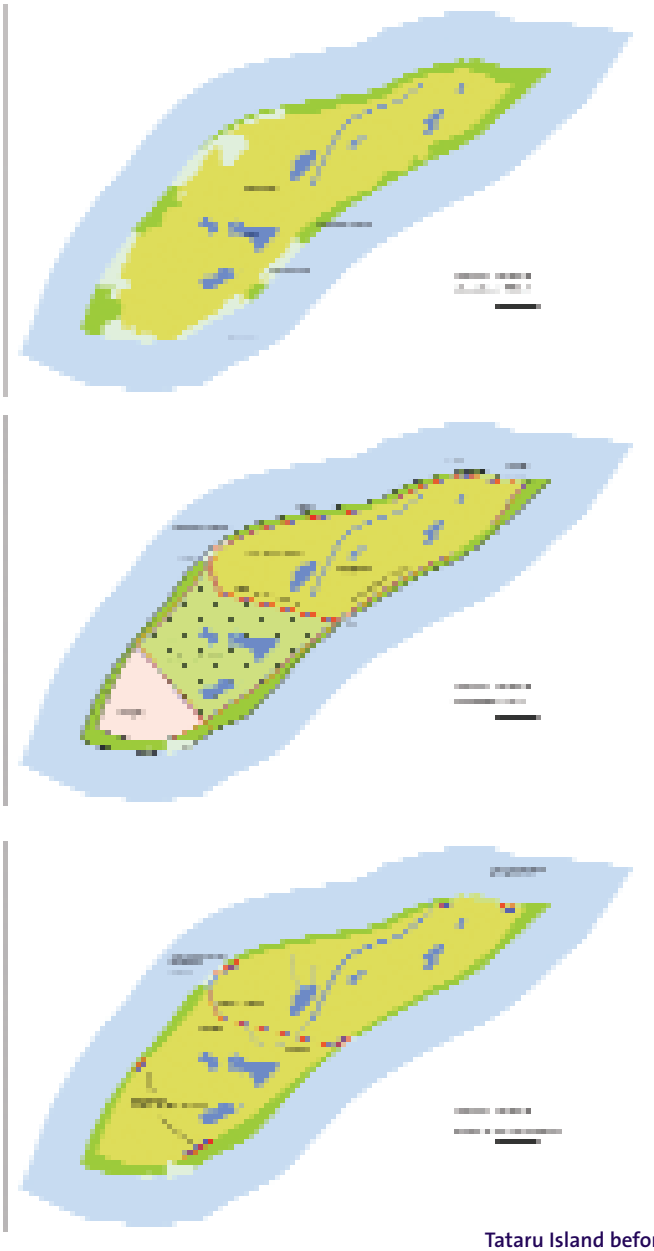
THE SITE

The two Daller Islands are in an almost perfect natural state, with a river bank in a ring around the reedbeds and lakes in the middle. Attempts have been made to embank Tataru Island but they have now been abandoned leaving several half-finished dykes.

The islands are grazed by domestic cattle from time to time. Boar, Roe deer and, on Tataru, Fallow deer are present. The Izmail Forest Service already has a policy to abandon forestry on the Islands and even to remove stands of poplars from Tataru. A first lodge with facilities for visitors has been constructed and a local commercial initiative is developing ecotourism. Boats are for hire and meals are provided.

AIM

To show the natural look of the Inner Delta at its best. On a trip from Vilkovo, tourists can visit the area and even stay for a while on the shores of a river branch.
The restoration of Tataru Island is relatively easy; it consists mainly of moving the earth from the dykes into the trenches from where it came. By removing the dykes completely, not only will the flooding of the middle part of the islands be restored, but the geomorphological development of the outer ring of the island as well. This will contribute to the growth of the Delta in general.



Tataru Island before and after restoration

The effects of grazing are still visible on Tataru Island. By letting the population of Wild boar and the two species of deer grow, the influence on the forest and the reed beds will grow. By introducing wild horses and cattle, the influence will become more effective.

The restoration of Tataru Island will be a source of inspiration for the restoration of the other islands in the inner deltas.

PARTNERS

- Izmail Forest Service
- Tourist enterprises
- Biosphere Reserve

PRIORITY

High. Partners have already been found, plans are in preparation, restoration can start almost immediately.

Artist's impression of the future of the first Inner Delta. The Islands Tataru (foreground) and Kislitsky are natural again, and Lake Katlabuh (background) has an open connection with the Kislitsky branch of the Danube

8.4 MODEL SITE: KATLABUH LIMAN

THE SITE

North of the Kislitsky branch, only a dam with a road on top of it, a fish pond and a marsh area separates Katlabuh Lake from the Danube. A canal regulates the in- and outflow of water.

AIM

To demonstrate refreshment of the water of the limans by reconnecting them to the changing levels of the Danube.

As large quantities of water have to flow in and out, the construction of several small bridges to carry the road will be necessary. First experiences with lower water levels may be gathered by using the existing canal. In this case, the accumulated silt in the mouth of the canal should be dredged. The consequences for the villages and shores around the lake as a result of the proposed transformations at this site have not yet been investigated. Especially the intake of drinking water for the upmost villages needs attention.

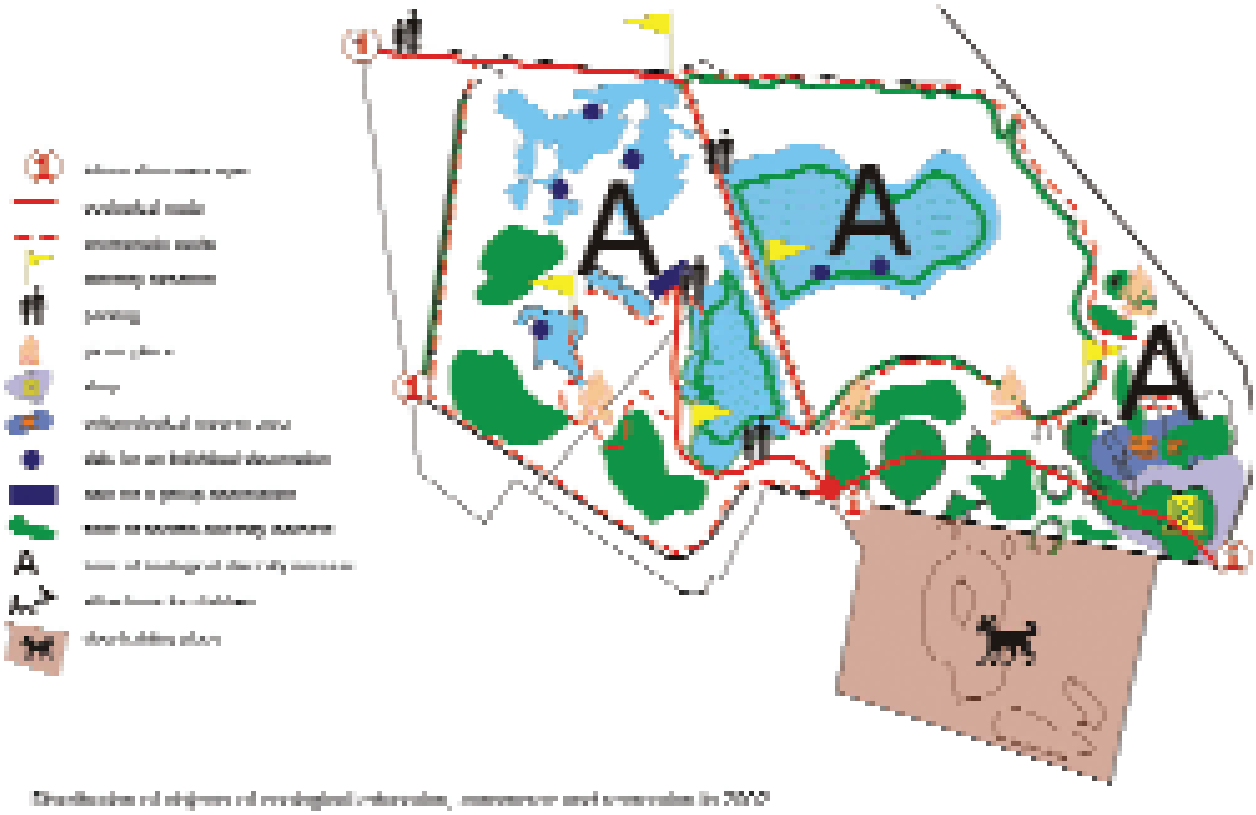
PARTNERS

- Water management Board
- Fisheries Board
- Private fishery organisations
- Province of Odessa
- Local community councils

PRIORITY

High. The Water Management Board already has plans to reconnect Katlabuh Liman to the Danube.

Izmail wetland park



8.5 COMMUNICATION PROJECT: IZMAIL WETLAND PARK

THE SITE

A part of the floodplain remains between the harbour and the city centre of Izmail. It has been used for excavation of sand, fishing, walking and as an uncontrolled waste dump. More than half the area is water. On the north side it is dominated by the beautiful skyline of the town of Reni with houses, gardens, and the cupolas and towers of several churches. The town literally looks down on the project. On the other side the quay for passenger ships and the cranes of Reni harbour dominate the horizon.

AIM

To show the main elements, characteristics and processes of the Danube floodplain to the urban population and to tourists.

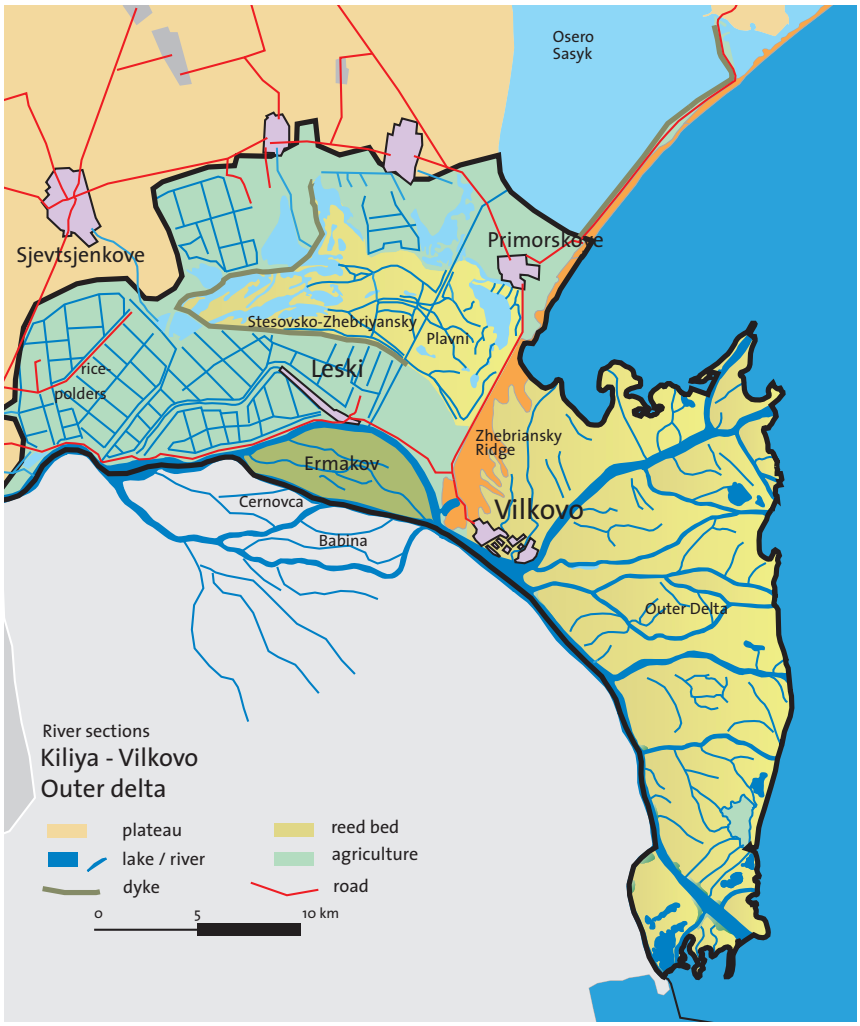
To do this properly, the floods of the Danube must be allowed into the park to a limited extent. A former connection with the river still exists and could be used.

PARTNERS

The city of Izmail is already involved in the project. New park entrances have been made, a separation ditch has been dug and litter has been removed. This initiative deserves to be supported with advice and money.

PRIORITY

High; the project has already started.



Danube-branches between Kiliya and the Black Sea, with Ermakov Island, Stensovsko- Zhebriansky Plavni, Zhebriansky ridge, and the Outer Delta

9 Model sites: from Kiliya to Vilkovo

After a narrow passage of the river near the town of Kiliya lies the second Inner Delta. The northern part consists of a marshland, the Stensovsko-Zhebriansky Plavni. This marshland is isolated from the river by rice polders, and from the Black Sea by the expanding Outer Delta. Ermakov Island, completely embanked and surrounded by two forks of the Kiliyskiye branch, is situated to the south. To the east is the Zhebriansky ridge, a part of the old sandbar that thousands of years ago separated the Black Sea from the inland lagoon in which the Danube Delta developed.

9.1 REVIVING THE DORMANT FEATURES

After reviving the dormant features, what changes might be seen in the area?

ERMAKOV ISLAND:

- return to natural river processes of Ermakov Island, with the characteristic outer riverbank, reedbeds, creeks and lakes in the middle of the island;
- natural grazing with a variety of species;
- spontaneous return of the riverine forest around and on the island.

ZHEBRIANSKY RIDGE:

- conservation of the Ukrainian part of the ancient sandbar;
- local revival of shifting dunes;
- natural grazing on the ridge and its gradients towards the Outer Delta.

Artist impression of Ermakov Island without dykes

9.2 MODEL SITE: ERMAKOV ISLAND

THE SITE

Ermakov is the largest island of the inner deltas on the Ukrainian side covering almost 2,500 ha. It is probably the result of several smaller islands that have grown together. The island used to have large reedbeds in the interior but these have suffered from salinisation and grazing of domestic livestock.

The island is surrounded by dykes. The soil is in a process of salinisation and in some locations the freshwater vegetation has completely disappeared in favour of a saltwater vegetation with Salicornia species.

AIMS

Project for construction of sluices

There is a project to build sluices for in- and outflow of water which amounts to a backward step away from restoration in the direction of a technocratic landscape. While biotope reconstruction and desalinisation might be achieved, fertility for intensive agricultural use will be restored as well which will probably be exploited in the future.

Controlled inundations for habitat reconstruction cannot replace the comprehensive and intricate morphological processes of natural floods. In particular, the filtering capacity of the reedbeds and the height of the reeds will be different because natural flooding involves continuous water flows for weeks over (parts of) the island whereas sluices allow only a limited flow.

The western point of Ermakov Island

Restoring the natural processes

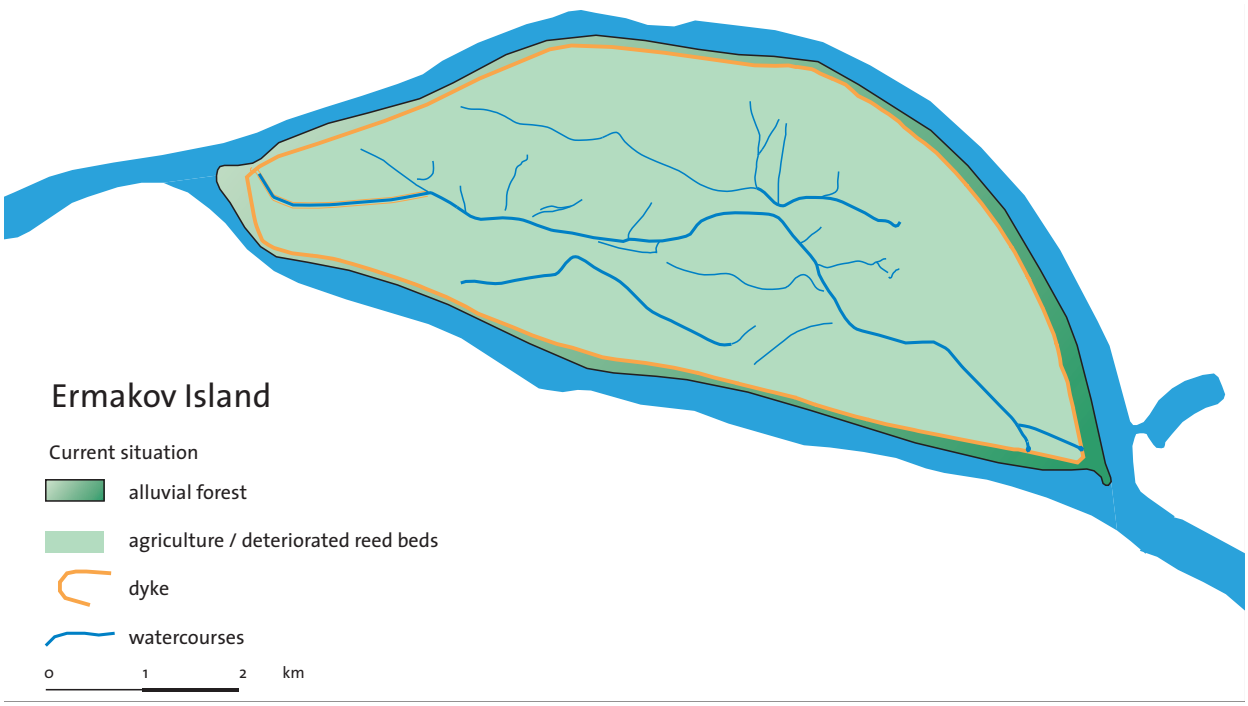
To restore the island to a natural floodplain, the unhampered processes of sedimentation (and a little erosion around the island) must be allowed. Ermakov is low and in times of normal discharge of the river, parts of the interior of the island will be flooded. Reedbeds and lakes will redevelop. During floods, the island will be almost completely covered with water.

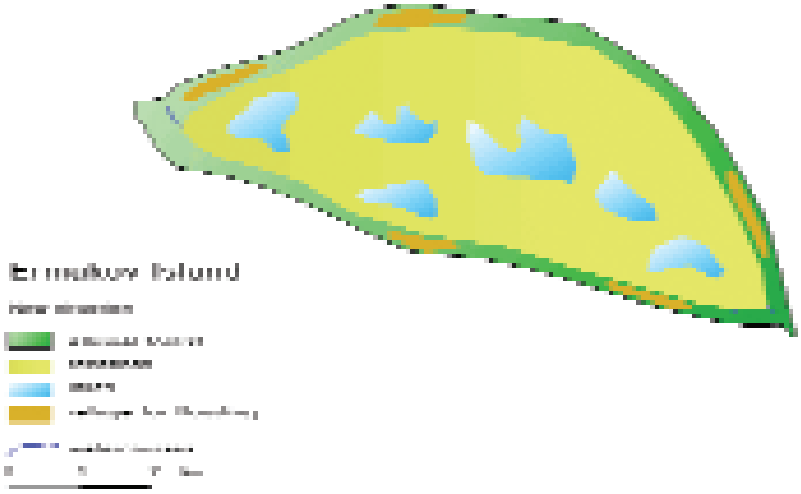
The second Inner Delta, where Ermakov is located, is younger than the first Inner Delta; Ermakov did not have as much time to grow as Tataru for example. In fact Ermakov is more like the developing islands in the Outer Delta. Without natural flooding, the island will not grow. Surrounded by dykes, the soil of the island will in fact shrink and the island will sink away.

PROPOSAL

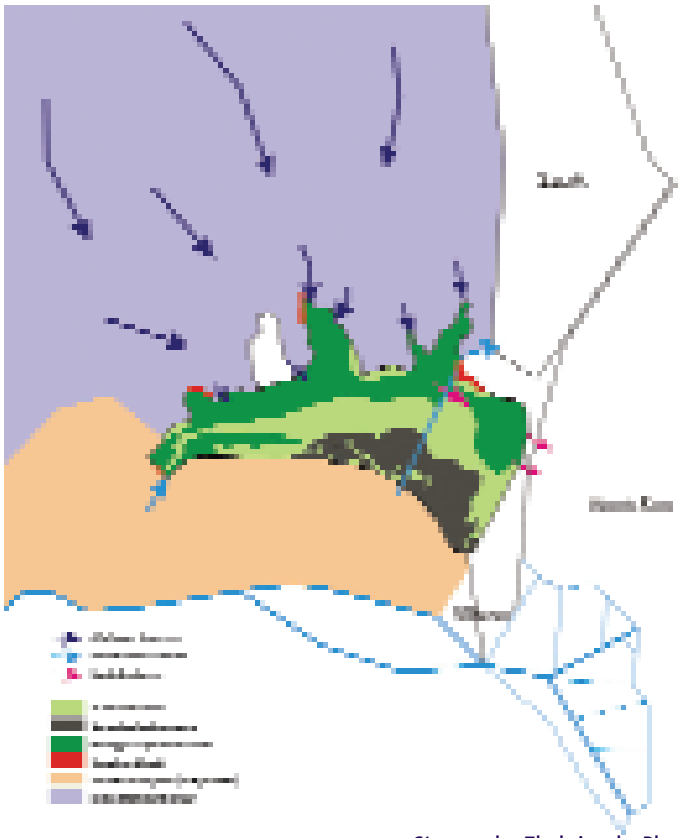
The proposal is to make an agreement with the current user of the island, the Leski Village collective Agricultural Enterprise and the co-user, the Biosphere Reserve. The island could become a model of how large-scale floodplain restoration should be undertaken, not directed at the partial, short-term restoration of one or several biotopes, but towards the integral genesis and growth system of the Delta.

For the inhabitants of Leski, income from sources other than agriculture must be a realistic possibility: ecotourism, meat and skins from animals caught as part of herd management, sustainable reed harvesting, gathering of natural products.





Ermakov Island: before and after restauration



Stensovsko-Zhebriansky Plavni (marsh)

The dykes must be completely removed, some of the soil being used to construct mounds for the survival of the animals during very high floods. Roe deer and Boar are already on the island and their populations should be allowed to grow. Feral cattle, horses and Red deer can be introduced in far lower numbers than those of the domestic animals that are grazing there now.

Following the re-naturing approach, the filtering capacity will be restored and the ability of the island to grow as the ecosystem gradually recovers. The site would be a key input to discussion of the Ukrainian Danube Delta as a whole, and would influence the debate about the large polders and embanked islands on the Romanian side as well. Restoration of the filtering capacity will give the discussion an international dimension in terms of both the nutrient load of the Danube and prevention of pollution of the Black Sea.

PARTNERS

- Leski Village Council
- Leski Agricultural Enterprise
- Biosphere Reserve
- Water Management Board
- International commissions (e.g. for the Danube; Black Sea)
- Green Corridor Project

PRIORITY

Medium. Steps have already been taken but agreement to develop the island according to these proposals has not yet been reached.

9.3 MODEL SITE: STENSOVSKO-ZHEBRIYANSKY PLAVNI

THE SITE

Stensovsko-Zhebriyansky plavni (SZP) was formed on the left of the Danube. Their current area exceeds 8,000 ha. The Plavni has not only a unique abundance of bird species, especially colonially breeding ones, but also unique morphological characteristics. The north part of plavni includes estuarial zones of local watercourses, which drain part of the Budzhak plateau. The area thus offers zones of two types: the main river, the Danube, and numerous local watercourses. In spite of transformations, the site is a valuable Ramsar wetland.

In the past, reed harvesting for export was developed and there are potential economic gains from harvesting Muskrat and Green frogs, and the organization of hunting.

The main problems facing the health of the plavni is their practically complete embankment along the perimeter, and division into two parts by the Danube-Sasyk canal. There is only one inverted siphon for water removal from one part of the plavni to the other. Malfunctioning sluices and a weak inflow of Danube water has favoured a sharp increase of eutrophication, contraction of the water surface, concentration of a large quantity of organic material and the beginning of terrestrialisation in the southern most distant part from the small watercourses of the Delta. The SZP is the property of and is managed by the Danube Biosphere Reserve Authority. The Authority plans to slow down the process of terrestrialisation and to maintain the mosaic of open water and reedbeds for as long as possible. Locally, small water bodies gradually being colonised by water plants have always existed and their vertical growth will continue.

Thus on the SZP territory, a good pilot project for monitoring successional changes in small deltas and their integration with the Danube floodplain can be carried out. As artificial rice polders are re-naturalised and as more land is contributed to the Danube floodplain, SZP will be the only zone to provide an opportunity to follow the stages of successional change.

AIMS

To carry out maximum restoration and support of natural processes.
To monitor successional change.

Work at this site has to take place in phases because of the large scale and the entire embankment of the plavni. During one of the first phases it is strongly recommended that the hydrological balance is restored in order to allow inflow of the Danube water, rich in biogenes. In further stages of restoration partial terrestrialisation in some areas and the formation of stable mosaic plavni in others should be allowed in order to carry out monitoring of mixed deltas.

APPROACH

Over the long term, it will be feasible to replace the sluices on the Vilkovo-Primorskoe road with several bridges; under them the present

Zhebriyansky plavni will be connected to separate inlets of Zhebriyanskaya bay.

In the short term, it is enough to guarantee a flow of Danube water into the plavni, to place a moratorium on building and repairing dykes, and to implement close monitoring of the natural processes. A next stage could improve the drainage and natural water run-off from local water bodies.

Without these measures, the natural 'small deltas' will be condemned to disappear and the resulting damaged ecological situation in the region will obstruct tourism development.

CURRENT AND PLANNED WORKS

Reconstruction of the sluices is already under way. It is necessary to organize monitoring on plots determined by previous WWF projects.

After repairing the sluices, maximum flushing of the SZP is planned.

To address excessive reed biomass, the Danube Biosphere Reserve intends to use several methods: cutting and dredging of the river branches in summer; burning in ecologically suitable terms, and encouragement of high populations of Muskrat and herbivorous fish.

Use of grazing as a way of managing vegetation is still not widespread, but it should be increased in light of the dry areas which will result after repairing the sluices and the more stable regulation of water level. Grazing will not only reduce green vegetation, but will also destroy some of the reed rhizomes.

PARTNERS

Biosphere Reserve Authority
Reed Cutting enterprises
Ecotourism enterprises

PRIORITY

High, as the monitoring can start immediately.

Artist Impression of the transition from the dry sand of Zhebriansky ridge towards the Outer Delta and the Black Sea

9.4 MODEL SITE: ZHEBRIANSKY RIDGE

THE SITE

The very dry, sandy Zhebriansky ridge, part of the sandbar that thousands of years ago separated the river from the sea, seems to be a forgotten part of the Danube Delta. Its extreme dry, hot conditions and sandy character are the very opposite of the wet and clayey world of most parts of the Delta. Nevertheless, the ridge played and continues to play an important role in the development of the Delta and, with its special characteristics, adds to its (bio)diversity. In the Ukrainian part, only a small area of these dry lands is found; while in the Romanian part it covers many square kilometres.

In the east the ridge gradually descends into a marshy area, with sand as substrate rather than heavy clay. This makes it rather unique and offers different opportunities than in other parts of the Delta.

The sandy ridge itself has an area of 1,000 ha; the marshland and reedbeds towards the first large branch of the Outer delta are about 3,000 ha in extent.

AIMS

To restore a small-scale shifting dune landscape.
To (re)introduce natural grazing
To improve the site for ecotourism.

Shifting dunes are very characteristic for this hot, windy and sandy environment. Without large-scale measures as the cutting of the exotic pine trees, local beginnings of moving dunes should be allowed. More dynamics, in the form of hoofs trampling the soil, might encourage this.

The ridge itself is not suitable for grazing domestic species except those adapted to desert conditions, Kulans for example. The combination with the marshland eastwards of the ridge, however, makes it very suitable for natural grazing. Species can use the different dry and wet habitats according to climatic conditions and water levels.

Feral cattle and horses will form the basis for the grazing. On the sandy soil Bison will find a suitable environment; Roe deer and Boar probably live there already. In the whole of the Outer Delta the wetland-specialised Elk is in the right place. Red deer could be introduced as well. The ridge might be a good habitat for introduction of the Kulan, a special and endangered species.

The proposed project site is easily accessible as it lies on the main road to Vilkovo. It adds to the qualities of Vilkovo as a centre for ecotourism and completes the menu of environments offered by the Danube Delta. It can influence the discussion on the management of the much larger sandy areas on the Romanian side.

POTENTIAL PARTNERS

Biosphere Reserve Authority
City of Vilkovo
Forest Service

PRIORITY

Medium. The area is managed by the Biosphere Reserve; once agreement is reached, the project may start.

Outer Delta

10 Model sites: the Outer Delta

The Outer Delta is relatively untouched by humans. Only the dredging of one or more of the outlets from the Danube to the sea poses a threat to the natural conditions of the area.

The Outer Delta is very well managed by the Biosphere Reserve. Excursions can be taken; wardens and their cabins can be found all over the area. Observation huts have been provided. In Vilkovo there is an office and guesthouse/hotel. Vilkovo and the Outer Delta are in fact the main attractions for tourism and ecotourism. From those points, excursions can be made to other parts of the Delta and, in the future, to model sites such as Tataru and the Daller islands.

10.1 MODEL SITE: NATURAL GRAZING IN THE OUTER DELTA

Forty years ago, a group of cattle was more or less abandoned in the Delta. These animals became feral and now live independently in the dunes near the Black Sea coast. Numbers are regulated by traditional hunting methods which make the herds very shy and cautious.

Experience with these cattle is very valuable both with respect to their influence on the landscape and to their behaviour, survival and social structure as wild animals. This knowledge, available in the Biosphere Reserve, could be the subject of several interesting and useful reports.

The Biosphere Reserve authorities propose to let the animals move freely on the low ridges along the reedbeds. The ridges are covered with a mixture of willows and reed. Natural grazing would change this to a richer and more diverse vegetation. The animals could be introduced into other parts of the Outer Delta as well, provided there are places where they would be safe in periods of high water of sea or river. Where the feral cattle is living, the dunes are high enough as has been proved over the last 40years.

The Outer Delta is suitable for more species of large herbivores, Elk in particular would be able to cope very well. On the drier parts in the dunes, Red deer and horses would find a congenial habitat and Beavers would also be at home there.

AIM

To maintain and enhance the existing natural values.

This could be achieved by:

- Studying the existing herd of wild cattle;
- Natural dispersion of the cattle through social pressure and/or need for food;
- Development of hunting methods without disturbance of the herd;
- Introduction of new species: Elk, horse, Beaver, Red deer;
- Natural growth and dispersion of populations of Roe deer and Boar.

PARTNERS

Biosphere Reserve Authority

PRIORITY

High. May start immediately.

A Vision for the Danube Delta, Ukraine

ANNEXES

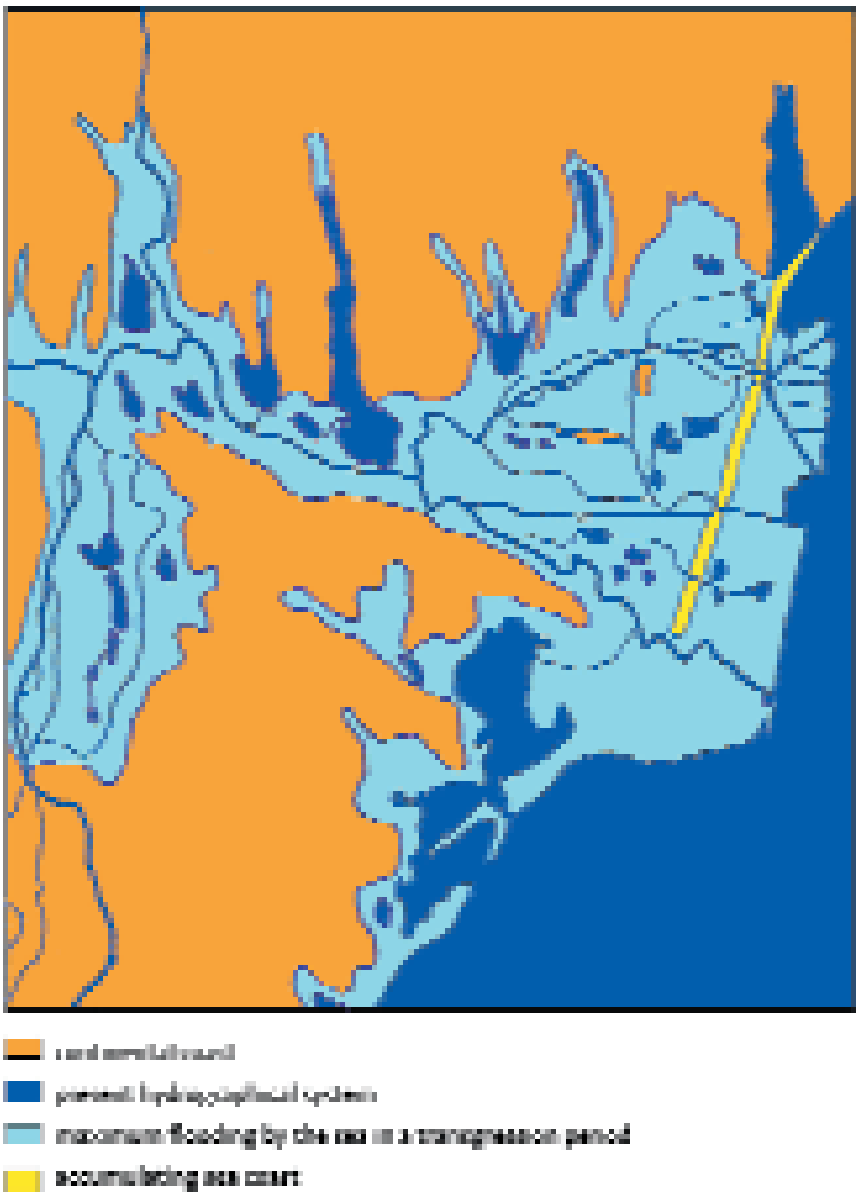


Figure A.1
Formation of the Danube bay (pre-liman) in Holocene

ANNEX A

The genesis of the Danube Delta

WETLAND MANAGEMENT UNIT, MELITOPOL

SEA-LEVEL CHANGES AND FORMATION OF THE DANUBE LAGOON

Present understanding of the evolution of the Danube Delta is based on the study of geomorphic features in the field and of aerial photographs, sedimentology and stratigraphy of deltaic deposits in seismic profiles and boreholes, biostratigraphic analyses, as well as C14 dating. However, a final theory has still not been agreed.

Generalizing from the material available, we can say that the Danube river started to discharge into the Black Sea in the Upper Pleistocene (Panin, 1989) and that subsequent development was strongly influenced by sea level changes during that period. Periodical floods or drainage of the adjacent Black Sea lowland contributed to the formation of a complex schistose system of bottom deposits in the ancient delta. Therefore, the present Danube Delta infrastructure (with thicknesses ranging from tens to 400 m) consists of deposits formed during the Upper Pleistocene and Holocene.

During the Wurm regression, the level of the Black Sea was about 130 m lower than today. This caused erosion of most of the Lower Quaternary deposits and re-deepening of the river channels entering the Black Sea basin.

As paleontological studies have shown, the modern morphology of the Delta is an expression of the fluvial-marine interaction in the Holocene (figure A.1).

Falls in sea level favoured the rapid formation of river deltas open to the sea while rises resulted in lagoons and filling of the bay. Around about 11,000 – 10,000 BP, a sharp increase in the Black Sea level, practically equal to the present level, formed a vast bay reaching up to the present Izmail Chatal.

Alternating regressions and transgressions of the sea changed the bay outlines providing for the growth of inner and marine deltas. The most powerful transgression, which ended in about 4,000 BP at a level some 4-5 m lower than now, flooded an ancient river valley up to the mouth of the right branch of the Seret river and Brailovsky plavni (figure A.2).

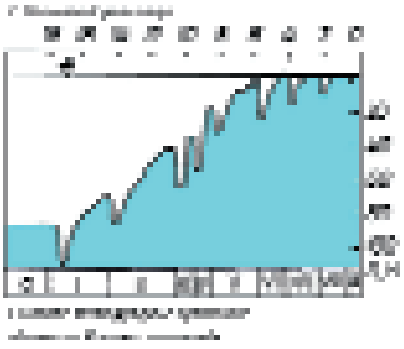
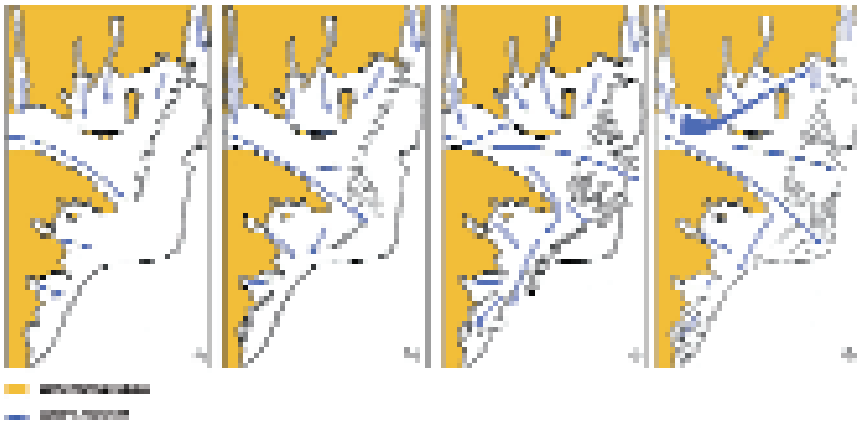
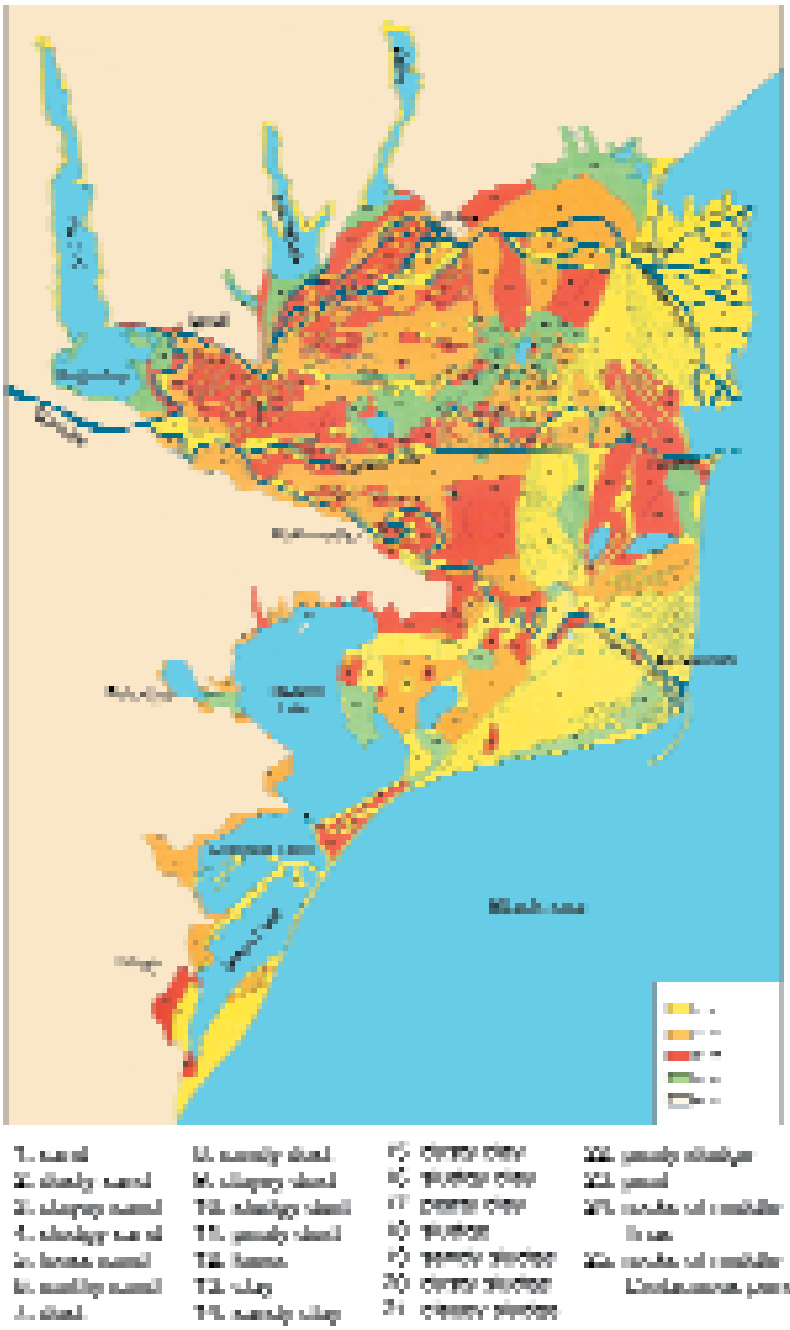


Figure A.2
Dynamics of the Black Sea level in Holocene



TOP Figure A.3
Scheme of the Danube Delta formation in prehistoric times
a) formation of a marine wave-cut wall Zhebriyany-Letya-Karaorman in the period of post-glacial climatic optium
b) formation of Karaorman ridge and beginning of forming Krasnikol, lupilor, Istriya and Stipok rigfes in the first half of the period between post-glacial climatic optimum and beginning of our era
c) formation of Letya ridge, a triangle delta of Sulinsky branch, such ridges as Krasnikol, lupilor and Istriya and beginning of forming a triangle delta in the mouth of Portitsa in the second half of post-glacial climatic optmum and beginning of our era
d) formation of triangle delta of Georgievsky branch and Kituk ridge, beginning of forming a northern branch (Kilysky branch)

RIGHT Figure A.4
Structure of the delta bottom deposits on the depth of 0.5 m



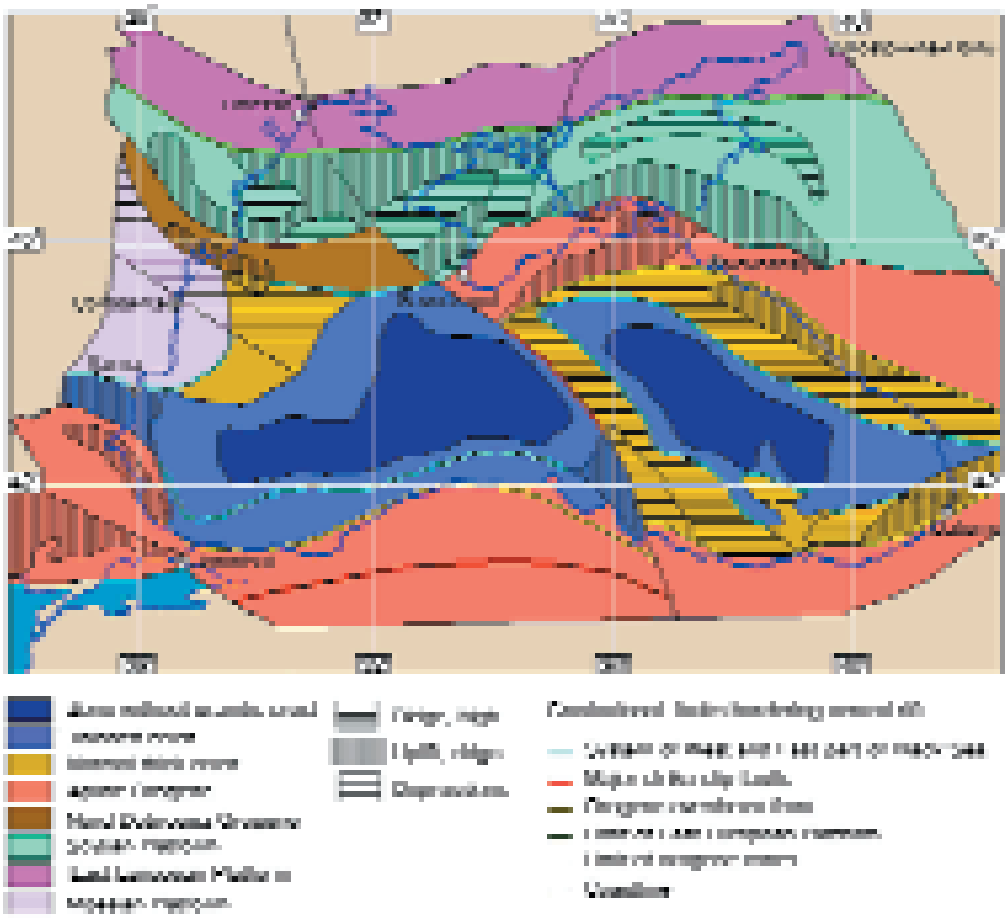


Figure A.5
Tectonic map of the northwestern part of the Black Sea

DELTA DEVELOPMENT

Around 8,000-6,000 BP, when the sea was at about the present day level, an 'initial spit' isolated a large, shallow area: the Danube bay. The spit was rooted on a promontory and built up by southerly sediment transport along the coast. In this 'blocked' phase, the Danube formed a delta inside the bay. Owing to predominantly marine (pre-liman) currents of a cyclonic type in the vast Danube bay, as well as northerly and easterly winds in the north-western part of the Black Sea, deposition of river alluvium in the bay was initially along the Dobrudzha bank, where the most ancient river branch, the Georgievsky, was formed (figure A.3). This process was assisted by run-offs from the very deep valleys of such small rivers as the Yalpug, Katlabuh and Enike.

Between 6,000 and 4,400 BP, during which there was a prolonged sea regression, a first open-sea deltaic lobe of the Georgievsky branch and Karaorman ridge were formed at the southern end of the initial spit. Subsequently, the partial blockage of the paleo-Georgievskye branch as a result of sedimentation in the south-eastern part of the ancient bay, redirected the main water and sediment discharge on a more northerly path, where the Sulina branch is now present. According to the authors (figure A.4), a structure of bottom deposits, alternating between clay and sand sediments formed as a result of more ancient processes of delta development, suggests that the most active development took place along a nominal line connecting Izmail and Tulcha. So, the main run-off in the delta was in the Izmail Chatal area at that time.

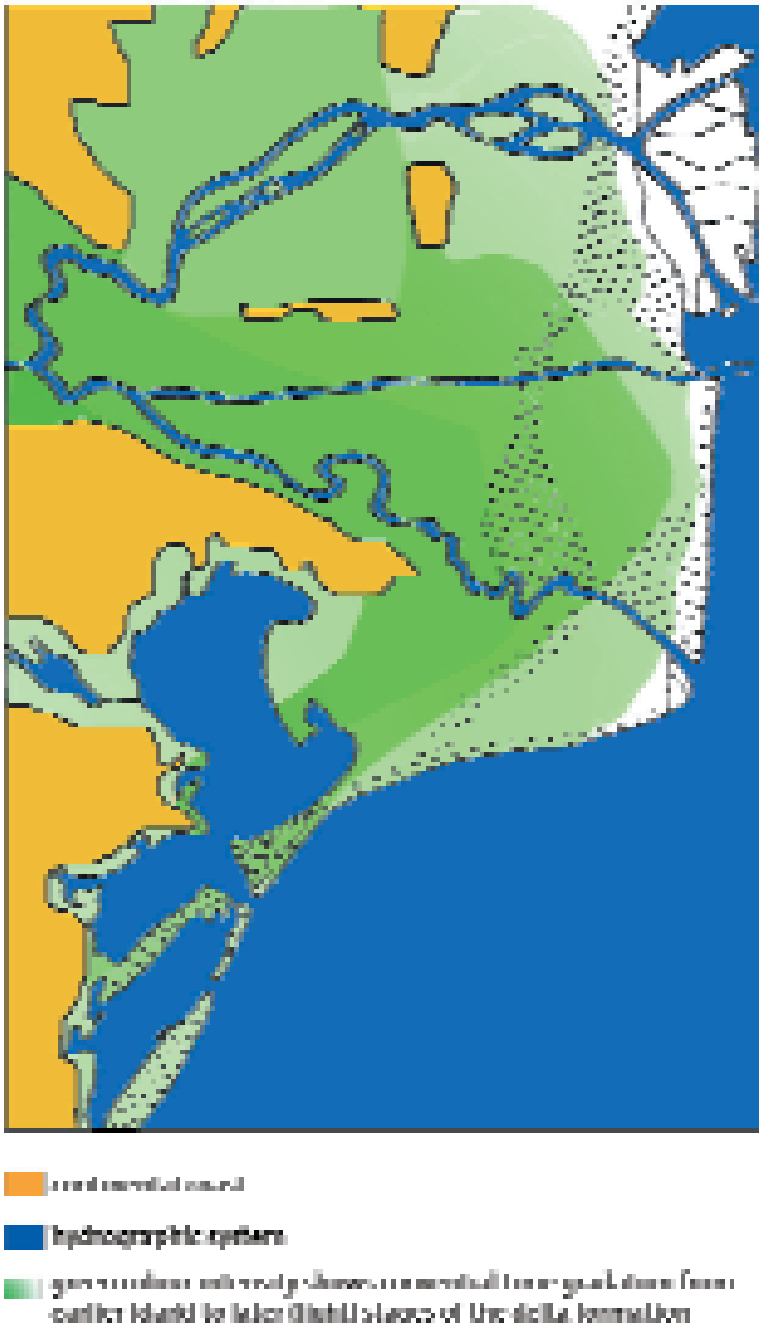


Figure A.6
Scheme of continous development of the Danube Delta

The new Sulina branch developed its own deltaic lobe between 4,000 and 2,000 BP during the next sea regression. Growth of the debris cone of the Sulina branch was rapid because deep water areas had remained between the old and new branches. As a result spits were formed which blocked sediment removal along the shoreline. Conditions for sand to be build up on Letya ridge were thereby created (figure A.3). Some of the sediments, which were earlier freely removed by waves and currents along the coast, penetrated to the south during strong storms, skirting the Danube stream and moving further into the sea. From these sediments small ridges were formed to the south of Sulina. As the sea level was dropping, they served as a basis for an outer wave-cut wall.
The latter stretched up to the southern border of the present lake Sinoe. Partially contemporaneous, a southern secondary branch built

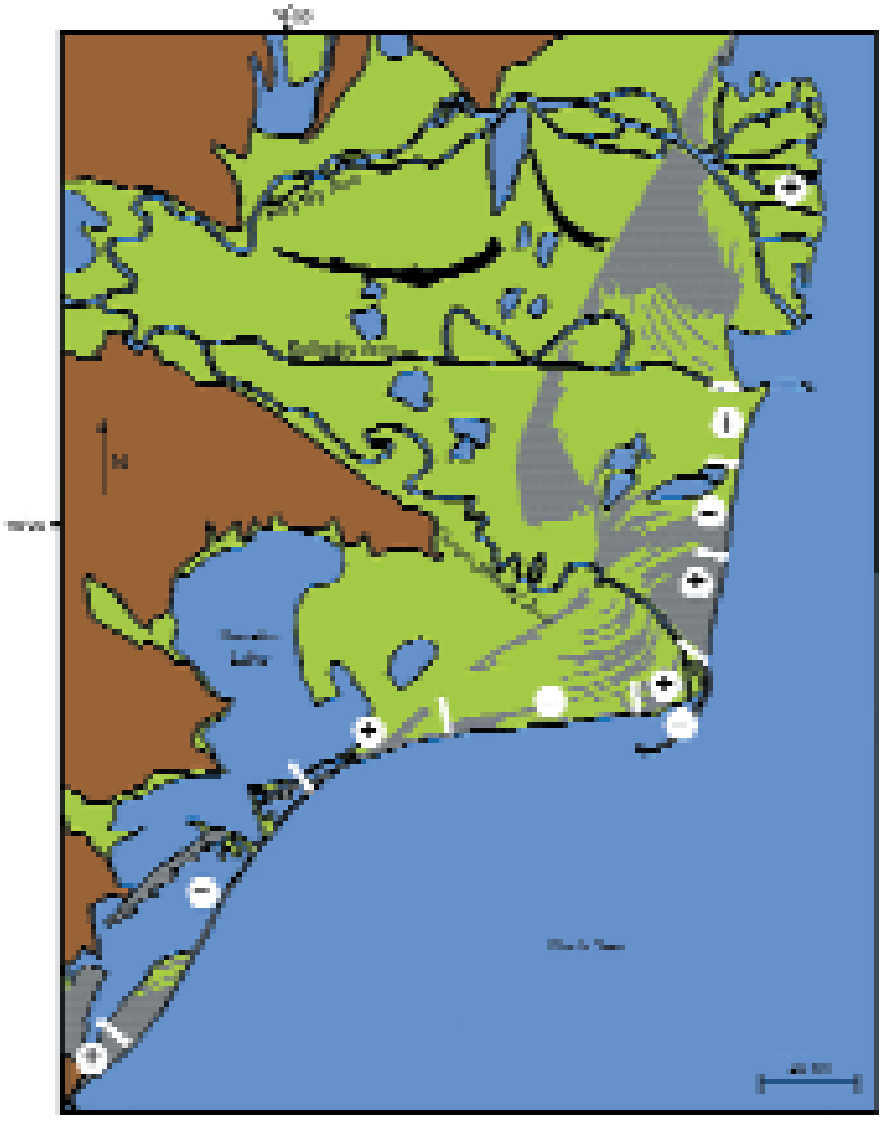


Figure A.7
Processes of erosion and sedimentation along the Delta seaside

two successive small delta lobes, Cosna and Sinoe, between 3,500 and 1,500 BP. The Sulina delta reached its maximum development around 2,500 BP, when the Black Sea level, having reached its minimum, began to increase.

The last regression (known as the '*Phonagor*') activated run-off redistribution between branches. The southern (Georgievsky) branch had to re-form the present part of the delta to the south of Karaorman ridge because of accrued sediments in the delta of the Sulina branch. By 2,000 BP, the Sulina lobe was being partially eroded by the next sea transgression and sediments accrued there were removed by currents to the delta of the Georgievsky branch. At this time, the most-northern (now Kiliya) branch was actively developing. Apart from progressive accrual of a thick alluvium layer in the southern part of the inner bay, which gives us the main features of the lagoon system, gradual redistribution of the main run-off through the Kiliya branch may have been assisted by tectonic land depression in the northern part of the delta (figure A.5).

Whatever the case is, two lagoons, Kiliyskaya and Vilkovskaya, were separated from the one at Tulchinskaya. It is quite natural that the run-off, meeting different barriers, began to swerve and flow along the line of least resistance forming two inner deltas in Kiliyskaya and the Vilkovskaya lagoons (step-shaped formations with water discharge during the primary stages into the sea through Sulina). When the two inner deltas had been formed, the Kiliysky branch was already prepared to absorb the main run-off. This was followed by erosion of the sea wall and its final breach in the region of the present Vilkovo (figure A.6).

Development of the Kiliya coastal delta began about 300 BP. At this time active building by the sea of the Zhebriyanskaya ridge also began. The primary triangular Outer Delta of the Kiliysky branch was transfigured as a result of the influence of the sea and the redistribution of run-off, and is now emerging as a blade-shaped or fan-shaped delta. The Kiliya delta is developing asymmetrically as it is gradually deflected in a southerly direction by coastal currents. To the north, in Zhebriyansky bay, there is continuous formation of sand spits, separating of parts of the sea bay which is being diluted by the fresh water river run-off. Today most of the deltaic coast is eroding with the notable exception of the Kiliya lobe which is maintained by the high discharge of its feeding channel (figure A.7).
For the future, it can be expected that channel-forming activity in the Kiliya delta will decline and that the run-off will be concentrated in some of its southern branches. In the area of Zhebriansky bay, sequential formation of the biologically valuable closed or half-closed freshwater bays (kuts) will take place, with a system of accumulative spits in the direction of Sasyk liman.

To restore nature in the Delta, it is very important not only to understand its evolution, but also to realize that many aspects of its history are still unclear. At least the following outputs are worth attention: (Nikiforov, Stanesku)

- three alternating transgressions and transient regressions of the Black Sea level over the last 6,000 years coincide with the development of the three main branches of the Danube and their coastal deltas;
- the sub-surface walls and spits of the flooded ancient delta may determine the configuration of sediments of the ancient lagoon;
- filling up of the ancient lagoon with sediments took place from south to north and, apart from sea currents and winds, were aided by neo-tectonic changes;
- formation of the plavni areas north of the Kiliysky branch was slowed by periodically strengthened run-off of small rivers, the valleys of which were very deep even in 100 – 150 BP;
- the most dynamic parts of the Delta are characterised by a constantly growing cone of debris on its periphery deposited by the active branches, and relatively stable inner floodplain zones with high biological productivity;

- local run-off basins along the Budzhak delta coast principally differentiates it from the Dobrudzha coast on the right bank. In the near future, this feature will determine conservation of the mini-processes of delta formation in the estuarial zones of every branch;
- saline run-off redistribution by the main branches at the breakthrough into inner lagoons of an ancient Danube bay.

Figure B.1
Average annual water levels in the upper delta (Izmail) and trends

ANNEX B:

Water processes

WETLAND MANAGEMENT UNIT, MELITOPOL

GENERAL DYNAMICS OF WATER PROCESSES

One of the most important factors affecting the development and formation of the Danube Delta is the dynamics of the principal hydrological elements: water discharge, sedimentation and water level.

DRAINAGE DYNAMICS

Danube river water is drawn from a large territory spanning several different climatic zones of Europe. There is thus a diversity of inputs and characteristics in the delta of the river, with flowing water throughout the year.

Average annual drainage of the Danube is 203 km^3. In dry years with 75% supply it is 173 km^3, in years with 95% supply it is 142 km^2. In wet years run-off can exceed 50% of the yearly average, for instance, in 1941 it was 313 km^3, while in dry years it can decrease by more than 30%, in 1921 it was 134 km^3. In recent years the discharge has had a tendency to decline. Alternative dry and wet years for a continuous series has been observed and has been approximately 25% of the average of previous periods. Highest discharges are in April, May and June, each having 10-12% of the annual run-off. Lowest water discharge is observed in September to October at 5-6% of the annual run-off.

Maximum water flows in flood periods reach 15-16,000 m^3/sec. In low water periods these contract to 1300 – 1500 m^3/sec, i.e. practically 10 times smaller.

Retention of run-off in the Delta itself is slight at about 1.5 km^3 /year.

In spite of increased irreversible water intake in the river catchment area, which was 10.6 km^3/year by 1980, there was no significant decline in the water volume of the river against the background of its cyclic fluctuations (Mikhaylov, Vagin, Morozov, 1981) (figure B.1).

REDISTRIBUTION OF THE DRAINAGE

Redistribution of water and sediment between the branches in the Delta is inevitable and is caused by natural processes, and human intervention mainly connected with navigation (see figure B.2).

The Kiliysky branch carries the greatest volume of water. Its maximum activity was at the end of the 19th century, when its share reached 70% of

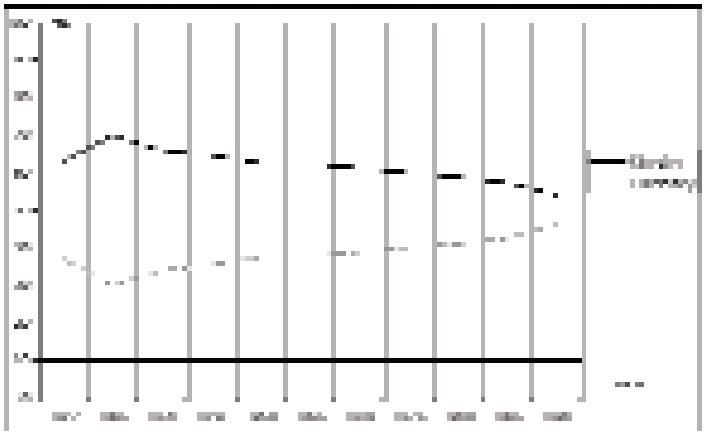


Figure B.2
Annual fluctuations in distribution of average run-off between principal Delta branches

the Danube in the upper delta. The share of the Tulchinskaya branch was about 30% in the same period, 7% flowed through the Sulinsky branch and 23% the Georgievsky branch (Nikiforov, Dyakonu, 1963).
As a result of canalisation and deepening of the Sulinsky *(1880-1902, 1930)* and Georgievsky *(1984)* branches, the construction of a stone dyke along the Izmail Chatal which drains a part of the run-off in the Tulchinsky branch, and extension of the estuarial parts of the Kiliyskaya delta waterways into the sea, discharge was diverted into the Tulchinsky branch. As a consequence the share of the Kiliysky branch over the last 100 years has been decreasing and, by the end of the 1990s, it was 53.9% of the Danube run-off (Kornilov, 1999) (see figure B.2). Investigations have shown that redistribution of the drainage into the Tulchinsky branch has now also slowed. As there have been no engineering works to increase the drainage in the Tulchinsky branch over the last 15 to 18 years, we could conclude that the artificial reduction in the share of run-off in the Kiliysky channel has finished and recent changes in distribution have been chiefly caused by natural processes (figure B.3).

Redistribution of the drainage in the Kiliysky branch system at the height of the first inner delta, will cause a rapid die-away of the Kislitskaya branch and then of the Ivanesht branch. The Sredny channel is relatively stable but, with the fading of the Kislitsky branch, it will gradually be activated.
The system of watercourses in the second inner delta is relatively stable although in future some activation of the Pryamoy branch, rapid die-away of the Chernovka branch and slower weakening of the Babina and Solomonov branches can be expected. Construction of the Danube – Sasyk canal to desalinate lake Sasyk (1980) increased the irretrievable water intake from the Kiliysky branch by 0.7-0.9 km annually and disrupted the natural development of the branches of the second inner delta. If the canal continues to function it will result in more rapid die-away of the Solomonov branch.

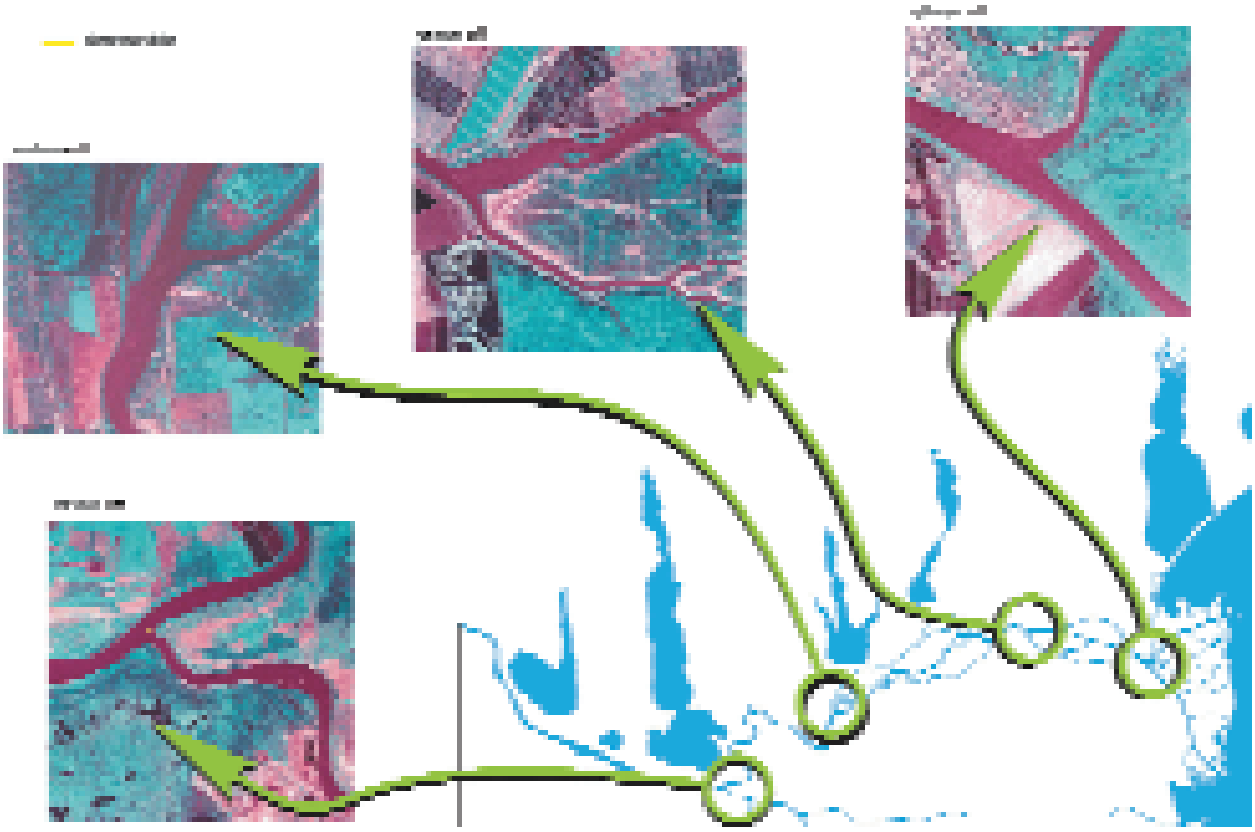
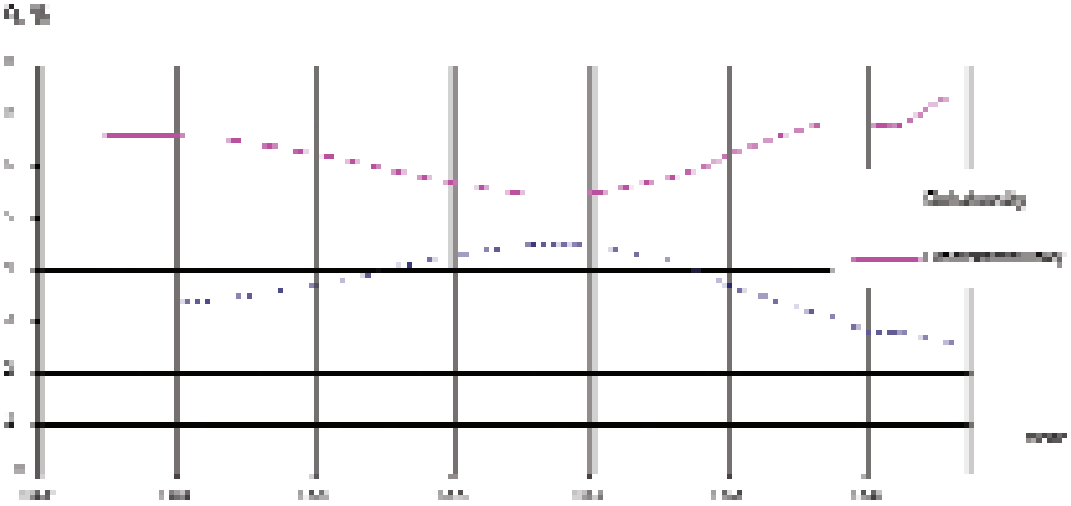
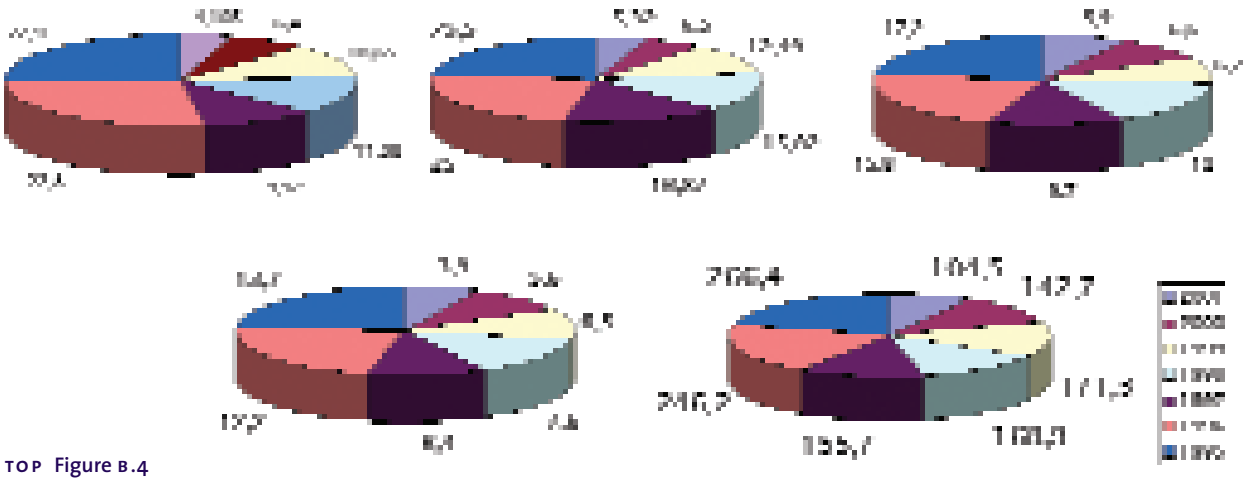


Figure B.3
Key sites for run-off redistribution for Kiliysky branch of the Danube

From 1872 to 1943, drainage distribution between the principal branches of the Danube Delta was characterized by activation of the Ochakovsky branch, the share of which had increased from 21% to 29.3 % by 1943. The Ochakovsky and Starostambulsky system then changed and increased discharge through the Starostambulsky branch began. By 1995 this had resulted in 41.7% of the river run-off through that system. Against the die-away of the Ochakovsky branch system, the Ankudinov, Poludenny and Gneushev channels amongst others are activating while the Potapovsky and Belgorodsky are filling in and dying (figure B.4).
In the separate Starostambulsky channel system, which is now becoming active, the branches with the highest discharge are the Bystry, Vostochny and Tsygansky, while the Limba and Kurilsky are dying. Activity in the Starostambulsky system will decrease mainly because erosion of the Bystry branch will slow as a result of lengthening its channel.
The results of the investigation show that, in the Kiliya delta, there is a process towards concentration of drainage in a limited number of large branches.
An important component of drainage redistribution is water exchange between the branches and inner and near delta water bodies. Before embanking the main watercourses and building the polder system, water discharge between the Delta branches during high water in the Danube decreased towards the estuaries of the branches because some was retained by water bodies and plavni between the branches. But, during low water periods, discharge increased because of additional supplies from the water bodies and plavni. In addition, during high water some of the water flowed in the floodplain as a broad stream (10 km and more in





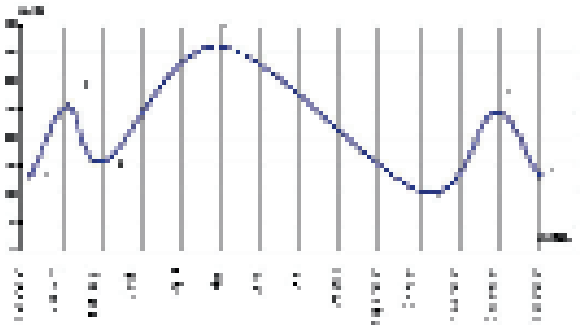
TOP Figure B.4
Run-off distribution for principal branches of the Kiliya delta

MIDDLE Figure B.5
Average volume of the Danube water, discharged in the lakes

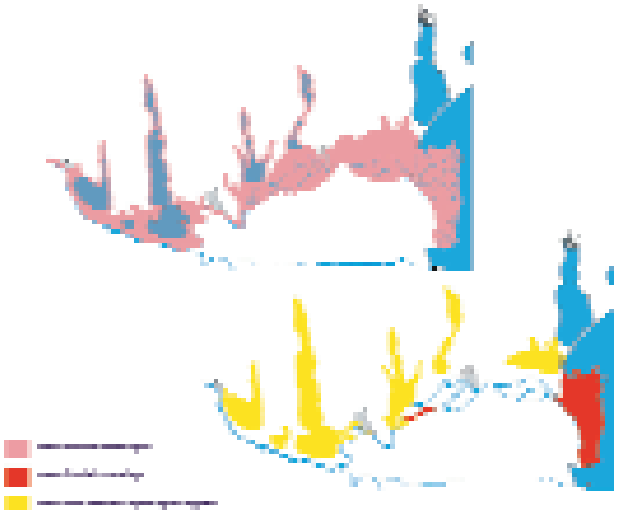
BOTTOM Figure B.6
Dynamics of Danube water discharge into the lakes between 1995-2001
Volume of used water resources:
– in lake Kitay, mln m³
– in lake Katlabuh, mln m³
– in lake Yalpug-Kugurluy, mln m³
– in lake Kagul, mln m³
– in the Danube, mln m³

width). At present, as a result of the above-mentioned engineering work, Danube drainage is concentrated in the main channels of the river, which excludes some stabilising water bodies from the exchange, and means a considerable reduction of water exchange between plavni, lakes and the Delta branches.

Continuous monitoring shows that average annual drainage of the Danube to the storage lakes fluctuates from 1 to 1.5 km³, and the volume of water drained from the lakes to the Danube is up to 1 km³. So the volume of water discharged from the Danube to Kagul lake is 0.1 km³, to Kartal 0.07 km³, to Yalpug-Kugurluy 0.37 km³, to Katlabuh 0.04 km³, to Kitay 0.04 km³ and to Sasyk 0.43 km³ (figure B.5, B.6).



LEFT Figure B.7
Annual fluctuation of the Danube water level 1921-1960 (Tulcha gauging station)
1) winter minimum,
2) winter maximum,
3) spring minimum,
4) spring-summer maximum,
5) summer-autumn minimum,
6) autumn maximum



RIGHT Figure B.8
Changes in the area of flooded territories in Ukrainian part of the Danube Delta after dikes building

WATER LEVELS AND FLOODS

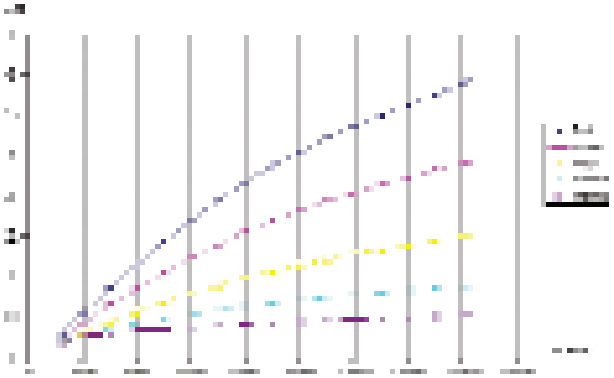
Systematic measurement of water levels has been carried out in the lower Danube since the middle of the last century, when gauging stations were opened in Galats, Isakcha, Tulcha and Izmail Chatal.

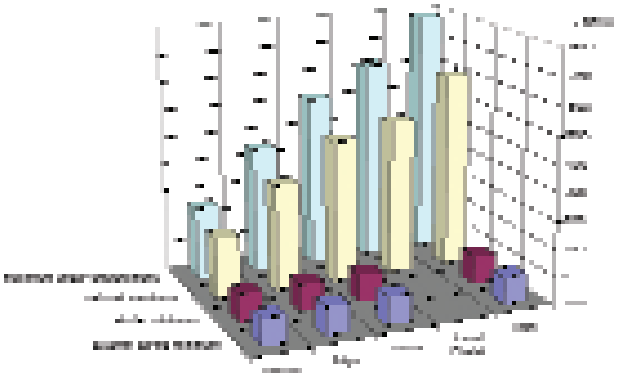
Danube Delta water levels are determined by two principal factors: change of water volume, and driving (piled-up and depressed by wind) at the estuary. Volume fluctuations are quite well distributed over the whole Delta. Driven water fluctuations have their main impact on the coastal part of the Delta but in periods of low water their influence reaches the upper delta and further. Other factors affecting the water level are: fluctuations of the Black Sea level, deposition of sediment or accretion, and human activities.

The following seasonal fluctuations occur in the Danube Delta: winter minimum and maximum, spring minimum-summer maximum, autumn –summer minimum and autumn maximum. These are connected with the diversity of climatic conditions in the Danube basin (figure B.7).

Maximum water levels in the upper and middle delta occur most often in the period of spring and summer floods. At the coast, maximum annual levels are registered both in spring-summer and in the winter period when there is a greater impact from wind-driven fluctuations. Minimum levels in the Delta are mostly observed in October and January.

Floods on the Danube are prolonged (e.g. in 1941: 216 days), the average flood being for about 4 months. In general, the area, depth of flooding and water volume are connected with the water level in the river. Until the main branches of the Danube were embanked and the polders were formed, the total flooded area reached 95% at high water level. When the discharge rate was 16,000 m^3/sec, the water level in the Reni was more than 5 m BS and the whole Delta area, except high ridges, was flooded. As a result of embankment, at the same discharge rate, the flooded area declined by more than half (figure B.8).





LEFT Figure B.9
Correlation between water level in different parts of the Delta and discharge in its upper part

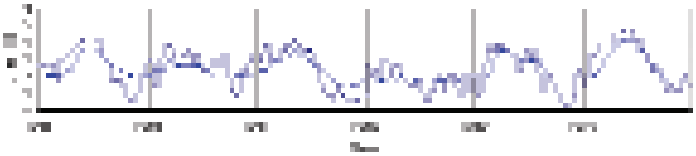
RIGHT Figure B.10
Distribution of minimum, average and maximum water levels in main gauging stations

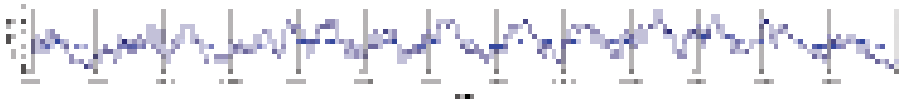
From the upper delta to the sea the run-off oscillation over a year reduces from approximately 5 to 0.5 m (figure B.9). Maximum amplitude of river level fluctuations is 6.2 m at Reni, 4.4 m at Izmail, 2.6 m at Kiliya, 1.7 m at Vilkovo and 0.8 m at Prorva (not taking into consideration any obstructions which can cause sudden and significant fluctuations) (figure B.10). The recently observed increase of the Black Sea level has affected the Danube Delta over the last 40 years. Its backwater was 23 cm and it spread 40 – 45 km up the Kiliyskaya branch. For the same period, the water level in Vilkovo (located 18 km from the sea) increased by 17 cm and that at Kiliya by 4 cm. An increase is registered more than 50 km from the river estuary.

Significant contemporary impacts on the hydrological regime of the Danube originate in various economic activities: irretrievable water use, building of storage lakes, embankment of the Danube and its branches, dredging watercourses, and canalisation. Those measures have not changed the general structure of the drainage (except its redistribution within the Delta watercourses), but has greatly reduced sedimentation (this will be discussed below) and has resulted in higher water levels in the estuarial part of the Danube. For instance, the water level at Reni, at the same water expenditures, has increased by more than 35-40 cm compared to the beginning of the century.

Generally, in spite of some increase of average annual water level (see figure B.1) in the Delta over the period 1921-2000, over the last four decades average annual levels in the upper and middle delta have tended to decrease. This has probably been caused by *inter alia* an increase of the annual levels in the Kiliya delta connected with increasing levels of the Black Sea.

An important element of the hydrological regime of the Ukrainian part of the Danube Delta is the water-level dynamic in the near Danube limans.





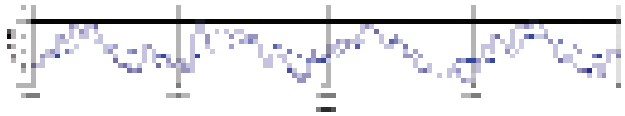


Figure B.11
Water level fluctuation in the Danube and lake Yalpug-Kugurluy

Figure B.12
Changes in average (over the period 1965-1970) and characteristic daily levels (1965, 1968, 1970, 1972, 1975, 1981, 1987) at the Kosa gauging station of lake Yalpug

Before enclosing the natural channels and bayous connecting the lakes with the Danube, the hydrological regime of the lakes depended on the water level in the Danube. During high floods, from February to June, the lakes were filled with water from the Danube and from other small rivers, flowing into the northern part of the lakes. At low levels on the Danube there was natural drainage from the lakes which provided good water exchange and high water quality. In the mid-1960s, construction of sluices on channels and regulation of water bodies resulted in major changes in the hydrological regime of the lakes (figure B.11).
Figure ???? shows three key periods of changes in water level in the Danube and Yalpug lake:

1965-1970 – water level in the lake corresponds to that of the Danube.
1971 – 1983 – a period of major engineering work during which the level in the lake is almost stable.
1984 – 1987 – *The Rules on Lakes Exploitation* are implemented and water management is initiated taking into account natural hydrological processes; nevertheless water levels in the lake reduce by more than 2 meters (figure B.12).

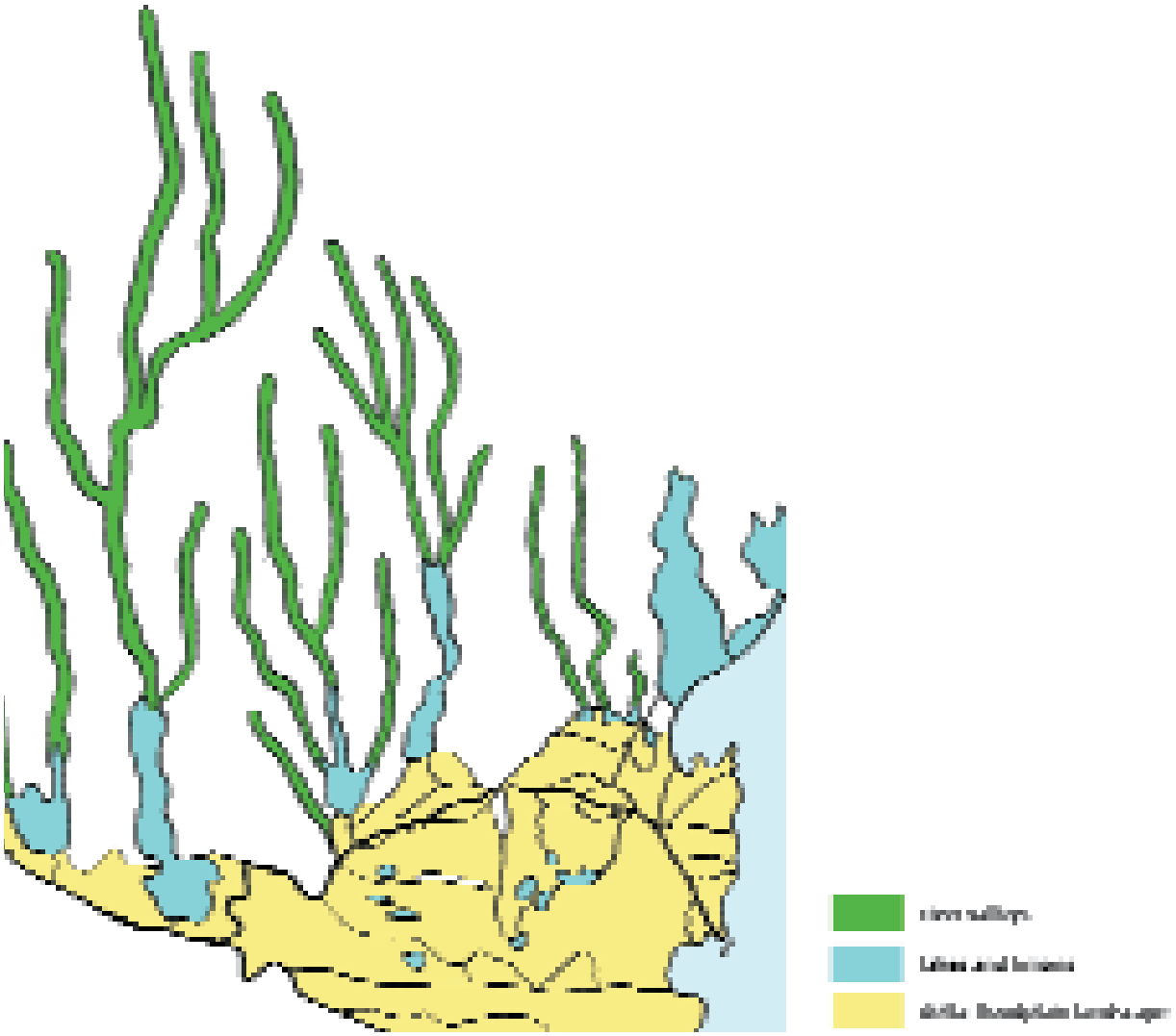


Figure B.13
Hydrographic net of the left bank of Kiliysky branch of the Danube

Recently, some of the organizations using the near Danube lakes, have become concerned about the degradation of water quality in the water bodies and have tried to increase water exchange. As a result of this, the amplitude of changes in level now tends to be natural.

TRIBUTARIES, LIMANS

The broken relief of the Budzhak plateau, along which the Kiliysky branch flows, determines a distinctive feature of the Ukrainian part of the Danube Delta: the presence of numerous permanent and temporary watercourses (small rivers) (figure B.13), which in earlier periods flowed into the Danube. These watercourses, re-deepened in the Pleistocene, were transformed under the Holocene transgression of the Black Sea into limans in the Danube bay. Here, the high loess banks were destroyed by wave erosion and the formation of precipices encouraged deposition of the river alluvia into the broad water surfaces of the bay and the conversion of the estuarial areas into boggy plavni. The extent of penetration of the plavni landscape into the estuarial areas was defined by the balance between the Danube and local drainage. As recently as one hundred years ago, during the spring-summer floods, these estuarial complexes

changed into a marshy kingdom where, because of biogenes, mud and fresh water inflow, a rich flora and fauna developed and migrating flocks of birds rested and fed.

After the construction of dykes and sluices these natural riches ceased to be part of an integrated system; the limans became almost completely isolated from the Delta and the intensity of water use from the limans for economic activities greatly increased.

There are now small rivers which supply local drainage, form mini-deltas in the upper lakes and help to conserve a chain of active floodplain systems in their estuarial areas. In many ways, due to this buffer characteristic of the local watercourses, high biological diversity has been saved in the embanked Stensovsko-Zhebriyansky plavni of the Danube.

THE KAGUL RIVER, 39 km in length and with a total catchment area of 605 km^2, flows into lake Kagul. Annual drainage at 50% supply is 4.16 million m^3, but maximum drainage at 1% supply is 287 m^3/sec.

THE YALPUG RIVER flows into lake Yalpug. The river is 142 km in length and the catchment area is 3,280 km^2. Annual drainage at 50% supply is 403 million m^3, at 75% supply is 98 million m^3 and at 95% it is 12 million m^3.

THE KARASULAK RIVER, also entering Yalpug lake, is 52 km in length with a catchment area of 221 km^2. Annual drainage of this river at 50% supply is 1.744 million m^3, at 75% is 0.502 million m^3 and at 95% is 0.09 million m^3.

THE ENIKA RIVER flowing into lake Katlabuh is 40 km in length with a catchment area of 243 km^2. Annual drainage at 50% supply is 1.99 million m^3, at 75% is 0.6 million m^3 and at 95% is 0.16 million m^3. Maximum drainage at 1% supply is 122 m^3/sec.

THE B. KATLABUH RIVER, flowing into another part of the lake, is 49 km in length with a catchment area of 536 km^2; its annual drainage at 0% supply is 3.78 million m^3, at 75% is 1.13 million m^3 and at 95% is 0.76 million m^3; maximum drainage at 1% supply is 219 m^3/sec.

THE RIVER TASHBUNAR also flows into lake Katlabuh; it is 40 km in length with a catchment area of 281 km^2. Annual drainage of the Tashbunar river at 50% supply is 2.3 million m^3, at 75% is 0.69 million m^3 and at 95% it is 0.19million m^3; maximum drainage at 1% supply is 123 m^3/sec.

THE KIRGIZH-KITAY RIVER enters lake Kitay. It is 64 km in length with a catchment area of 725 km^2; its annual drainage at 50% supply is 6.94 million m^3, at 75% is 1.94 million m^3 and at 95% it is 0.46 million m^3.

THE ALIYAGA RIVER, also flowing into lake Kitay, is 67.5 km in length with a catchment area of 467 km^2. Annual drainage at 50% supply is 2.86 million m^3, at 75% is 1.11 million m^3 and at 95% it is 0.29 million m^3.

THE TOTAL LENGTH OF THE COASTLINE OF THE LAKES is 403.7 km. Over 17 % (71.2 km) is formed by banks subject to abrasion and slipping. Nearly half (29.2 km) of the banks that are subject to slippage are found around lake Yalpug.

THE OVERALL AREA OF THE LAKES' WATER SURFACE is nearly 50,000 hectares. The largest of them are Kagul, Kartal, Yalpug, Kugurluy, Kitay and Katlabuh. The lakes are connected with the Danube through sluices and canals (figure B.14).

THE VIKETA CANAL (its through-put capacity is 75 m^3/sec), the Orlovsky (50 m^3/sec) and the Luzarsa canals flow into lake Kagul.

LAKE YALPUG-KUGURLUY is connected with the Danube through the

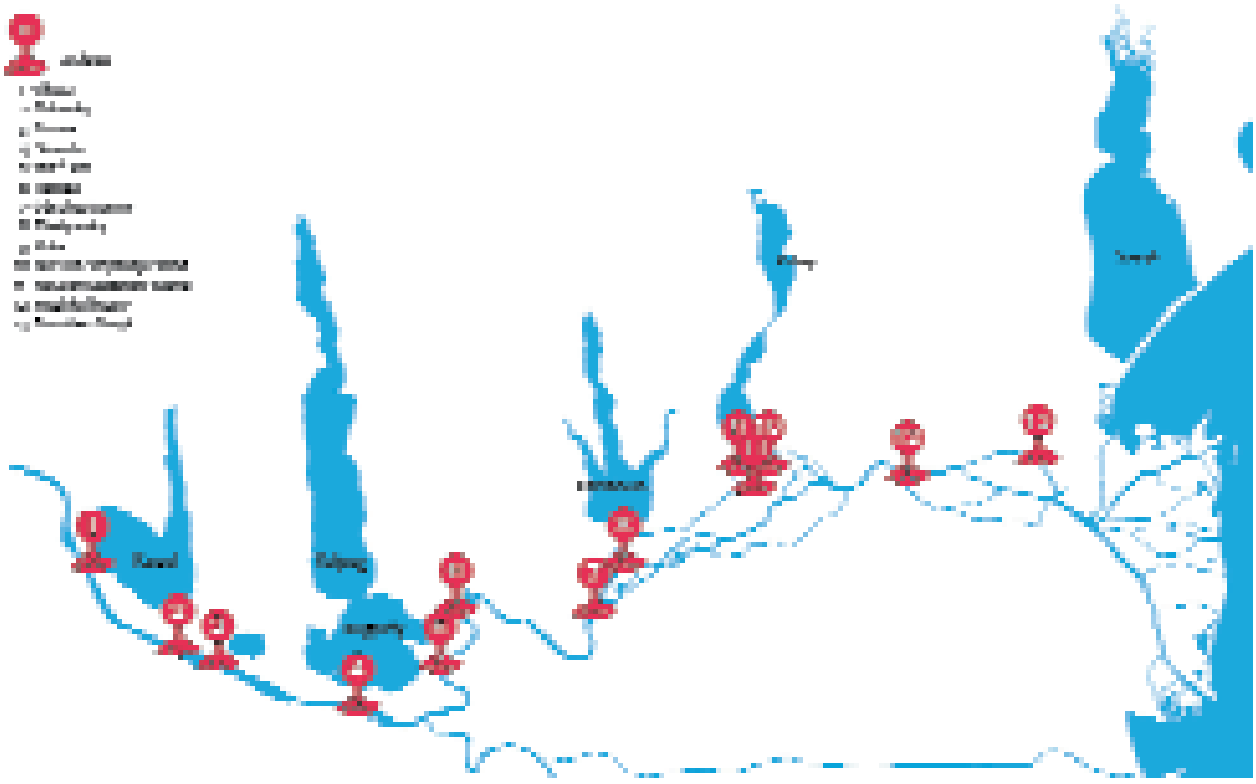


Figure B.14
Scheme of sluices distribution in Ukrainian part of the Danube Delta

Skunda canal (63 m³/sec), the '105 km' (63 m³/sec), Repida (150 m³/sec) and Tobachello (11 m³/sec) canals, while lake Katlabuh is connected through the Zhelyavsky (70 m³/sec) and 'Obschestvenny' (60 m³/sec) canals.
The regime of lake Kugurluy filling gravity is actually determined by the inflow of Danube water through the Cofa (30 m³/sec), Starotroyansky (16 m³/sec) and Stepovoy (20 m³/sec) canals.

DEBRIS CONE

The more sediment that is carried by the river, the larger the debris cone and the size of the delta. Shallow coastal waters, sea regressions and tectonic elevations also determine delta development.
The development of the Kiliya delta from the beginning of its formation until now corresponds to these conditions.
From approximately 1740, the Kiliya delta began to extend into the open coast of the Black Sea which is tideless, is slightly rising in level and is of moderate roughness. By the time it had separated from the main delta, filling a river bay, a characteristic bar of the Danube pre-liman had begun to form in the sea.
Until recently, rapid development of the Kiliya delta was determined by an increase in Danube sediments. This was caused by natural factors (increase of rainfall during the so-called small glaciation from the 15th to the 19th century) and human activity (increased erosion in the Danube basin because of deforestation and ploughing on slopes in the 18th and 19th century) (Mikhaylov, 2001).
As was shown above, sediments forming the debris cone arrive in the Delta in two ways: through river run-off, and from the north through the coastal waters of the Black Sea. A part of the sediments are taken with the beach drift towards the south. The rest, consisting mainly of small suspended sediments, drops into the sea outside the borders of the debris

Figure B.15
Evolution of the Kiliya delta of the Danube and directions of its growth

cone. In parallel with the evolution of the Kiliya delta, there is an increasing share of Danube sediments being deposited in the debris cone. This share is now about 66%, which is characteristic for large rivers of the world (Mikhaylova, Levashova, 1999).
As a result of the predominant north-south coastal current, the Kiliya delta has always been slightly asymmetrical. The asymmetry was oriented north-west/south-east which resulted in the appearance of the Ochakovsky and Starostambulsky branches (Figure B.15).
The most active growth of the Danube Delta was registered during the wet period between 1871 and 1922. During that time, the Delta area increased by 163 km² with annual growth of 3.1 km² per year. Over the same period, the linear delta growth towards the Ochakovsky branch was 1.18 times (or 18%) greater than that towards the Starostambulsky branch and was 12.7 and ?? km per year respectively (figure B.16, figure B.17).

As Delta run-off reaches greater depths, the level of the Black Sea rises, there is a reduction in the Danube sediments load (which will be discussed below) and the growth of the Delta area decreases (over the period 1941-1980 it was only 1.1 km per year). The speed of growth towards the main branches has also reduced and is on average 4 km/year.
According to data from Moscow University and the Danube Hydro meteorological Station, as well as the latest expert estimates (Mikhaylova, Levashova, 1999), the share of the suspended and bedload sediments of the Danube in the upper delta must have been 87.8 million tons per year between 1921 and 1960, and over the period 1961 to 1998, 51.2 million tons

LEFT Figure B.16.
Increase of the Delta area and volume by selected years

RIGHT Figure B.17
Ending parts of the delta branches, zone of the delta growth into an open sea

per year. It is necessary to note here that the sharp decrease in suspended sediments is explained by the construction of storage lake cascades in the Danube basin (in particular the Dzherdapv dam in 1971).
Distribution of sediment each year is closely connected with water discharge. Maximum water turbidity corresponds to the spring-autumn period when suspended sediment is 2 – 2.5 times greater than the average annual value. Two additional peaks of turbidity are observed in April and in June – July. The first peak is greater than the second and maximum suspended sediment is observed earlier than the drainage water maximum. Fluctuation of sediment loads within a year is greater than that of water.
Distribution of sediment between the branches of the Danube Delta generally follows the water drainage distribution. The exceptions are the branches which are successfully developing or dying away. In the first there is a relative increase of sediments and, in the second, there is a reduction.
Turbidity of the Danube water within estuarial areas oscillates in a wide range from several grams to 2-3 kg per cubic meter of water. The mean value is 160-200 g/m^3. In the composition of suspended sediments of the Danube estuarial area, particles of mineral origin predominate (95-98% out of all suspended material).
Suspended sediments and water turbidity as well as water discharge along the Kiliysky branch change little, certainly no more than 5-10% during flood periods. Storage of sediments in non-embanked areas occurs, the evidence for which is the slow vertical growth of the Delta and siltation of the lakes. But the main area of sediment accumulation is still the Kiliya delta and the bars at the mouths of the Sulinsky and Georgievsky branches.

EROSION AND SEDIMENTATION, MEANDERING

The main erosion processes in the Danube Delta are wind and heavy rains; wave activity and channel erosion.

Figure B.18
Precipitous banks of lake Yalpug

Features of erosion processes in lakes
Erosion processes play an important role in the functioning of the near Danube lake-limans. The main impact is a contribution to terrestrialisation because of bank collapses and the inflow of suspended sediments through the Danube and small rivers as a result of basin erosion.
After transforming the near Danube lake-limans into storage lakes, and water level stabilisation, bank erosion greatly increased together with a longer period of wave influence. Other factors contributing to bank erosion are overgrazing and ploughing of slopes (Figure B.18).

Features of erosion processes in channels and on the coast
Erosion and sedimentation processes in the river channel are closely connected with meandering and the development of accumulative forms.
On the Danube river between Reni and Vilkovo, there are seven morphologically uniform areas, i.e. areas within which different types of processes are present: free or limited meandering, i.e. a process of both building and breaking-up of banks with the development of oxbows, islands, die-away of branches, and transition to one-branched forms, etc. (Figure B.19).
In the area between Reni and Izmail Chatal, there are short-term river erosion processes in operation. They are characterized by the risk of local disintegration.
The stretch from the head of the Tulchinsky branch (Izmail Chatal) to the beginning of the Kislitsky branch, is characterized by limited meandering. Embankment of the right and left banks probably assisted stabilisation of oxbows which is why none of them reaches the shape of a loop, i.e. has no clear neck and consequently a rinse area.
The section from the city of Kiliya to the headwaters of the Babina branch represents a one-branched watercourse of the Kiliysky branch, consisting of two contiguous weakly-developed oxbows. There is slight accretion on the left and right banks and, in the lower half of the oxbow,

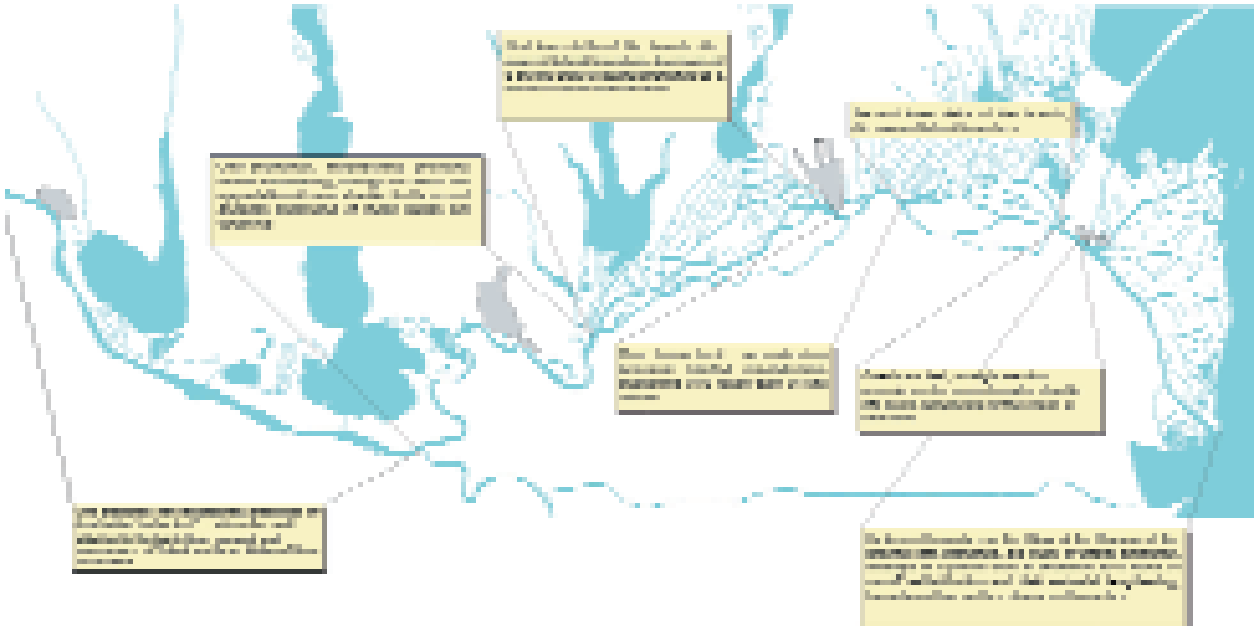


Figure B.19
Morphologically homogeneous parts of Ukrainian part of the Danube Delta according to a degree of their erosion processes

there is erosion of the concave bank and wash-over of the convex one, which has resulted in general slippage.
On different sections of the two inner deltas there are fragments with different types of channel processes, but generally all these systems are tending towards contraction of lateral branches and concentration of the discharge in a main branch.
In the Kiliya delta division of the channel into branches continues, but the die-away of secondary branches is already being observed.
The influence of erosion and sedimentation on economic activities and the possible consequences of a disastrous flood at 1% supply, are presented in chapter #.

LANDSCAPE-FORMING ACTIVITY OF THE RIVER AND SEA

The landscape-forming activity of a river results in islands, the development and eclipse of branches, channels and bayous, changes in the relief of the bottom of the coastal waters and of the coastline, silting up of lakes and plavni. As a consequence of sedimentation, the Danube Delta is constantly growing vertically and horizontally, projecting into an open sea. Detritus is unevenly distributed on the Delta territory, depending on water and silt load movement in the inner and outer zones of the Delta.

The Outer Delta is the most dynamic part of the Delta. The main sculptors of the Outer Delta are water discharge and sedimentation together with the action of waves.

The determining factor for general delta development are water flows and sediment deposition which are closely connected. Vegetation and soil-forming processes are of less importance.

In more recent times, the development of the Delta has been affected by human efforts to control and transform it.

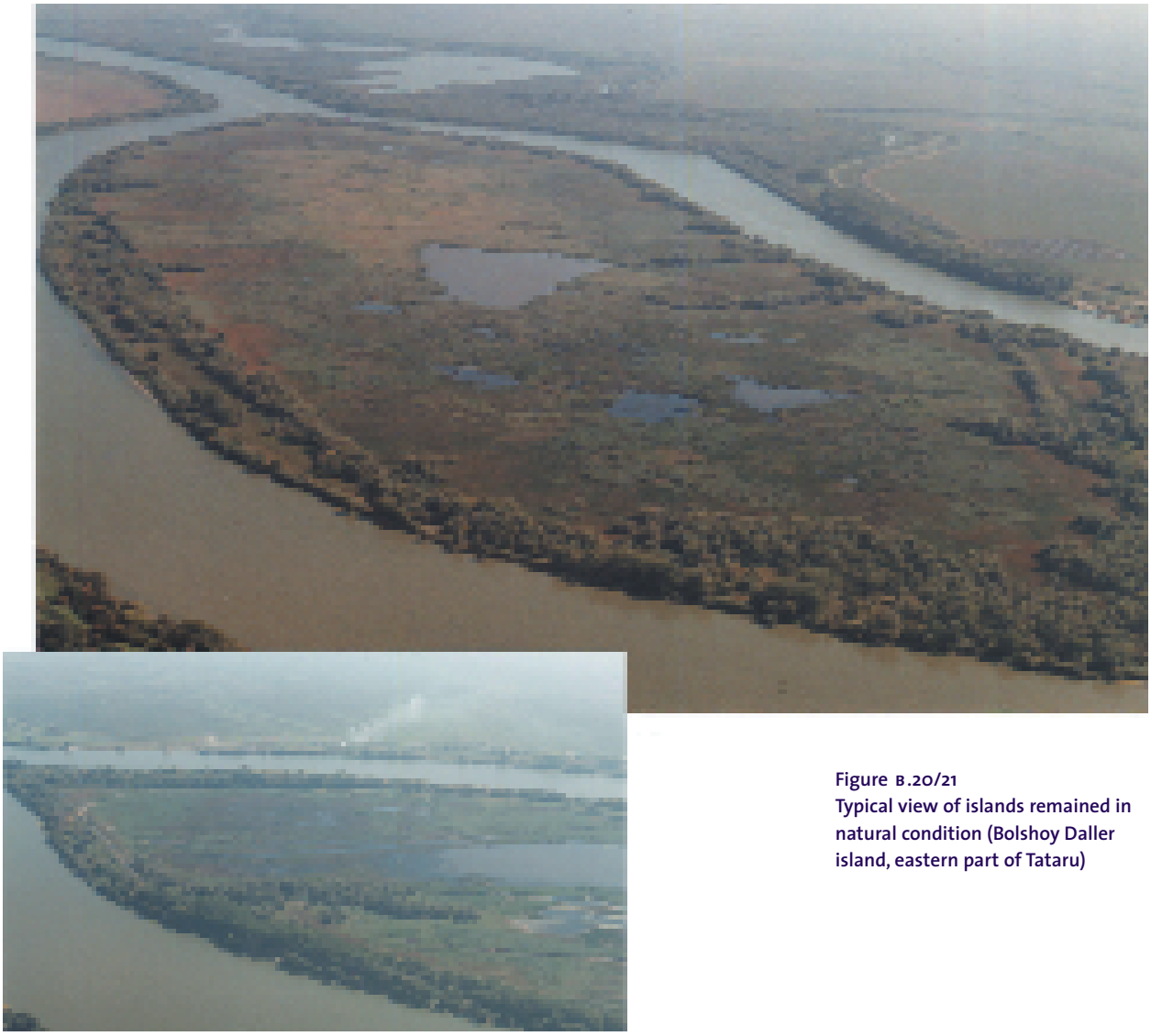


Figure B.20/21
Typical view of islands remained in natural condition (Bolshoy Daller island, eastern part of Tataru)

ISLANDS

Amongst the most remarkable accumulative landmarks of the Danube Delta are islands. These can be sub-divided into two groups according to the stage of their formation: islands of the inner deltas, and islands of the Kiliya delta.

Islands of the first group, the inner deltas, were formed as a result of accumulation of alluvium in shallow lakes (limans) before the Kiliysky branch had broken through the wave-cut sea wall into the sea. Two phases of their formation can be distinguished. In the first stage they formed as islands in the open sea deltas and had an imperfect triangular or rectangular form with a base along the Outer Delta. Under the influence of channel processes, the islands were reformed and further developed as inner channel islands. Now the islands of this group have a spindly form; they are depressions encircled by channel ridges. In the centre there can be from one to ten or more lakes. Soils are of alluvial and moor types. Moor vegetation occupies more than half of the island territory while gallery forests are situated on the perimeter. Before embankment, the islands were almost entirely covered by water during high floods on the Danube (figure B.20 and B.21).

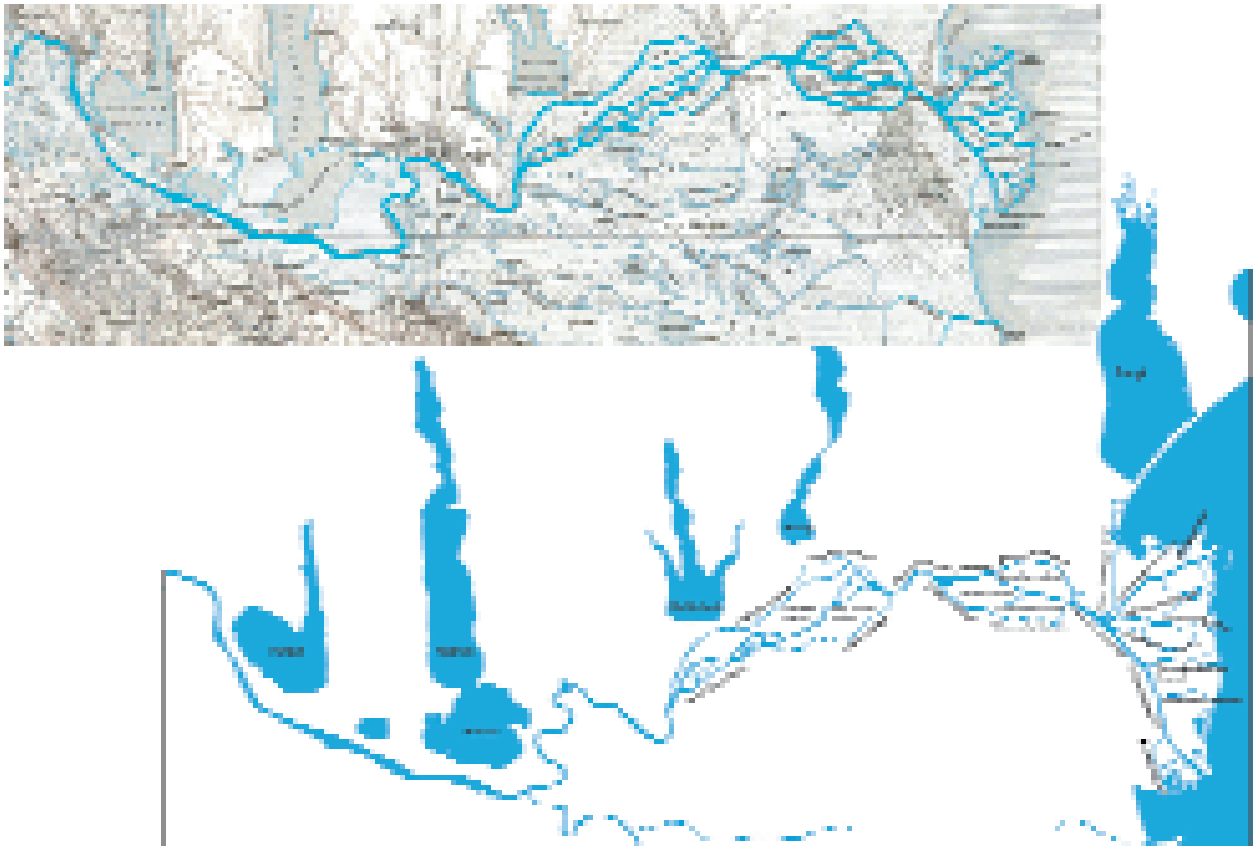


Figure B.22
Map-scheme of islands of the Inner Delta of Kiliya branch

The first inner delta now includes such islands as Kislitsky, Maly and Bolshoy Tataru, Maly and Bolshoy Daller as well as Katenka and Mashenka (figure B.22).

The islands of Babina, Chernovka, Salmanov and Ermakov belong to the second Inner delta.

At present all the islands of the internal deltas of the Kiliysky branch, excepting Tataru, Maly and Bolshoy Daller, are embanked and drained mainly for agricultural use.

Islands of the second group are relatively young formations (from a few hundred years old to a few decades) which have developed as a result of the extension of the Kiliya delta into the open sea. Their contours correspond to the first phase of the inner delta islands showing the influence of waves. The Kiliya delta includes 15 large islands: Ochakovsky, Ankudinov, Staro-Stambulsky and Kubanu are the largest. They have hilly relief with many rounded and elongated depressions which are flooded by the Danube at the average water level. On the river banks alluvial soils are formed while in the depressions there are bog soils. The major part of the islands is occupied by reedbeds.

At present the formation and development of the islands continues. However, as mentioned earlier, the speed of delta projection is slowing and that also applies to the development and formation of the islands.

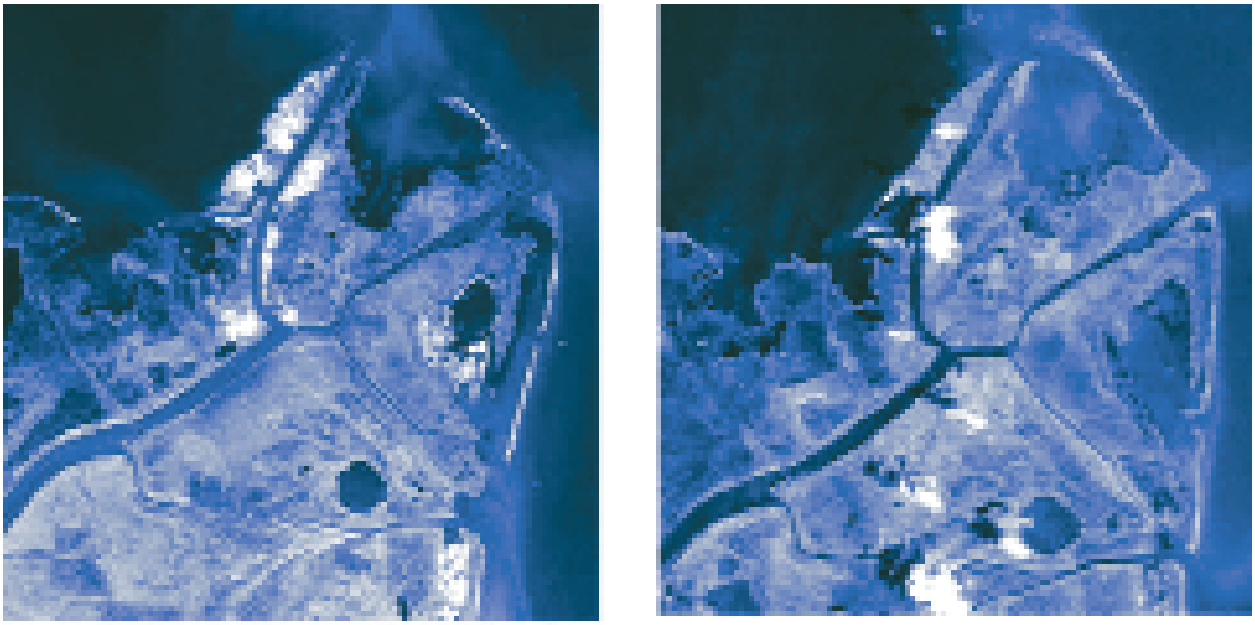


Figure B.23
Development of spits, seperation of sea bays (lagoons) and transformation of them into fresh inner lakes

SPITS AND SEPARATION OF 'KUTS' (LAGOONS)

The formation of spits and the separation of 'kuts' (lagoons) in the Danube Delta takes place as a result of the prevailing northerly winds (40-50%), sea currents and beach drift in a southerly direction, and wave influence. In addition, an essential role in the development of accumulative forms is played by flora and fauna. For example, molluscs such as *Lentidium mediteranium, Donax semirstriatus, Cerastoderma Lamarski, Chamelea gallina* add their shells to the sediment of the coastal zone when they die. On average, for the north-western part of the Black Sea, beach sediment contains up to 15-20% of the shells.

Spit formation in the Ukrainian part of the Danube Delta can be divided into two types. The first is chiefly formed under the influence of coastal beach drift. Zhebriyanskaya spit, located in the bay with the same name and formed by a cusp of the Delta and the primary bank, belongs to this type. This spit is still developing. Since 1957, secondary spits forming in the direction of Belgorodsky island have been developing on the Zhebriyanskaya spit. The rate of spit formation depends on the intensity of bank abrasion where beach drift is active. Over the last 15 years the growth of some spit sections was 30m/year (Shuysky, Vykhovanets, 1989). In time, as a result of the spit growth and its eventual linkage with Belgorodsky island, the south-west part of Zhebriyanskaya bay will become separated from the sea.

The second type of spit is formed directly on the sea margin of the Delta and, like the first, it depends on waves, the direction of the currents and so on. However, in this case, the Danube sediment has a greater impact on formation and, in favourable periods, development is quite intensive as shown in figure B.23, B.24, B.25 en B.26.

LEFT Figure B.24
Primary stage of overgrowing near sea lagoons

RIGHT Figure B.25
Late stage of a bay isolation and overgrowing of 'kuts'

BOTTOM Figure B.26
Lake Zhebriansky earlier was a marine lagoon

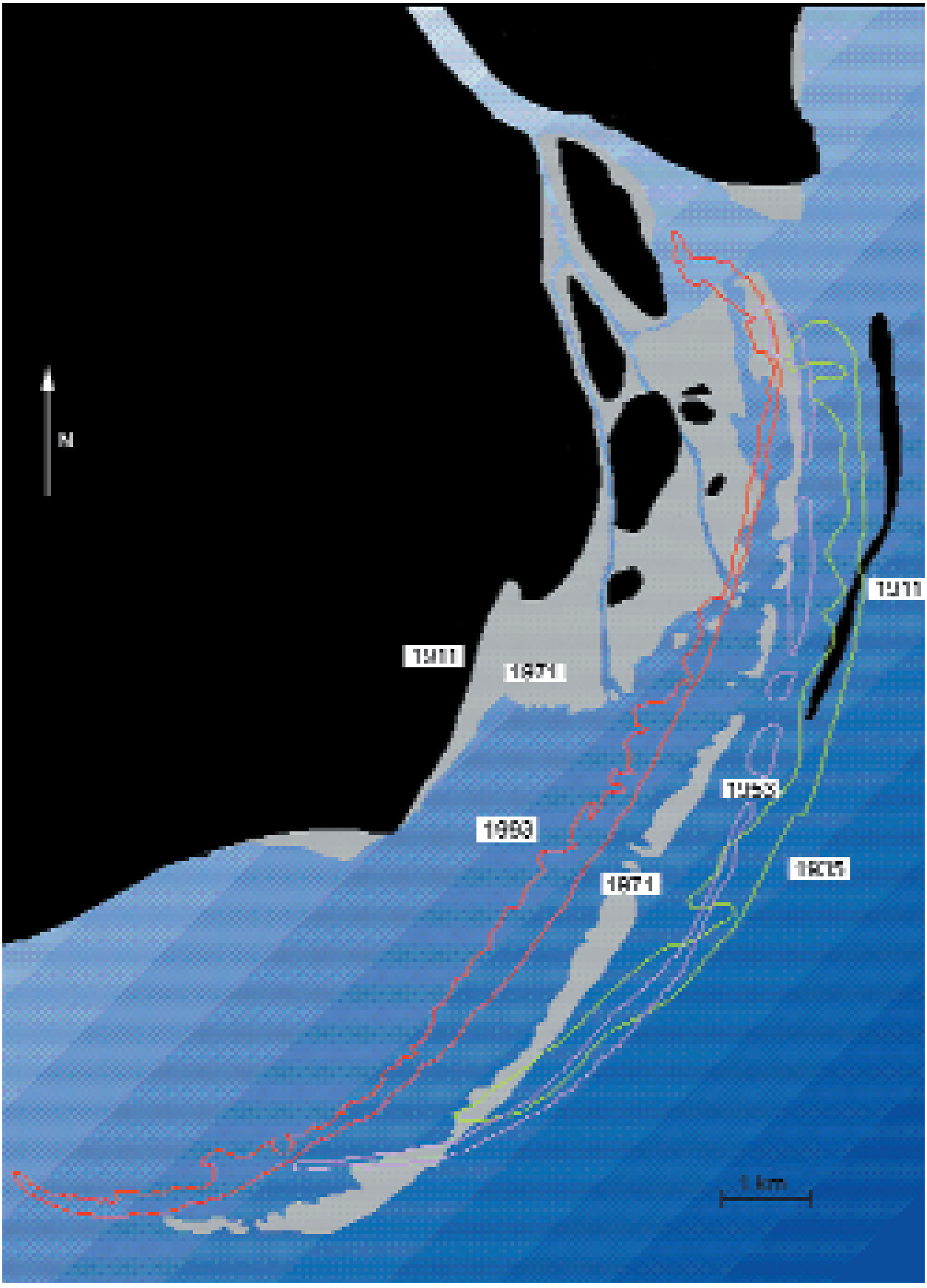


Figure B.27
Destruction and gradual removal of the spit in the Georgievsky branch estuary

As a result of spit formation, there is a separation of marine 'kuts' and their further transformation into freshwater inner lakes. The process is accompanied by successional changes of higher aquatic vegetation, further terrestrialisation of the water bodies because of concentration of Danube sediments and organic matter, and also a decline in water exchange intensity.

Analysis of the dynamics of a marine margin in the Kiliya delta over the period 1975-1985 (Sagmanov, 1999), showed which of the formative factors dominated in the development of estuarial bars and coastal spits. The wet years of 1978-1981 and 1984 saw the most growth while in 1989-1990 and 1992-1994 there were only small amounts of sedimentation and water run-off. These periods in most places were characterized by the destruction of estuarial bars and the removal of spits to the Outer Delta. Such processes were clearly demonstrated in the estuarial zone of the Georgievsky branch over the period 1911-1971 (Figure B.27). Some increase of water discharge and sediment load in 1996-1998 did not cause a significant increase of accumulative landscape forms. At the same time abrasion of the sea coast, assisted by an increase in the level of the Black Sea, was observed in the estuaries of the Bystry and Vostochny branches where the Zavodninsky branch had died back.

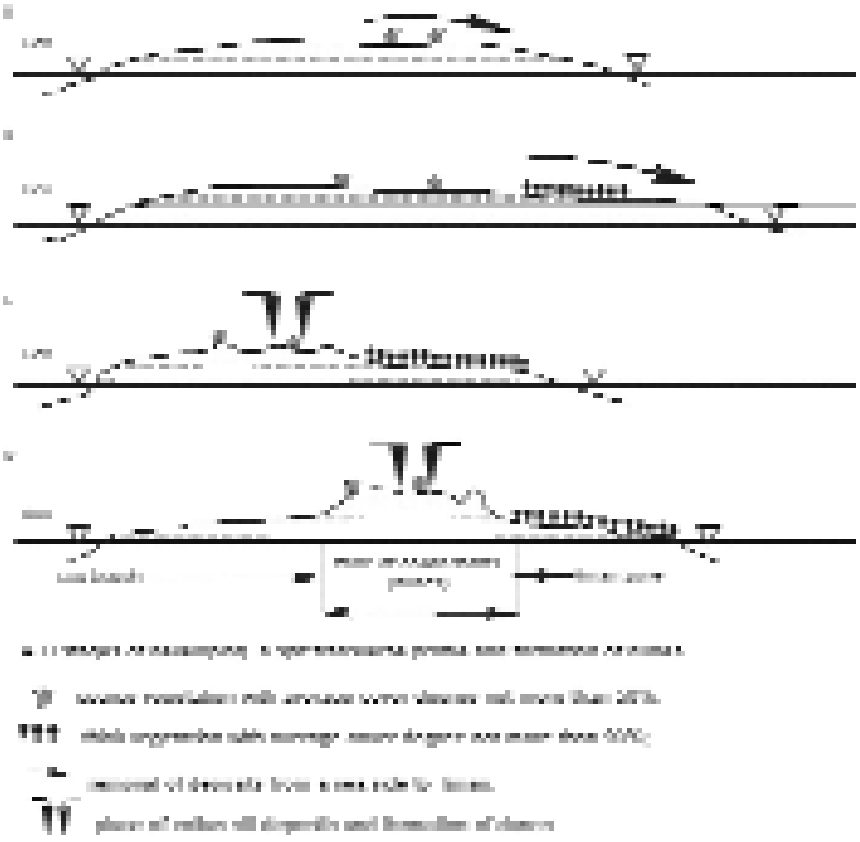
DUNE FORMATION

Eolian processes play a great part in forming the landscape in the Danube Outer Delta especially dunes, which are most clearly visible on the more ancient marine ridges such as the Zhebriyanskaya, Letya and Karaorman. For example, the height of the dunes on the Zhebriyanskaya reached 6 m before aforestation (in the middle of last century). The most interesting dunes are found on the marine edge of the Kiliya delta where they are developing in absolutely natural conditions.

The action of wind on the coast of the Delta is double-edged. On the one hand the wind destroys parts of the accumulative forms, blowing sand into the sea for example, but on the other it plays a formative role. Sand, blown from the beach and with the addition of broken shells, forms dunes and increases the height of spits and ridges. Under conditions in the Danube Delta, sand movement begins at a wind speed of 4 m/sec mostly small particles of 0.1-0.25 mm. Maximum intensity of sand movement is registered on summer days.

Sea winds are the most powerful forces in dune formation. They build up waves which bring sand to the beach where it is deposited on the seaward side of a sand bar. From the beaches the dried sand moves into plavni and the inner lakes (limans). Where vegetation suppresses the wind, material carried by it is deposited and contributes to dune formation (figure B.28 en B.29).

The creation and evolution of new accumulative forms (spits, ridges, dunes) is still continuing. It should be noted that the present marine ridges are much smaller than the ancient ones (such as Zhebriyanskaya, Letya and Karaorman) because of differences in conditions. Ancient



TOP Figure B.29
Formation of sand spits on the sea coast of the delta

BOTTOM Figure B.28
Scheme of dune formation in the delta

ridges emerged at the time of the Danube pre-liman and formed one wave-cut wall. Their size was determined by the action of powerful liman hydrological processes which are now absent.

TOP Figure B.30
Development of floodplain forest on riverine walls

BOTTOM Figure B.31
Dry ridges in the delta, overgrown with bushy willows

VEGETATION ZONES, DEVELOPING ON THE BASE OF MORPHOLOGICAL PROCESSES

Peculiarities of territorial organization and differentiation of vegetation cover depend on morphological processes in the river estuaries which are, in their turn, considerably influenced by anthropogenic factors. These are determinant for all types of delta vegetation such as moorland, aquatic, riverine, forest and coastal vegetation.

RIVERINE FORESTS

Forest vegetation is found on the banks of the Danube and its numerous water bodies, bayous and branches, as a narrow strip 100 to 150 m wide. The tree layer is formed by *Salix alba, Populus nigra, P.alba* and other species. The bushy layer is represented by species of the *Rubus* genus. On

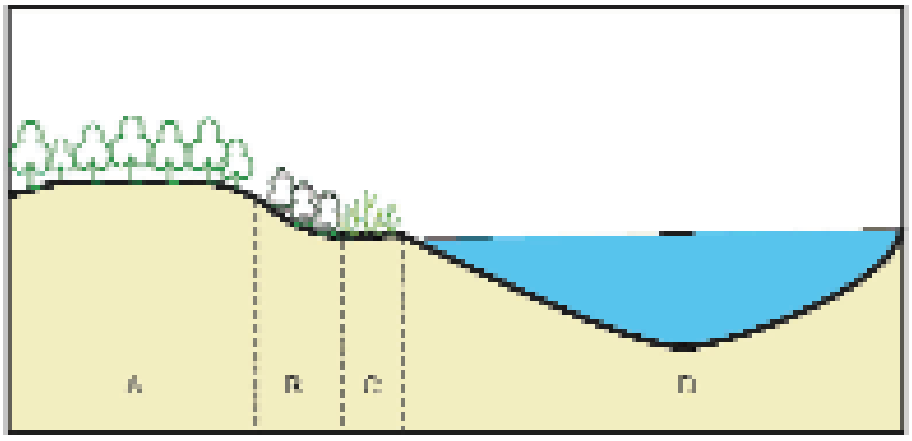


Figure B.32
Scheme of vegetation distribution on a riverine wall of the Danube river
a) riverine wall with arboreal plantations of *Salix alba* and *Populus nigra*;
b) shrubby zone of *Amorpha fructicosa*;
c) riverine bar with shrubby thickets of *Salix triandra*
d) watercourse

open well-lit areas they are succeeded by brushes *Amorpha fruticosa*, and by *Salix triandra* on the narrow riverside levees (figure B.30 en B.31).

On average, trees are 20-30 years old and 12 to 18 m high; crown density fluctuates from 0.4 to 0.9. Quite a common feature of the forests is lianas *Vitis sylvestris*, *Periploca graeca,* etc.

The character of the grassy cover depends on moisture and light. A dense grassy sod, created by groups of *Elythrigia repens,* develops on open, drier, elevated areas. In waterlogged areas there are groups of *Phragmites australis*. In places where the light is poor, the grassy cover is weakly-developed and represented by shade-demanding species of floodplains and meadows (*Scutellaria galericulata, Glechoma hederacea, Symphytum officinale, Lysimachia nummularia, etc.).*

As a result of embanking the main channel of the Danube and its principal arms, there has been degradation of the natural forests.

Considerable areas of riverine forests have been completely replaced by artificial single-aged plantations (the average age is 20-30 years), consisting of species of the genus *Populus, Fraxinus*, etc. Species of the *Fraxinus* genus have invaded riverine walls, and on the lower part of the walls *Amorpha fruticosa* dominates, spreading over the bars and sometimes up onto the wall (figure B.32).

The appearance of forest vegetation on 'young' riverbanks depends on the rate of sod formation. If young trees develop before the sod has formed, the growth and development of the forests are normal. If the grass sod had formed before tree re-growth, grassy meadows develop with a great number of bushes (*Amorpha fruticosa*).

In order to support the ecological stability of the natural riverine forests, it is necessary to withdraw a part of the biomass such as *Elytrigia repens* (to make hay), to provide moderate grazing (to break the grass sod) and opening-up stands of *Salix alba*, *Populus nigra* and others.

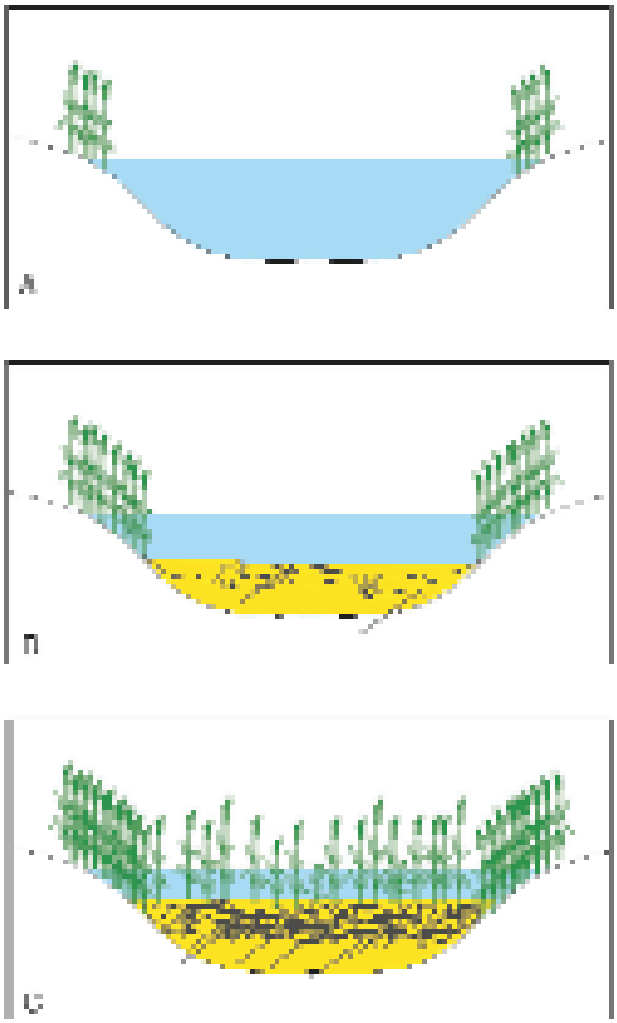


Figure B.33
Scheme of development of flood-plain reed communities
a) primary stage of communities formation;
b) formation of sludge deposition and horizontal reed spears;
c) increasing of a sludge layer and complete overgrowing of a water-course

Where the vegetation is artificial, progressive replacement of non-native species (*Fraxinus excelsior*) by native limosa species is desirable.

REEDBEDS

The distribution and productivity of *Phragmites australis* communities depends on water depth and flow rate, the degree of terrestrialisation and salinization as well as the composition of the sediments and the length of flooding.

Reed communities located in the shallow waters of the water bodies are the youngest. They are most frequently found in the lower reaches of the Kiliya channel taking advantage of the multiple waterways there. With the deposition of alluvia and lowering of the flow rate, partial and then complete growth over the water body occurs. (figure B.34, B.35)

Coastal communities are also amongst the youngest. They are located on the periphery of the estuaries on the borders of the Outer Delta. The appearance, extent and phytomass of the communities are tightly connected to the alluvial deposits of the Danube and sea currents.

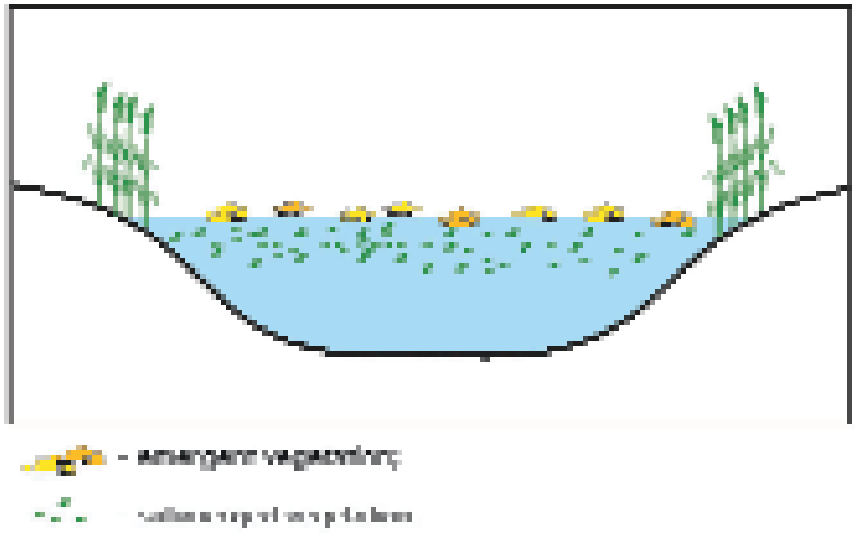
34
Process of overgrowing watercourses

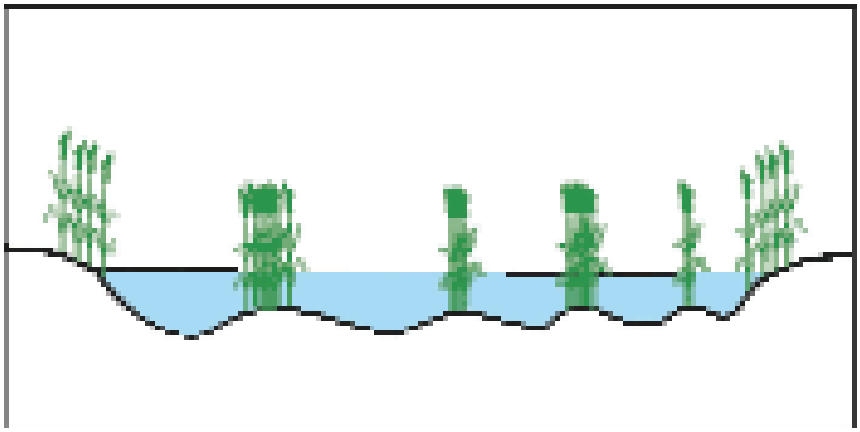
The rate of growth of the coastal and riverine sand ridges is a key influence on the structure of reed growth and its further development. Isolation from marine influence determines the development of freshwater bays, kuts and phytocoenoses with a complex vertical structure (figure в.35). As layers of silt are deposited, the water body is colonised by reeds from the periphery towards the centre. (figure в.36). Thus the genesis of the reed communities of the coastal group is the following: communities of the coastal group ' communities of the lake group ' plavni coenosis.

Under the active influence of the sea, salt and brackish bays form. Reed communities do not play an important role here and degrade when the water salinity is high.

Communities of the lake group of *Phragmites australis* are found in the near Danube lakes and in the closed water bodies with low water circulation. The contours of the reedbeds practically follow those of the elevated portions of the bed of the water bodies (figure3.2x). Colonisation of the higher parts is blocked by wind and by the relatively dense sandy soil. As the silt layer emerges and the water level drops, the water bodies are completely overgrown by communities of *Phragmites australis* of the lake group and transformed into plavni.

Phragmites australis of the plavni group occupy 85% of the whole territory. They are concentrated in the flooded areas of the Delta islands and in local depressions near those water bodies which are subjected to frequent and prolonged inundation. According to this criteria coenoses can be subdivided into two groups such as marshland and dry. Communities of the first group occupy larger territories and have an abundant floristic composition. Communities of the drier, plavni groups are rarer and form smaller concentrations. The latter are typical of elevated places where the surface inundation is not constant and salinization takes place.





TOP Figure B.35
Vegetation structure of seperated bays of a maritime coenoses group

BOTTOM Figure B.36
Scheme of distribution of reed communities of a lake group

ACCUMULATION OF VEGETATION AND BIO-MASS IN WATER BODIES

The total area occupied by aquatic and aerial-aquatic vegetation in the Ukrainian part of the Danube valley and Delta is about 30,000 ha. Annual primary production of higher vegetation reaches 250,000 tons. In contrast with the northern regions the vegetation does not maintain itself, but is decomposing and this is the main reason for the natural eutrophication of the water bodies. Bio-mass redundancy negatively influences the biodiversity of the Danube Delta water bodies. However, water exchange minimizes the natural eutrophication and this is necessary for the restoration of biodiversity, especially in stagnant basins or in reservoirs with weak circulation (isolated water-bodies of the Danube Delta, the Stensovsko-Zhebriyanovskie plavni, inner stagnant water bodies of Ermakov island, and the islands of the lower reaches of the Kiliya delta). A second method is to partially destroy phytomass by burning or cutting. There has been a positive result following the introduction of weed-eating fish species in the near Danube lakes.

SWAMPING

Swamping is found everywhere and is caused by the natural processes of terrestrialisation of the water bodies under the slowing-down of natural

water exchange. Swamps cover about 70% of the total area of vegetation cover. These ecotopes of neutral or low acidity support the development of moor species groups although their more extensive areas are located in more northern regions. Growing under conditions of extreme salinization, moor communities form a so-called 'phytogenic field', which provides a high level of biodiversity.

If swamping occurs as a result of human-induced eutrophication, communities form which lack members and with low biological diversity as in the Stensovsko-Zhebriyansky plavni.

SALINIZATION

Processes of salinization are characteristic only for the north and partially for the north-western part of the Kiliya channel. These are areas of primarily chlorine-sulphate salinization where vegetation typical of saline basins and saline meadows are found with a high number of endemic species. Vegetation of alkaline plots occupies limited areas mainly on disturbed sites associated with dykes, road slopes, etc.

The extent and character of salinization of the peripheral areas depend on the freshwater influence of the Danube watercourses. At present, in connection with the natural redistribution of the drainage and decrease of the water content of the branches towards the north-east, an increase in the areas of halomorphic vegetation in the north and north-eastern part of the Kiliya delta is observed. Before embankment and artificial increase of water level in the SZP (Stensovsko-Zhebriyansky plavni) and construction of the Danube - Sasyk canal and Sasyk dike which separated Sasyk Lake from the sea, saline meadows and basins dominated and produced a high level of biodiversity.

In connection with the problem of the SZP the question of restoring the primary vegetation of saline meadows and basins is currently being considered.

ANNEX C:

Dynamics of landscape and vegetation

WETLAND MANAGEMENT UNIT, MELITOPOL

THE IMPACT OF DOMESTIC LIVESTOCK GRAZING

It is well known that extensive grazing of wet natural areas supports their floristic diversity (Noy-Meir, 1995; Zhang, 1995; Miller, Halpern, 1998). At the same time a general protective herbage layer remains, though phytomass and primary productivity during the first years are lower than before grazing (Zhang, 1995). Under over-grazing the most negative influence on vegetation is not the direct impact of the grazing itself, but trampling and packing the ground. In this situation hassocks form on moist ground and a mosaic, even complexes, of vegetation communities develop (Rabotnov, 1974).

EFFECTS OF GRAZING ON DIFFERENT TYPES OF VEGETATION

MOOR AND MEADOW VEGETATION

Under the conditions in the Danube Delta, moor and meadow are the principal types of pastures. Grazing takes place on the majority of the riverine ridges and on parts of the fluvial islands. The general trend of change under grazing is an increase in the variety of plant species during the initial period, principally as a result of the wide range of moor and meadow species, and then a decrease leading to the formation of saline-meadow and saline vegetation. A decrease in the flushing water regime accelerates this process. In the first stage, the coenotic role of *Phragmites australis* (a dominant species in most phytocoenoses of such a type of organization) decreases and species of the second sub-layer begin to play a leading role (*Carex elata, C.acutiformis, C.pseudocyperus,* etc.).
In the second stage there is an expanded species composition of phyto-coenoses on account of the meadow and moor vegetation (*Symphytum officinale, Myosotis palustris, Euphorbia palustris, Stachus palustris, Scutellaria galericulata*, etc). In the third stage unformed communities emerge, mostly consisting of species of *Carex* genus. This is determined by their greater tolerance to trampling and grazing in comparison to *Phragmites australis*. In the absence of a flooding regime, moor species are succeeded by communities such as *Asteretea tripolium, Bolboschoenetea maritimi, Juncetea maritimi*.
In light of the above, it is advisable to maintain moderate grazing densities, up to 3-5 head of cattle per hectare, to increase the diversity of moor

vegetation communities up to and including the second stage. Intensive grazing of saline moor communities (*Bolboschoenetea maritimi*) favours rapid formation of saline meadows which is why it must be limited to 1-2 head per hectare.

After stopping grazing before the third and fourth stage of digression, a sharp increase in the share of opportunistic species (*Grindelia squarrosa (Pursh.) Dun., Erigeron canadensis, Solidago canadensisi*, etc.) is observed which are not characteristic. It is assumed that moderate grazing densities limits their development to some degree.

VEGETATION OF ALKALINE PLOTS AND SALINES

Vegetation successions on alkaline zones and salines under grazing influence are chiefly characteristic for Zhebriyanskaya ridge and small parts of Kubanu and Ermakov islands, where the cattle concentrates to rest. Where cattle have gathered for a long time, the ground is packed and saline to such a degree that the diversity of moor and meadow species completely disappears as can be seen in the Danube estuary. The general plant cover in such plots does not exceed 10-15%. Large areas with Wild boar potholes and mud-baths are also observed and these strengthen digressive succession. Succession in this case tends to form alkaline and saline groups consisting of species with low nutrition needs. Ceasing grazing does not result in complete restoration of successional series because of changes in habitats conditions. An especially noticeable gap in successional series is typical for saline vegetation where salinisation is a limiting factor strengthened by intensive grazing.

PSAMMOPHYTIC VEGETATION

Successions of psammophytic vegetation as a result of grazing have a place on Zhebriyanskaya ridge as well as on the coastal parts of Kubanu and Kubansky islands. A common tendency for psammophytic vegetation successions under the influence of grazing is an increase of species as a result of the presence of a wide variety of mesoxerophytic species during the first stages of digression, and then a sharp decrease during further stages leading to arenose communities, including *Secale sylvestre, Heliotropium dolosum, Bassia sedoides, B.hirsuta, Euphorbia seguirana* and ephemeral plants such as *Cardaria draba, Erophila verna, Alyssum desertorum*, etc. In terms of the unformed soil substratum and weak coenotic organization of the psammophytic communities, grazing is acceptable only on a part of the area. It must be strictly controlled and the load must be limited to 0.5 – 1 head per hectare.

RARE SPECIES

Communities which include rare and endangered species (*Leucojum aestivum, Chrysopogon gryllus, Dianthus bessarabicus, Stipa borysthenica* and all *Orchidaceae* species) react differently to cattle grazing. For each of them a specific regime and grazing density is necessary but, in general, moderate levels of grazing favour conservation of these species.

On plots of *Epipactis palustris, Orchis palustris* and *Dactylorhiza majalis*, grazing at a density of 1-2 head per hectare constrains the growth of bushes and herbaceous vegetation and therefore favourably influences their development. A high grazing density (3 or more head per hectare)

results in salinisation of the habitats and vegetation succession towards communities of *Saliceto (rosmarinifoliae) – Holoschoenetum vulgaris*. As a result *Orchis* numbers sharply decline and other species of *Orchidaceae* practically disappear.

Moderate grazing (0.5 – 1 head per hectare) favours *Dianthus bessarabicus*, while overgrazing results in non-vegetated and strongly dispersed sands that negatively affect species survival.

For A*renose* communities, including *Chrysopogon gryllus* and *Stipa borysthenica,* cattle densities of 0.5 – 1 head per hectare, especially in the autumn and winter periods (owing to the limited supply of bushy vegetation), favours seeding. A high grazing load in these cases results in a succession which is sustainable (*Euphorbia seguierana, Cynodon dactylon*, etc.).

Conservation of populations of *Leucojum aestivum* in corresponding communities is favoured by a density of 3-5 head per hectare while overgrazing (10 and more head per hectare) inhibits their success. On plots where grazing has been halted, this species disappears in 2-3 or 5 years (depending on the primary stage of digression following grazing of moor-meadow vegetation).

HAYMAKING

Haymaking in the Danube Delta is a traditional use of natural resources. It affects the formation of the Delta ecosystems to some degree. But its influence on the landscapes and vegetation communities is much greater than that of, for example, fires and winter reed harvest.

Cutting moor vegetation results in meadow vegetation. One hay harvest in spring or autumn causes relatively slight changes but multiple summer cutting causes degradation of communities and encourages vegetation typical of saline habitats. However, even one-shot hay cutting reduces phytomass. The same tendency is also observed directly for *Phragmites australis*.

Integral management of the Delta means that haymaking should be applied to limited plots in the spring or autumn while summer cutting should take place only if it is needed to form alkaline biotopes to support biological diversity (with *Artemisia santhonica, Juncus maritimus, J.gerardii, Samolus valerandi L., Plantago major L., Limonium meyeri, L. danubiale, Spergularia marina* and other species of alkaline plots and salines, and in lower plots *Typha angustifolia* and *Schoenoplectus lacustris*).

The impact of haymaking on vegetation communities of the Danube Delta is intensified by fire or grazing. In these cases a catastrophic succession in communities takes place, especially *Phragmitetum communis*. The phytomass of *Phragmites australis* on scorched plots declines even under one summer cutting. Double (spring and autumn) cutting for three seasons results in a decrease of *Phragmites australis* phytomass.

FIRE

Fire in the Delta has been, and still is, the most important landscape-forming factor. As Walter (1982) and other authors underline, fire, in most cases, stimulates the development of plant associations.

In the Danube Delta fire is traditionally used for management of plavni vegetation. In order to improve pastures, hay meadows and the winter reed harvest, fires were periodically set in winter. According to a survey of people in the Danube Delta, each plot is scorched once in 2-4 years; as a result there is a traditional integrated system and culture surrounding the midwinter fires (Zhmud, 1999).

On the scorched plots the number of vegetated stalks of *Phragmites australis var. gigantissima* are from 3.1 (plots, periodically flooded) to 2.8 times (constantly flooded plots) greater. The general number of stalks declines by 5-10%. After fire there is also a decrease in the height of the stalks' (of 36% and 15% respectively in comparison with controls) and in diameter (59% and 15%). For *Phragmites australis var. flavescens* the decrease of total stalk numbers is 3.5 times and that of vegetated stalks, 0.1%. For both reed species an increase of phytomass (26.7% and 79% respectively) is registered as well.

In terms of ecosystem and landscape it is important to note that after the fires reed stalks damaged by parasitic insects are practically absent (their seeds do not mature), while on non-scorched areas they are present on from 3 to 7 plants per square meter. This is characteristic for all communities associated with *Phragmites australis* and is of significance for some bird species.

In general, winter reed burning stimulates expansion of the species composition of its communities. When the reed habitat is flooded to high levels, dead reed stalks are not completely burned, even less the rhizomes. In this case firing results only in an increase of phytomass and the number of stalks.

Fires have a negative effect on trees and bushy vegetation. Absence of fire over the long term in functioning plavni ecosystems (the Kurilsky, Lebedinka islands), favours dense growth of *Salicetum albae, Salicetum albo-fragilis, Salicetum cineraea*.

ICE

The impact of ice on the Delta landscape is both direct and indirect. Its landscape-forming role is strongly determined by the character and duration of the cold season.
Nearly all still inner water bodies of the Delta are covered with ice more or less continuously in the winter months. The thickest ice is in the upper Delta in the vicinity of lakes Yalpug and Katlabuh which stretch deeply into the continental plateau. The ice remains there for 2.5-3 months and is thick enough to bear light vehicles which do indeed take advantage of it.

On the water bodies in the marine zone of the Delta, ice phenomena are less severe. However, in most years, ice on open water surfaces and banks

of snow in the reedbeds is a typical feature of the landscape in the coldest period. On all the larger lakes of the Outer Delta, air-holes are usually present and are very important for wintering water birds, particularly swans, geese and ducks. Huge numbers of wintering birds in the outer Delta is an unmistakeable and integral part of the winter landscape.

Shallow coastal waters are not covered with ice every winter. But icy ridges of different sizes do form and they are also a part of the winter landscape.

Ice has a physical impact on the landscape and on Delta vegetation. At its extreme, it accelerates abrasion of the river and channel banks destroying riverine vegetation communities. However, the impact on the vegetation of the rivers and channels is rarely significant because of the lack of intensity and the short time of freezing conditions in the Delta. Occasionally, during particularly severe ice formation on the river coupled with strong winds, ice dams or barrages form in the mouth of the river which disrupt navigation. This grouping of circumstances is usually also the principal reason for the most powerful floods in the Delta.

QUAGMIRES

Quagmires are a typical element of the plavni landscape of large rivers deltas in the Black Sea area. They chiefly form as a result of reed expansion to deeper water where attachment of its rhizomes to the substratum is impossible. Rhizomes of the reed, the reed mace, as well as dead stalks of reed and other plants, form the primary stage of the quagmires.

The quagmires in the Ukrainian part of the Danube Delta are not such a characteristic feature of the plavni landscape as in the Romanian part, mainly because of differences in their age. Plavni of the Ukrainian part of the Delta, especially its marine zone, are about half as old as on the Romanian side. At present quagmires are most typical for the south-east part of Zhebriyansky plavni, where it is estimated that they cover some hectares. Because of considerable seasonal fluctuations in water levels, most are now partly attached to the bottom of water bodies while many sites are overgrown with bushy willows. Here the quagmires completely occupy the water surface, an indicator of their significant successional age.
On the water bodies of the secondary delta the quagmires are much younger. They are not attached to the bottom. In some cases they can freely move in open water and occur to some degree on almost all large water bodies of this part of the Delta. But the quagmires are most typical of Lazarkin Bay and the western part of Anankin Bay. On one side they border an open water surface, gradually overgrowing it, on the other they border the reedbeds. A considerable part of quagmire vegetation in Lazarkin Bay is bushy willows.

The quagmires have a relatively rich floristic composition and give a certain specificity to the plavni landscape; the fauna is also rich and specific. They provide oases within dense reedbeds and, when mature, can bear Wild boar which frequently inhabit them.

Grazed mosaic landscape on Tataru Island

ANNEX D

Landscape-forming processes: natural grazing

WITH EXTRACTS FROM :
Stichting Ark, Natural Grazing, Hoog Keppel 1998.
Stroming bv, Willem Overmars, Frans Vera

GRAZING AS A NATURAL PROCESS

Where plants are found, animals that live on them are also found. It has been this way for millions of years and, during the evolutionary process, a fascinating relationship has developed between animal and plant. Each herbivore has adopted a food strategy of its own. For their part, plants arm themselves against grazers (thorns, poison, taste) or benefit from their presence by spreading their seeds via the grazers, using for example their manure. Other animals in turn adapted themselves to the grazing patterns, to the manure of grazers or to the grazers themselves (predators, parasites).

In those ways complex ecosystems developed in which herbivores played an important role amidst thousands of other animal and plant species that, directly or indirectly, depend on plant eaters.

SHAPING LANDSCAPES BY GRAZING

By selecting their food and by their behaviour, some herbivores have a pronounced effect on the structure and composition of the plant world. Large grazers in particular can reshape entire landscapes because they maintain richly-structured grasslands, make forest rejuvenation possible, peel bark, or even fell full-grown trees.

Attention to the role of grazing in modern nature or landscape management is growing. There is also a keener awareness that large herbivores are a vital part of the species composition of an ecosystem. In some larger nature areas, including the Oostvaarder wetlands in the Netherlands and parts of the associated river basins, the introduction of horses, cattle, Beavers and deer are no longer simply a means to achieve, but are also features of, the objective: the development of ecosystems which are as complete as possible.

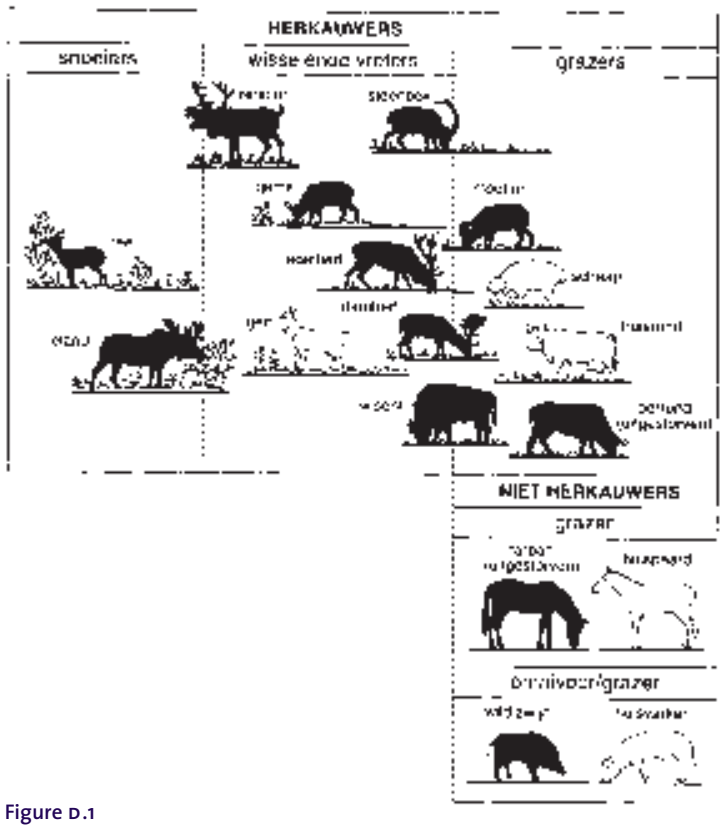


Figure D.1
Various species of large herbivores that are indigenous to Europe, as well as the omnivorous Boar, classified according to their feeding regimes. The domesticated animals are sketched in white; wild species are in black.
From: Grazing ecology and forest history, Frans Vera 1997.

GRAZERS: SPECIES, STRATEGIES AND DISTRIBUTION

FROM CATERPILLAR TO ROE DEER

There are herbivores of all shapes and sizes. Small plant eaters, too, can play an important role in the landscape, both locally and periodically. Think of Caterpillars which sometimes appear massively, defoliating entire forests. But their influence is limited and often, after a month or so, you can no longer see what had taken place.

Grazing water birds, such as coots, ducks, geese and swans, often maintain short vegetation near the water. In other places, water birds benefit from the preliminary work of large grazing quadrupeds.

It is especially this last category of grazers that can leave permanent and unmistakable marks on the landscape. The eight most obvious classes are described below.

LARGE GRAZERS AND THEIR FEEDING REGIME

The different species of grazers have their own strategy for using the terrain and selecting food. Hence they each have a specific influence on the landscape. Figure D.1 presents a scheme of a number of wild and domesticated classes of grazers in relation to their feeding regime (adapted from Vera, 1997).

The various species are discussed below along with their biotopes, food preferences, and distribution.

Figure D.2
Tree felled by Beavers

BEAVER

The effects Beavers have along brooks, lakes and rivers can be dramatic. These animals feed on barks and twigs of small and large trees which are gnawed down for this purpose. They use the remaining wood for building their lodges and dams (see figure D.2).
Other sources of food are grasses and especially herbs on the water edge. Trees that have been gnawed by Beavers and have sprouted again (willows in particular) may be maintained in this way by the animals for years creating a kind of natural osier thicket. In other places, Beavers' activities produce more open vegetation.

Beavers are helpful in forming a half-open landscape in wet zones of an area. Some North-American rivers are flanked by long, narrow grassy stretches where grazers feed, the origins of which are attributed to Beavers.

European Beavers once occurred throughout Europe and Asia, but habitat loss and over-hunting drastically reduced their number. By the early 20th century the population had dropped to about 1200 individuals. Only five isolated sites remained in Europe: in France (Rhone), Germany (Elbe), southern Norway, Belarus (Dnepr) and Russia (near Voronezh). Remnant populations were found in Siberia and Mongolia as well. Since Beavers have been widely re-introduced, the estimated population now is about half a million. (Atlas)
Beavers are not present in the Danube Delta. As alluvial forest on the banks of rivers and creeks can be found everywhere, the conditions for re-introduction of this animal are good.

WILD BOAR

Boars are omnivorous animals. Their technique is to root in the earth, grubbing up the soil and eating everything they come across. Their rooting creates bare spots and they may even break up matted grassy areas thus creating suitable conditions for the growth of herbs, bushes and trees, and a place where pioneer communities can become established. Boars love reedbeds where they may dig out the reed roots.

Boars are numerous in the Danube Delta; they live in large populations in the reedbeds where they are more difficult for hunters to find than on the riverbanks.

The influence of boars on forest rejuvenation and succession can be strong and in the projected model sites their population should be allowed to grow to natural densities.

ROE DEER

Of the ruminants, Roe deer are the most finicky trimmers. They often live in the cover of the forest, although they are not really forest animals. Their favourite landscape is a variety of grassland, woods and shrubby areas on a small scale. Their food mostly consists of buds, young twigs and juicy leaves. Roe deer also feed on grasses and some even seem to specialise in them. The Roe deer's influence on the forest is subtle and small in scale. They also feel at home in reed and forest swamps. In severe winters, many animals fall victim to food shortage.

Roe deer are present in the Danube Delta in relatively low numbers. In the model sites natural population density, dispersion and migration can be studied by letting the population grow without interference or population management. With a larger population, the influence on the landscape may become clearer.

RED DEER

Red deer are ruminants, too. In spring Red deer eat mainly grass supplemented in summer with leaves and young twigs. In winter they change over to buds, bark, especially of thicker trees (10 – 15 cm), and shoots. They like eating grass in winter, too, and for that reason they are not found in areas that have more than 30 to 40 cm of snow for long periods.

Red deer are both grazers and trimmers. They take advantage of the presence of cattle and horses, grazing on the grasslands created by them.

Red deer have a preference for open forest areas; river valleys with alluvial forests are a particular favourite. But they also live in swampy forests, heathlands and grasslands.

Red deer originally occurred in large parts of west, central and eastern Europe. The northern boundary approximated to the southern coast of the Baltic Sea, and the southern boundary was marked by the Black Sea, around which they were present in the steppe areas. Red deer occur in several regional forms. Their habitat shows a wide variation: forests,

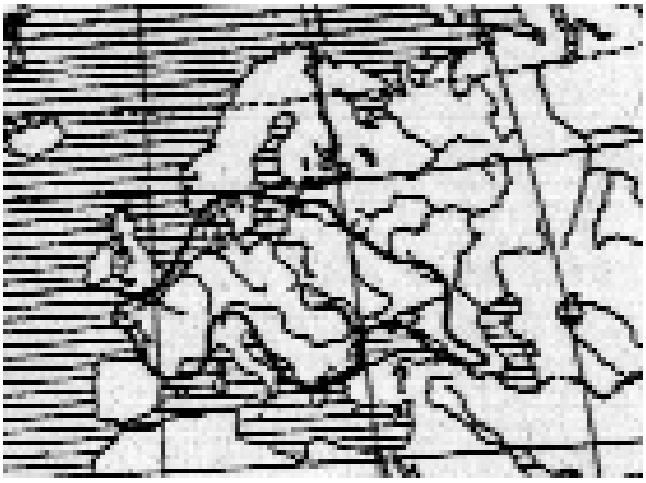


Figure D.3
Original distribution of the Red deer *(Heptner)*

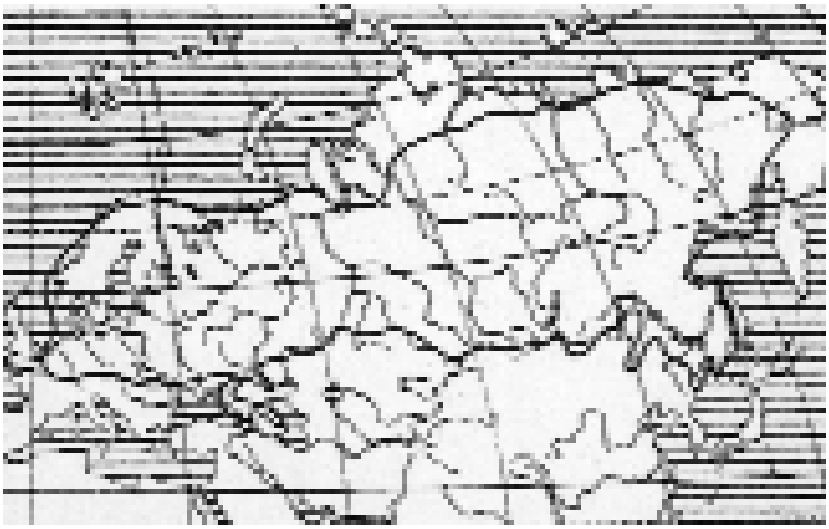


Figure D.4
Original distribution of the Elk. *(Heptner)*

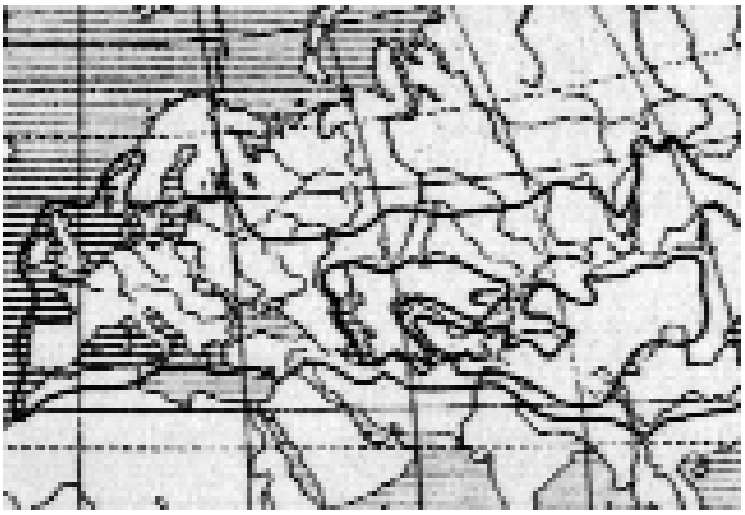


Figure D.6
Distribution of Bison *(Heptner)*

forested steppe, steppe, alluvial forests and from lowlands to mountainous areas (Heptner p.154).
Red deer are not present in the Danube Delta. The nearest populations can be found in the Carpathians and on the Crimean Peninsula.

FALLOW DEER

Fallow deer are ruminants feeding both in forests and on grasslands. The species probably originated from Turkey, but had spread already in ancient times to other parts of Europe (Heptner).
In the Danube Delta Fallow deer can be found on the Tataru Islands. If the population is allowed to grow to natural density, social pressure and the need for food would favour migration to other parts of the Delta.

ELK

Elk are ruminants and their food mainly consists of leaves, twigs, branches and bark of shrubs and trees. In spring these trimmers also eat grasses and sedges and in summer they treat themselves to all kinds of water plants. With their large flat feet they manage quite well in bogs and marshy areas.

Locally, elks can have a great impact on forest structure. Young trees are regularly trimmed back by them and kept in shrub form. As Elk often retreat to quieter places in winter and stay there for a long time, the forest will locally show open plots. Not only does damage from feeding have an influence on the forest structure, but male elks also strip the bark from the trees with their antlers, especially during the rutting season.

Elks have a liking for border zones between (deciduous) forest and more open terrain. They roam about in areas covering tens of thousands of hectares moving to more open areas in spring and summer while they withdraw to the sheltered environment of the forest in winter.

The original distribution of the Elk was very large, from the shores of the North Sea in the west to the eastern parts of Siberia. In the north, the shores of the Eurasian continent were the boundary. In the south the area included large parts of the steppes. Whether the Danube Delta was inside the original distribution or just outside remains unclear according to Heptner.

As Elk live in the taiga in the north, as well as in mountainous areas, marshy plains, forest steppes and in alluvial forests in the steppes, the landscape of the Danube Delta seems to be appropriate. However, the literature consulted allowed no decisive conclusions. Given that Heptner mentions that a strong southward migration was occurring in the sixties of the last century, more recent data are necessary.

BOVINES

Bovines are ruminants specialised in eating grass. They graze half the height of the grass with their tongues and need larger grazing areas than, say, horses, which graze smaller areas more intensively. This selective grazing is favourable for the development of herbs amongst the

Figure D.5
Herd of feral cattle

grass and produces a flower-rich pasture. Most grass enters winter uneaten but is eventually foraged by the bovines. Bovines occasionally eat young twigs, brambles and the bark of trees. In winter they may show a pronounced liking for brambles, but not all kinds of brambles are eaten. They are less restricted to open terrain than horses.

Bovines generally have a preference for food-rich areas. In winter and early spring, sandy areas offer more easily digestible organic matter which may result in seasonal migration to these areas. However, when they remain in sandy areas over the long term a shortage of minerals (sodium and phosphorous) may develop.

The wild Auroch has been extinct since the 16th century. Very diverse races of domesticated cattle are the direct descendants of *Bos primigenus*. During thousands of years of domestication regional breeds of cattle have developed different characteristics in response to different environments: cattle that have been living in a dry, hot area for a long period, will have different characteristics from those living in a cold wet climate. Some breeds are domesticated to a degree that makes survival in the wild very difficult, but there are races that manage to survive easily.

In the Danube Delta 30-40 years ago a group of cattle in the dunes of the Outer Delta became wild. On the shores of the Black Sea and along the edges of the reedbeds of the Delta, they have managed to survive and now even thrive as perhaps the only group of feral cattle in Europe. The herd consists of approximately xxx animals. Numbers are regulated by shooting some animals from time to time. The Biosphere Reserve

authorities have plans to extend the area where these animals may roam freely into other parts of the Outer Delta.

The very existence of a group of wild cattle habituated to the sea, the river and the climate of the region is very valuable. A more detailed study of this group, its provenance, social structure, behaviour, food strategies, territory and influence on the landscape should be carried out. This herd is the perfect source for the introduction of feral cattle into other places in the Delta.

BISON

Bison are ruminants that prefer feeding on grass, but also eat tree bark and the thicker branches. This latter characteristic distinguishes them from many other herbivores. Physically the Bison most resembles the bovine, but its diet as grass eater and tree trimmer, is closer to that of the Red deer. According to Heptner, the Bison is wrongly regarded as a woodland species. The more optimal habitats are: forests with open spaces and grassy areas, forested steppe, steppe and forest along rivers.
There were only 45 Bison remaining in Europe in 1922 (all in zoos) but a successful breeding programme saved this animal from becoming extinct. At present there are some 2,000 head of Bison living mainly in the vast east-European forests, but also in some west-European nature reserves.

Bison were distributed across forested areas of western and middle Europe, stretching to some southern European areas as well; the western and southern parts of the forest and steppe zones in the western part of the Russian Federation, the Caucasus, Ukraine and the Baltic states. Bison are recorded in historic times for the Carpathians, Romania and Bulgaria.

In the Danube Delta Bison are not present. As the Delta falls within its original distribution area, re-introduction could be considered.

HORSES

The horse is a grass eater, but not a ruminant. Horses digest the grass directly and are therefore always on the look out for the most nutritious patches. They take advantage of the high-protein new growth of recently grazed grass by grazing it anew. As a result, there are typical short-grazed horse meadows which contrast with the rougher parts of the vegetation where the horses don't feed. Horses sometimes eat the bark of trees or twigs.

The original distribution of horses probably covered most of Eurasia. Data, however, are not clear as it is almost impossible to distinguish between wild and domesticated animals.

As with cattle, the European wild horse lives on in the genes of the many breeds of domesticated horses. Some breeds, such as the Polish Konik, probably strongly resemble the wild Tarpan.
In order to host wild horses on a model site, an inventory of 'primitive' local breeds should be made, ranging from southern Ukraine to neighbouring Moldavia, Romania and the Carpathian mountains.

THE KULAN

Another wild horse, or ass, the Kulan, had the extreme western extent of its distribution area near the Danube Delta. The Kulan is a species of the desert, semi-desert and dry steppe. They were probably (Heptner) present on the plains of Ukraine until the 12th century, although their numbers would never have been very high. It is likely that they only left the steppes for short visits to the river to drink. Only a few hundred of these animals survive in the deserts of Asia. The western form is perhaps already extinct.

Re-introduction of the Kulan into the Danube Delta is not an obvious project at first sight. However, as part of a plan to save the species, the Zhebriansky Ridge with its dry sands may offer a more appropriate and natural space than could be offered by a zoo.

INTERACTION BETWEEN SPECIES, FACILITATION

The different food strategies of grazers generally contribute to separate biotopes, but there is an overlap in the way the terrain is used. This sometimes results in competition for the same food resources, but it is mostly a matter of facilitation: one species creates the conditions needed by another.

Bovines, which eat only half the height of long grass, smooth the way for horses which feed on shorter grass, and they, in their turn, give way to grazing geese. Beavers create open, food-rich plots along the water (including Beaver lakes standing clear of the water), where other grazers then assemble. That is the reason why, in the pursuit of natural grazing, we must focus as much as possible on the return of the total range of species of large grazers.

NATURAL DENSITIES

For most large grazers we can only make assumptions about the densities in which they naturally occur. The variation in time and space has probably always been great. This report has been written with Dutch circumstances in mind but the climate in the Danube Delta is very different. Careful experiments and observation are necessary to gather the necessary knowledge about conditions in the Danube Delta.

For the species that are already present in the region, such as boar, Roe deer and Fallow deer, natural densities will become clear if artificial regulation of the population is stopped in the model sites. After a few years, there will be many more animals and, at the same time, migration and dispersion will grow. Careful monitoring over several years will be able to answer many questions on these species. The same applies to a certain degree to the feral cattle in the Outer Delta.

For re-introductions (Beaver, Red deer, Elk, Bison), a plan including further research must be made.

MINIMUM RANGE

The question of how big an area must be for natural grazing can be answered in different ways.

First, we may take as the starting-point the *genetic minimum population*. This is roughly estimated at a population of 50 procreating individuals equally balanced in terms of gender. The population can survive in the long term without loss of variation by the autonomous process called 'genetic urge'.

In predominantly monogamous animals (Elks) this will give a population of 100–150 (allowing for young, old and other non-reproductive individuals). In gregarious animals with a harem structure (horses and Red deer) or other polygamous mating patterns (Bovines and Bison), this will mean an effective population of at least 250 animals. Taking into account food supply or habitat, and social behaviour we can calculate the minimum range required for each species. In food-rich and varied systems, minimum areas vary from 1,000 ha for horses, Red deer or Bovines, to 4,500 ha for Elk, and 7,500 for Bison.

The area needed can also be obtained by adding together smaller areas between which, with some regularity, animals must be moved. This is more appropriate when the animals are manageable. In the Dutch river area, the Koniks and Galloways have now actually formed a viable population.

Reasoning on the basis of ecosystem management, the surface area is less important. Grazing by some animals adds much value, even within very small areas. In the extreme case of only a few hectares, temporary grazing by the smallest group of horses or Bovines may have a positive effect on the natural development of the area.

It is true, however, that the larger the area the more the animals show preferences for a certain part of the terrain and the more pronounced will be their differentiating influence on the vegetation. Moreover, in large areas the risk of 'self-contamination' with parasites (through their manure!) is much smaller.

GRAZING AND THE FORMATION OF FORESTS

OVERGRAZING AND THE STEPPE CLIMATE

In the dry steppe climate of the south-western Ukraine, forests only grow where water from a source other than rain is available. On the other hand, in the endless wetlands of the Danube Delta, only the narrow strips on riverbanks are dry enough for forests.

Forests in the Delta therefore mainly occur as 'gallery forest' along the rivers. For a long time, these river banks were used by the inhabitants to graze their horses, cows and pigs. On the largest riverbanks, just downstream from Reni, old maps show the last remnants of the alluvial forests in the form of solitary trees. Overgrazing here has caused the disappearance of the forest.

Figure D.7
Tree meadows along the Kislitsky branch

On Ermakov island most of the forest has disappeared with only a narrow outer strip of trees remaining. The disappearance of the trees removes shade from the soil making salinisation worse. Agricultural grazing leads to an impoverished ecosystem.

TREE MEADOWS AND INTERRUPTED GRAZING

On Tataru island and along the Kislitsky branch, an intermediate stage of the effects of grazing on the vegetation can be seen. Here, old willows form with their branches an almost closed canopy. Under the trees, protected from the sun, grass grows and no young trees can be found.

This type of shadowed meadow develops out of alluvial forest under grazing pressure. Under the trees no young willows germinate as they can only do so on bare soil. Other species, however, germinate well in the shadow of the willows: Ash, Elm, and wild fruit trees such as apple and pears. Under heavy grazing pressure, however, the seedlings of these species are eaten too and no young trees are present.

Whenever grazing is interrupted, the shadow-germinating species will grow. On Tataru island thousands of ash trees are growing underneath the old willow and poplar trees. Here the forest not only rejuvenates itself, but a new phase in the succession towards a mature forest with different species is underway.

Figure D.8
Young ash trees under old willows as a result of interrupted grazing

INTERACTION: BROWSING FAVOURS THE GROWTH OF FOOD FOR HERBIVORES

Young trees provide good forage for the forest-dwelling herbivores, Deer and Elk. Each species browses the young twigs of the trees at different heights. The following year, the 'pruned' branches form new sprouts which are browsed again. In time, broom-like shrubs are formed under the influence of browsing herbivores. In this way, a forest which is regularly browsed by herbivores, contains much more food for them than a forest without browsers, where young trees either die of lack of light, or grow high up into the canopy.

For a number of species, bare soil favours germination of seeds. The activity of Boar opens up the soil, giving trees such as Elm a chance to germinate.

THE MOSAIC LANDSCAPE: BALANCE OF FORCES

Under certain circumstances such as cold weather, flooding and social pressure, animals will remain for a prolonged period in the same spot. Then severe damage to the bark, roots and branches of trees is possible, even causing the trees to die forming open areas within dense forest.

The forest dynamic then is, on one hand, grazing that prevents seedlings from growing, damaging young trees and is even killing mature trees while, on the other hand, interrupted grazing creates the opportunity for rejuvenation to a new phase in the succession, and disturbance of the soil provides new opportunities.

Figure D.9
Open area with young trees on Tataru Island

In an ideal situation these two forces are in equilibrium. The herbivores damage the seedlings and the trees in a process that leads to meadows. At the same time, interrupted grazing and disturbance of the soil create the opportunities for the forest to develop.
Obviously no one is intervening to maintain an equilibrium in the natural situation. In prosperous times, with many animals, open areas tend to enlarge. After disasters or diseases amongst the herbivores, the forest returns.

FOREST FRAGMENTATION

The strong tendency towards forest formation is accompanied by some natural counter forces which prevent succession from being completed, or even lead to temporary destruction of the forests. In traditional forestry (and likewise in nature management), some of these counter forces were reputed to be 'disasters': forest fire, flooding, trees uprooted by the wind, 'diseases', grazing, etc.
Although counteracting these natural processes may be economically useful in production forests, in natural forests they enrich and structure. They are helpful in creating a varied age composition, myriads of species and spatial variation. Hence it is important to look upon these dynamic forces as normal features, each of which has its own specific effect on the forest.

A short description of some of these dynamic forces is given below at the end of which the effects of grazing as a landscape-forming process will be discussed.

Currents and flooding

In the floodplains along rivers and streams we can see the development of characteristic alluvial forests where shade-tolerant forest species such as Beech, Chestnut and Maple are absent as they avoid flooded areas. Such alluvial forests have an open structure allowing much light to enter. They are rich in species and have a varied vertical composition with herbs, thickets, small trees and large trees.

When the forces of water are powerful enough, the forest may be physically damaged. Eroding banks and waterways bursting through the forest may wreak havoc. Trees that have been up-rooted and swept away may set up large barrages causing streams to change direction and the water to impact on hitherto unflooded forest areas. Not only does a river erode, it also forms new deltas, banks, islets, embankments and river dunes. New open land may be quickly covered with forest.

In river valleys there is a very dynamic interaction between the constructive and destructive forces of forest and river. In all, the dynamics along rivers, and in particular along larger rivers, can be so violent that there will always be open spaces within the alluvial forest. However, it is probably in river plains that large herbivores can keep open spaces for the longest periods by grazing.

Ice

Ice may destroy forests in various ways. Ice floes, sometimes drifting to form into ice hills or ice dams, may entirely flatten or up-root the forest locally. When, after a spell of frost, the water in a river or stream rises sharply, the ice floors still present in the river courses or undulating lowlands may be lifted abruptly and start floating. Such ice floors can wipe away entire forests on their voyage downstream.

When the bed of a river floods over and freezes , ice floors will be formed high up in the vegetation. When the water subsequently drops below the level of the ice, the ice will press down heavily on the shrubs and trees below it. In 1986, in the Millingerwaard holmes, almost all trees that were not entirely vertical were pulled down by the weight of the ice and shrubs were almost completely flattened.

Icing

Icing cannot easily make the forest disappear, but it can have a strong influence on the vertical composition. With massive icing, which we saw locally in the Netherlands in the early 1980s, the weight on the trees can become so heavy that their branches snap. With their tops broken and their branches drooping, the trees are ravaged.

But the trees do survive, although it may take years for them to recover. Meanwhile the forest is open and more light can reach the forest floor. This enables new trees to grow and a layer of herbs, bushes and small trees to develop. Grazers in the neighbourhood profit from the undergrowth and keep the bare plots open even longer.

Uprooted trees

Wind can damage the forest both locally and over vast areas. The chaos on the forest floor may be so great that even large grazers cannot enter. In the open spaces, increased light will cause an explosion of plant growth. Eventually the forest will develop again, filling the empty space. When enough grazers are available and they can enter, they will form a short-cropped pasture where forest formation is delayed for some time. Wind damage benefits the vertical composition, the spatial spread of open and closed areas, the age distribution and the richness of species.

Trees uprooted by wind have often been subjected to other previous 'disasters'. The impact of river dynamics or icing for example, means that trees that were once sheltered stand free or on the margins of the forest; they will be more vulnerable to the wind and the open area can be extended once more.

Fire

Deciduous forests are not as prone to fire as planted monocultures of coniferous trees. Nevertheless, there is the chance that deciduous trees will burn during long spells of dry weather. Burning dry reedbeds is effectively able to kill forests.

A grazed mosaic landscape with small woods and thickets, alternating with small and large open plots, will give a profusion of withered herbage, grasses and dry thickets in late summer. From time to time thunderstorms, often taking place in late summer, cause wildfires, and it can be assumed that in the open places amidst the thickets those fires can kill young trees in the grass. Fire can therefore be an important agent for keeping the grazed area open.

Diseases

'Diseases' have often been called 'plagues'. Nevertheless, most caterpillars, fungi, beetles and bugs that can kill trees are part of normal life in the forest.

THE EXPLOSION OF LIFE

In the first paragraph, it was stated that, thousands of plants and animal species have co-evolved with natural grazing processes. The re-introduction of natural grazing therefore implies that an increasing number of species will re-occupy their natural place. How natural grazing will affect the landscape in the Danube Delta will only be known by experimenting. The sketch below shows what such experiments meant to the landscape of the Dutch River area.

The model of the Ark Foundation project in the Netherlands gives an impression of what may be in store but on a much larger scale in the case of the Danube Delta.

According to the model, grazing transforms the area into a mosaic of young alluvial woodlands, shrubs and herb-rich grasslands. In the course of the summer, the herbage develops into a colourful pattern of short-cropped pastures and flowering herbage (summer herbage) which is

partly foraged in winter, whereas other parts (winter herbage) will remain until spring.

The species we know from the agrarian man-made landscape of meadowland concentrate in the summer herbage: riverine plants, myriads of butterflies, birds including the Corncrake and Partridge, and a great number of amphibians. The winter herbage provides forage and shelter to numerous seed-eaters, wintering caterpillars, mice, and raptors such as the Hen harrier and the Short-eared owl.

Fluvial forests are one of Europe's richest ecosystems. On such fertile soil, all this may be developed out of former farmland and pastures in a relatively short time (from some years to some decades). After starting, we saw within a few years in almost all pilot projects that the number of plant species increased, from some dozens to 200-400 species per 10 ha. The continuous supply of seed brought by the river plays an important role, but it is the natural grazing that provides a varied supply of germination sites. Within ten years, almost all tree and shrub species of the rare hardwood alluvial forest had managed to establish themselves.

ANNEX E

Human impact

THE DANUBE DELTA: A HISTORY OF SETTLEMENT AND DEVELOPMENT

A BRIEF OVERVIEW OF POLITICAL HISTORY

The Danube Delta is a bright example of a region where the interests of states, peoples, administrative institutions, departments and organisations were focused. The region is distinguished by a complex history of land development and settlement.

Although any traces of primitive societies in the Delta are absent, the geography of archaeological monuments gives information about human settlements since the Palaeolithic.

There were frequent changes of ethnic groups inhabiting the area. *Scythians, Sarmats, Goths, Huns, Avars, Pechenegs, Polovets* as well as other nomadic people inhabited the Danube lower reaches. Together with them there were fortified areas of *Milets, Romanians and Ottomans,* amongst others; *Slavs* settled permanently. Byzantine historians such as Jordan, Mavrikiy and Prokopiy mention *Slavs* in the Delta between the 4th and 8th centuries. Russian chronicles from the 11th and 12th centuries record the *Tiverts* and *Ulichy* living in the area between the Danube and the Dniester.

Once stable states had established themselves, competition was fierce to possess the region for its significant stock of natural resources and its location at the crossroads of water and land transport corridors. For over 500 years the Danube Delta was of geopolitical interest to Turkey, Moldova, Hungary and Romania, chiefly expressed through war and redistribution of territory. The consequences were changes in ethnic groups, reduction of population, and destruction. From the 15th to the beginning of the 19th century, it was Turkey who had gained the upper hand, then it was Russia's turn.

The most active period of Russian-Turkish rivalry was from the end of the 18th to the beginning of the 19th century during which the Danube Delta was shuttled from one side to the other. Thus, from 1770 to 1774, the area belonged to Russia but was signed away to Turkey through the Kyuuchuk–Kaynardzhiysky Peace Treaty. In 1790-1791 the region was a Russian possession again only to be returned to Turkey in 1791 as a result of the Yassky Treaty.

As far back as the period of Turkish domination, some groups of Russian so-called '*staroobryadets'* (people who observe old religious rites) began to penetrate into the Danube Delta. Eventually all dissenters became known as *'lipovane',* a designation which first appeared as the name of a sect under the guidance of Philip.

Active settlement of the Danube area began in the period of the Russian-Turkish war in 1806-1812. In 1806 the *Nogai* people left Bessarabia to settle in Priazovye (near the Azov Sea), and *Bulgarians, Moldavians, Ukrainians* and *Russians* took over their land. Migration was especially intense after the end of the war and signature of the Bucharest Treaty. The first *Bulgarian* villages, a settlement of *'nekrasovets'*, appeared at this time. In 1827, in the Izmail area, there were 24,634 *Bulgarians*, 11,375 *Moldavians*, 8,078 *Ukrainians* and 2,906 *Russians*. The populations of other groups were much smaller. The chief occupation on the plains was agriculture and, along the Danube banks and branches, it was fishing. From Vilkovo alone, up to 20,000 'red fish', 800 pounds of fish roe and 200 barrels of herring were exported.

After the defeat of Russia in the Crimean War, the Danube was signed away to the Moldavian principality (which was a Turkish vassal state). Slavonic people (mainly *Bulgarians*, *Ukrainians* and *Russians*) migrated to Priazovye. *Moldavians* and *Ottomans* together with some others settled on the abandoned lands.

In 1898 according to the Berlin Treaty, the region was returned once more to Russia. Active settlement and development of the region continued. The development of commercial agriculture and fisheries required improved transportation which led in particular to river embankment and clearing of the Delta branches. However, the engineering work was constrained by the state border running through the territory.

In 1818 the Danube area was occupied by Romania and remained under its rule until the Ukrainian part joined the USSR in 1940. This was marked *inter alia* by the development of an agrarian-industrial complex in the region which was accompanied by extensive engineering works.

BUILT STRUCTURES IN THE DELTA

The structures remaining from antiquity are fortified settlements on the lower Danube. Thus *Miletsy* built the *Antifal* fortress at the site of the present Izmail. In the II century a Roman fortress was located in the same place.

A bridge was built across the Danube by *Mendrocl* while Darius was undertaking his campaign against the Scythians.

Dominance of nomadism over centuries does not favour permanent settlements. Historic sources connect the appearance of the latter with the penetration of the Slavs into the Danube Delta (*Zaporozhtsy and Staroobryadtsy*).

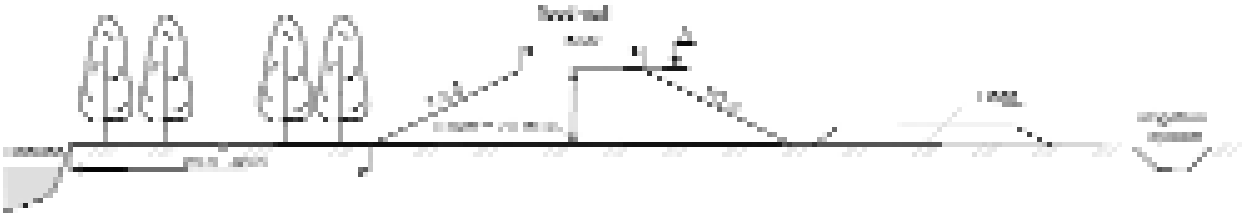


Figure E.1
Transverse profile of dikes in the section 'Prorva' sluice 'Skunda' sluice, 50-48 mile of the Danube river

The constant threat of destruction has determined building materials used in the Delta: reed, withes, rarely clay. Even *Svyato-Pokrovskaya* church in Vilkovo was built by *Zaporozhtsy* of 'reed and clay or sludge' and it was only in 1918 that a stone foundation was laid for a new orthodox church but the church itself was built of wood. The materials used were a rational solution to the environment, underlined by the fact that Vilkovo's citizens lived in boats during high water periods.

Topographical maps from the second half of the 19th century show that fluctuations of the water level in the Danube was the reason why there were no settlements on the islands of the Delta. Once a high primary embankment had been built along the river, the absence of threats to buildings by flooding allowed the construction of *pisé* and then brick houses.

In the first years after World War II, housing construction still took into account the risk of high water levels. That is why in the Kiliya reconstruction plan, established by the Izmail Regional Executive Committee, the development of the city towards the north was foreseen.

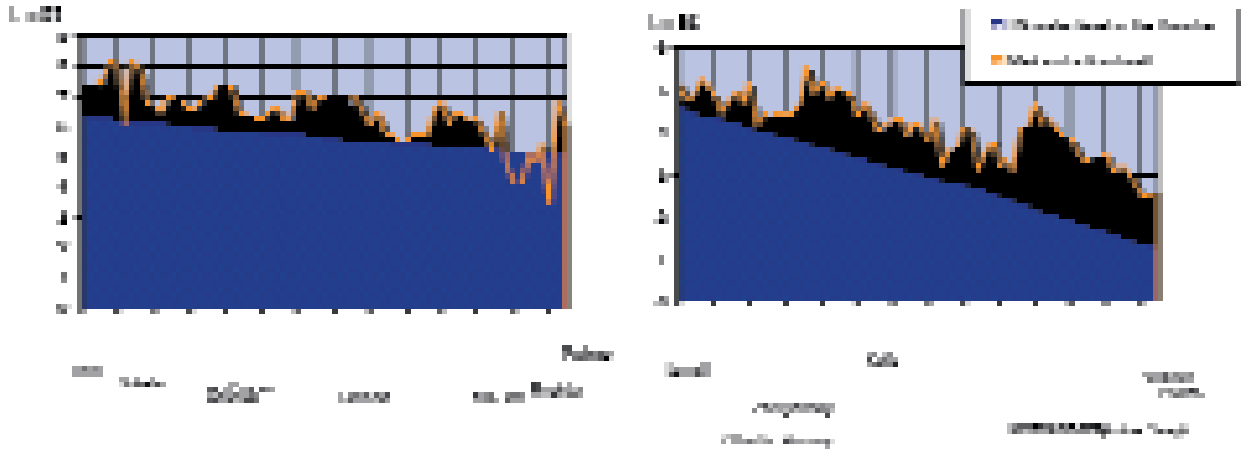
Works on embanking the Danube islands and channel, begun in the early 1950s, allowed construction of houses in a zone which was formerly flooded, and an increase in the share of brick buildings.

PROTECTION AGAINST FLOODS AND EROSION

The coastal area of the Danube river was historically subjected to inundation which impacted on land development and settlements. Many settlements were relocated to higher areas or were embanked. Disastrous floods were observed in the 1950s and 1960s. In 1969 the city of Vilkovo and the village of Leski were inundated as a result of very high water levels in the Danube.

Nowadays the majority of floodplains are embanked. Among them are such considerable areas as Novoselsky, Repidsky and Liskovsky plavni, Kislitsky island, Kislitsky plavni and Vostochno-Kiliysky plavni. More than half of the embanked area is used as arable land.

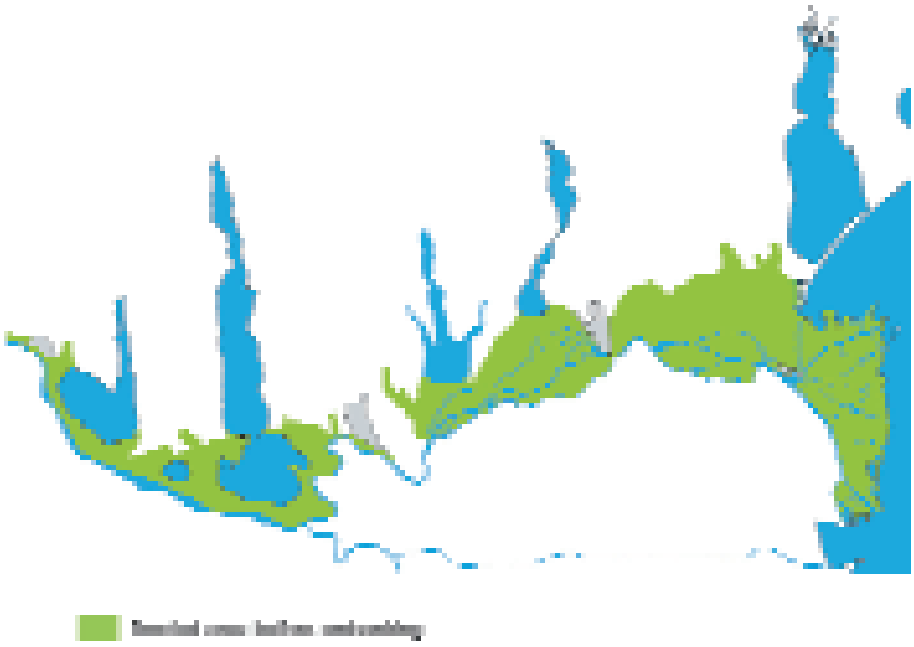
Constructions on the Danube river are designed to protect settlements, ports, industrial premises, agricultural areas, fish-farms and flood-defence equipment. The total length of these constructions is 239 km, including 215 km of dykes and 13 sluices designed to regulate the water level in the Danube lakes. The flood protection works provide for the

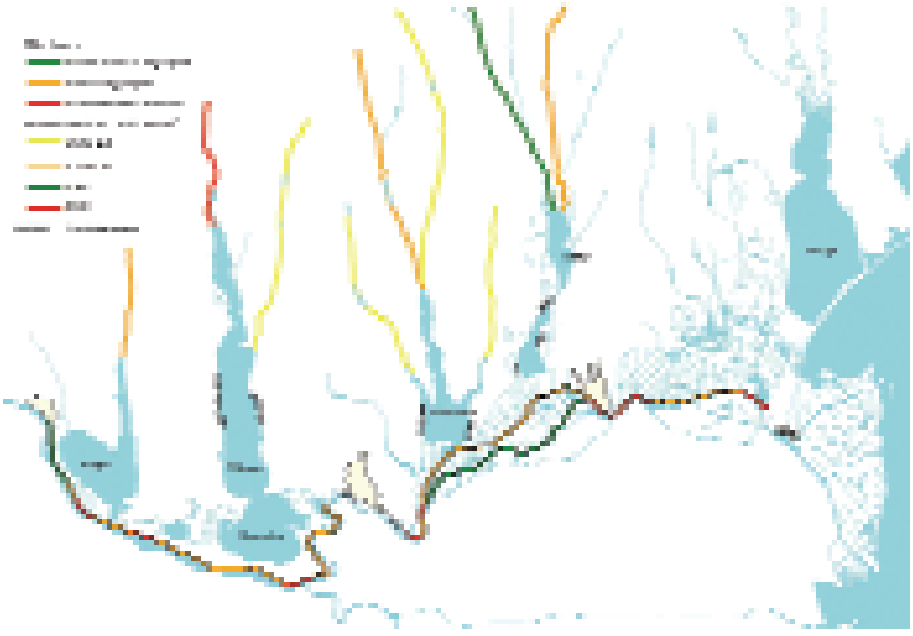


TOP
Figure E.2
Graph of the relationship between the height of the protection dykes and 1% (extreme) water level in the Danube

MIDDLE
Figure E.3
Flooding of the delta territory under extreme flood of 1% supply

BOTTOM
Figure E.4
Types and conditions of dikes of Ukrainian part of the Danube Delta





protection of Reni, Izmail and Vilkovo as well as for 16,000 ha of arable land, 10 km of the Russia-Romania-Turkey gas pipeline, 10 km of the electricity transmission line from Dubossary through Romania to Bulgaria, and roads (figure E.1).

Surveys carried out by the Odessa Regional Department of Water Economy in 2001, have shown that the current flood protection works along the Ukrainian bank of the Danube do not guarantee protection from high and disastrous floods (figure E.2, figure E.3).

Out of the total length of dykes (215 km), fewer than half (106 km) meets the necessary standards and do not need to be repaired (type A). Over a length of 32 km, the dykes have completely broken down (type B) and need to be repaired immediately, and over a length of 52 km the reconstruction of embanking dykes is necessary mostly because of their insufficient height (type C) (figure E.4).

Water levels at an extreme 1% flood can be one metre higher than the calculated level because winds can pile-up the water and this can be aggravated further by seismic phenomena. This means that flooding is possible even where the height of the dykes slightly exceeds the calculated level. For instance, current heights of the dykes (the first figure in centimetres) and a 1% flood (the second figure in centimetres) the objects and areas that will be flooded are identified below:

THE GAUGING STATION: RENI

475 511 – overflow through 'Viketa' sluice
470 506 – overflow through 'Prorva' sluice
489 525 – overflow through 'Skunda ' sluice
514 550 – inundation of the oil-base territory
559 565 – inundation of piers 1-5
559 595 – overflow through 'Orlovsky ' sluice
569 605 – inundation of piers 6-7
579 615 – inundation of piers 8,9,15,16,22,23,25,26, 30-33

THE GAUGING STATION OF IZMAIL

350 342 – inundation of territory of Izmail repair yard
380 362 – inundation of 55th km section of Izmail port
387 369 – overflow through 'Obschestvenny ' sluice
395 377 – overflow through 'Zhelyavsky' sluice
395 378 – inundation of 1st loading region
405 387 – overflow through '105 km'
407 388 – inundation of piers on a section of 85th km
424 405 – overflow through 'Repida' sluice
443 426 – inundation of closing dykes between crawls and overflow of water through the dike of the repair yard of the Ukrainian Danube Steamship Line
466 448 – inundation of closing dykes between crawls and overflow of water through the dike of the arable lands on 98th km
484 466 – inundation of closing dykes between crawls and overflow of water through the dike of the piers of Izmail repair yard

Figure E.5
Breakdown condition of some flood walls in Ukrainian part of the Danube
LEFT Underwashing part of a dike on a section of the Danube river (40-45 km)
RIGHT Ruinous dike on a section of the Danube river (45-47 km)

THE GAUGING STATION OF KILIYA

265	232	– flooding of piers of the repair yard and piers of Kiliya port.
270	237	– inundation of power cable of the repair yard.
350	317	– flooding of piers of the port.

THE GAUGING STATION OF VILKOVO

150	75	– inundation of 30% of the city territory
180	105	– inundation of 80% of the city territory
240	165	– inundation of 100% of the city territory

The main reasons for the state of the dykes are erosion of the submerged slope because of channel deformations, degeneration of a bank because of absence, insufficient width, or sparse growth of protective tree plantations, and also because of the influence of wind and the wake of ships (figure E.5).

Only two (on the Mezhkolhozhy canal and the main sluice on the Danube-Sasyk canal) of thirteen sluices meet modern requirements regarding their dimensions and technical condition.

Other sluices were built more than 30 years ago and do not correspond to modern standards regarding flood protection, through-put capacity and technical condition (figure E.6).

Figure E.6
A sluice on Skunda canal
(view from lake Kugurly)

To protect areas along the Danube banks from floods, a 'Regional Complex Protection Programme from Harmful Water Influence in Odessa Region during 2001-2005 and Prognosis for 2010' has been approved. The Plan includes a complex of measures directed at stabilising and strengthening the protective constructions on the Danube. In addition, the law of Ukraine 'About National Programme on Development of Water Economy' has been passed. It includes a programme to protect territories of the Danube region from flooding.

Over the period 1994-2001, the near Danube Department of Canals, Protective Constructions and Storage Lakes carried out protection measures costing 1.9 million grivnas. Bank stabilization was implemented over 19.6 km, and 17.8 km of walls were reconstructed or restored. The works were financed by the State Budget.

DREDGING

In the Ukrainian part of the Danube Delta large-scale dredging of channels has taken place for over a hundred years (and still continues) for two main objectives, the first being the most important: to accommodate ships of large tonnage, and to distribute water to different parts of the Delta. Dredging work for navigation is generally concentrated in the avandelta which is where the most problems are encountered.

In the first half of the XX century the main work was carried out in the Polunochnoye channel and, in the second part of the XX century, in the Prorva channel. In the 1980s and early 1990s almost all the Ochakovsky

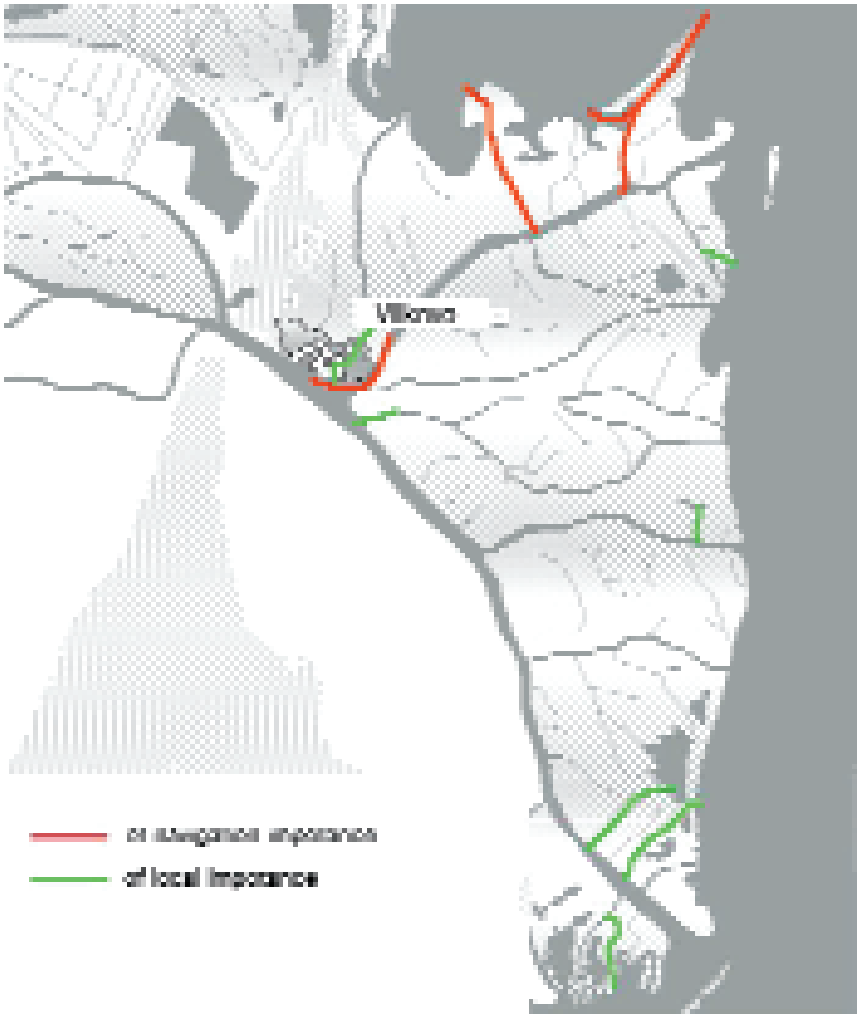


Figure E.7
Principal regions of channels dredging in the secondary delta of Kiliysky branch of the Danube

arm was deepened especially in the Vilkovo region. The scale of dredging is now decreasing sharply (figure E.7, figure E.8) mainly because of the collapse of Ukrainian shipping on the Danube. Dredging for deepening is now concentrated on the Soedinitelny canal between the Prorva channel and the port of Ust-Dunaysk.

Deepening work was also undertaken in other areas of the Ukrainian Danube, but they cannot be compared with the scale of such work in the avandelta.

The dredging of channels to support or restore water availability and supply to different parts of the Delta has probably been a feature of Delta life since occupation of the region by people (figure E.9) but its range has certainly increased with the growth of financial and technical resources and population. Dredging for this purpose is only found in small and mid-sized watercourses. It is possible that the dredging of channels was first implemented in the near Danube lakes and was aimed at maximising connections with the Danube.

In the 20th century, and especially in the second half, this activity was concentrated in the avandelta. Intensive Delta formation in this area

TOP Figure E.8
Vilkovo bayous

BOTTOM Figure E.9
Artificially deepened and dredged canals

Figure E.10
Artificial canals, dredged by population between Zhebriyansky liman and the bank near the village Primorskoe

resulted in rapid mortality of old water bodies and the formation of new watercourses. As a consequence areas important for fishery, forestry and agriculture were at risk of being cut off from the river so people tried to prolong their use. In addition to allowing access for people to isolated regions, dredging of small watercourses allowed flows of river water into them which was rich in biogenes and thus increased fish and general biological productivity (figure E.10). Over recent years, in connection with the massive economic decline, the intensity of this kind of human impact on the natural Delta ecosystems has sharply decreased.

TRADITIONAL USE OF THE NATURAL RESOURCES

HARVESTING WATER CHESTNUT AND REED

Harvesting water chestnut is significant only in the secondary delta and is an occupation confined to residents of Vilkovo. This activity has a long history with harvesting taking place from the moment the large growths appeared.

The chestnut was chiefly used for fattening pigs; the human population consumed it generally in 'hunger' years. After the war many families in Vilkovo harvested 2-4 tons of the chestnut a year. During the 1970s there was a gradually reduction of harvesting because cheaper grain was available for animals. In 1976 the Danube branch of the Chenomorsky reserve, established in the coastal part of the Delta (then an independent reserve 'Dunayskiye plavni'), prohibited water chestnut harvesting; stocks decreased sharply and finally were completely depleted. Attempts by the

Danube Biosphere Reserve authorities to restore this traditional activity on some water bodies has had no success. The reason remains as earlier: relatively cheap grain, but also the hard work involved in chestnut harvesting and the loss of traditional knowledge. Restoration of the chestnut stock will be possible only if a different and more attractive use can be found and financially supported.

Reed harvesting in the Danube Delta is also a traditional economic activity. The use and quality of reed is changing but there are two distinct main sectors: use of the reed for local needs and, secondly, for commercial markets. For local needs the reed is used for two different purposes: green reed is gathered in summer as a grassy fodder for domestic animals, and in winter dead stalks are laid-in for building purposes and for low-grade fuel. In recent years, reed for export as a natural roofing material has been developing.

The use of green reed for fattening cattle is typical in Vilkovo. This is explained by limited agricultural land and pastures suitable for hay. In general use of the green reed is quite small and has a local character. Only in years of strong drought was green reed stocked for use in the adjacent steppe regions.

Harvesting of the reed for commercial purposes is discussed in other papers in the Appendices.

PHYTOMELIORATION

Phytomelioration was implemented mostly by fishery organizations and partially by hunting associations. The main purpose of the fishery efforts was to extend the capacity of shallow waters overgrown by aquatic vegetation. It increased the productivity of commercial areas. Passages made in the dense growths favoured fish migration and more universal use by them of the whole area of the water bodies.

Phytomelioration for fisheries reached its largest scale in the inner water bodies of the secondary Delta. However, since the 1990s its scale has decreased sharply.

Making and maintaining passages in the reedbeds is chiefly carried out by hunting associations, and partially by commercial fishermen, to provide access to distant parts of the Delta. This kind of phytomelioration has reached its largest scale in Stentsovsko-Zhebriyansky plavni. It is also characteristic for other well-watered and large reedbeds of the Ukrainian part of the Danube Delta. Such passages are often maintained for a long time and mostly follow existing or former watercourses. They play a role in regulating the hydrological regime of plavni areas and also as migratory routes for different animals. In small inner areas of open water, clearing aquatic vegetation from aerial-aquatic vegetation (reed in particular) was carried out on quite a small scale in Stentsovsko-Zhebriyansky plavni and the near Danube lakes.

AFFORESTATION

Until the 1960s, afforestation in the Delta was functional. It is explained by the natural desire of the local population to protect their houses and workplaces from the sun and wind. High water levels blocked the natural afforestation of river valley ridges in the secondary delta. In addition to this, arboreal plants (practically only willow species) can only establish themselves naturally on new formations in the river, in shallow waters near the bank which were temporarily uncovered after flood periods (typical for the upper delta), and in areas with artificially drained soils. This has been observed on a large scale following construction of embankments in practically all the Ukrainian parts of the Danube. Similar processes are observed on dredged channels and along new watercourses in plavni areas where earth has been dumped on high ground near dyke walls.

Intensive afforestation of the Delta and adjacent areas was carried out in the 1950-60 period when forestry enterprises appeared. This was connected to the general forestry strategy of that time for the south of Ukraine, and for the planting of windbelts. The largest scale work was carried out on the lower Danube sands.

After failed attempts to afforest the shifting sands with different species, the pine *Pinus pallasiana D. Don* was successfully cultivated. Nowadays practically all the sand area of the Zhebriyanskaya ridge is forested with nearly 2,000 ha of plantations of different ages.

Most river valleys in the secondary delta, only excepting the youngest, are now artificially forested and this process is still continuing. The plantations in river valleys have reached 60 km with a total area of about 300 ha.

In the upper delta the most extensive afforestation was carried out on Tataru island and along the water course upper the city of Izmail. Different willow species and the white poplar *Populus alba* are the principal species.

Among the near Danube lakes the most forested are the banks of Lake Yalpug. The composition of forest species is quite wide and therefore different from plantations in the valley. The total area of trees planted is estimated in hundreds of hectares.

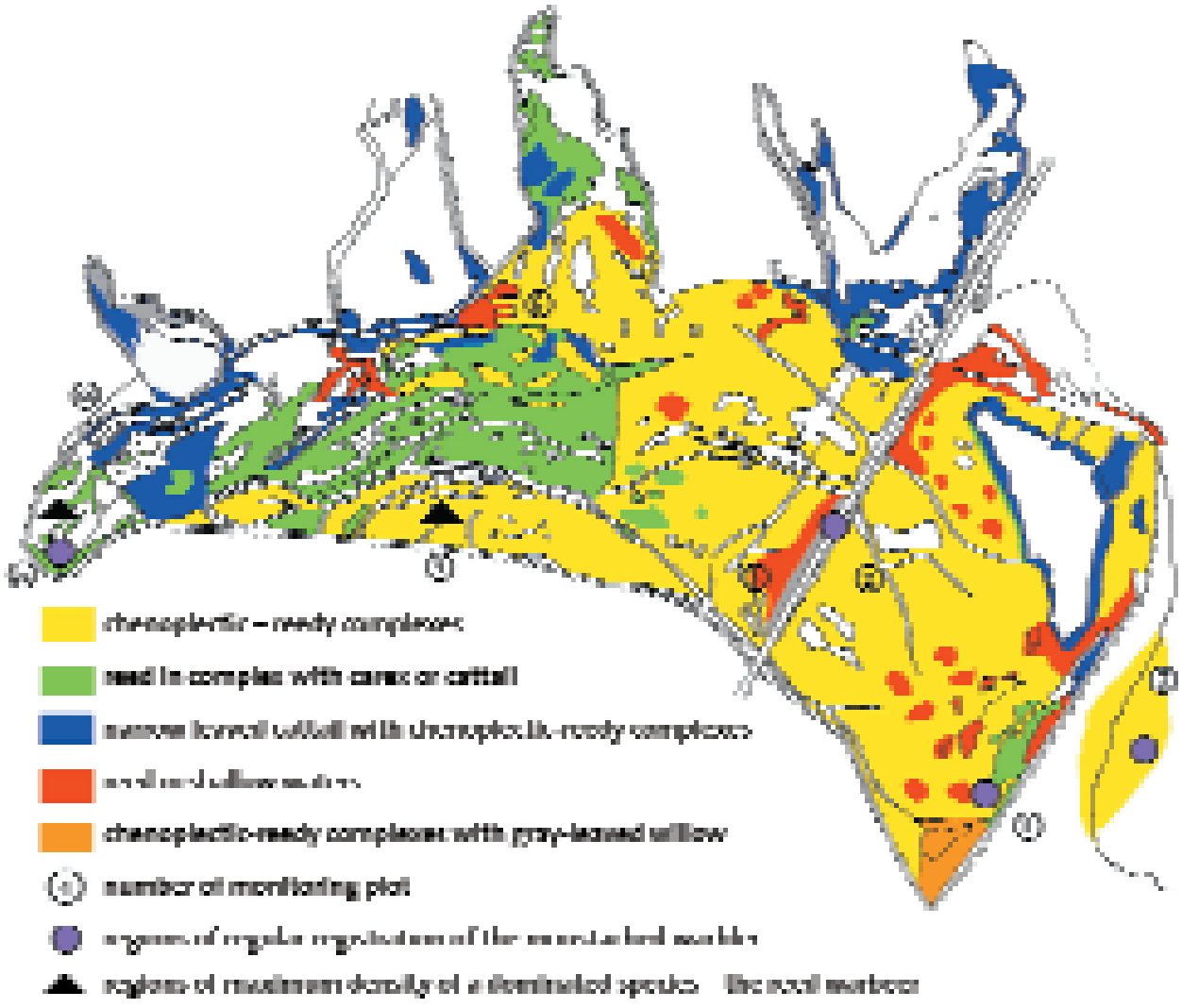


Figure F.1
Diversity of breeding habitats in
Stensovsko-Zhebriansky plavni

ANNEX F

Ecological situation in the Danube Delta

WETLAND MANAGEMENT UNIT, MELITOPOL

ECOLOGICAL SITUATION IN THE DANUBE DELTA

The ecological situation in the Danube Delta should be regarded as an integral expression of the processes in the Delta and also as an indicator of the practicability of any transformation or restoration on the model sites.

BIODIVERSITY

The variety and mosaic structure of biotopes in the Danube Delta as well as the presence of the 'river-sea' ecotone (a zone of interaction between freshwater and marine ecosystems), has resulted in high biological diversity. According to data from a survey conducted between 1995 and 1998 in the Ukrainian part of the Delta, there are 4,322 species of flora and fauna, among them: 950 higher plants; 717 planktonic one-celled algae; 277 aquatic invertebrates; 91 fish species; 5 reptile species; 10 amphibians; 256 birds and 42 mammals. In comparison 3,569 species are registered in the Romanian part of the Delta (Gomoiu, 1996). The highest biological diversity is observed in some parts of the Outer Delta and in Stensovsko-Zhebriyansky plavni (figure F.1).

The dynamic of the Delta landscape means that biological diversity varies from one area to another. In connection with this, different approaches to restoration measures in the model areas of the Danube lower reaches are being planned.

TYPICALITY

The Danube Delta is the second-largest and least transformed delta in Europe. The largest reedbeds in Europe with a total area of over 200,000 hectares offer a habitat for thousands of species of animals and plants. WWF has classified the Danube Delta as one of the 200 most valuable sites on the earth with regard to its global biodiversity importance.

Typical features of the Ukrainian part of the Delta follow from its active dynamics. These include the largest water discharge of the Delta through the Kiliysky branch, and the presence of an intensively growing area in the Kiliya delta, where new lagoons and islands are forming in large freshwater lakes, former sea limans, and flooded estuarial zones of the Danube tributaries.

SPECIES ABUNDANCE IN THE DANUBE DELTA

Taxon	NUMBER OF SPECIES Danube Biosphere Reserve	Red Data Book of Ukraine	European Red List
1	2	5	6
Higher plants	950	3	?
Phytoplanktonic algae	692	?	?
Algae of microphytobenthos	304	?	?
Zooplankton	301 *	?	?
Zoobenthos	259	?	?
Orthoptera	42	0	0
Homoptera: Aphidinea	44	0	0
Coleoptera: Mordellidae	25	0	0
Coleoptera: Curculionoidea	41	0	0
Lepidoptera	110	1	0
Hymenoptera: Symphyta	52	0	0
Hymenoptera: Ichneumonidae, Braconidae	237	0	0
Hymenoptera: Chalcidoidea	46	0	0
Hymenoptera: Formicidae	14	0	0
Hymenoptera: Scoliidae, Sphecidae, etc.	180	5	0
Hymenoptera: Apoidea	96	3	0
Odonata	50	2	1
Fish	91	?	0
Amphibians	11	0	1 IUCN Red Data Book
Reptiles	5	0	?
Birds	256	32	8
Mammals	42	7	?
Total	3850	53	> 10

** 468 according to Polischuk (1974)*

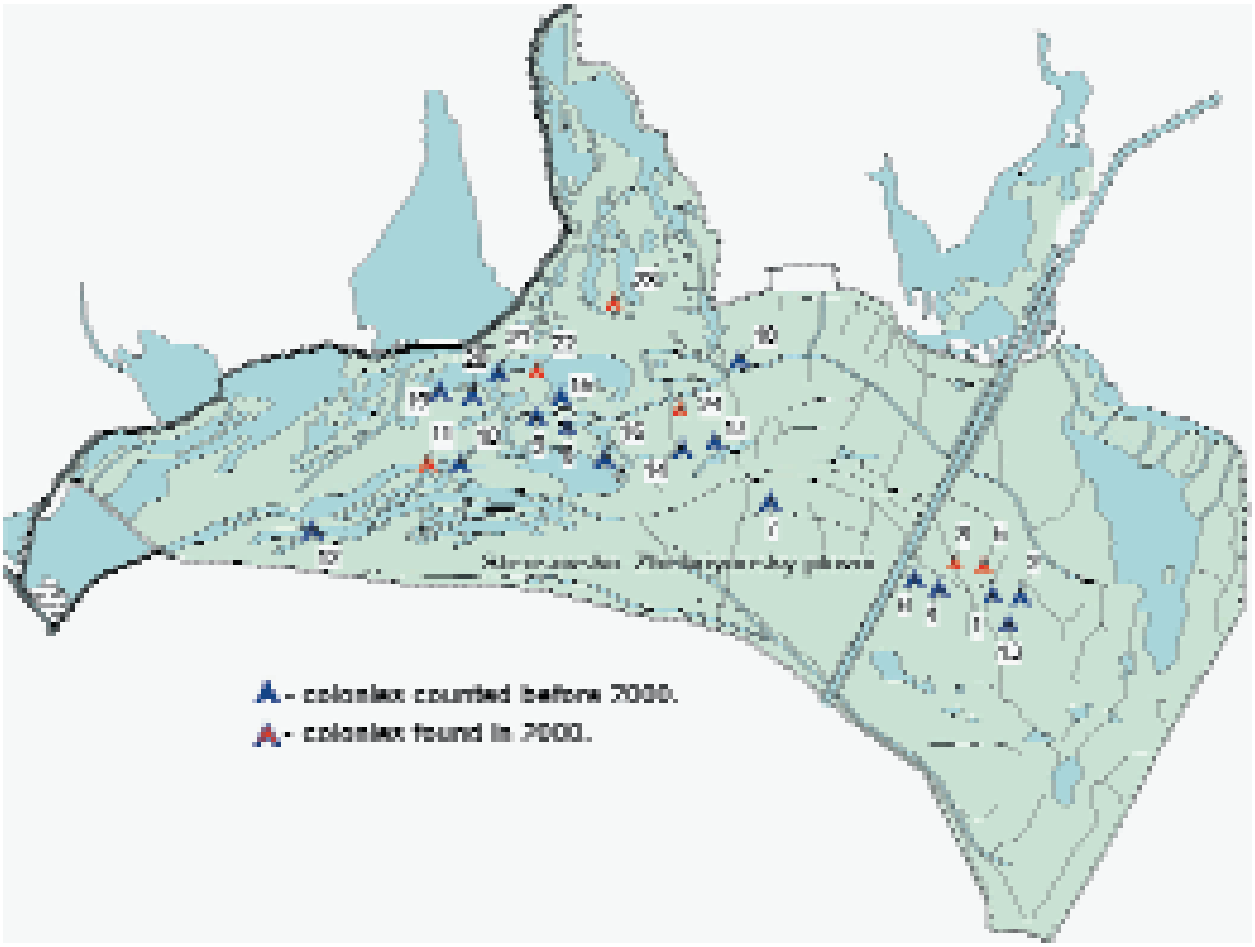


Figure F.2
Scheme of bird colonies distribution on example of Stensovsko-Zhebriyansky plavni during 1976-2000

The Danube Delta offers a unique model for scientific research, conservation and restoration as well as implementation of mechanisms for the sustainable use of wetlands.

NATURALNESS

The Danube Delta still remains the most natural delta in Europe, where natural habitats and species are found in conditions that have changed relatively little. This has been possible thanks to the considerable buffering of the biota and delta landscape, in spite of significant human impact.

In the middle of the last century and over several decades, more than 50% of the floodplain in the Ukrainian part of the Danube was lost or transformed. Pollution of the Danube water and small tributaries, and the introduction of new species occurred.

Thoughtless wetland use, such as embankment of the river and the Inner Delta water bodies, and transformation of floodplains and islands for agriculture, resulted in the destruction or radical change of many plant habitats and habitats for animal species, and a reduction of their spatial distribution. Many functions of the Delta, significant for supporting biodiversity not only in the Danube but also in the Black Sea, were modified.

Figure F.3
Clutch of a globally threatened species Ferruginous Duck

KEY SPECIES

A key species, forming an extensive biotope, is certainly reed *Phragmites australis*. Among one-celled algae the diatom *Cyclotella meneghiniana* and the blue-green alga *Oscilltoria tenuis* are predominant. Among macrophytes the green alga *Rhizoclonium hieroglyphicum* is typical. Its mass growth is determined by stagnant processes in plavni streams. Increased trophness of water bodies is favourable for the development of zooplankton of rotiferic -cladocerean type. Key species among plankton invertebrates are the rotifera *Lecane luna* and the crayfish *Chydorus sphaericus* and *Dyaphanosoma brachiurum*. Among bottom-dwelling invertebrates representatives of the Chironomidae family are key species.

Frogs are important for the functioning of the Delta ecosystems.

Key species among birds are colonially breeding *Ciconiiformes* (such as *Ardea, Egretta, Nycticorax, Plegadis, Platalea*) (figure F.2), the pygmy cormorant (*Phalacrocorax pygmeus*), ferruginous duck (*Aythia nyroca*) (figure F.3), red-crested pochard (*Netta rufina*) and pochard (*Aythia ferina*), the coot (*Fulica atra*) and the greylag goose (*Anser anser*).

INDICATOR SPECIES

Water indicator species, in particular of river and marine water, can be identified amongst the hydrobionts. Indicators of Danube water quality are the diatoms of the *Cyclotella* and *Melosira* genus, in particular *C. kuetzingiana*, *C. meneghiniana*, *M. granulata* and *M. italica*.

Characteristic indicator species of fresh waters among invertebrates are representatives of *Brachionus* and *Keratella* genus and the crayfish

LEFT Figure F.4
Great Crested Grebe, an indicator of phosphoric pollution and high fish productivity

RIGHT Figure F.5
Kingfisher - an indicator species of precepitous erosion banks, feeding in clear shallow waters, richen in fish

Bosmina longirostris and *Moina micrura*. Indicators for marine waters are diatoms of *Pleurosigma* genus, the copepod *Acartia clausi*, cyclops of *Oithona* genus, a crayfish *Pleopis polyphaemoides*, as well as numerous larvae of barnacles, *Polychaeta* and molluscs.
A reliable indicator of the trophic conditions of water bodies is the presence of macrophytes with a specific correlation between the total photosynthetic surface of thalloma and their biomass.

Indicators of clear flowing water are the alga *Chara foetida* and flowering macrophytes *Potamogeton pectinatus*, *Najas marina*, *Ceratophyllum demersium* with minimal correlation between their surface and biomass. Different species of blue-green algae of *Lyngbya* genus, as well as green filamentous algae *Rhizoclonium hieroglyphicum*, *Cladophora fracta*, *Spirogira tennuissima* are reliable indicators of unfavourable conditions such as high organic pollution and stagnant processes.

Indicators of flowing water and olygotrophic conditions are, together with algae, representatives of relict fauna such as copepods *Heterocope caspia*, *Eurytemora velox*, *Calanipeda aquae-dulcis*.

Indicators of reedbed structure among birds are *Acrocephalus* species, of the depth and forage value of floodplain lakes, grebes (Podiceps) (figure F.4) and Aythia species and most piscivorous birds (figure F.5). Indicators of the health of floodplain forests are the efts (newts) among amphibians, European wild cat and bats among mammals, and the white-tailed eagle among birds.

INVASION AND INTRODUCTION

Sixty-five introduced species in both water and land ecosystems have now been identified in the Black Sea basin, including the Danube Delta. Among them are 11 species of aquatic plants, 40 species of invertebrates, 7 fish, 2 birds and 5 mammals. Thirteen species are directly associated

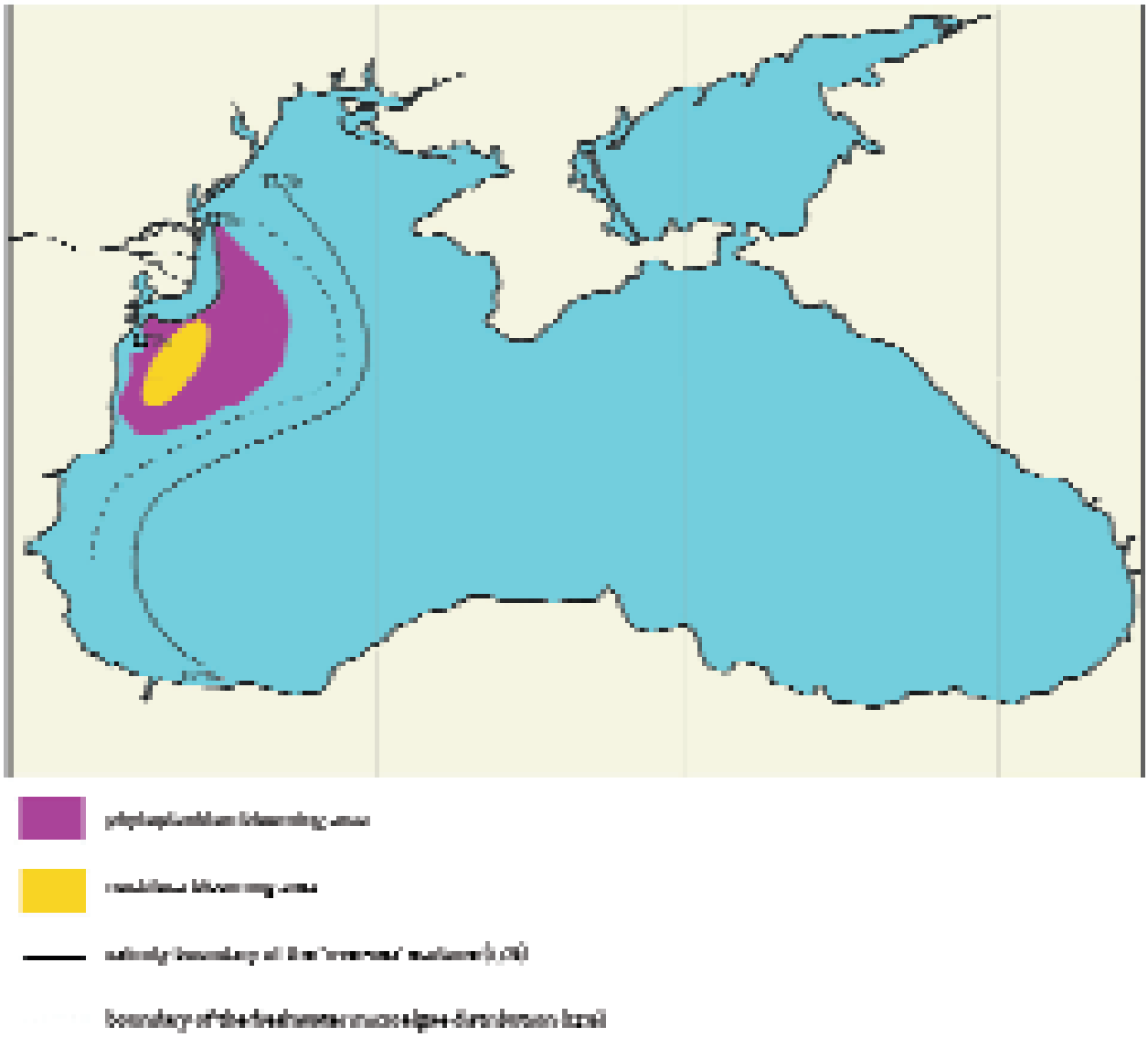


Figure F.6
The Danube influence on the western part of the Black Sea

with the Danube Delta. Three of them (the musk-rat *Ondatra zibethicus*, *Hypophthalmichthys molitrix* and the grey mullet *Mugil soiuy*) were deliberately introduced, while the others were accidentally introduced mostly in the ballast and bilge waters of sea-going ships.

Most exotic species of the Black Sea have a North-Atlantic origin (68%), 13% penetrated from the Indo-Pacific region and 8% from the Western Pacific. Three species have commercial importance in agriculture.

The highest economic losses have been caused by the introduction of the jelly-fish *Mnemiopsis leidyi* into the Black Sea in 1982. The total loss caused by attacks on the fishery, estimated by international experts (GESAMP, 1997), was equal to US$ 200 million per year. In the last decade, which has seen increased shipping traffic and greater use of water ballast, the invasion rate has reached one species per year. The jelly-fish *Beroe ovata* and the crab *Eriocheir sinensis* were first discovered in 1997 in the Danube Outer Delta. Since 1999, Ukraine has been involved in the International Maritime Organisation GEF/IMO/UNDP project 'Removal of Barriers to the Effective Implementation of Ballast Water Control and Management Measures in Developing Countries' to prevent invasion.

KEY INTERACTIONS IN THE COENOSES

The following processes should be regarded as key for the functioning of Delta coenoses:

- Inflow of biogenes and their consumption by plankton and higher aquatic vegetation;
- High bio-productive potential at the expense of a long vegetation period (temperature regime and water-logging, mosaic of habitats and high species diversity of ?producents);
- Extreme branching of trophic chains on principal levels, favouring support for high biological diversity and buffering of the Delta ecosystems.

Flowing water in the Danube channel is rich with plants and animals which conduct their life-cycles there. While most bottom organisms are static, pelagic species are freely transited to the sea; this mostly concerns bacteria, microalgaes and invertebrates (zooplankton). The general quantity of river-transported hydrobionts, not including biogenes, determines not only the productivity of the Outer Delta, but also influences the Black Sea (figure F.6). For instance, average productivity of the Romanian part of the Delta is 18-35kg/ha, and that of the Ukrainian part is 27-45 kg/ha. The estimated annual volume of plankton run-off in the Upper Delta is about 1,340 thousand tons, including bacteria (80.8%), phytoplankton (11.1%) and zooplankton (8.1%).

Comparison of the quantitative parameters of hydrobionts from the Danube channel to the sea gives an opportunity to identify the following characteristics:

- the biomass of hydrobionts in the sea is on average 5-10 times greater than in the river (phytoplankton x5, zooplankton x14, macrozoobenthos x8);
- in comparison with adjacent zones (the river channel and the coast) there is a decrease in number and biomass of hydrobionts in the Delta water bodies.

A reason for the observed spatial distribution of water organisms is intensive deposition of suspended solids in the Delta as a result of slowing the water flow. The presence of many species typical of a coastal complex, including migratory species from the sea to the river such as sturgeon and herring, is determined by the highly productive 'river-sea' ecotone in the Outer Delta.

The process by which the plavni are colonised by higher aquatic vegetation is a natural phenomenon, but human activity can greatly accelerate this process as a consequence of the increase of bio-organic run-off (figure F.7).

It should be noted that successional changes in development of higher aquatic vegetation are also a consequence of the transformation from a multiple-branched to a simpler-branched Delta together with hydrobiological factors. Expansion of the Delta with aerial-aquatic ???, aggradation of spits and small ridges causes rapid isolation of bays. They become transformed into isolated water bodies which is followed by a rapid increase in the volume of organic matter in water and bottom deposits, deterioration of the oxygen regime and water exchange. Degradation of water quality certainly impacts productivity and the biodiversity of

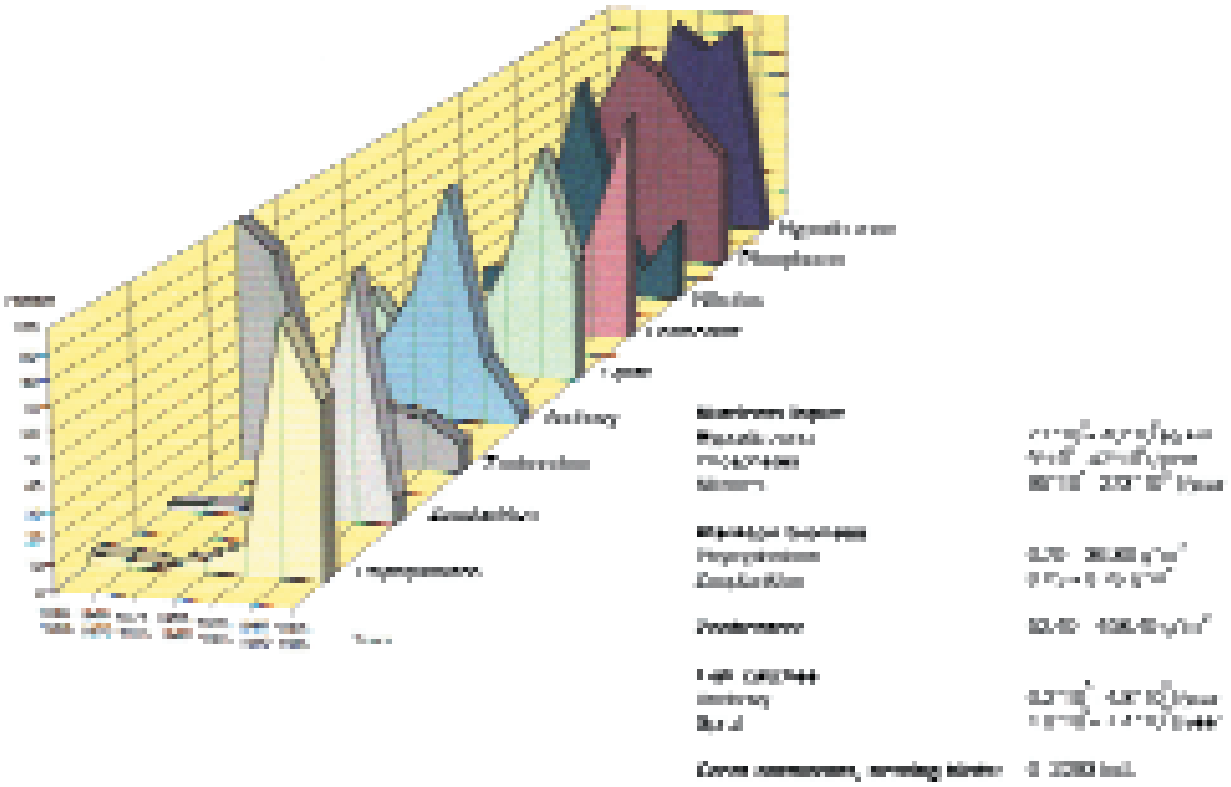


Figure F.7
Dynamics of change in principal parameters of the Danube Delta ecosystem as a result of a regulated discharge and eutrophication of water bodies

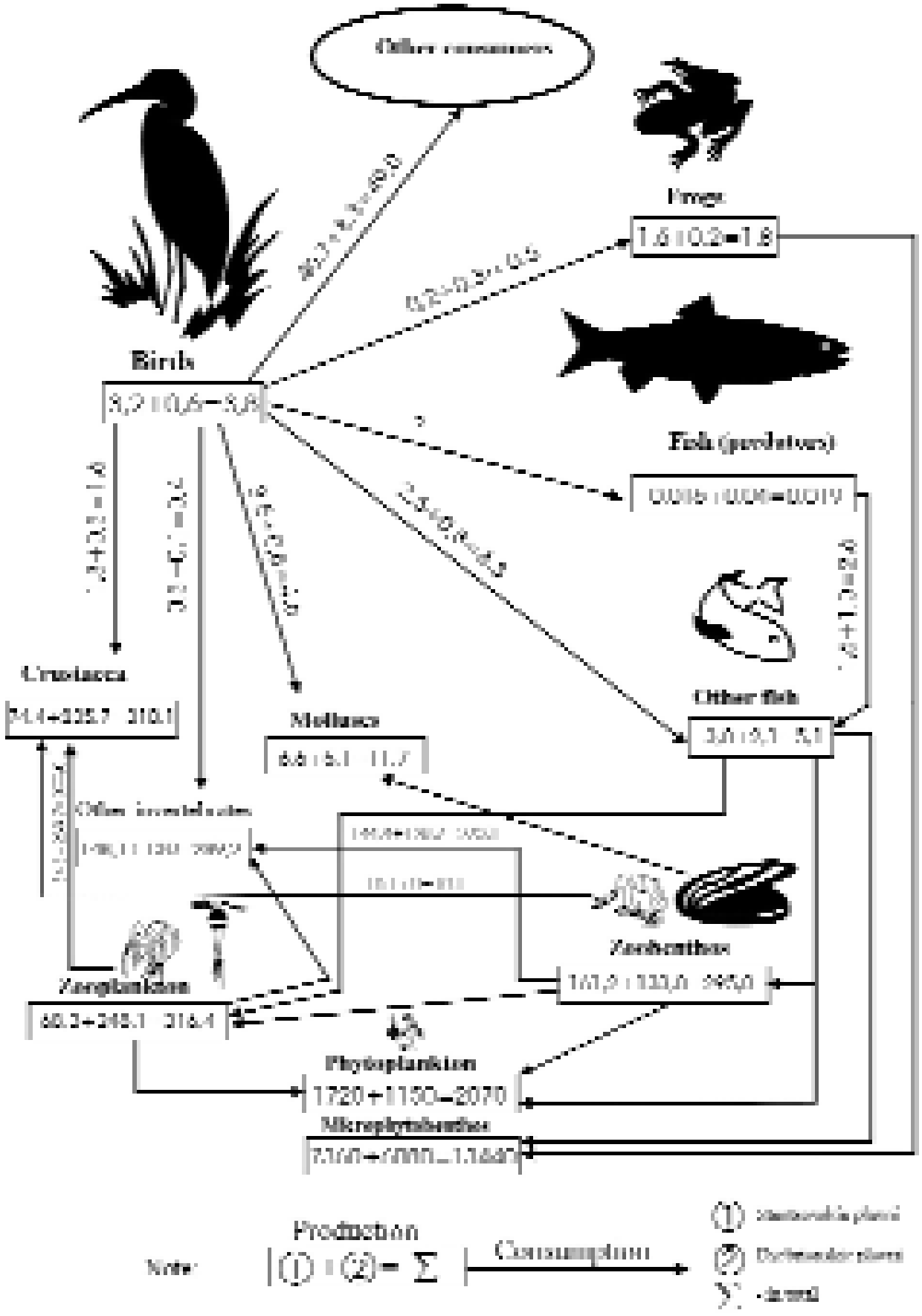
PAGE 149 Figure F.8
Trophic links of birds in the Danube Delta as an example of their divarication

plavni ecosystems. Comparison of the contribution of higher aquatic vegetation and changes in hydrological regime over a period of more than 20 years leads to the conclusion that the latter has a much greater impact on changing the Delta landscape.

Vegetation of water bodies from the centre to the borders takes place through a series of stages or successional changes of various plant communities. For the Ukrainian part of the Danube Delta such a series has generally included not more than 10 vegetation associations, sequentially changing each other and completing the process by monocoenosis of the reedbeds. For the last 10 years there has been on average a transition of not more than 1-2 nearest links in a successional series (Kharchenko, *et al.*, 1993).

An illustration of the most typical trophic chains together with temporal changes in principal key processes of the Danube Delta is represented below.

Assessment of the quantitative interrelations between structural elements in the ecosystem of the Ukrainian part of the Danube Delta, necessary to manage the water regime in the plavni, prevent them from being overgrown with reed, and to make forecasts of breeding and wintering bird dynamics, was carried out in Stensovsko-Zhebriyansky plavni (SZP). The quantitative interrelation between aquatic vegetation, pelagic and bottom invertebrates, fish and birds was calculated on the basis of a bio-energetic approach, taking into account their production and trophic links (figure F.8).


Other consumers
Frogs
1.6 ± 0.2 = 1.8
Birds
3.2 ± 0.6 = 3.8
Fish (predators)
Crustacea
Molluscs
Other fish
3.0 ± 0.1 = 3.1
Other invertebrates
Zoobenthos
Zooplankton
Phytoplankton
1720 + 1150 = 2870
Microphytobenthos
Production
(1) + (2) = Σ
Consumption
Note:

It was established that hydrobionts are contained in approximately one quarter of a bird's diet, while on overgrown plavni they are reduced more than fourfold. The basis of the food pyramid in the plavni is one-celled algae. Their total production for SZP is 1.63?10^{12} kJ, which is twice as high as the total production of all the surveyed representatives of water and land ecosystems connected with the algae in the food web.

Among hydrobionts, molluscs and fish are of most importance as food for birds. On average they are contained in 44% and 35% respectively of the total amount of aquatic animals consumed.

The closest link with the trophic connections within the water ecosystem is observed for the Coot *Fulica atra* and the Pochard, *Aythia ferina*. In their diet up to 28% and 11% respectively of all hydrobionts consumed by birds are found. The Coot takes the leading place because it is the most numerous representative of SZP ornithofauna (on average 44% of all bird populations dwelling there). In their turn *Authia* species, fewer in number than the Mallard, *Anas plathyrhynchos* and Teals, *Anas querquedula*, are more active consumers of hydrobionts.

Analysis of the structural features of Stensovsky and Zhebriyansky plavni showed that differences in the production of one-celled algae, zoobenthos and fish was slight, while for zooplankton development in the most overgrown part of the plavni (Zhebriyansky) intensification was observed. Production of pelagic invertebrates was 3.6 times greater there than in Stensovsky plavni. This is mainly at the expense of Crustacea species.

The distribution of biological resources in the plavni underlines the necessity of implementing bio-ameliorative measures in Zhebriyansky plavni, directed at regulating reed growth. With relatively the same biomass, 2.8 t/ha for Stensovsky plavni and 3.1 t/ha for Zhebriyansky, the density of bird concentration in Stensovsky plavni is almost 2.5 times greater than that in Zhebriyansky and is on average equal to 8 ind/ha.

Generally, 64% of the total biomass of hydrobionts, including 66% of fish and 83% of birds in SZP is concentrated in Stensovsky plavni.

CHANGES IN SPECIES COMPOSITION AND POPULATION OF THE ICHTHYOFAUNA OF THE DANUBE RIVER OUTLET AT THE BLACK SEA AND SELECTED ECONOMIC EVALUATIONS

Species	BEFORE EUTROPHICATION** (1956 – 1959) Market price, Grn*/kg	Average annual catch, tons	Share of catch, %	AFTER EUTROPHICATION *** (1995 – 1997) Total price, millions Grn	Average annual catch, tons	Share of catch, %	Total price, millions Grn
PLANKTON FEEDING FISH							
Sprat	2.00	1,398.4	42.31	2.797	3,933.0	83.15	7.866
Anchovy	3.00	826.1	25.00	2.478	249.0	5.26	0.747
Danube shad	4.00	13.1	0.40	0.052	163.3	3.45	0.653
Black Sea scad	4.00	498.5	15.08	1.994	30.7	0.65	0.123
Bonito	10.0	189.8	5.74	1.898	0.0	0.00	0.000
Mackerel	8.00	94.3	2.85	0.754	0.0	0.00	0.000
Total		**3,020.2**	**91.38**	**9.973**	**4,376.0**	**92.51**	**9.389**
BOTTOM FEEDING FISH							
Great sturgeon	30.00	38.3	1.16	1.148	0.0	0.00	0.000
Russian sturgeon	25.00	5.8	0.18	0.145	0.7	0.01	0.018
Starred sturgeon	17.00	3.1	0.09	0.053	0.0	0.00	0.000
Grey mullet	5.00	2.5	0.07	0.012	0.3	0.01	0.002
Turbot	9.00	152.0	4.60	1.368	0.0	0.00	0.000
Flounder	9.00	2.2	0.07	0.019	23.7	0.50	0.213
Total		**203.7**	**6.16**	**2.745**	**24.7**	**0.52**	**0.232**
Others	0.10	81.0	2.45	0.008	329.5	6.96	0.033
Total		**3,305.0**	**100.00**	**12.726**	**4,730.1**	**100.00**	**9.654**

**Rate of exchange is 1 USD= 5.00 Grivnyas (Grn)*

***According Salnikov [8];*

****According to the data of the Danube Biosphere Reserve (A.Voloshkevich – personal communication).*

THE ROLE OF THE DANUBE DELTA IN CONSERVATION OF BIOLOGICAL DIVERSITY AND SUSTAINABLE USE OF NATURAL RESOURCES WITHIN THE FRAMEWORK OF THE ECOLOGICAL NETWORK AND THE NORTHERN BLACK SEA ECOLOGICAL CORRIDOR

An ecological network consists of the following components:

1 areas with high biological diversity, natural territories or natural cores (usually reserve areas or refuges);
2 a buffer zone around them, and
3 associated ecological corridors (transport of biogenes, migration, interchange between populations, distribution, etc.).

Such components are typical of river systems, water-courses, sea coasts and the currents along them. On the Black Sea coast the structure of the ecological corridor becomes more complicated because of the presence of linked elements such as the river-liman-sea system. According to this approach, the Danube river can be regarded as the largest transport system for biota of the lower Danube natural core area and the adjacent part of the Black Sea. The function of the ecological corridor is also fulfilled by connecting similar landscapes or biogeocoenoses, forming a continuous chain of ecologically associated links.

Speaking about restoration of the degraded ecosystems of the lower Danube and optimisation of all Delta functioning, it is very important to realize the significance of the lower Danube natural core region within the structure of the Black Sea component of the ecological network, against the background of other areas with high biological diversity.

According to the law of Ukraine on development of the national ecological network for 2000 – 2015 N 1989-III of September 21, 2000, the natural region of the Lower Danube is included in the coastal natural (ecological) corridor.

The coastal corridor has some specific features. The deltas of five large European rivers are found there (the Danube, Dniester, Southern Bug, Dnieper and Don); they influence the water balance of the Black Sea and support a unique biological diversity both in continental and ecotone systems. In addition, liman-estuarial complexes, numerous small and mid-sized salt lakes and the largest salt lagoon of the Sea of Azov, Sivash, are also located along the coast. Almost all the Ramsar sites of Ukraine are located there.

At the junction of the southerly river valleys and the east-west-facing coast, a complex concentration of principal waterbird migratory stop-over sites are found which are used before the departure to North Africa, Southern Europe and the Middle East.(Figure F.9)

All these facts determine the biological originality of the corridor which is recognised by its identification as a separate marine-delta biogeographical region (Polischuk, Bagnyuk, 1999) with floristic and faunistic peculiarities.

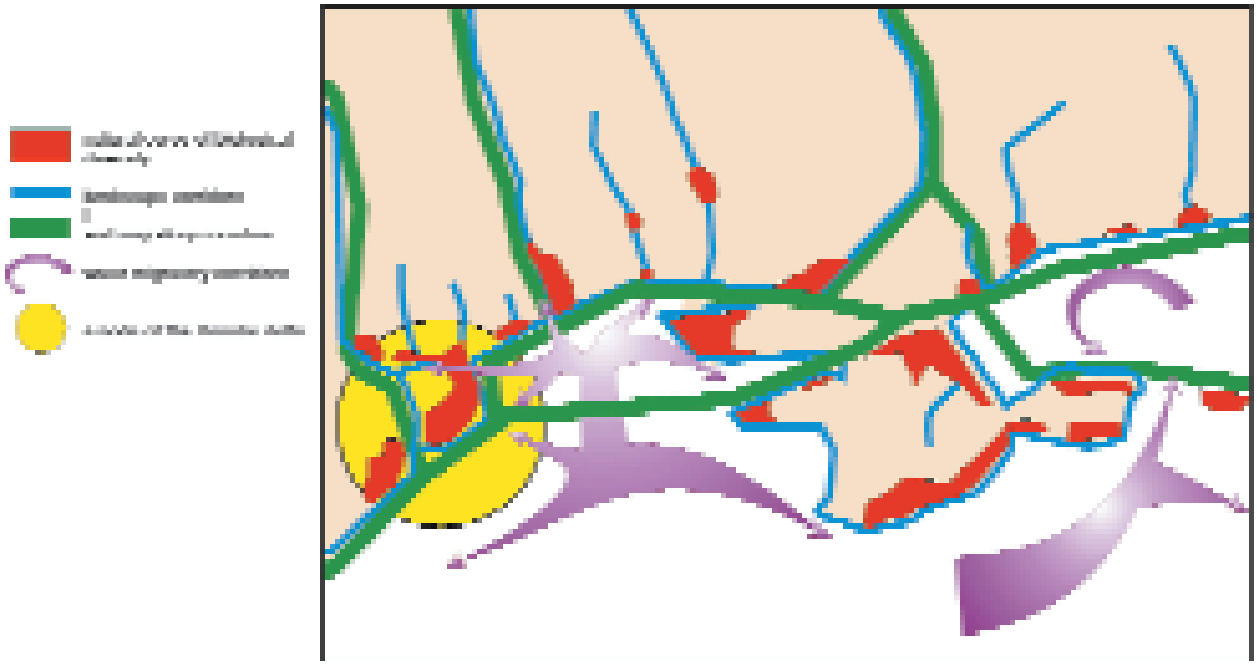


Figure F.9
Significance of the Danube Delta in the structure of the North-Black Sea ecological corridor

Terrestrial vegetation in general has a halophilic-psammophilous character with remnants of gramineous-absinthous and psammophitous steppe on slopes and in some plain areas. Aquatic vegetation is poorer in species and more widespread within the corridor.

Peculiarities of the area include remnant features and characteristics of brackish and weakly-salted water bodies, contact zones of marine and fresh water. The Danube water bodies are refuges for Pontic relicts, chiefly distributed in limans and the least saline parts of the Black Sea basin, where conditions remain closest to those of the Tertiary basin. The Pontic relict fauna in the Danube Delta is mainly represented by Crustacea and fish. Among Crustacea there are 2 species of plankton copepods (*Heterocope caspia, Eurytemora velox*), 16 species of amphipodes (*Pontogammarus maeoticus, Corophium curvispinum, Dikerogammarus villosus,* etc.), 2 species of mysids, etc. Fish of relict Pontic-Caspian fauna is represented by 5 species of Sturgeon and 9 species of Goby. Other Pontic relicts include the polype *Cardilophora caspia*, polychaeta *Hypania invalida* and *Hypaniola kowalevskii*, the mollusc *D.polymorpha.*

Having been isolated from the ocean for more than 1.5 million years, 'Caspian' fauna is endemic to the Ponto-caspian basin, that is, they do not live outside its borders. The Danube Delta water bodies are important refuges for Pontic relicts. The number of these is closely connected with salinisation and eutrophication of the lower Danube water bodies. The total discharge of the Danube, Dnieper, Dniester and Southern Bug in 2000 was estimated at 83-84 km^3. It is estimated that a decline to 80-100 km^3 a year will result in an increase in salinity of 150 m of the upper layer, of 0.6-0.7%. A consequence will be a further reduction of relict species habitat.

The average perennial level of primary gross production in the water bodies of the Danube Delta is 3.15 mg C / liter / day, which is 2.7 times greater than the intensity within similar shallow plavni ecosystems of the Danube Delta.

Among a large number of other natural core areas within the corridor (see Figure F.9) the lower Danube stands out as an independent bio-geographical area, possessing such peculiarities as:

- High biological productivity, abundance of species and forms, conservation of the genofund (about 1,000 species of higher plants, more than 900 species of algae, 300 species of birds, etc.)
- A powerful bio-filter of Danube run-off, and protection of the Black Sea shelf. The efficiency of the bio-filtering qualities of the Danube Delta vegetation can be illustrated by the average annual volume of substances removed from the river and included in the phytomass: nitrates 59.100 tons; phosphates 20.500 tons; heavy metals 23.300 tons, and about 100 kg of pesticides. The rate of nitrate removal in the Danube plavni is 38.7 kg/min^{-1}, phosphates 49.6 kg/min^{-1}. An estimate of the purification capacity of higher aquatic vegetation in the Delta compared with other main rivers of the north-western Black Sea area according to total area, showed that the intensity of pollution fixation in the Danube plavni is greater than that in the Dniester by a factor of 13, and the Dnieper by a factor of 16 (Alexandrov, 1998);
- The close ecological association between the Delta and the coastal shelf, including the Phyllofora field of Zernov;
- The centre of several trans-continental migratory routes for water-birds and a site of seasonal concentration with significant ecological capacity;
- A zone of fattening, spawning and migration of diadromous and fluvial anadromous fish;
- A site of migration and stop-overs of some bat species and, more generally, a zone of distribution and interchange between populations of rare and low-density species.

THE DANUBE DELTA WITHIN THE CORRIDOR OFFERS:

- **Relative stability of habitats;**
- **A buffer zone and protection for many globally threatened and relict species over a large area of territory;**
- **An important contribution to the conservation of migratory populations on the Afro–Eurasian migratory route;**
- **A zone of high potential productivity of biological resources.**

ANNEX G

Sustainable Use

WETLAND MANAGEMENT UNIT, MELITOPOL

OPTIONS FOR SUSTAINABLE USE OF THE DELTA RESOURCES/SOCIO ECONOMIC ASSESSMENT

INTRODUCTION

People's use of a landscape determines to a greater or lesser extent how it functions, both economically and ecologically. People exploit the ecosystem using animals, plants and materials for their own consumption; when cultivation is introduced the ecological character and the landscape change more dramatically.

The main locus of economic and agricultural exploitation of the Bessarabian part of Odessa Province was traditionally on the higher grounds, north of the Danube Delta floodplain. Fifty years ago, the agricultural use of much of the floodplain was restricted to grazing on the higher ridges of land near the rivers and, occasionally, small-scale horticulture on the most fertile parts.

After almost the entire floodplain was embanked in the sixties and seventies of the twentieth century, and the lands behind the dykes were meliorated, the floodplain became available for more intensive agricultural use: essentially for cereals and grazing. Several decades after embankment, it is becoming clear that the absence of the former floods causes salinisation of the soils in many places and this restricts agricultural use.

Restoration of the former flooding regime of the river is an obvious way of bringing back the fertility of soils and lakes and the richness of the ecosystem, but to do so successfully it must fit into the socio-economic context of the region. The context is above all characterised by emergence from the collapse of the former Soviet system.

In this paper the most important economic uses of the land, plants and animals in the floodplain are considered, and ways are suggested for sustainable use of the ecosystem. Sustainable use in this context means that exploitation takes place within the limits of the local ecosystem, and that regrowth of plants and reproduction of animals are sufficient to maintain healthy populations in the landscape.

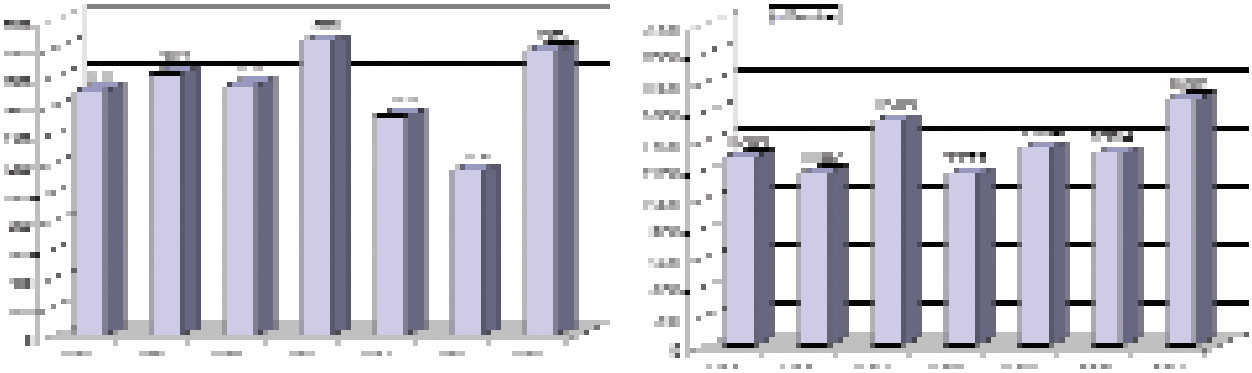


Figure G.1
Volume of water for domestic use taken from the Danube from 1988-2001

USE OF WATER FROM THE DANUBE AND DANUBE LAKES

According to a national report on use of the Danube water, the number of water users in 1986 was 137, and total water uptake was 2,179 million/m^3. From 1987 to 1994 there was an increase of water users to 148-150 but water intake fell from 2,179 to 1,989 million/m^3. Since 1996 it has decreased further to reach 1,692 million/m^3 in 2001. This trend is connected to the reform of agriculture (figure G.1).

Water from the near Danube lakes is used for irrigation, village water supply and the fisheries. For these purposes, average up-take from lake Kagul was from 17 to 12 million/m^3 over the period 1995-1998 and 6.7-5.7 million/m^3 over the period 1997-2001; from lake Yalpug-Kugurluy, 13.7-12.2 million/m^3 over the period 1995-1996 and 7.6-3.9 million/m^3 over the period 1997-2001; from lake Kitay, 22.9 million/m^3 over the period 1995-1996 and 11.4-4.1 million/m^3 over the period 1997-2001; from lake Katlabuh, 22.5-16.9 million/m^3 from 1995-1997 and 15.8-5.3 million/m^3 from 1998-2001.

Lake Yalpug-Kugurluy is a source of drinking water supply for Bolgrad. Over the period 1995-1996, 1.7 million/m^3 was taken for household use; from 1997-2001 this figure was 1.0-1.3 million/m^3.

Economic and land reforms in the neighbouring Danube region has greatly influenced the intensity of economic activity and therefore the use of water from the Danube lakes.

AGRICULTURE IN THE NEAR DANUBE AREA

An indispensable production factor for agriculture, including melioration, is water supply and quality. Water mineralisation has occurred to such an extent that much cannot be used and farmers have had to reduce the area of cultivation. Unsatisfactory water quality has negatively affected the soil condition, its productivity and harvests. Low harvests have, in turn, affected the economic health of the region as a whole, not just the agriculture sector.

We should note that the general volume of agricultural production decreased considerably over the 1999-2000 period. The sharpest decline

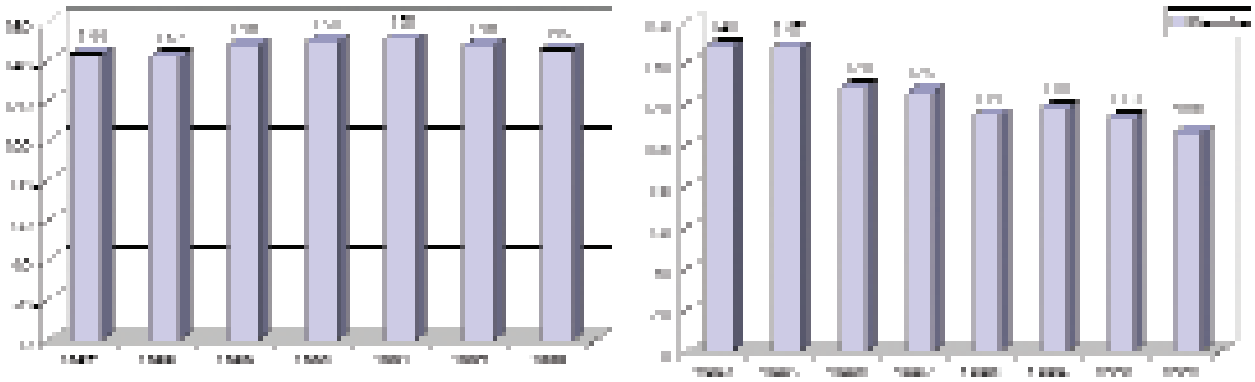


Figure G.2
Number of water consumers over the period 1987-2001

in productivity has been in the livestock sector. This is explained by the protracted reform of the agrarian economy, notably the legislation, as well as unsatisfactory and unstable tax, credit and price policies.

All the same, there has been an increase in production by part-time farmers. As large livestock holdings are not always accompanied by adequate land resources for feed crop production, a principal recourse is to use pastures and grasslands.

The potential for sustainable development of agriculture in the region is considerable. This will require, however, more rational and efficient management of the 'Economy – Nature' balance by using modern, ecologically safe technologies adapted to local conditions, and by developing a processing capacity.

THE CROP STRUCTURE

Agriculture is a traditional activity and a leading economic sector in the Danube area of Ukraine. According to the most recent data (1999-2001) the share of agriculture in the gross domestic product (GDP) of the local economy is:
Izmail district – over 70% (first rank)
Kiliya district – 40% (first rank)
Reni district – about 12% (second rank)
Share of people employed in agriculture over the same period was:
Izmail district – more than 60%
Kiliya district – 17%
Reni district – nearly 11%.

The agriculture in these districts is both intensive and extensive.

Two main difficulties standing in the way of sustainable development of agriculture are its financing, in particular the provision of credit to agricultural producers, and the need to modernise the sector taking into account land-use traditions.

About 60% of the regional land resources belong to agricultural concerns, lower than in other regions of Ukraine because of the significant area occupied by lakes and limans. However, the proportion of arable land

within the total, is the highest in the region, nearly 90%. In comparison with other areas of the region there is a large share of perennial plantations, but a lack of natural foraging land.

The near Danube agricultural region is intensively irrigated; about half of all irrigated land in the Odessa region are here. The greatest concentration is in the Kiliya district, more than 55% out of the total area of agricultural land within which the share of arable is nearly 95%. Orchards, vineyards and pastures are also irrigated.

Irrigation determines the crop structure. In the Danube region more than a half of irrigated areas of vegetables and melons are found as well as over 60% of crops, more than 70% of corn for grains and about 70% of irrigated areas of spring crops, cereals, pulses and all the rice fields in the Odessa region.

The structure of land resources in districts runs as follows:

IZMAIL DISTRICT

the total area of agricultural land is more than 89,000 ha, distributed as follows:

ARABLE: ABOUT 79,000 HA, OF WHICH:
- cereals: 48,000 ha,
- rice: 500 ha,
- industrial crops: 9,000 ha,
- vegetables: 1,600 ha,
- melons: 500 ha,
- forage crops: 10,000 ha;

PERENNIAL PLANTATIONS: 3,653 HA, OF WHICH:
- orchards:1,425 ha,
- vineyards: 2,112 ha;

GRASSLANDS: 1,281 ha;

PASTURES: 4,925 ha.

KILIYA DISTRICT

the total area of agricultural lands is nearly 74,000 ha, distributed as follows:

ARABLE LAND: OVER 66,000 HA, OF WHICH:
- cereals: 36,000 ha,
- rice: 3,100 ha,
- industrial crops: 7,000 ha,
- vegetables: 2,900 ha,
- melons: 200 ha,
- forage crops: 16,000 ha;

PERENNIAL PLANTATIONS: 3,511 HA, OF WHICH:
- orchards: 1,039 ha,
- vineyards: 2,409 ha;

GRASSLANDS: 40 ha;

PASTURES: 3,930 ha.

RENI DISTRICT

the total area of agricultural land is about 42,000 ha, distributed as follows:

ARABLE LANDS: NEAR 34,000 HA OF WHICH:

cereals: 21, 000 ha,
industrial crops: 4,320 ha,
vegetables: 1,000 ha,
melons: 200 ha,
forage crops: 7,000 ha;

PERENNIAL PLANTATIONS: 2,573 HA OF WHICH:

orchards –258 ha,
vineyards – 2,225 ha;

PASTURES: 4,970 ha

FALLOW: 173 ha

It should be noted, that the region produces nearly 25,000 tons of rice, i.e. practically all the rice in this area. The region is also characterized by well-developed market gardening and its share of vegetable production in the Odessa region reaches 20%.

In plant breeding, cereal and pulse production the region is in the lead. Among cereals, spring crops, corn for grain and barley growing are of considerable volume.

Vegetable farming includes the production of tomatoes, peppers, egg-plants and peas amongst others.

Viticulture contributes a considerable proportion of the goods structure although it is less important than in more northerly regions.

THE LIVESTOCK SECTOR

Livestock farming is a traditional branch of agriculture, although a decrease in production as a consequence of the crisis in the sector should be noted.
Milk and meat cattle-breeding was the most important activity accounting for 23% -33% of the total value of livestock production. Pig breeding was also important with a share (for example in the Reni district) of up to 16% of livestock production. Sheep and poultry were also present.

At present the situation is as follows:

IZMAIL DISTRICT:
cattle: 13,000 head, of which cows 5,400;
pigs: 32,500; sheep and goats: 35,600;
poultry: 520,000.

KILIYA DISTRICT:
cattle: 19,000 head, of which cows 8,100 head;
pigs: 30,200; sheep and goats: 31,700;
poultry: nearly 311,000.

RENI DISTRICT:
cattle: 6,700 head, of which cows 3,300 head;
pigs: 9,100; sheep and goats: 29,600;
poultry: over 275,000.

BASIC INDICES OF LIVESTOCK PRODUCTION

The average milk yield per cow is nearly 2,500 l in the Izmail district; 1,400 in Kiliya and 1,500 in Reni, while the average for the Odessa region is 1,750 litres.

Production of eggs per hen for recent years is 80-120 in Izmail, 60-80 in Kiliya and 50-60 in Reni.

Meat production on 100 ha per year is between 18-24 centers in the Izmail district, 18-27 in Kiliya and, 13-20 in Reni, while the average for the Odessa region is 11-15 centers

Milk production per 100 ha per year is over 60 centers in the Izmail district, more than 85 in Kiliya and over 50 in Reni, while the average for the Odessa region is 72 centers.

In should be noted that over the period 1999-2000 there was a sharp decrease of productivity in the livestock sector.

GRAZING

This traditional activity, using renewable resources in the Delta, has some specific features. Cattle-breeding and, over the last few decades, horse-breeding is typical. Pig grazing, which is so typical in Romania, is quite limited in Ukraine. Keeping goats and sheep is found only in Delta areas bordering the continental plateau and is small scale.

Cattle- and horse-breeding in the Delta, except on Ermakov island, has traditionally been a private enterprise. Its peculiarity is an absence of large farms so typical of the adjacent steppe regions.

The main feature of Delta animal husbandry is year-round outdoor grazing. Combined indoor/outdoor methods may however be found near to towns and villages.

In recent decades in the coastal parts of the Delta, the numbers of cattle free-grazing all year round has reached 500. Unfortunately, however, there is a move to reduce the numbers especially in places adjacent to continental areas. This is because of protection problems. A combination of free-grazing and stabling caused high rates of reversion to a wild state, especially on the most inland littoral ridges of the Delta. A specific herd of cattle is forming the individuals of which are very wary of humans, have developed dense long hair and are gradually reverting to a feral state. This bi-product of local husbandry is very valuable for nature conservation; cows are virtually substituting for large wild herbivores and the important ecological functions they used to perform.

In socio-economic terms seasonal grazing of the cattle in the Delta is of more importance. The capacity of the land in the Delta is estimated at several thousand head on the assumption that the ecologically sustainable density is 2 head per hectare on riverine ridges, and 1 head per 2 hectares on sandy areas.

Grazing can be an important feature of ecologically and economically sustainable local development. Where there is no grazing on the riverine ridges they are rapidly overgrown by reed, losing a considerable portion of their biological diversity in the process.

NATURAL RESOURCE USE

REED HARVESTING

Taking into consideration the vast extent of the reedbeds and increased demand for reed on the European market, reed harvesting is suggested as one of the most important future components of sustainable use of the Delta resources. Moreover periodical exemption of mosaics of the annual increment of biomass in light of widespread eutrophication, is also useful for nature conservation purposes.

Reed harvesting in the Danube Delta has a long tradition. The quality of the harvested reed and its use have changed over time but, in general, there are two principal destinations: local use and commercial use.

Locally, the reed was used for two different purposes: the green reed was gathered in summer as fodder for domestic animals and, in winter, the dead stalks were stored for building and fuel.

Harvesting of green reed for fattening of cattle is not widely practised and is mostly restricted to Vilkovo residents. For this purpose low reed growth, of short stalks with an admixture of other grassy vegetation is used.

In the near Danube regions up to the middle of the last century, reed was the first choice of fuel. The majority of the harvest was thus stored. Reed of varying quality was used, but high growth with thick stalks was preferred. This use has all but died out now. An economic assessment has shown that even with grant support of US$ 100,000 it would be impossible to efficiently produce household fuel briquettes made of reed stock.

Traditionally reed was also used as a wall and roofing material in the region but this practice was mostly lost by the 1960s as other relatively cheap, synthetic roofing materials appeared. However, taking into account both the increasing popularity of reed roofs in Europe and a developing tourism sector in the region, their reappearance in the region could be expected over the next few decades.

For wall and ceiling construction in private buildings, reed is still quite widely used even now. It is especially popular in this regard in Vilkovo.

Turning to the commercial sector, reed was used as a raw material for the paper-cellulose industry, for warming slabs and in recent years for export as a natural building material. Commercial harvesting of reed reached its largest scale for cellulose production, for which a factory was built in Izmail. In the 1960s reed was harvested over an area of about 18,000 ha (Salnikov, 1967) but it was soon found to be unprofitable partly because

the reed resources were destroyed by unskilled management and the quality of the reed quickly became unacceptable.

Local forest economies were involved in the production of warming slabs. The volume of this trade on the Danube was never competitive with that on the Dniester delta. Nowadays this use of reed has practically disappeared.

It is suggested that the most promising avenue in terms of sustainable use of renewable natural resources is reed harvesting for export as a roofing material. A high and steadily increasing demand on the European market, a favourable pricing policy and high levels of unemployment in the region have assisted rapid development in that direction since 1998. According to expert estimates, during the winter of 2001-2002, about 450,000 sheaves representing 3-4% of the European market were harvested from an area of about 1,200 ha.

For roofing purposes, only reed of low height and strong thin stalks is suitable. The share of this kind of reed growth out of the total is relatively small but this is offset by the high quality of the reed from the Ukrainian part of the Danube Delta.

The socio-economic aspects of reed harvesting are particularly sensitive under the present conditions of high unemployment in the region. Thus, during the winter of 2001-2002 nearly 950 people worked in this sector in Vilkovo and adjacent villages. For Vilkovo, this equals total employment numbers in all other spheres of activity.

With regard to the vast quantities of high reed with thick stalks which are not suitable as roofing material, they could be promoted as decorative building material. In this light it is advisable not only to harvest this reed type, but also to process it thereby greatly increasing employment opportunities.

HARVESTING OF MEDICINAL HERBS

In the late 1980s, harvesting of medicinal herbs was taken over by the Ukrainian Cooperative Union (UkrCoopUnion). Common species such as *Polygonum hydropiper, Bidens tripartita, Artemisia absinthium, Achillea millefolium,* etc. were harvested. According to the UkrCoopUnion, the raw volume harvested was 0.5 – 1.5 tons for every species. Over the last few decades these have fallen sharply.

Gathering of medicinal herbs benefits from the availability of large volumes and a wide choice. There is an abundance of medicinal flora in the Danube Delta and valley, including more than 25% of the total vegetation (950 species of higher plants). More than half is used in folk medicine, up to 30% in conventional medicine and nearly 25% in homeopathy.

There is extensive knowledge about the use of medicinal herbs which has been refined over several centuries and includes contributions from folk healers of different cultural traditions living along the banks of the

Danube. Unfortunately, this knowledge has not been studied until recently and is rapidly being lost.

Analysis shows that among the harvested herbs, species connected with the treatment of diseases linked to the main occupations of the population dominate (fishing, navigation, land development). Local people harvest more than a hundred plant species, principally *Mentha aquatica, Rubus caesisus, Hippophae rhamnoides* (fruits and leaves), *Bidens tripartita, Equisetum arvense, Helychrisum arenarium, Plantago major, Polygonum aviculare, Potentilla anserina, Tanacetum vulgare, Viola arvensis*.

Regional phytotherapeutic specialties also seem to exist. This is suggested by the sale in local markets of large amounts of some medicinal herbs which are absent or rarely mentioned in reference books on folk medicine. For instance: *Myosoton aquaticus* (to treat lung diseases), *Errigeron canadensis* (stomach upset), *Thlaspi arvense* (anaesthetic for tooth ache), *Lycopus europaeus* (thyroid diseases), *Lysimachia vulgaris* (women's diseases) and many others.

Lately there has been wide distribution of plants used as tea substitutes (*Mentha aquatica*, *Rubus caesius, Lamium purpureum* and many others).

Medicinal herb harvesting does not currently have a major impact on the stock of medicinal flora. At the same time, as there is a trend towards expansion, questions should be asked about rational use and conservation of the resource. This means the creation of reserve areas in which replenishment and conservation of the stock is the main objective.

MARKET GARDENING

This kind of land use is widespread in the Ukrainian countryside as a whole as well as in the Danube Delta. Market gardening is traditionally developed on smallholdings. The size of them in the region is from several hundred metres to one hectare, the majority being given over to orchards and vegetables. These smallholdings characterise the typical landscape of rural areas. Such gardening is non-commercial and mostly for the subsistence needs of families. However, up to one quarter of the produce, especially in the villages with large land plots, is sold.

Considering sustainable use of the Delta resources, market gardening that takes place outside the populated areas and directly in the Delta, is of more interest. It is most typical in the upper parts of islands in the secondary delta of the Kiliysky branch.

Garden plots of the secondary delta are found on the riverine ridges of the numerous islands, chiefly concentrated close to Vilkovo to reduce transport costs. Plots are a system of beds made after excavations from canals, cut perpendicularly to the bank. The width of the beds is from 5 to 20m. The height and fertility of the plots are supported by silt deposition during flooding. Garden plots of this type create a typical landscape on the river banks of the upper parts of the secondary delta islands. They are

rather attractive for certain biota especially as mineral fertilizers are not used so the land use is more or less organic. However, a significant problem is intensive use of pesticides for apples.

Gardening on the islands is chiefly commercial. Over recent years, as a result of industrial decline and an increase in unemployment, it has been attracting a larger and increasing proportion of the local population.

Amongst the principal products, there is the renowned Vilkovo 'Novak' grape variety which is adapted to wet soils, apples and strawberries. Chemical methods of pest control are not used for grapes and strawberries.

The future for market gardening is quite promising economically especially if the local production is directed at a wider market, and is of particular importance to the sustainable use of the Delta resources.

APICULTURE

Apiculture is practised by the local population but large industrial apiaries have never been established in the Delta area itself. The main reason is the changeable foraging base for the bees and low nectar productivity of the plavni, the main type of land in the region.

A peculiarity of the Delta in terms of apiculture is a plentiful supply of nectar in the spring and autumn but very poor supply during the whole summer season. It is therefore practically impossible to develop an economically viable bee-keeping industry all year round. However, the apiculture capacity of the Delta in autumn is really prodigious. It is especially interesting in light of the almost total absence of a foraging base for the bees in adjacent areas in that season. A great number of hives are brought to the Delta in the autumn season and the numbers of bees exceeds that of the local bee population several times.

There are no exact statistics regarding apiculture in the Danube region but there is no doubt that the number of hives belonging to the local population in the Delta and in nearby towns and villages, is at present in the several thousands. As for nearly all activities in the private sector in Ukraine, it is growing steadily.

As the apiculture capacity of the Delta in autumn is about 15,000 bee hives, a reasonable approach to income-generation for local people would be to charge fees for hosting hives from elsewhere.

FORESTRY

Forestry was not established in the Delta until the middle of the 1950s. That is why the region has no vast plantations, and riverine forests which occupy only a small area

It is possible that wood was cut for household needs in the past. According to old people in Vilkovo, at the end of the 19th century it was compulsory for every household to plant a certain number of willows in the locality. We do not know the size and locations of these plantations.

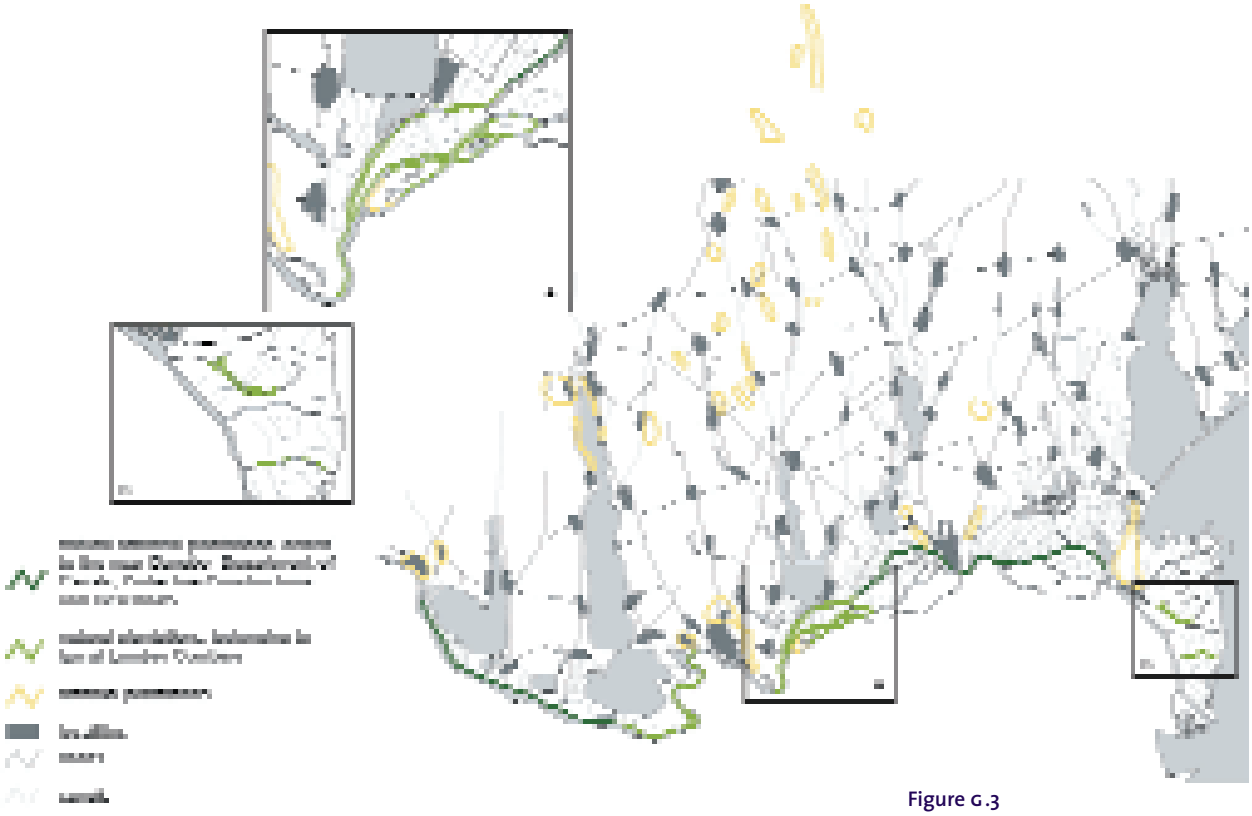


Figure G.3
Distribution scheme of arboreal plantations of Izmail Lumber Combine

In order to develop forestry in the near Danube area, the Izmail Lumber Combine was established in 1952. By January 1, 2001 it united 5 forest enterprises with an overall forest area of 23,260 ha (table 1). Total stock of wood is 539,980 m^3.

Natural woodland (riverine forests) occupied only 527.5 ha, while 5,700 ha of forests were planted after the creation of the Lumber Combine (figure G.3). Principal species in plantations are species of Poplar genus *Populus,* as well as *Pinus pallasiana, Robinia pseudoacacia, Gleditsia triacanthos, Quercus robur, Fraxinus lanceolata* (ash). Attempts were made to acclimatise the latter species, of North American origin, in riverine forests for commercial timber. Even though conditions were suitable there was no harvest because the wood is damaged by *Cossus cossus* when the tree is young and it becomes unfit for manufacturing use. However, ash has become entrenched in riverine coenoses and is even displacing indigenous species (*Salix alba*, etc.) making it necessary to replant constantly with natural species.
According to staff of the Lumber Combine (there are no historical records at the Combine), the main plantations on riverine forests were on Tataru island at the end of the 1960s and beginning of the 1970s. On other areas of riverine forest plantations were not attempted.

Figure G.4
Traces of cutting in the flooded forest on Ermakov island

Over the last 10 years, the main forestry activity has been clearing and cutting. (figure G.4) According to the data of the Izmail Lumber Combine, in 2001 the volume cut per principal species was the following:

Robinia pseudoacacia : 937 m^3
Populus : 670.7 m^3
Salix : 243.4 m^3
Pinus pallasiana: 189 m^3
In 2000 the total volume cut was 3,633 m^3 including wood materials (374 m^3), wood for industrial needs (137 m^3) and firewood (2,852 m^3).

HUNTING AND TRAPPING

There are more than 30,000 hunters in the Odessa region. Preferred game is waterfowl (teal c.18%; coot c.14%; mallard c.10%) and field species of which the European hare (annual capture of 27-33,000) and fox (700 to 2,600) are of most significance. In the 1970s organisations for hunting Roe deer and Wild boar formed; the numbers taken of the latter reached its maximum of 309 individuals in 1989. The gathering of crabs and frogs is not registered so the real size of the harvest is not known.

The near Danube area is the most important region for hunting where duck, geese, doves, pheasant, European hare and Wild boar are especially popular. Although there are only a small number of hunters resident in Kiliya, Izmail and Reni districts (about 1500), 12-15,000 people hunt there each year. In 1975 the average take per hunter was some 20.5 individuals/species?? of game bird but now this diversity has decreased to 10-12 birds.

Game bird hunting takes place on three days a week (Saturday, Sunday and Wednesday) and traditionally opens between August 12-15. For pheasant and partridge the hunting season is from October 1 to December 31. Goose hunting continues until February 1. Hare and fox hunting are from between 9-15 November every Saturday and Sunday until January 31. In the near Danube area, therefore, each hunter can hunt over 60-70 days for birds and 20-26 days for hare and fox. The average catch per year is 1.2-3.5 hares (average weight of 3.6 kg). In recent years a hunter has been permitted to take 10 doves, 6-10 ducks, 2 geese and one hare a day.

For many people, hunting has become an expensive activity because of the increased price of ammunition (one cartridge costs 1-1.2 grivnas, for expensive guns it is 5 grivnas), guns (a new one costs from grivnas 750) and other items (travelling expenses, accommodation, permits). The cost of a day's permit to shoot doves, issued by the Club of Hunters and Anglers of the near Danube area in the Odessa region, was 6 grivnas in 1999. Country residents fired not less than 200 rounds a year, while the city hunters fired 500 and over.

Muskrat trapping is of particular importance in the region. The quota is fixed according to water levels and their seasonal dynamics. The maximum annual quota reached in the best areas (Stensovsko-Zhebriyansky plavni), is two thousand. This is the maximum appropriate harvest on the basis of the current population of 3,000 individuals. Thus trapping of rare species is inevitable (European mink, otter, European wild cat and many bird species) and it is desirable to limit or even prohibit the use of traps in conformity with the Bern Convention (1979). The most efficient method in the near Danube area is to use snares to catch the game alive.

The region is a wintering ground for waterfowl and the length of the hunting season for them cannot be justified. It is therefore recommended that the number of hunting days be reduced by deferring the start of the hunting season until the first days of December, in particular because in August the nestlings are not yet fledged. Hunting of hare should be limited only to Sundays and should be finished on December 31 because the quotas on these animals exceeds their annual reproduction rate, and is reducing the size of the population. Hares have a breeding period in January so the hunt obstructs normal reproduction.

Population Management
Another approach to the regulation of animal populations has to be developed in the model sites.
For animals that are already present in the floodplain, the population can be allowed to grow to the number that will provoke dispersion out of the area by natural migration. The point at which this situation occurs is unknown. Experimentation is the only way to find out how many Roe deer, fallow dear and Wild boar can be supported in the landscape. For Roe deer and fallow deer this almost certainly means a density of many times the present population. The impact on the landscape will be far greater than it is now.

For most reintroductions, for example Red deer, the same experimental approach towards the number of animals is appropriate. For moose and Bison population management is different in that they can only live in restricted areas; numbers will have to be managed. The same applies for wild horses and wild cattle.

Traditional hunting methods cause considerable disturbance so the animals develop wary behaviour and avoid people. New techniques must therefore be applied and management plans developed that should, nevertheless, take into account local trapping and hunting traditions.

FISHING AND FISH-BREEDING

Spawning and conservation of spawning grounds

After the embankment of 30,000 ha of the floodplain over the period 1955-1960, where the fish mostly spawned, catches of Carp decreased from a yearly average of 378 tons in the period 1951-1960, to 30 tons in the period 1960-1970, and have not recovered since.

The development of aquatic vegetation in lakes, which is a fish spawning habitat, was negatively affected by the artificially regulated water regime, inflow of muddy Danube water through canals, eutrophication, water pollution and mass introduction of the Grass carp *Clenopharyngodon idella*.

After the introduction of Silver carp *Hypophthalmichthys molitrix Valenciennes* and *Aristichthys nibilis* was halted for economic reasons, indigenous fish species once again composed the basis of the catch. As a consequence, it became necessary to collect data on natural spawning grounds again.

Migration

Regular and reliable migrations are known only for Sturgeon species and the Danube herring. For the first group, migrations are of a double character.

The Sterlet (*Acipenser nudiventris Lovetzky*) was not numerous in the Danube Delta, and since 1964 it has not been registered in commercial statistics. However, among total juvenile catches of Sturgeons the share of the Sterlet was up to 70% in some periods. The juvenile fish of this species never goes far out to sea and, after fattening on the rich feeding base of the Outer Delta, it migrates back up the Danube.

Migration of adult Sturgeons is now limited by the Dzherdapv (Iron Gates) dam (at the 964th km of the Danube). In the area upstream of the dam, Serbia continues to intensively fish the Huso which is included in the Red Data Book of Ukraine. The juvenile fish of the huso (*Huso huso*), as well as of the Russian sturgeon (*Acipenser guldenstadti colchicus*) and the starred sturgeon (*Acipenser stellatus Pallas*) pass through the Danube to the Black Sea, where they fatten to the age of maturity. Unfortunately, Yugoslavia has not been able to investigate the spawning grounds of Sturgeon until very recently.

The region of Herring (*Alosa kessleri pontica*) spawning changes according to environmental conditions, water temperature, and the structure of the spawning school, and takes place at between 400-700 km upstream of the Danube mouth. On Ukrainian territory, occasional catches in the embryo phase have been of solitary individuals. After the downstream migration and a further three years of maturation, Herring again migrate upstream to the Danube and are fished there. A small proportion of individuals (usually 15-20%, but in recent years up to 60%) of four-year-olds are caught (individuals of 5-6 years old are rarely observed). This means that Herring remain alive after the first spawning and breed twice.

The Danube salmon (*Hucho hucho*) and the Eel (*Anguilla anguilla*) also migrate to the Delta from the middle Danube. Their role in the Danube Delta ecology and in the commercial catch is insignificant (the Danube salmon is included in the European Red List).

Certain upstream migrations for tens and even hundreds of kilometres from the coast, are undertaken by such commercial species as Carp *Cyprinus carpio*, Crucian *Carassius auratus gibelio*, Bream *Abramis brama*, *Lucioperca lucioperca*, Catfish *Silurus glanis*, *Vimba vimba*, and even introduced species such as *Hypophtalmichthys molitrix* and *Aristichthys nobilis,* and the Grass carp *Ctenopharingodon idella*. Research into migration has been preliminary and small scale; no significant recoveries of tagged fish have been achieved so it is not yet possible to provide reliable information about migration of fish species between the middle and low Danube.

Commercial fisheries
The Kiliya delta is the most important fishing ground in the region. The majority of Danube herring, almost all Sturgeons *Acipenseridae* and up to 70% of other fish are harvested there. For the last decade (1992-2001) herring continued to dominate the catch with a share of 58.4%, although the mean catch in that period was equal to 191 tons, showing a twofold decrease. However, it should be noted that commercial statistics no longer record the majority of the catch.

Acipenseridae (the Russian and Starred sturgeons) was caught only for research reasons over the last few years (it did not exceed 1 ton per year) but in reality poaching accounts for much greater volumes.

During the last three decades about 60% of the total catch of other commercial species was stable and composed of the Crucian *Carassicus auratus gibelio*, while the share of introduced species such as Grey mullet *Mugil so-iuy* and Silver carp have increased. At the same time nurse runs??? of the most valuable ordinary species such as Carp *Cyprinus caprio*, Sheat-fish *Silurus gianis Linne*, Luce *Exos lucius Linne* and Zander *Stinostedion lucioperca* are overexploited. The basis for the trade is 2 or 3 generations, and frequently it supports on first spawning individuals of these species as usual of three years old.

The total number of fishermen in the region is almost 1,100, however, taking into account fish-processing and other services there are about 5,000 people employed in the industry. If illegal and sport fishing are added, the economic significance of this branch for the local population is hard to overestimate.

Detailed investigation of the fish feeding base shows that for the last five decades there has been no decrease. The main reasons for the decline of the catch is bad regulation, poaching and an almost complete halt to improvements.

On the near Danube lakes, Crucian *Carassicus auratus gibelio* and Bream *Abramis brama* clearly dominate in the catch. Lake fishery has great potential and lakes Katlabuh, Safyany and Kitay are designated as STF – Special Trade Fisheries. Fish capacity in these lakes in years with mass seeding of Carp *Cyprinus carpio*, Silver carp *Hypophthalmichthys molitrix Valenciennes* and *Aristichthys nibilis* was stable and equal to 100 – 120 kg/ha, while that in Safyany was frequently more than 300 kg/ha.

Even in years with relatively high seeding, only 20-40% of the rich foraging base of these lakes was used. This implies that productivity was not as high as it could have been in those years. Now the catch has decreased by half, and the total harvest (including indigenous species) has decreased by 3-4 times.

Fishpond operations in the region have practically disappeared. Ponds created in the Soviet period consume large amounts of energy to pump water into them and are unprofitable. In some of them (for example in the Chapaev fish farm in Reni district) there are attempts to breed fish on the natural feeding base without food supplements but this is also failing. There are large arrears in payment of electricity costs. Detailed estimates show that one kilogramme of pond fish costs seven times more than that of lake-bred fish.

The strategy of the regional fishery favours nursery ponds and seeding lakes. In some places (for example the fish farm in Vilkovo), even these ponds have not been functioning for the last four years. As these territories are not suitable for agriculture because of soil alkalinity, and pumping stations, dams and roads are dilapidated, revitalisation of former economic activities is almost impossible.

From our point of view, it would be more expedient to restore these thousands of hectares of former plavni and return them to nature.

Organization of fisheries in the near Danube region as well as in Ukraine as a whole is very far from satisfactory.

Suggestions for improvement of fishing and the fishery in the Delta
Over the last few years a sharp increase in the number of fishery companies has been observed in the Kiliya delta. For several decades only one fish farm in Vilkovo operated there. In 1995 three companies appeared, in 2001 there were 9 and in 2002 there are 17. Under these conditions it

is hard to control the catch and there are a high number of illegal nets. The former careful monitoring and nurturing of the fish stock has turned into a race for short-term profit by any means.

To solve this problem fishermen should be given ownership of the tools of their trade. Like farmers, a fisherman needs to feel personally responsible for his own future, controlling bait, fighting against poaching, and so on. The fishery companies do not give any equipment to their fishermen; they do not receive boats and nets or fuel, only the fishing licence. A fisherman must spend much of his own money to organize his catch. In practice, the companies have become intermediaries between the State Fishery Committee, from where they obtain the fishing quota, and the fishermen.

There is no doubt that such a system cannot function because, to make ends meet, a fisherman has to conceal a part of his catch. In order to do that he must give a part of his 'concealed' harvest to the controlling structures. Thus there is a 'black market' and as a result a poor local fishery economy.

Implementation of a licence trading system in the Danube Delta is urgent
The licence is in fact a fixed tax on the commercial fish catch. By obtaining a licence, a fisherman becomes the owner of his harvest, free to sell at a reasonable price, and therefore no longer needs to steal.

A licensing system would increase contributions to the local public budget as the 'black market' is liquidated; accurate catch statistics would provide an opportunity to organise rational use of the fish stock, and the proceeds from licensing would make it possible to improve the ecological health of the water bodies.

RECREATION AND TOURISM

One of the most common ways of obtaining benefits from natural areas is development of all kinds of tourism. WWF supports forms of tourism which do not harm but support conservation and also provide direct economic benefits to local communities (the generic term usually applied is 'ecotourism').

What kind of ecotourism product does the Ukraine Danube Delta offer and what must be done to exploit and improve it?

The near Danube area is characterized by: a considerable diversity of flora and fauna, some of which is endemic; the intermingling of land, river and sea; a complex geological history, and a rich social, economic and cultural identity developed by people with different ethnocultural traditions.

There are already 15 designated natural reserves of different categories in the region (figure G.8). Amongst them there are two of national importance (the Danube Biosphere Reserve and the zoological natural reserve on Zmeiny island), 12 reserves of local importance and one regional landscape park (Izmailsky islands). Apart from those, Kugurluy and Kartal

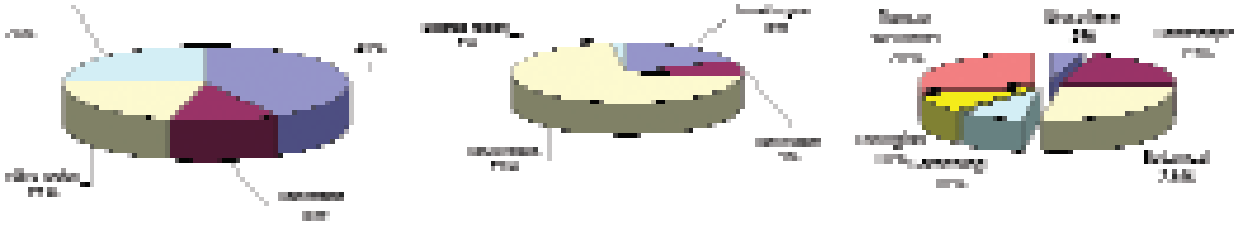


Figure G.8
Nature reserves are the basis for development of ecotourism:
- Distribution of number of natural reserves in the near Danube regions
- Distribution by area of natural reserves in the near Danube regions
- Types of nature reserves

lakes and the Kiliyskoe channel are included in the Ramsar list of Wetlands of International Importance. In 1994 some territories of the near Danube area (upper and low reaches of lake Kugurluy, lake Kartal, upper and lower reaches of lake Yalpug, lake Kugurluy, Nekrasovsko-Bogatyansky plavni and the Danube channel islands of Bolshoy and Maly Daller, and Tataru) were included in the natural reserve fund. The largest number of reserves are in Izmail district (figure G.9), but the total area of protected territory is largest in the Kiliya district (figure G.10).

The presence of such a number of natural areas undoubtedly creates a significant natural infrastructure on which to develop ecotourism in the region.
At present, the following tourist/recreation activities are pursued in the Delta area:
- physical activities - health
- motor touring - cognitive
- architectural - historical
- educational tourism (field training, educational excursions)
- field sports (hunting, fishing)

Activities that could be envisaged for the future may include:

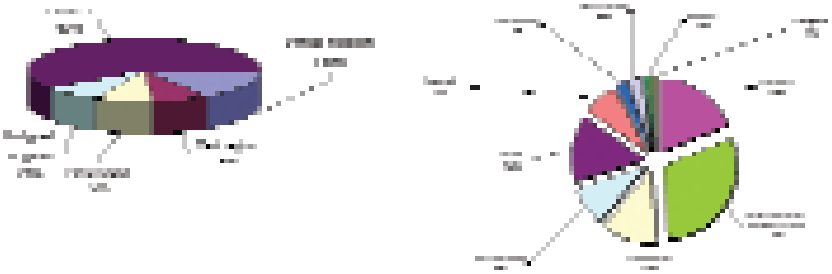
SPORT TOURISM
- cycling
- horse-riding
- fishing

EDUCATIONAL TOURISM
- war history
- ethnographical
- religious

SCIENTIFIC TOURISM
- conferences, workshops, meetings, training courses, etc.

RURAL (GREEN) TOURISM
- sea/coastal and rural health stays
- farm/country tourism

WORKING HOLIDAYS AND LOCAL CRAFTS
- harvesting of medicinal herbs, nuts, fruits and berries
- farm tourism (integration of holiday and harvesting of grapes, fruits and vegetables, haymaking, etc.)
- food and wine tasting



LEFT Figure G.9
NGOs of the near Danube area as a determining factor for public opinion
- distribution of NGOs by region
- NGOs distribution according to interests of their members

RIGHT Figure G.10
Organisations and individuals: partners of WWF Odessa Office in Ukraine

However, the local population's poor awareness of the natural values of their region has prevented an enthusiastic attitude toward ecotourism. This is being addressed by providing information about the value of nature and local species and their conservation, as well as about alternative sources of income and employment. The channels through which this information is being communicated include the staff of the Danube Biosphere Reserve, local print media, radio and TV, and citizens organizations for nature conservation.
According to the WWF Odessa Project Office there are 25 NGOs (non-governmental organizations) active in the region (figure). The influence of these organizations in forming public opinion and ecological awareness is considerable but not sufficient. Their activity is mainly directed towards raising the ecological awareness of schoolchildren and youth. Only a small number of NGOs attempt to address adults. (figure). The greatest number of NGOs are concentrated in Odessa and Izmail.

The WWF Odessa Project Office in Ukraine assists all governmental and public structures in the region to distribute ecological knowledge. Together with the Danube Biosphere Reserve and public organizations and with the support of the EU Tacis programme, special leaflets on development of ecotourism in the near Danube area, the ecological role and use of reed, the value of natural resources, the economic benefits for the local population from wise and rational use of nature were published.

The attitudes of the local population are divided. On the one hand, there are those people who have lived in the area for a long time and who have actively exploited the natural resources through 'soft' management: construction of new and dredging of old channels, winter burn of the reed. On the other hand, during the years of Soviet power an attitude of maximum consumption of natural resources was introduced through which taking but giving nothing in return was the norm.

Wetland resources are still assumed to be inexhaustible and a majority of the population is interested in getting an immediate benefit, mainly from fishing, with little concern for the future. However, the opportunities for developing ecotourism have improved recently through, in particular, the increasing number of interested NGOs, and the great interest shown by both local and foreign businessmen and investors.

An important objective is for the tourism product to develop out of existing activities such as agriculture and fisheries. In our view, the following

products have economic potential and the local population may feel able to establish small businesses to produce them:

- Typical national food and drink products made from local resources (e.g. grapes, *Hippophaë L.,* honey, pepper, strawberry);
- Herbal teas, spices, extracts;
- Various souvenirs made of wood, dry herbs, collections of herbs, wood engraving ... ;
- Renewal of crafts taking into account the variety of different traditions found in the Delta region including articles made of leather, felt, wool, iron, casks, horse harnesses, ceramics.

Besides the above, the local population, organizations and associations should be able to levy fees for visiting reserves, using natural resources, tourism and hotel services, taking pictures or using video and movie cameras.

The current level of local ecological and commercial awareness with regard to the opportunities described above is insufficient. Together with traditional forms of working with the public (organization of thematic routes, publication of thematic guides, booklets, postcards, distribution of souvenirs), it is necessary to expand the on-going educational work with the local communities through training courses and discussions about the concepts and practice of nature conservation in the Delta area, and also about the economic benefits from the wise use of nature.

SHIPPING

The effective functioning of water transport is a factor in the sustainable development of the Ukrainian Danube Delta. Shipping is a key branch of the regional economy, represented by the following organisations:

THE SHIP-OWNERS: the Ukrainian Danube Steamship Line;
THE PORTS: Reni, Izmail, Ust-Dunaisk, Kiliya;
THE REPAIR YARDS: Kiliya and Izmail.

It should be noted that the total capacity the Ukrainian Danube Steamship Line is not used at the moment and this is having serious socio-economic impacts which, in their turn, affect ecological and nature conservation activities.
The operations and profitability of the Steamship Line and of the Delta ports were dramatically affected by the war in Yugoslavia and the destruction of the Danube bridges. There has been a general decline in cargo volume and demand for the services of the Steamship Line.

At the beginning of 1990s, the Steamship Line was one of the largest shipping companies on the Danube (and still remains so in spite of the disruption of shipping in the river). The overall number of employees at that time exceeded 25,000. Total traffic volume of the regional ports was on average about 20 million tons a year, chiefly cross-frontier operations (export-import, trans-shipment, and servicing of transit cargoes). The Steamship Line transported an average of 10-12 million tons a year.
A significant share was taken by cargoes of foreign hauliers. In general, the Danube fleet specializes in trans-shipment, working in the past with

a large number of small loads formed in Hungary, Slovakia, Austria and Yugoslavia and then transited by river and sea to, *inter alia*, Tunis, Egypt and South Korea. During the embargo on trade with Yugoslavia and then the war, the Delta region suffered great economic losses and traditional traffic was re-routed.

The data on goods traffic passing through the ports of Izmail and Reni illustrate the decline; volumes were 4,414 million and 2,889 million tons respectively in 1998, compared with 2,873 million and 1,622.1 million tons in 1999. The decrease of traffic was 35% and 44%. Traffic decrease in Ust-Dunaisk port was 35% over that period.

Further difficulties standing in the way of development of riverine goods transport in the region include:

- uncertainty with regard to Ukraine's exit into the Danube and to the Black Sea;
- isolation of the town and port of Reni from land transport routes.

For the first problem to be solved a shipping route, taking into account the impact on the ecosystem and Danube Biosphere Reserve, will need to be studied and agreed.

To solve the second problem, the construction of a section of railway between Reni and Dzenilor is proposed as well as other measures. One barrier to a more economically successful operation of Reni's transport sector, is the high tariffs imposed on the Moldavian section; ways must be found to solve this problem.

The reduction in welfare provoked by the decline in the transport sector has caused expansion of the black economy which is not always ecologically friendly.

Taking into consideration the transport-communication vocation of this territory and at the same time its ecological uniqueness, the aim should be to balance economic (namely shipping) and ecological activity.

With that in mind, the most promising direction for maintenance of riverine transport is transborder (frontier) co-operation, especially between the three countries bordering the lower Danube: Ukraine, Moldavia and Romania. In this direction there are plans to develop an international passenger ferry between Reni and Galats (Romania), and between Izmail and Tulcha (Romania).

The Ukrainian transport complex in the Delta area, particularly shipping, will continue to be a leading economic sector taking into account new ancillary activities, for example tourism and recreation.

ANNEX H

Land legislation: categories, ownership and use

During implementation of the principal Vision actions, that is, restoration of ecosystems and of natural processes on model sites, Ukrainian laws regardingland ownership use and categories will be applied.

Under the new economic arrangements in Ukraine land has become a specific economic resource. Owners and land users have begun changing their attitude toward more principal while Ukrainian law is still developing. This will cause certain peculiarities in realising the Vision in the Ukrainian part of the Danube Delta.

The main categories of land in the Delta as well as the most important Laws and Statutes regulating its use are listed below. The main normative document regulating all the land policy in the country is the Land Code of Ukraine of 25 October 2001, no. 2768-III.

A LANDS OF THE WATER FUND

1 CATEGORIES

Water Fund land includes land covered by:

- seas, rivers, lakes, reservoirs, other water bodies, marshes and islands;
- coastal protective belts along seas, rivers and water bodies;
- hydrotechnical and other constructions relating to the water economy, canals and land strips dedicated to their functioning;
- coastal zones of waterways.

2 LAWS AND REGULATIONS DETERMINING STATUS AND REGULATING USE

- Land Code of Ukraine
- Water Code of Ukraine, 20 December 2001, no. 2905-III

1 OWNERSHIP AND USE

Water Fund land can be state, communal or private property.
Land can be transferred to specialised water enterprises and other institutions for constant use as long as the specialised activity does not change.
Coastal protective belts, allocation strips and coastal zones of waterways can be temporarily transferred inagreement with constant users.
Articles 87-93 and 96-105 of this Law regulate the use of Water Fund land.

Closed natural water bodies with an area of up to 3 ha can be transferred to citizens of Ukraine and juridical persons free of charge in agreement with governmental water institutions.
Water Fund land can be rented to citizens of Ukraine and juridical persons. This includes coastal protective belts, allocation strips, coastal zones of waterways, lakes, reservoirs, other water bodies, marshes and islands for haymaking, land for the needs of fisheries and for scientific research.

B LANDS OF THE FOREST FUND

3 CATEGORIES

Forest Fund land includes land covered by forest vegetation and non-forested land which is designated and used for forestry needs.

4 LAWS AND REGULATIONS DETERMINING STATUS AND REGULATING USE

Land Code of Ukraine
Forest Code of Ukraine of 20 December 2001, no. 2905-III

3 OWNERSHIP AND USE

Forest Fund land can be state, communal or private property.

It can be transferred to specialised state or communal forestry enterprises for constant use and can be rented to other enterprises and institutions. The duration of leases is for up to 50 years.

In agreement with constant forest users, lands of the Forest Fund can be temporarily transferred to institutions and organisations, citizens of Ukraine and foreign juridical persons in order to fulfil approved activities, including scientific research. Temporary use of Forest Fund land can be short term, up to 3 years, or long term, from 3 to 25 years.

Transformation of forest land into non-forested and other types of land in the pursuit of an approved activity, determined by Articles 43 and 44 of this Law, can be executed with permission from regional departments of forestry and in agreement with regional departments of environmental protection.

Location, design and building of different objects and communications infrastructure are governed by Articles 45-47 of this Law.

C AGRICULTURAL LAND

2 CATEGORIES

2.1 Agricultural land (arable land, perennial plantations, grasslands, pastures and fallow land).
2.2 Non-agricultural land (roads and tracks, forest windbelts excepting those of theForest Fund, and temporarily unused land).

3 LAWS AND REGULATIONS DETERMINING STATUS AND REGULATING USE

- Land Code of Ukraine
- Decree of the Cabinet of Ministers of Ukraine 'About the Order to

Change Target Use of Lands, Being the Property of Citizens or Juridical Persons' of 11 April 2002, no. 502
- Decree of the Cabinet of Ministers of Ukraine 'About the Order of State Registration of Agreements on Land Rent' of 25 December 1998, no. 2073

4 OWNERSHIP AND USE

3.1 Orders governing use of the land

Agricultural lands are transferred to:
- Citizens for own haymaking and grazing;
- Agricultural enterprises for agricultural use;
- Agricultural research institutions and educational institutions for development and education;
- Non-agricultural enterprises for accessory agricultural economy;

- Agricultural land cannot become the property of foreign citizens;
- Mostly non-agricultural land or land of poorer quality is available for housing and communal services, railroads, power and communication lines, pipelines and for other needs (Articles 22-23 of the Land Code of Ukraine);
- Lands obtained by citizens as a result of privatisation of state and communal agricultural enterprises, where ameliorative systems are in place and functioning, are used conjointly under an agreement (Article 26 of the Land Code of Ukraine);
- Executive? National?? and local government bodies may establish common grasslands and pastures on state or municipal property (Article 34 of Land Code of Ukraine).

3.2 Orders governing changes in the designateduse of land

These are laid out in the Decree of the Cabinet of Ministers of Ukraine 'About the Order to Change Target Use of Land, Being the Property of Citizens or Juridical Persons' of 11 April 2002, no. 502

There are two approaches:
- The first approach relates to changing the use of land outside of built-up or urban areas for agricultural, forest and water management purposes.
- The second approach means changing the target use of lands outside of built-up or urban areas for other needs.

The following processes are stipulated for both cases:
- Application by an owner or juridical person (a land owner);
- A decision by city authorities to prepare a project on land allotment;
- Preparation of a project on land allotment by a land-construction organisation;
- Approval on the project from Departments of Land Resources, environmental, health and architecture bodies;
- Consent from regional authorities on changing the designated use.

If change of use is connected with arable land, perennial plantations for non-agricultural needs, forest of the first group with an area of more than 10 ha, with protected and recreational lands and lands of special

significance, the following additional steps are necessary:

- Preparation of project materials by regional authorities on the base of the above-mentioned documents;
- A resolution of the Cabinet of Ministers of Ukraine;
- Agreement of the Verkhovna Rada (the Supreme Council) of Ukraine.

D LANDS OF THE NATURE RESERVE FUND AND OF OTHER ENVIRONMENTAL SIGNIFICANCE

1 CATEGORIES OF LANDS

1.1 Monuments of nature
1.2 Reserve areas of local importance
1.3 Reserve areas of state importance
1.4 Wetlands
1.5 Nature reserves, national nature parks, biosphere reserves, regional landscape parks.

2 LAWS AND REGULATIONS DETERMINING STATUS AND REGULATING USE

- Law of Ukraine 'About Environmental Protection' of 21 June 2001, no. 2556-III
- Law of Ukraine 'About National Programme to Form a National Ecological Network of Ukraine for 2000-2015' of 21 September 2000, no. 1989-III
- Decree of the Cabinet of Ministers of Ukraine 'About the Order to Confer Wetlands the Status of Wetlands of International Importance' of 29 August 2002, no. 1287
- Land Code of Ukraine of 25 October 2001, no. 2768-III

3 REGULATIONS FOR ESTABLISHMENT AND USE OF TERRITORIES OF THE NATURAL RESERVE FUND (NRF).

3.1 Time horizon of NRF territories existence and their liquidation

Designation of NRF territories is for an unlimited period but their liquidation is stipulated by articles 51-54 of the Law of Ukraine 'About Environmental Protection'

3.2 Transmission from one NRF status to another

NRF territories of the categories 1.1 and 1.2 can be transferred to another status on the basis of the following documents:

- a project of the statute;
- agreement of landowners and land users;
- permission from the Regional Departments of Ecology and Natural Resources.

NRF territories in categories 1.3 and 1.4 can be transferred to the upper category 1.5 on the basis of the same documents (as for NRF territories 1.1 and 1.2) together with an order from the Ministry of Ecology and Natural Resources of Ukraine (Minecoresources).

3.3 Regulations for existing and new NRF territories and wetlands

NRF territories of the categories 1.1 and 1.2 are regulated by:

- a statute on the protected territory;
- a commitment to conservation signed by landowners, land users and

the State Department of Ecology in the region;
- a resolution of the Executive and Administrative Organs of local Councils.

NRF territories of the categories 1.3 and 1.4 are also regulated by 'the Statute' and by a commitment to conservation signed by all the above-mentioned institutions together with
- the agreement of Minecoresources and the Cabinet of Ministers of Ukraine.

Establishment of wetlands of international importance are regulated by the Decree of the Cabinet of Ministers of Ukraine 'About the Order to Confer on Wetlands the Status of Wetlands of International Importance' of 29 August 2002, no. 1287, which requires the following steps:
- a declaration on the fulfilment of the criteria established by scientific organizations and other interested institutions;
- an agreement on the wetland territory with executive bodies and local authorities, landowners and land users;
- agreement of the Cabinet of Ministers of Ukraine.

3.4 Design, reconstruction and building.

These are determined by article 51 of the law of Ukraine 'About Environmental Protection' but procedures depend on the scale of the project.

Projects of a small scale are proposed on the basis of the following documents:
- a scientific justification;
- an agreement with regional health and architectural authorities;
- a map(s) showing the territory and proposed reconstruction and building zones;
- an agreement with the State Department of Ecology in the region.

Projects of a large scale include all the above-mentioned items with additional ones as follows:
- an extended scientific justification;
- a project document;
- an ecological prognosis (expertise);
- an agreement with landowners and land users;
- an agreement and resolution of executive and administrative bodies of local Councils.

3.5 Ownership and use of NRF territories

Territories of the Natural Reserve Fund can be state, communal and private property. All actions within these territories are regulated by the law of Ukraine 'About Environmental Protection'.

With regard to the order for using lands of other environmental significance, the law about NRF regulates wetlands, not falling under the forest and water fund as well as land areas with natural objects of special scientific value on their territories.

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PROJECT MANAGEMENT

WWF –Danube Carpathian Programme Office, Vienna
Phil Weller
WWF – Netherlands
Frans Schepers
WWF – Ukraine
Misha Nesterenko

PROJECT TEAM

WWF – Ukraine
Misha Nesterenko
Wetland Management Unit
Joseph Chernichko
Stroming bv, the Netherlands
Willem Overmars
Alphons van Winden
Wim Braakhekke

AUTHORS

Wetland Management Unit, Melitopol
Joseph Chernichko
Stroming bv, the Netherlands
Willem Overmars
WWF – Ukraine
Misha Nesterenko

CO-AUTHORS

Wetland Management Unit
Boris Alexandrov - Institute of Biology of Southern Seas
Oleg Dyakov
Ivan Kitchuk – Odessa Oblast Water Management Committee
Michail Zmud – Danube Biosphere Reserve
Alewxndr Voloshkevich – Danube Biosphere Reserve
Nikolay Krylov
Sergey Podorozny
Dmitry Dubyna
Anatoly Voloch
Raisa Chernichko
Valery Siochin
Viktor Tkachenko – Odessa Oblast State Econimic Board

Stroming bv:
Wim Braakhekke
Alphons van Winden
Advisors:
Alexander Klink
Frans Vera

TRANSLATION
Russian-English
Olga Oreshkova
Dutch – English
(partly) Mereije Wenneker

EDITING
Liz Hopkins

MAPS
Wetland Management Unit
Svetlana Vinokurova
Elena Isaeva
Stroming bv
Willem Overmars

PHOTOS
Wetland Management Unit
Joseph Chernichko
Stroming bv
Willem Overmars
WWF
Anton Vorauer
Jan Maarten Dros
Geert Overmars

ARTIST IMPRESSIONS
Jeroen Helmer

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Franka van Loon

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