ADAPTING TO CHANGE

CLIMATE CHANGE ADAPTATION STRATEGY AND ACTION PLAN FOR DANUBE DELTA REGION

ROMANIA - UKRAINE - MOLDOVA

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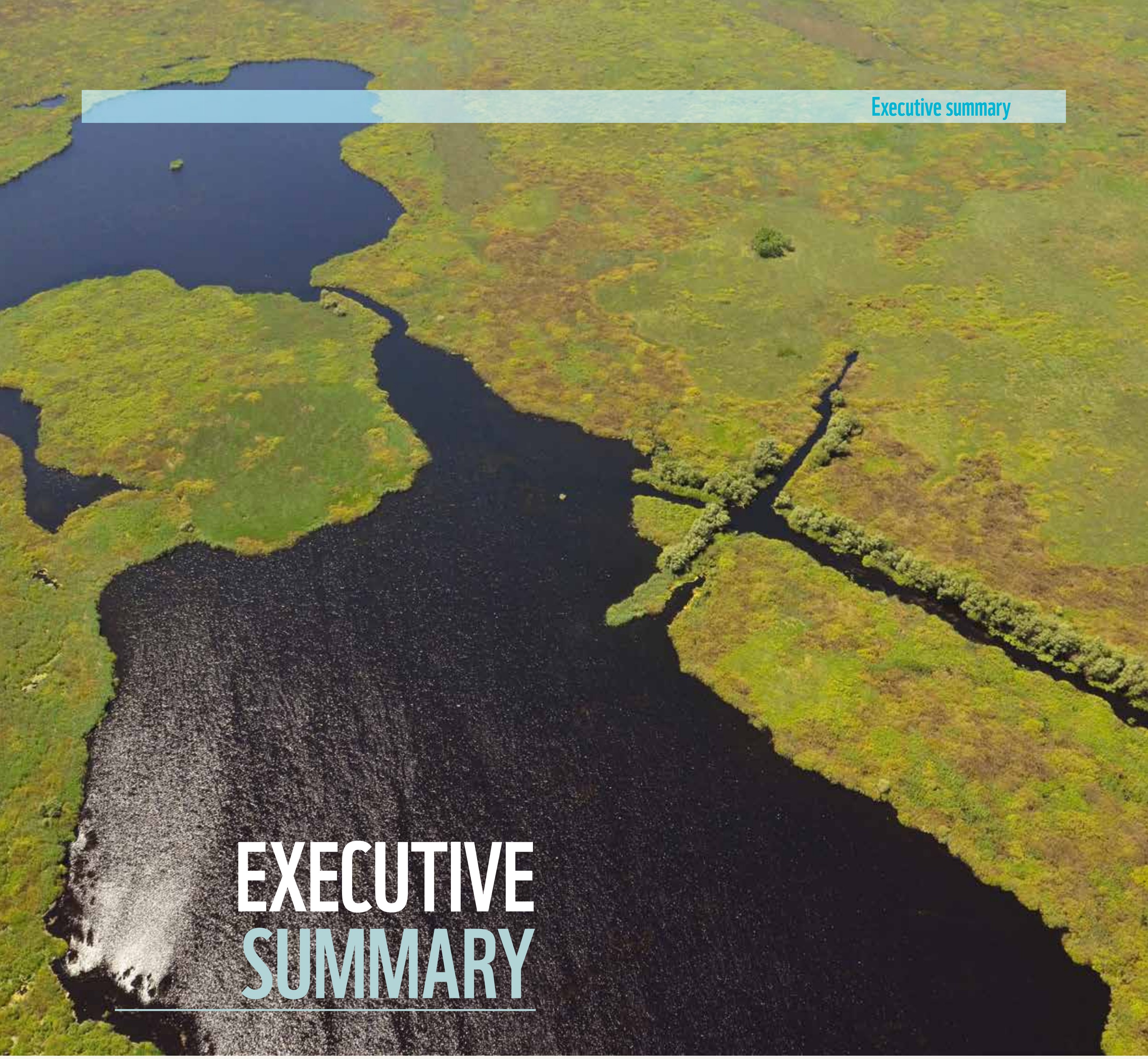
CONTENTS

CRS	Centre for Regional Studies (Ukraine)
DBR	Danube Biosphere Reserve (Ukraine)
DDBRA	Danube Delta Biosphere Reserve Authority (Romania)
DDRBMD	Danube Delta River Basin Management Department (Ukraine)
EEC	European Economic Community
EFD	European Floods Directive
ENRTP	Thematic Programme for Environment and Sustainable Management of Natural Resources Including Energy
EU	European Union
ICPDR	International Commission for the Protection of the Danube River
IPCC	Intergovernmental Panel on Climate Change
MD	Moldova
NGO	None-governmental organisation
OSCE	Organization for Security and Co-operation in Europe
RO	Romania
SZP	Stentsovsko-Zebriyansky Plavni
UA	Ukraine
UNDP	United Nations Development Programme
WFD	Water Framework Directive of European Union
WMB	Water Management Board
WWF	World Wide Fund for Nature



EXECUTIVE SUMMARY

A unique ecosystem and home to more than half a million people, the fragile Danube Delta is already now experiencing the first impacts of climate change. Earlier spawning of herring, less snow in winter and higher water temperature in summer have been reported. In the future, unprecedented sea level rise, water scarcity, and more frequent and severe extreme weather events will be the major drivers of change. Policy-makers and civil society in the region must act now to take steps to adapt to the challenges posed by climate change.

This document lays out a foundation for transboundary action for adaptation in the region. Based on the outcomes of the vulnerability assessment, it focuses both on facilitating the adaptation of natural systems and reducing human pressures on ecosystems while improving quality of life. The list of measures suggested here is far from being exhaustive; rather, it highlights urgent needs and sets the overall strategic direction.

Sectors particularly vulnerable to climate change include water resources, agriculture, and human health. Reducing the vulnerabilities in each sector is possible though targeted policy interventions, developing and enforcing robust environmental protection legislation, and encouraging the involvement of civil society and the general public in working to mitigate the effects of climate change. Later we will give a short overview of the impact of climate change on water, biodiversity and various sectors of economy, as well as the highest priority adaptation measures; you can find a more comprehensive list of measures in the adaptation action plan.

Climate change impacts on WATER RESOURCES

Flood predictions are of high uncertainty, especially at the local level in small catchments, however, most studies point to an increase in flood events. Climate change will most likely exacerbate and prolong periods of water scarcity and drought in regions which already experience water stress. The minimum runoff will diminish as the temperature and evaporation rise. Average water temperature will significantly increase, up to 2°C by 2050, in all water bodies, especially in shallow lakes/reservoirs with regulated water regimes and poor water exchange. Due to rising water temperatures in all surface and ground waters, the water quality will decrease. By 2050 sea level could rise by 0.15 m (the most favorable scenario) and by 0.5m (the most unfavorable scenario) leading to erosion and the flooding of the coastal areas.

The highest priority adaptation measures identified are related to the designation of water protection zones and the protection of river banks through afforestation along small rivers and lakes. Further adaptation measures include improving the water exchange processes in the lakes and restoring the natural hydrological regime on the former floodplain where possible, along with reinforcing flood protection structures at environmentally dangerous sites such as the oil extraction installations on Beleu lake, in Moldova.

Climate change impacts on ECOSYSTEMS

Higher water levels in the Black Sea will enhance wind-induced surges which will entail long-term water-logging of the terrestrial floodplain ecosystems of the secondary delta. In the northern part of the Delta, freshwater flora which has a low tolerance to salinity, will be substituted by vegetation more typical of brackish and saltwater environment. A higher frequency of fires will encourage a succession of marsh-and-grassland communities with a great share of miscellaneous meadow herbs (represented by species tolerant to fire) and low share of reeds. Wintering conditions for most mammal species will improve. Fewer days with snow will give competitive advantage to amphibians and reptiles but deteriorate the wintering conditions for rodents and insect-eating mammals. Changes in the life cycle and phenology of birds will result in a shift of migration timing (ducks, geese).

Long-term monitoring, studies of climate impacts on key species and trophic chains, as well as identification of climate refugia are priority adaptation measures presented in the action plan as they are crucial to further promote and facilitate adaptation based on the ecosystems.

Climate change impacts on SETTLEMENTS AND INFRASTRUCTURE

Torrential rains are expected to occur more frequently this pushing existing drainage systems to their limits. Flash floods may lead to infrastructure damages and high economic losses. Assuming the nutrient load stays the same, higher water temperature will lead to lower water quality and potential algae blooms, especially in shallow lakes/reservoirs with regulated water regimes and poor water exchange, thereby endangering drinking water supply.

Priority adaptation measures linked to infrastructure are mainly focused on water-related infrastructure in settlements, for example: identifying infrastructure at risk of flooding and preventing further construction in flood-prone areas, developing collective water supplies for villages to adapt to droughts and water shortages in summer, reducing nutrient flow into water bodies from cities and villages through waste-water treatment, and constructing drainage systems to cope with flash floods in high risk settlements.

Climate change impacts on AGRICULTURE

As more than half the population in the region is employed in agriculture, this sector is highly important. Future decreases in the availability of water resources due to climate change may lead to an increase in production prices and drop of competitiveness of local produce on international markets. At the same time, climate change may bring some positive effects to agriculture by offering the possibility of cultivating secondary crops due to prolonged periods of vegetation, as well as the introduction of new warm-loving drought-resistant crops.

Priority adaptation measures for agriculture sector are those closest to nature practices: crop rotation to help to revitalize the soil and prevent pest infestations without reliance on chemical fertilizers and pesticides. Practices to help cope with drought include planting trees to provide shade, use of cover crops to enhance seedling survival, and “harrowing” of fields in early spring (which prevents evaporation).

Climate change impacts on FISHERIES

The projections for how climate change will affect inter-species relations and for how individual species will respond to climate change are still highly uncertain. The growing period of the main commercial fish species and the number of days suitable for fishing may be prolonged which would increase pressure on the populations of the main industrial species. Future changes in climate will not trigger a considerable reduction in catches in the Danube, though their quality may deteriorate. At the same time fish production in the Danube lakes/reservoirs may decrease due to the worsening of water exchange and lower water quality. In summer, higher levels of fish mortality can be expected due to algae blooms.

Priority adaptation measures presented in the action plan include harmonising the timing of fishing bans and fishing quotas and norms. For Ukraine, a special measure has been identified: rice growers may provide fish nursery services for local fisheries in ponds or lake as rice fields are ideal nursery sites for young fish and may act as natural flooded meadows.

Climate change impacts on FORESTRY

There will be changes in forest structure and species composition. Species more adapted to droughts and heat will benefit and advance. Forest fires will play an important role in changing species composition.

Restoration and the protection of floodplain / riparian forests on small rivers and lakes is the main priority adaptation measure for the Danube Delta, which is a much less forested area.

Climate change impacts on THE ENERGY SECTOR

Higher air temperatures will drive up demand, leading to new challenges in balancing the power grid. This can be quantified as 0.1% lower efficiency for every increase in temperature of 1ºC for natural gas and oil fired power plants. This translates into more expensive power generation due to higher fuel consumption on the order of a 2 ‰/oC loss in power generation. During heat waves operational costs may go up with more people in service (an increase of 50-100%) and more material in stock (an increase of 10-20%).

The priority adaptation measure for the energy sector is to adapt to climate change through enhanced energy efficiency and diversification of energy sources, especially those locally available.

Climate change impacts on TOURISM

Due to a longer summer season, a higher number of visitors may be expected. This will lead to greater pressure on the environment unless it is managed wisely.

One of the priority adaptation measures identified is to maintain the tourist industry within the region's ecological and socio-cultural carry capacity. Forms of tourism which are considerate of the environment, including eco-tourism, rural tourism, agritourism, outdoor activities, canoe, cycling etc. and which protect the most sensitive habitats from human disturbance are other priority measures included in the action plan for the Danube Delta sub-basin.

Climate change impacts on PUBLIC HEALTH

A warmer and wetter climate will open up new habitats for the local species of mosquitoes which transmit arboviruses (a group of viruses that are transmitted by arthropod vectors) thus leading to more hot spots of fevers and encephalitis. It can be expected that the northern borders of malaria mosquitoes will shift northwards and southern populations may substitute northern ones. Due to new, favorable conditions, the exotic vectors *Aedes albopictus* and *Ae.aegypti* which transmit dengue fever and yellow fever may appear on the Black Sea coast.

Heat waves are likely to be more frequent thus increasing the risk of heat strokes Rapid temperature changes may exacerbate cardiovascular diseases - hypertension, angina pectoris, and heart attacks. Elderly, chronically ill and disabled people are particularly at risk. Higher water temperatures will be favorable for the development of pathogenic bacteria. An increase in diseases caused by the consumption of low-quality drinking water (cholera, leptospirosis, rotavirus infections) may occur. The local situation may be complicated by toxic algae blooms in drinking water sources.

Two priority adaptation measures presented in the action plan are: raising awareness about the risks climate change poses to human health and developing effective early warning systems for health risks.

The impacts of climate change are diverse and will seriously influence all major sectors and natural assets. Proactively planning of adaptation measures and mainstreaming them into day-to-day decision making is thus necessary. Adaptation must become a systemic process which actors integrate into their work programs. The adaptation action plan lays out a strategic direction and basic guidance for each sector with the intention that the responsible stakeholders will follow up with more comprehensive adaptation programs.

INTRODUCTION

The Danube Delta is the second biggest wetland ecosystem in Europe. It is home to about 330 bird species, including 70% of the world's white pelican population and 60% of the world's pygmy cormorants. For centuries people lived off the resources the Delta provided.

There is a scientific consensus that the climate is changing and this process is likely to speed up in the future. In its last Assessment Report (2014) the Intergovernmental Panel on Climate Change (IPCC) states:

"In recent decades, changes in climate have caused impacts on natural and human systems on all continents and across the oceans... The top ten warmest years on record have occurred since 1997, with 2005 and 2010 tied for the warmest year"

The first signs of climate change impacts have already been recorded in the Danube Delta – earlier blooming of fruit trees and earlier spawning of herring, one of the main commercial species in the region, just to name a few.

Changes in climate will impact all spheres of life. European, Danube basin and national climate change adaptation strategies for Romania and Moldova are being revised now with the aim of preparing those countries for upcoming challenges and opportunities. They provide a solid basis and a framework for adaptation. However, transboundary dialogue and coordination between the three countries of the Danube Delta – Romania, Ukraine and Moldova - are of paramount importance in this region as the local economies are dependent on the ecosystems and ecosystem services transcending administrative borders.

This document outlines a pathway to a climate resilient Danube Delta region where people and nature benefit from each other's presence and preserve the Delta's ecological, social and economic values. It is a pioneering effort in the region, the first step towards adaptation, and further sectorial strategies may be needed.

The structure of this document is very straightforward. In the first chapter we present the background and the process behind the strategy's development. Chapters two and three look at the status quo and climate change impacts on natural and socio-economic systems respectively, while Chapter four presents strategic directions and adaptation action plan. We hope to inspire you through the case studies in the text-boxes which provide examples of various climate-smart practices already employed in different parts of Europe. You may skip the first three Chapters and go straight to adaptation measures if you are familiar with the region or you may look through the background and climate impacts for the relevant sectors first.

This climate change adaptation strategy for the Danube Delta sub-basin is prepared within the context of the project "Climate Proofing the Danube Delta through Integrated Land and Water Management" with the financial support from European Commission[1].

1 http://ec.europa.eu/europeaid/how/finance/dci/environment_en.htm

1.BACKGROUND

1.1 APPROACH AND METHODOLOGY

Climate-driven changes in the Delta ecosystems may threaten livelihoods of those communities dependent on them. Any significant changes in the natural resources' structure and functionality have a direct impact on the local socio-economic system. Furthermore, human presence and resource use over carrying capacity of the ecosystems undermines their ability to regenerate and cope with stress. Therefore, this strategy focuses both on facilitating adaptation of natural systems and reducing human pressures on ecosystems while improving quality of life.

Figure 1 presents the logic of this document: after identifying the anticipated changes in climate parameters, we looked at how those changes will impact water availability, its quality and ecosystems and then, how those will influence economy and well-being of local population. Finally, we developed adaptation measures for each scenario.

Chapter 3 consists of sub-chapters by economic sector (e.g. agriculture, fishery, forestry etc). In each sub-chapter you will find a snapshot of the current status, main climate impacts and the general strategic directions followed by the adaptation measures of the highest priority. Adaptation Action Plan (Chapter 4) goes into more detail and suggests urgent (next 5 years), short-term (until 2030) and long-term (2050) activities.

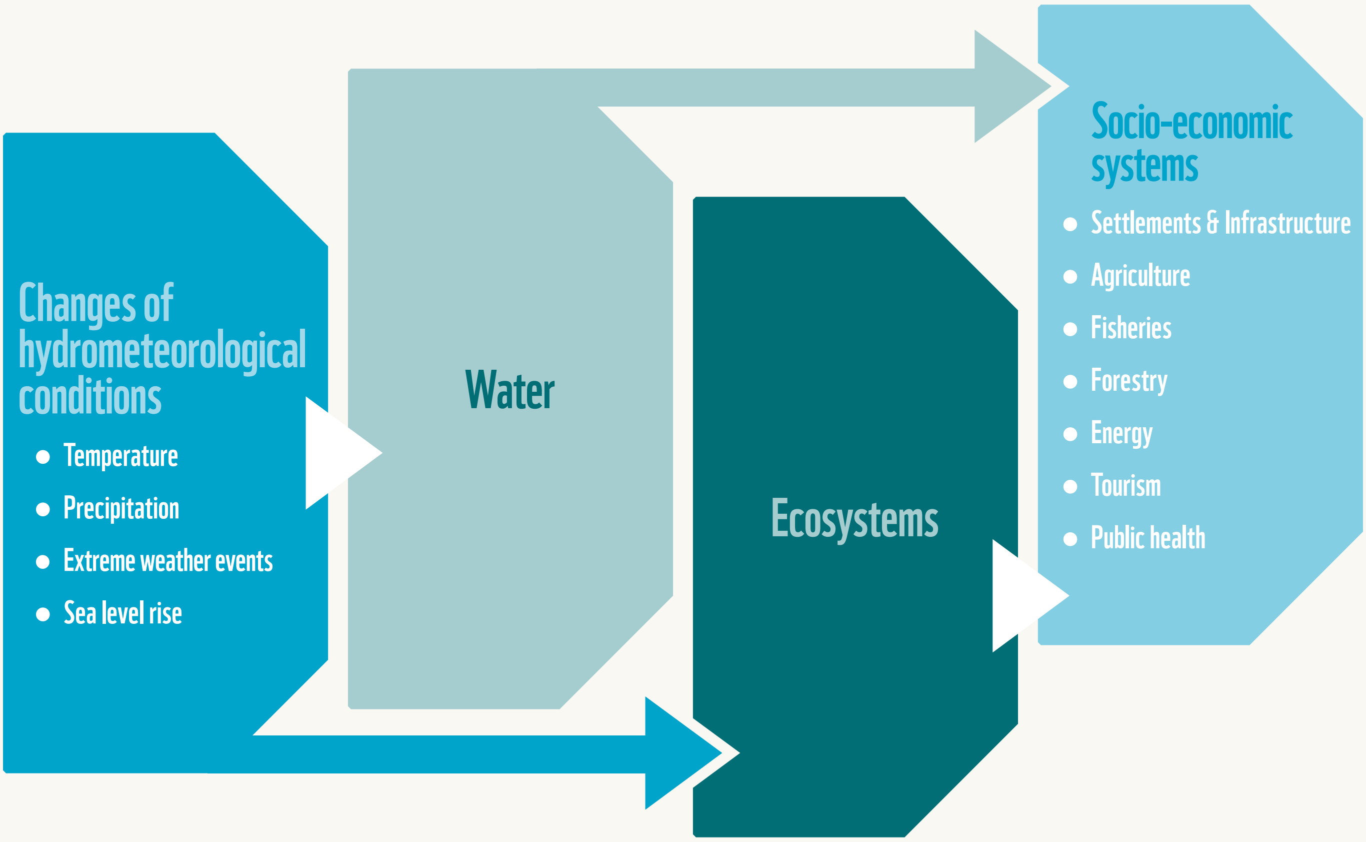


Fig 1. Approach to the strategy development

Conceptual framework

The conceptual framework of the strategy follows key principles presented in the guidelines on developing adaptation strategies, released by the EC[1].

We have used the latest research, data and best practices from other regions ***(evidence-based adaptation)***. A number of scientists and academics from Romania, Ukraine and Moldova have contributed to the vulnerability assessment of natural systems and socio-economic sectors, identified key climate risks and opportunities in the region as well as adaptation options.

To compare adaptation options and identify the most suitable ones, multi-criteria analysis was conducted. The criteria for the analyses were effectiveness, costs, benefits for other sectors and mitigation linkages of each potential measure. In this way we made sure the measures were ***sustainable***.

The ***prioritization*** of adaptation measures was done during consultation workshops with key local stakeholders and businesses. Participants were offered a list of measures (result of multi-criteria analysis) where they negotiated among themselves priority (high, medium, low) and time frame of implementation. Measures that were identified as those of low priority were not included in the Action Plan.

The climate change adaptation strategy for the Danube Delta (CCAS) is based on the general directions given in national, regional and EU climate change adaptation strategies. Thus, the main strategic objectives for increasing resilience of the Danube Delta have been shaped in line with ***higher-level policies***. At the same time, the strategy is developed to be mainstreamed into relevant political documents on the local level.

Transboundary cooperation and a ***participatory approach*** have received special attention as only a coordinated response across the region will be efficient. The key authorities responsible for water and nature management at regional level, NGOs and relevant local stakeholders together with external experts took part in identifying and prioritizing adaptation measures. The bottom-up, stakeholder-driven approach represents the backbone of the entire process of the climate change adaptation strategy development.

In this document we focused on public adaptation over private adaptation. This is primarily because our target audience is local authorities, public and private decision-makers. According to Parry *et al* (2009)[2], adaptation to climate change is essentially private, in contrast to mitigation. Parry *et al* (2009) note that private autonomous measures will dominate the adaptation response as people adjust their buildings, change space-cooling and -heating preferences, reduce water use, alter holiday destinations or even relocate. However, governments and public institutions have a responsibility to create enabling conditions for private adaptation to occur.

The strategy outlines measures in all the steps of the ***adaptation chain***, focusing especially on preventive and preparatory actions:

Preventive - measures that reduce risk and sensitivity of people, property or nature to climate change (no new construction in flood risk zones, land-use planning taking into account climate impacts)
Preparatory - measures that build or enhance awareness about effects of climate change in the region (includes carrying out studies, awareness raising and communication exchange activities)
Reactive - measures that address changes that has already happened and facilitate living in a new climate (management of invasive species, insurance, subsidies etc.)
Recovery - measures that create mechanisms such as establishing a funding instrument to support reconstruction or insurance systems

Moreover, to boost the resilience of the Danube Delta, ecosystem-based adaptation measures have been favored, enhancing the adaptive capacity of natural systems. Most of the measures suggested are either ***'win-win'*** (cost-effective adaptation measures that have positive social or environmental externalities; or contribute to climate change mitigation) or ***'no regret'*** (cost-effective measures that will have positive impact regardless of the scale of changes).

This is by no means an ultimate document that would resolve all climate change related challenges but a start of the process that needs to be constantly monitored, reviewed and adjusted accordingly. Climate change needs to be a routine consideration, factored into day-to-day decision making processes rather than a risk to be managed once in a while. Therefore, adaptation must become a systematic process that actors integrate into their work programs. This strategy is a basis for explaining what climate change means for selected target groups and how it should be tackled in their respective businesses.

1 European Commission (2013), Guidelines on developing adaptation strategies; Accompanying the document – Brussels

2 Parry, M., Arnell, N., Berry, P., Dodman, D., Fankhauser, S., Hope, C., Kovats, S., Nicholls, R., Satterthwaite, D., Tiffin, R. and Wheeler, T. (2009) Assessing the Costs of Adaptation to Climate Change – A Review of UNFCCC and Other Recent Studies. International Institute for Environment and Development and Grantham Institute for Climate Change, Imperial College London, London, UK.

1.2 GEOGRAPHICAL SCOPE

The Danube Delta Region includes the Danube Delta sub-basin and the Moldavian part of the Lower Prut River Basin[3]. The region occupies 24 686 km² with a total population of more than 600 000 people. 82% of the Delta is situated in Romania and 18% in Ukraine.

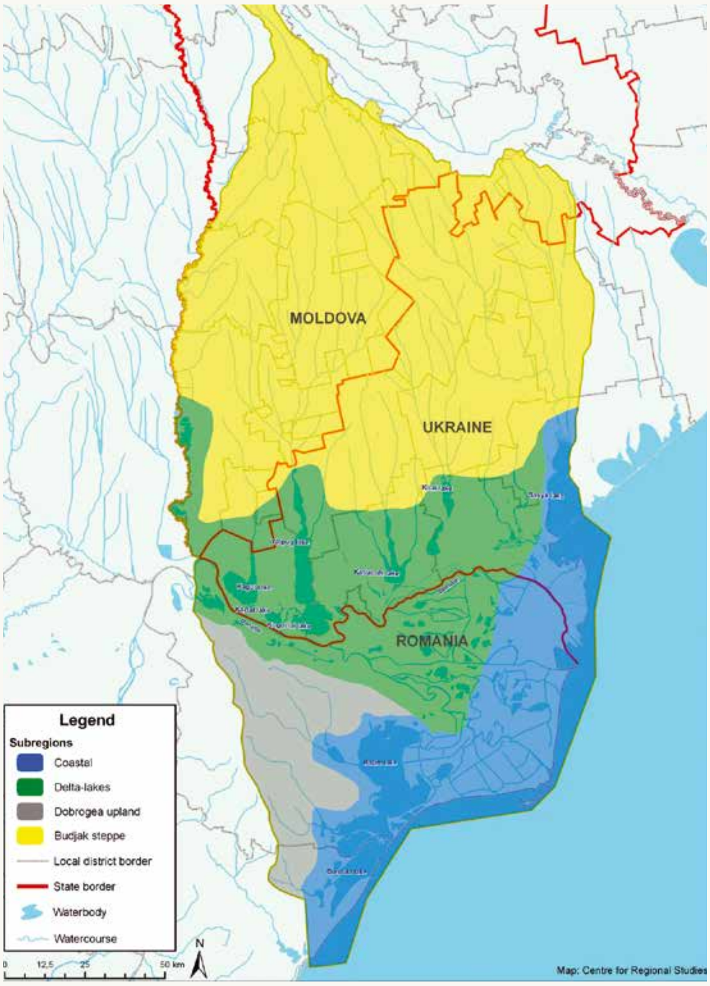


Fig 2. Subregions of the Danube Delta sub-basin

Main administrative units are the Bilateral Romanian-Ukrainian Danube Delta Biosphere Reserve; 4 districts of the Odessa region of Ukraine, the Cahul and Yalpug river basins located on the territory of Moldova and the Moldovan part of the Lower Prut river basin (4 rayons and Territorial Unit – Gagauzia).

On the map (Figure 2) you can see country boundaries and the ecoregional sub-divisions, illustrating the ecological and economic traits of the area. Annex 1 provides main characteristics of the region (population and area by country, protected areas, land-use, area under forests etc).

The Budjak steppe (yellow on the map) is the most arid area that suffers from a deficit of surface and ground water resources. However despite this, agriculture is the main source of income for the local population.

The Delta lake area (green on the map) is a mosaic of wetlands, lakes and reedbeds hosting a significant number of species. Main economic activities here are aquaculture, fishing and reed harvesting. The biggest lakes in the Ukrainian part have been disconnected from the Danube and are used as reservoirs for the local water supply.

The Coastal sub-region (blue) signifies the transition area from the salt- to freshwater ecosystems; it is characterized by higher air temperature with less precipitation. The ***Dobrogea upland*** (grey) is an area with hilly landscape with heights more than 400 m above sea level. This sub-region is outside the study area. Borders between the sub-regions are nominal as Delta is in a constant flux – it has been growing for years due to accumulation of the sediments at the water front and its front edge is altered by the sea level rise.

1.3 POLICY FRAMEWORK ON CLIMATE CHANGE

A number of international agreements and processes on the national and international level create the legal framework for adaptation; provide support for development and implementation of this Strategy.

All three countries are parties to the *United Nations Framework Convention on Climate Change* and have also ratified the *Kyoto Protocol*, ensuring achievement of the internationally agreed objectives on mitigation and adaptation to climate change.

On the European Union level, the most relevant document is the *EU Climate Change Adaptation Strategy* whose "overall aim is to contribute to the more climate resilient Europe. This means enhancing the preparedness and capacity to respond to the impacts of climate change at local, regional, national and EU levels, developing a coherent approach and improving coordination."
In addition to this communication document, the EU developed a series of accompanying documents providing more detailed accounts of climate change adaptation issues[4].

3 It was agreed to include the Lower Prut sub-basin as it is a major Danube tributary in this area, and an important part of the Delta ecosystem.
4 http://ec.europa.eu/clima/policies/adaptation/documentation_en.htm.

Despite the fact that only Romania is a member of the EU, both Moldova and Ukraine are aligning their policies to the European ones. For example, parts of the Water Framework Directive have been implemented Ukrainian and Moldavian legislation.

A number of existing EU policies contribute to adaptation efforts. In particular, the *Water Framework Directive* establishes a legal framework to protect and improve the ecological status, quality or quantity of surface and groundwater across Europe and to ensure the long-term sustainable use of water. In support of a proper implementation of climate-proof River Basin Management Plan, the EU developed the *Guidance document No. 24 River Basin Management in a Changing Climate*. In addition, climate change concerns must also be properly integrated in the implementation of the *Floods Directive*. Harmonisation of the two directives and their proper implementation by the EU Member States will help increase resilience to and facilitate adaptation to climate change.

Regarding habitats, the impact of climate change must also be factored into the management of Natura 2000 sites ensuring the diversity of and connectivity between natural areas that would allow for species migration and survival in changing climate. In this regard, EU released in 2013 the "*Guidelines on Climate Change and Natura 2000*" dealing with the impact of climate change on the management of the Natura 2000 network of areas with high biodiversity value.

The EU Climate Change Adaptation Strategy recognizes that "one of the challenges for cost-effective adaption measure is to achieve coordination and coherence at the various levels of planning and management. The recommended instrument at the global level, under the UN Framework Convention on Climate Change, is national adaptation strategies. These are key analytical instruments designed to inform and prioritise action and investment." Thus, in order to develop the Climate Change Adaptation Strategy for the Danube Delta sub-basin, the available drafts of *national climate change adaptation strategies for Romania, Moldova and Ukraine* have been taken into consideration.

Regional cooperation in the framework of the International Commission for the Protection of the Danube River (ICPDR) contributes greatly to the process. The ICPDR was created to implement the "Convention on Cooperation for the Protection and Sustainable use of the Danube River" and has an important role in the Danube countries to ensure coordinated implementation of the WFD, together with the EU Floods Directive (EFD). Following requests by the Danube Ministerial Conference 2010, the ICPDR has become active in developing a climate adaptation strategy. As an essential step in this process, a study on Climate Change in the Danube Basin and the ICPDR Strategy on Adaptation to Climate Change were finalized in 2013. The focus of the strategy is on issues relevant on the Danube basin-wide scale, being in line with the mandate of the ICPDR, while at the same time paying attention to the different levels of the river basin management as requested by the WFD and EFD. This document takes into account the general directions presented in the ICPDR relevant documents.

The next step in the process of adapting to the climate change is to develop climate change adaptation strategies and action plan at the national level and for the sub-basins that would address local impacts and suggest local solutions in line with global initiatives. This Climate Change Adaptation Strategy and Action Plan for the Danube Delta is one of the first such initiatives.

1.4 KEY CLIMATE IMPACTS IN THE REGION

Analysis of the long-term hydrometeorological observations in the region[5] demonstrates a trend towards the following changes by 2050: the average annual air temperature will increase by 1-1.5 °C; the average summer temperature by 1.8°C; and the average winter temperature by 1.3°C entailing a shorter frost period, longer warm period and extended arid period. These will lead to higher evaporation, the increase in number of extremely hot days (heat waves) and a significant decrease of snow cover period.

Future projections of annual precipitation and its seasonal distribution are of high uncertainty. Based on the current trends, the insignificant 6% increase in average annual precipitation (mainly due to more frequent rainfalls) can be forecasted[6]. Other scenarios show a decrease in average annual precipitation by 5-15% and changes in seasonal distribution – wetter winters and dryer summers . In recent decades, the spring–summer flood peak began 10–15 days (on average) earlier than in previous years[7].

Sea level rise and consequent inundation are one of the major threats to the coastal areas. Analysis of water levels at the gauging stations of Primorskoe (near the shore zone at the mouth of the Danube) and Prorva (at the Prorva branch, 3.6 km from the sea) revealed that, between 1958–1984, the water level at these gauging stations increased at a rate of between 1.9 and 2.2 mm/year, respectively; during 1985–2010, the rate of sea level rise had already increased to between 6.9 and 9.8 mm/year. These values exceed 1.5–2 times the data available for the world ocean over the same

5 Cheroy O. Analysis of hydrometeorological data sets for 1945-2013 and projections of future climate parameters in the Danube Delta region. Expert report. 2013
6 Danube Study – Climate Change Adaptation. 2012, Department of Geography, Chair of Geography and Geographical Remote Sensing, Ludwig-Maximilians-Universität Munich, Germany
7 Gidrologiya del'ty Dunaya (Hydrology of the Danube Delta), Moscow: GEOS, 2004.

periods[8]. This is indicates that Danube runoff plays big role in shaping the Black Sea water regime[9].

In the northern most arid sub-region (Budjak steppe) the major threats will be desertification and extreme water stress. Higher average temperatures even under the same precipitation conditions will lead to higher evaporation and water stress. Small changes may be expected in the average Danube runoff (-5% by 2050), but a significant reduction (5-25 %) of runoff from the small rivers may occur in summer (high uncertainty)[10]. Drought periods and peaks of extremely high temperatures may become more frequent (by 10-20%) until 2020-2025. Longer droughts and heat waves will have significant implications for public health, key sectors of economy (first of all agriculture and fishery), and natural ecosystems.

Extreme weather events such as torrential rains, waterspouts, storms, and thunderstorms, hail, etc. will occur more often, especially in the coastal area. Increased frequency and intensity of heavy rain storms may lead to flash floods in small water bodies.

1.5 KEY SOCIO-ECONOMIC TRAITS OF THE DANUBE DELTA REGION

The Danube Delta region has a complex history. In the latter years of communism there was an attempt to transform the Delta into a productive industrial/agriculture region, which meant people were brought in from other regions of the country and allowed to settle, leading to a period in which the Romanian part of the Delta had the highest population numbers on record. Parts of the floodplain were drained and transformed into cropland, pastures or aquaculture ponds. This has had a clear negative effect on the health of the Delta ecosystems.

Since the fall of communism, and to this day, the population of the region no longer has the socio-economic and physical infrastructure to sustain itself – thus there has been significant outward migration since 1990. Currently older age groups dominate the age structure of the region. In Ukraine there is a slow recovery trend, in response to greater benefits (USD 3400) paid at child birth; this remuneration increases with the birth of the next child in the family.

The Danube Delta area is primarily rural. Natural conditions, as well as how much of the territory is part of the biosphere reserve, dictate the type of economic activities each territorial unit engages in.

Within the region, agriculture continues to be an important source of employment. Up to 80% of population in the Lower Prut region, 34% of population in the Reni district and up to 70% in the Ismail district, in Ukraine, is employed in agriculture. There exists the potential for expanding current activities practiced by locals without negatively impacting the environment, such as apiculture or harvesting reeds and medicinal plants. However, while organic agriculture and aquaculture are spreading slowly, for the most part the type of farming being practiced in the region does not follow sustainable practices (e.g. manure is dumped in the waterways, aquaculture concessions are turned into dry farmland).

Since ancient times, fishing has been the main occupation of the Romanian Danube Delta inhabitants and although today the supply of fish has diminished and changed in quality, it continues to be the staple trade. Poaching is of considerable concern, as overfishing allows many of the local families to sustain themselves in the short term, but has significantly decreased the fish stocks.

Seasonal tourism is the second most important occupation for many of the Romanian Danube Delta's residents, and has the side benefit of encouraging construction - mainly new tourist housing structures and secondary homes for seasonal visitors. While there are a few large scale developments, most of the communities practice small-scale informal agro-tourism using small guest houses.

Traditional crafts, such as crafting reed into fences, roofing and various decorative objects is slowly disappearing. Official tourism operators are still required to have reed roofs, but within the general population it is now seen as more expensive and less durable. Reed had also been used for cellulose and paper production. Nowadays, the only area in which reed is still harvested commercially is along the coastline, as reed in the marine regions tends to be of higher quality. The Danube Delta residents have the right to harvest up to 10t of reed annually per person, and can also legally associate to petition for larger areas to harvest, but few do so.

Despite a low official unemployment rate of 3% (in Romania, 1.2-3.1% in Ukrainian Delta[11]), there are reports of hidden unemployment. Shortage of jobs and of economic activities have negative impacts on the young workforce in particular. The numbers turning to farming are limited by land unfit for agriculture, while fishing and the number of fishermen decreases by the year. At the same time, relative remoteness from the regional centres, inadequately developed transport and lack of employment opportunities have led to young people continuously leaving the region.

8 Climate Change 2007. Synthesis Report. Summary for Policymakers, www.ipcc.ch
9 Mykhailova, M.V., Mykhailov, V.N., Moroz, V.N. Extreme Hydrological Events in the Danube River Basin over the Last Decades. Water Resources, 2012, Vol. 39, No. 2, pp. 161–179
10 Lehner, B., Henrichs, T., Döll, P., Alcamo, J. 2001, EuroWasser - Model-based assessment of European water resources and hydrology in the face of global change. Center for Environmental Systems Research, University of Kassel, Germany.
11 Concept of the state regional program for the development of the Ukrainian Danube Delta Region in 2014-2017.

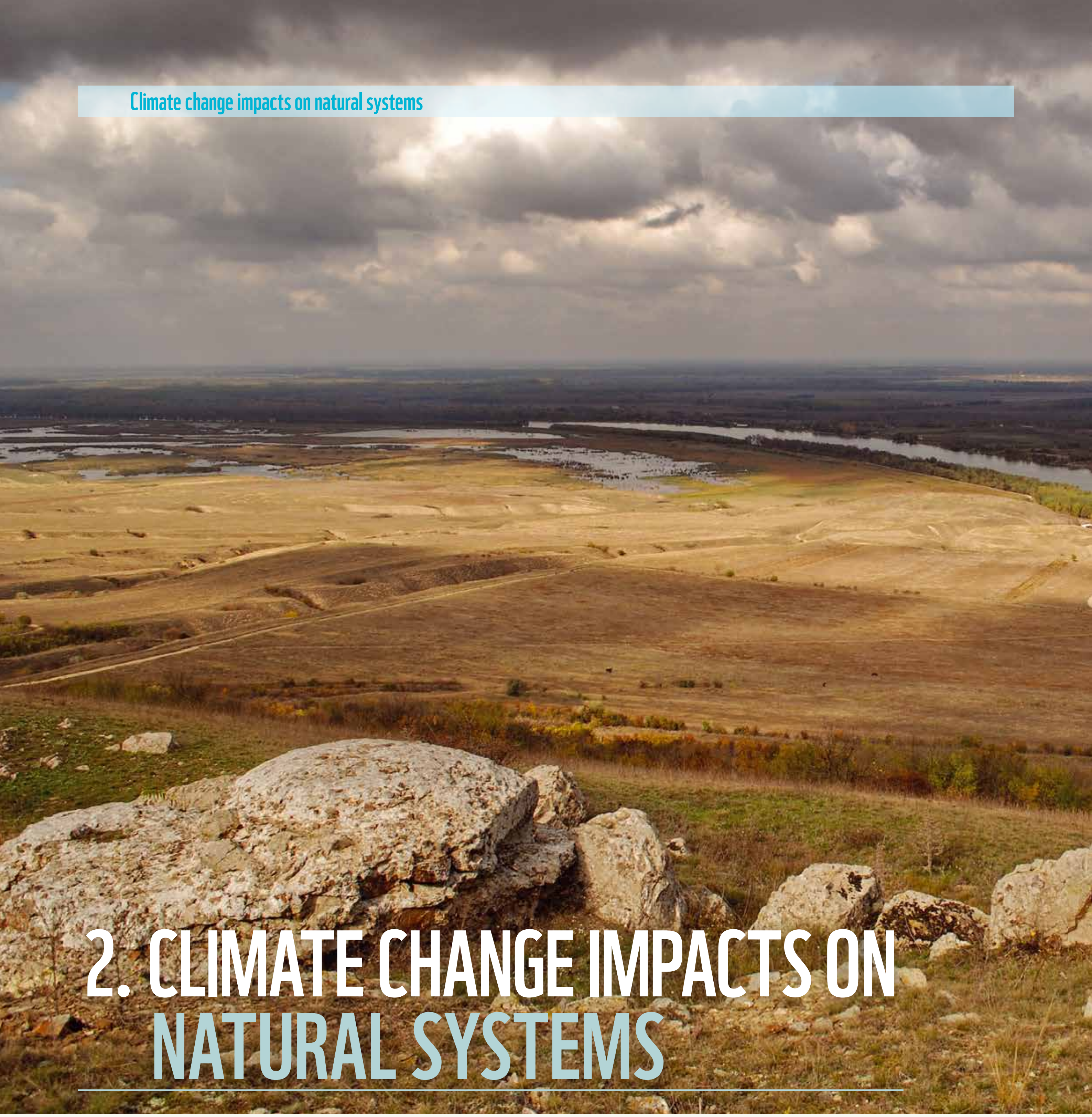
Poverty in the Romanian Danube Delta (21% of Romanian population are living below the poverty line[2009][12]) is associated with poor health and reduced life-span caused by heart diseases, improper diet, and unclean water. Low income, little access to education, the absence of access to mass-media to voice concerns or their viewpoints on the conservation of the Danube Delta Biosphere Reserve also add to a state of poverty[13].

Poverty levels among rural population in Ukraine are higher – around 40%. Most of the poverty-stricken are children, youths and families with many children. A reduced level of education makes it difficult for people to find a job and therefore their future living standard will be unsatisfactory. Unemployment is high especially amongst women. People with disabilities, the elderly with very small pensions and no prospects to obtain decent incomes, and families with many children are permanently faced with poverty[14].

Of the 585, 000 poor people registered in the Republic of Moldova[15], 480 000 are in rural areas. The poorest households are families which depend on agricultural activities, the elderly, people without education and professional skills, as well as households with many children. However, there is some good news: in 2009, about 26.3% of the citizens were poor, in 2010 the number of poor people decreased to 21.9%, and in 2011 to 17.5%. Those figured indicate that over the last two years, around 300,000 inhabitants escaped poverty.

Compared to other deltas in Europe, the geo-morphological landscape and lack of access to the region have played an important role in maintaining healthy ecosystems, wild landscapes and a low population density. Although this is one of the oldest populated regions in Romania, and one in which the life of the locals is so intrinsically linked to the resources of their natural environment, the best balance between the needs of the environment and the type of economic activity best suited to maintain it has not yet been found.

12 http://www.indexmundi.com/map/?t=0&v=69&r=eu&l=en
13 http://www.rjgeo.ro/atasuri/revue%20roumaine_55_1/N.%20Damian.pdf
14 http://www.rjgeo.ro/atasuri/revue%20roumaine_55_1/N.%20Damian.pdf
15 Poverty Report. Republic of Moldova 2010-11



2. CLIMATE CHANGE IMPACTS ON NATURAL SYSTEMS

2.1 CLIMATE CHANGE IMPACTS ON WATER

In the delta area Danube splits into 4 main arms – Kilia, Tulcea, Sulina (the main navigation channel) and Sf. Gheorghe. The Ukrainian part of the delta has been growing steadily, and every year its total area increases by about 2 ha, while Romanian shoreline has retreated inland between 180 to 300 meters. 80 ha/year of the beach have been lost over the last 35 years[1].

The Danube has a complex water regime with 3 phases: spring flood, summer and autumn high waters, autumn and winter low water. The spring flood starts in February-March and lasts until June. It has two waves: first is created by melting snow on the plains and the second (mixed) by heavy rains and melting snow in the mountains. The high water subsides in the second half of summer. In the last decades, the periods of maximum average monthly discharge flow rates shifted from May – June to April - May. In October and November heavy rains lead to the next wave of high waters.

A flood-control dam stretches from Reni to Vilkovo. Vast areas of the floodplain located between the river

1 Administraţia Bazinală Dobrogea Litoral (ABADL), 2012. Master Plan Protecţia şi Reabilitarea Zonei Costiere. www.rowater.ro/dadobrogea/

and the Danube lakes have been drained and turned into arable land while the lakes are used as water reservoirs (Kagul, Kartal, Yalpug-Kugurlui, Katlabukh, making a system together with Safyan and Staro-Nekrasovskiy flooded areas, Kitai water reservoir and Stentsovsko-Jabrian flooded areas) for potable water supply, irrigation and fish breeding. Disturbance of the natural hydrological conditions of the lakes and reduced water exchange with the Danube became the main reasons for higher mineralization and overall worsen quality of water in the lakes, including intensified siltation.

Small rivers emptying into the Danube lakes - Kagul, Kartal, Yalpug-Kugurlui, Safyan, Katlabukh, Kitai and Sasyk liman – make up an important part of the natural system of the region. For the last 50 years the anthropogenic activities, particularly straightening and deepening of river beds, construction of lakes and water reservoirs, drainage and tilling of flooded plains, have led to the disappearance of almost half of all small rivers in the region, and those left are in catastrophic condition. Their waters are polluted with effluents from municipal sewage systems, dumping sites, cattle farms and agricultural lands (e.g. river Kyrgyzh-Kytaj, the most polluted river in the Danube delta: in 2010-11 the chemical oxygen demand was 46 times higher than the maximum allowable concentration and biological oxygen demand – 100 times).

Climate impacts

According to the latest research, the most significant impacts of climate change on water resources will include: changes in water temperature, river flow (annual and seasonal), frequency and intensity of extreme weather events (floods and droughts), sea level rise and salinisation of groundwater and estuaries[2].

The average annual temperature of water in the Delta arms between 1961 and 2010 increased, on average, by 1.00˚C. Still more pronounced are positive trends of the maximum annual temperature for the same period: 1.90˚C. The average temperature for July and August increased considerably and will continue rising. Water temperature in these summer months is increasing with an intensity of 0.50˚C every 10 years.

Flooding

Flood predictions are of high uncertainty, especially at the local level in small catchments, however, most studies indicate an increase

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in flood events. Flash floods may become more frequent as a result of extreme meteorological events (e.g. torrential rainfall). Early spring floods are becoming less likely because of reduced snow coverage.

Water scarcity and droughts

Climate change will most likely exacerbate and prolong periods of water scarcity and drought in regions that already experience water stress. Average water temperature will significantly increase in the Danube Delta region, up to 2°C, especially in shallow lakes and reservoirs with a regulated water regime and poor water exchange.

Surface runoff during summer months has decreased to some degree (from 26.9 to 25.6 % of annual discharge). Simulations of runoff seasonality show a future increase of the mean annual discharge in winter and a decrease in summer for the entire Danube River Basin. The runoff is likely to decrease by 5-20% until 2020, or by 0-23% until 2020 and 6 to 36% until 2070, leading to severe water stress in summer[3]. As a consequence, small rivers that are now on the verge of disappearance may dry out completely.

The most vulnerable region is the south of Moldova which already suffers from limited water resources, a small network of surface water distribution and smaller underground water reserves. The problem of water supply will be particularly severe for rural localities. In addition, some of the inner rivers in southern Moldova flow past rock masses with high salt content that makes their waters unsuitable for direct use.

Concentrations of dissolved oxygen will decrease in all bodies of water, especially during the summer months. Assuming the organic load remains the same, higher water temperature will intensify algae blooms. Frequency and intensity of hypoxia (including due to toxic algae) in coastal waters, lakes, and reservoirs will increase. Low water level in the lakes and the volume of water in combination with high mineralization and temperature will considerably change ecology of water basins (eutrophication, mass mortality).

The National Administration “Romanian Waters” anticipates difficulties due to droughts. The navigation channels are inaccessible because of sedimentation or low water levels. Droughts lead to a decrease in water flow, a disconnection of wetlands and floodplains, changes in sediment transport, an increase in local pollution and insufficient groundwater recharge. Droughts will also lead to difficulties in water supply for various sectors.

Sea level rise and coastal erosion

Over the period 1901 to 2010 (IPCC, 2013), global mean sea level rose by 1.9 mm (1.7 mm to 2.1 mm). The sea level registered in Constanţa between 1933 and 2004 shows a trend towards an increasing sea level with the mean rate of about 2.2 mm/yr. (JICA, 2007). Between 2000 and 2004, the mean sea level was much higher than the mean sea level between 1933 and 2004. Gradual sea level rise is the main cause of erosion in the coastal area of the Danube Delta Biosphere Reserve in the long term. It is projected that by 2050 sea level could rise by between 0.15 m (the most favorable scenario) and 0.5m (the most unfavorable unfavorable scenario). In response to the sea level rise it is possible that under natural conditions (Panin, 1999), the deltaic coast will be reshaped by marine processes mostly in the more vulnerable sections (Gârla Împuţita - CâşlaVădanei, Zaton - Perişor and North Porţita – South Edighiol) and is likely to produce changes in intradeltaic depression or the transformation of lagoon areas into bays.

CASE STUDY

Wetlands reduce flood risks in Egå Engsø, Denmark

In Denmark climate change is projected to lead to more intense rainfall and rising sea levels. This prospect makes the provision of flood protection a necessity. An inexpensive and intelligent solution is to create what Mogens Bjørn Nielsen from the Nature and Environment department of the city of Aarhus calls „change”. Egaa Engsoe, a lake of 115 hectares surrounded by 165 hectares of wet meadows, is an example of creating ‘time and space for water’. It is located in the densely populated and low-lying valley of River Egaa close to Aarhus. In 2006 the old river dikes were removed and the drained and pumped area was flooded. A dynamic flow model for the area shows that the lake has reduced the flood risk in the densely populated areas in the lower part of the river valley. As a further benefit, the lake reduces the amount of nitrogen leaching from surrounding agricultural areas into the river.

Source: Circle 2 – Adaptation Inspiration Book, 22 implemented cases for local climate change adaptation to inspire European citizens (www.circle-era.eu)

3 Danube Study – Climate Change Adaptation. 2012, Department of Geography, Chair of Geography and Geographical Remote Sensing, Ludwig-Maximilians-Universität Munich, Germany

2.2 CLIMATE CHANGE IMPACTS ON ECOSYSTEMS

The waters of the Danube, which flow into the Black Sea, form the largest and best preserved of Europe's deltas. In 1999, the UNESCO's Man and Biosphere Programme formally recognised the Danube Delta as a trans-boundary Biosphere Reserve. The Delta is an environmental buffer between the Danube and the Black Sea, filtering out pollutants and providing natural habitats for fish and birds in the Delta and shallow waters of the north-western Black Sea.

There are more than 30 types of ecosystems in the Delta including extensive shallows, islands, sand bars, reed beds and picturesque patches of the floodplain forest. There are 49 types of natural or partly man-induced habitats (according to Romanian habitats classification). Moreover, it harbours the largest reedbeds in Europe – a unique ecosystem that even has its own microclimate.

The Danube Delta is home to about 3000 species, among which are more than 950 vascular plants (57 endemic), 2000 species of insects, 5 species of reptiles, 10 species of amphibians, around 300 bird species, 42 species of mammals and 95 fish species including 5 sturgeons. To preserve the unique landscapes and biodiversity, 17 protected areas were created in the Ukrainian part.

The Delta is part of one of the largest migration corridors connecting the north of Eurasia with the Mediterranean coast, the Middle East and Africa; it is a very important nesting and wintering ground for waterfowl birds. The Dalmatian Pelican *(Pelecanus crispus)*, pygmy cormorant *(Phalacrocorax pygmaeus)*, and ferruginous duck *(Aythya nyroca)* can be observed here. The white-tailed eagle *(Haliaeetus albicilla)* and saker falcon *(Falco cherrug)* also breed in the old oaks on the islets.

The remoteness of the region and an abundance of water, fish and fertile lands has attracted people for centuries. As a consequence, the level of land transformation is relatively high within the whole area of study with the highest values (up to 80%) in the Moldavian part and the lowest (42%) – in the Romanian due largely to the existence of the vast protected area. The main types of land transformation are conversion of wetlands for agricultural activities, construction of dikes and fish ponds. Floodplain loss along the Danube for development purposes was dramatic: from 79% in the middle Danube to 73% in the lower Danube and 35% in the Delta itself.

This inevitably leads to a human-nature conflict: poaching, illegal fishing, sewage and fertilizers from the fields are washed down into the rivers causing eutrophication and algal blooms in summer.

Climate impacts

The change of climate will impact the Delta ecosystems to a considerable extent[4]. Less Danube runoff and flow speed in the Kilia arm, quantity and re-distribution of silt sediments will cause expansion of the southern part of the front delta and the northern part will suffer abrasion. Higher water level in the Black Sea will enhance wind-induced surges which entail long-term water logging of terrestrial flood plain ecosystems of the secondary delta. In the northern part of the Delta freshwater flora which is not so tolerant to the increase of water and soil salinity will be substituted by salt-loving vegetation. Currently observed fragmentation of phytocenoses accompanied by disappearance

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of rare plant species will be more pronounced.

In the central and southern parts of the seaside reserve the Delta will grow steadily and vegetation typical of fresh-water ecosystems will be formed here. Overgrowth of water basins will take place so that certain stages of the vegetation formation process will cease. This may result in the degradation of higher water vegetation and a higher share of algae and adventive kinds of plants. Fragmentation and deterioration of the species composition in the Kilia delta and, particularly, in the delta front will be intensified by appearance and development of adventive kinds of plants. The share of adventive species in tree vegetation (maple) and bushes (salt cedar, silverberry) near the river channel and at rice polders will increase.

The annual temperature increase of 1.5-2.0 °C will lead to changes in the reed development cycle, especially in the transition to winter stage. Over the last 3-4 years, for example during the winter of 2011, leaf fall stage practically did not occur, and it substantially interrupted the period of reed harvesting[5].

Reeds are sufficiently resistant to slight water and soil salinity which means an expansion of its monodominant communities may be expected. Besides, the reeds growing in subsaline habitats ripen quicker and their offshoots are much stronger and viscous, thereby improving its consumer attractiveness. On the other hand, a prolonged flooding period in spring delays the reeds' development, giving way to mace and bulrash. This will likely be observed in the lower parts of the Kilia arm due to an increase in the level of the Black Sea and more frequent wind-induced events. Lower water level in the Stentsovsko-Jabrian floodplain and Sasyk water reservoir will contribute to the formation of salt meadow and marsh/grassland communities where the share of common reeds is small.

Higher frequency of fires will bring a change in vegetation which will be more of the marsh-and-grassland type with a great share of miscellaneous meadow herbs represented by pyrophytes and low share of reeds. This process of "meadowing" of wetlands is observed even now across vast areas of the islands Stambulskiy, Kubanu, Kubanskiy, Ochakovskiy, Ankudibov and Prorvin – territories where fires became common in recent years. A change of the reed wall structure will be the other negative consequence of fires as the ash elements accumulating in soil will cause parenchyma thinning and, consequently, a weaker stem, which reduces commercial requirements for reeds considerably.

During the last decade, Danube water quality has somewhat improved as the content of mineral forms of phosphorus, nitrogen and silica has reduced, though the trend towards greater content of organic substances is still present. Provided that the

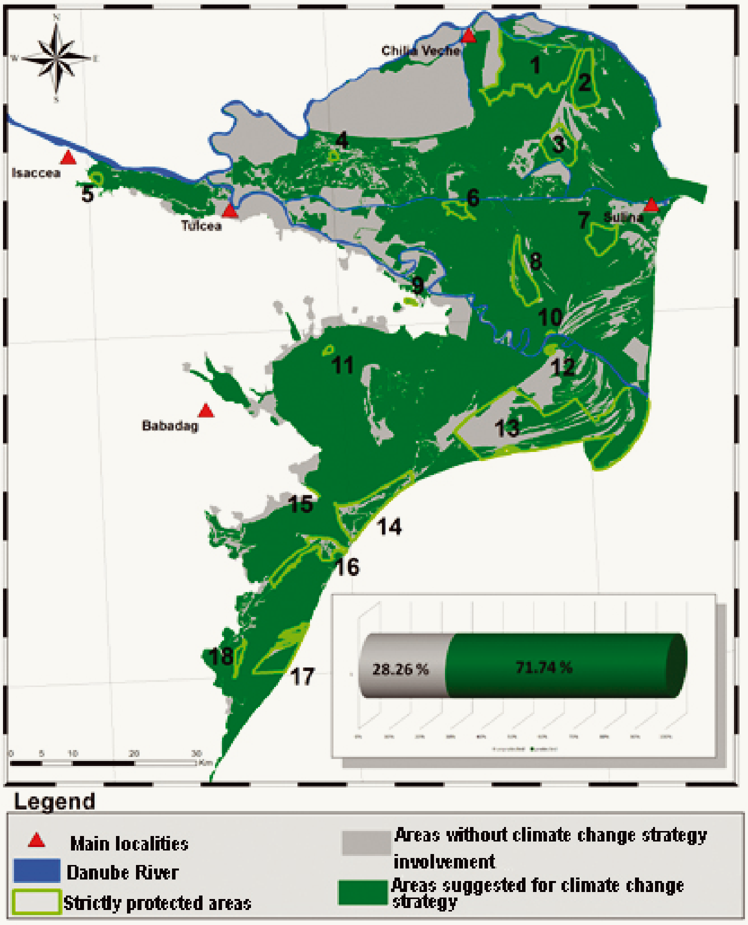


Fig 3. Map of the DDBR (RO) showing most vulnerable habitats

5 Matveev A. 2012, Climate change impacts on fauna in DBR. Fishery in DBR and climate change. Expert report

content of organic compounds in the water stays the same, with rising water temperature, the risk of eutrophication will increase, leading to the decline of the dissolved oxygen content and higher stress on aquatic ecosystems.

Wintering conditions for most mammal species will improve. Fewer days with snow will give competitive advantage to amphibians and reptiles but deteriorate the wintering conditions for rodents and insect-eating mammals. Changes in the life cycle and phenology of birds will result in a shift of migration timing including important commercial game species. Nesting conditions for a number of bird species may deteriorate – including those species nesting in trees and bushes as well as aquatic birds[6].

Out of the 49 habitats identified (Romanian classification system[7]) in the Danube Delta Biosphere Reserve (DDBR), so far, 29 habitats have an important status in terms of the Habitats Directive 92/43. EEC[8]. And 71,74% from the total area of the Natura 2000 habitats with conservation value should be included in climate change strategy process (Figure 3). From the latter, 18 habitats are found within strictly protected areas. The most vulnerable habitats occupy small surfaces, and are included in strictly protected areas. These types of habitats are represented by coastal formations, sand dune forest, and salt marshes[9].

An increase in number of invasive species in the delta ecosystems is expected. The intrusion and spread of invasive species will put pressure on less adaptable native species. Nowadays, human interventions in wetlands can foster the spreading of alien species. Most of the terrestrial and freshwater alien species are found on disturbed or altered wetlands, or polders.

CASE STUDY

Maintenance of alluvial forests in Pojejena, Romania

Riparian, alluvial forests are the natural type of vegetation along streams and rivers, and are strongly influenced by flooding and high groundwater levels. Due to their small-scale mosaic site conditions, riparian forests count among Europe's most species-rich habitats. Near-natural riparian forests have virtually disappeared from Central Europe, as many have been cleared and transformed into pasture.

Benefits of the well-maintained riparian forest are multiple:

- **The riparian forest can act as spawning grounds; therefore maintenance of alluvial forests is expected to have a slight positive effect on fish populations and fishing.**
- **Depending on their size and condition, they can also contribute to flood protection.**
- **As ecosystems associated with flowing waters, they are extremely important for ecological connectivity.**
- **Riparian forest contributes to carbon sequestration, water purification and reducing quantity of nutrients and pollutants.**
- **Erosion control is enhanced and sediment transport to the river is limited.**
- **The strongest positive effect is expected for species diversity: extension of the wintering and nesting habitat for the pygmy cormorant and ferruginous duck (protected species).**
- **Riparian forests have high recreational value, store water and improve groundwater quality.**

Source: CARPIVIA project (www.carpivia.eu)

6 Matveev A. 2012, Climate change impacts on fauna in DBR. Fishery in DBR and climate change. Expert report
7 Doniţă N., Popescu A., Păucă-Comănescu M., Mihăilescu S., and Biriş I. A., 2005, Habitatele din România, Editura Tehnică Silvică, Bucureşti.442 pp.
8 Gafta D. and Mountford O. (coord.), 2008, Manual de interpretare a habitatelor Natura 2000 din România, Elaborat si tiparit în cadrul proiectului PHARE: "Implementarea retelei NATURA 2000 în România" (publicatia UE nr.: EuropeAid/121260/D/SV/RO Editor: Ministerul Mediului si Dezvoltarii Durabile
9 Doroftei M., Tudor M., 2013, Climate Change Adaptation Strategy for the DDBR

3. CLIMATE CHANGE IMPACTS ON SOCIO-ECONOMIC SYSTEMS

3.1 SETTLEMENTS AND INFRASTRUCTURE

About 40% of the population in the region lives in cities. From 2000 to 2012 proportion of the urban population in Moldova and Ukraine has increased by 2-5%. Urban conglomerations are the biggest spatial CO2 producers; roughly 80% of energy consumption takes place there. Due to their large population and density, municipalities are especially vulnerable to heat waves, floods, extreme weather events, drinking water shortages and energy system failures. As a consequence, adaptation to climate change affects various fields of action and actors: infrastructure (especially water related infrastructure), buildings and spatial planning.

Infrastructure

A society cannot function without well-maintained infrastructure that provides critical services for its citizens. These services include providing habitable residential and workspace, transportation, telecommunications, clean water, and safety.

A problem common to infrastructure design is that planners, engineers, and designers traditionally have used historic weather characteristics to determine conditions that infrastructure assets can withstand. Since future climate patterns are expected to be different, designs based on historic weather patterns could leave infrastructure at risk.

Despite living next to the second largest river in Europe, not everyone has access to drinking water of good quality. 60% of rural population in Moldova consumes well-water with a high nitrate content.

Water supply and sewer infrastructure all over the region is either in a very poor state or non-existent. Rural settlements in Ukraine are provided with the centralized water supply at

a very low level and the potable water deficit amounts to only 50%. The Danube and Yalpug Lake are used for the drinking water supply: the Danube – for the town of Kilia, the village of Vilkovo, the village of Leski and the village of Primorskoe, while the Yalpug tames the thirst of the citizens of the town of Bolgrad. In the other settlements water needs are satisfied from underground water reserves.

If urban centers are more or less equipped, almost no centralised sewage and waste water treatment systems are in place in rural areas -- in Moldova, wastewater treatment facilities in rural localities are available only in 1.6% of areas and septic tanks are mainly used for waste water collection. However, significantly higher share of population is connected to water supply networks (65% in Romania, 50% in Ukraine, 91,4% in urban and 39,8% in rural Moldova) than has access to sewers (71,9% and 1,6% in urban and rural areas of Moldova respectively)[10]. City water authorities uses filtration fields to treat wastewater but there is no wastewater treatment plant in either Bolgrad, or Orlovka, Ukraine. This leads to huge pressure on local water bodies where sewage is dumped. Eutrophication and algal blooms are common in summers and are expected to become even more frequent in the future. Moreover, limited availability and access to clean drinking water will be a major health concern.

Buildings

Since in the future, climate extremes are more likely to occur and for longer periods of time, existing buildings may be affected. Thermal stresses on building materials will be greater, cooling demands will be higher, existing flood-proofing may be inadequate, heat island effects may increase, corrosion of building materials may accelerate, and building-related illnesses, primarily caused by mold build-up, may increase.

CASE STUDY

Rain gardens to manage extreme rainfall events, Norway

The Norwegian city of Trondheim is building rain gardens to reduce the water load on the sewers and retain water at the site where it falls as rain. Rain gardens are shallow depressions in the soil that receive runoff after rain. In this way water quality is improved and ground water is recharged. A pilot rain garden in Trondheim was constructed in 2010, in the city of Brasrow Risvollan, with help of the landscape and construction company. These rain gardens were designed and built under an initiative led by the Norwegian Water Resources and Energy Directorate with the aim of helping cities adapt to climate change. Creating more room for water and ecological niches might also increase biodiversity.

Source: Circle 2 – Adaptation Inspiration Book, 22 implemented cases for local climate change adaptation to inspire European citizens (www.circle-era.eu)

10 Audit of Apele Moldovei (2012) http://lex.justice.md/viewdoc.php?action=view&view=doc&id=343220&lang=2

If climate change is considered when a building is being designed or altered, it is likely to remain comfortable for long, far less likely for its entire lifespan.

Spatial planning

Integrating climate change concerns into land-use planning is one of the most cost-efficient adaptation measures. Climate-proof land-use plan will help prevent further development on the territory that is under high or medium risk of flooding. Increasing area of green zones will mitigate the formation of a heat island effect (temperature in the cities is couple of degrees higher than in the surrounding environment due to high density of buildings), while better insulation of existing and new buildings will protect inhabitants during rapid temperature changes and reduce energy demand for heating and cooling.

Climate impacts

Predicted climate change impacts have the potential to damage or destroy key infrastructure in Danube Delta region. The risk of flooding with further mapping of potentially flooded zones was assessed in the framework of FLOODRISK project[11] and 'Emergency planning and flood protection in the Lower Danube Euroregion'[12]. Annex 2 presents dangerous water levels for key infrastructural objects in the Ukrainian Delta. Water levels were calibrated following the damages from flood in July 2010.

The oil terminal in Moldova's Djurdjulesti village has a capacity for 2 million tons of stock of oil products/year. Flood events in 2008 and 2010 caused damages and required dike maintenance which cost approximately 350,000 euro. Special attention should be given to flood-protection of the above-mentioned objects.

11 http://www.danube-floodrisk.eu
12 http://crs.org.ua/en/projects/archive/47.html

3.2 AGRICULTURE

Agriculture plays a prominent role in Moldova and Ukraine. 80% of the teritory of the region in Moldova and almost 70% in Ukraine constitute agricultural lands, most of them occupied by arable land used for subsistence farming. In the Romanian part of the Delta less than 1% of land is under agriculture as the rest is highly unsuitable for growing crops. Shares of population employed in this sector of the economy follow the same pattern: up to 80% of population in Moldova makes a living from agriculture, approximately 50% - in the Ukrainian part of the Delta and about 30% in Romania. The left bank of the Danube is famous for fruit orchards and local wine production.

Agriculture is a source of quite a number of environmental problems - soil degradation, water pollution from agrochemicals, and lack of sustainable manure management practices, contributing to the eutrophication of local water reservoirs and, through Dniestr and Prut Rivers, of the Black Sea.

A shift to organic agriculture would not only reduce pressure on the environment but also allow farmers sell their produce at a premium price. In the opinion of local authorities, there are favourable conditions for the development of organic agriculture in the Gagauzia region of Moldova. The global market demand for organic food is steadily growing. The EU organic market alone was estimated at EUR 21.5 bn (2012), while the total consumer market in Russia is estimated at $148 million with high growth potential. According to governmental estimates, approximately 30% of agricultural lands could be used for this purpose. This would create about 1000 new jobs and increase farmers' income by 30-40%. Main obstacles are poor infrastructure (substandard roads, lack of modern cooling storage and irrigation systems), low awareness about certification procedures and access to the markets.

Financial assistance and advisory services for organic products, marketing assistance, easier access to credit and capital investment for farmers would facilitate and promote organic agriculture in the region while helping reduce pressure on soil and water resources.

Climate impacts

Despite the huge water resources of Europe's second biggest river, a considerable number of inhabitants of the Ukrainian and Moldovan Danube region and many industries suffer from a drinking water deficit. A future decrease in the availability of water resources due to climate change may lead to an increase in production prices and drop of competitiveness of local produce on international markets.

Agricultural activities, in particular crop cultivation, are threatened by reduced crop yields and less employment opportunities due to water scarcity, physical damage to crops due to cold spells, flash floods and fires, reduced fertility of soil due to a raised intensity of draughts and flash floods, soil erosion. Animal husbandry is at risk of diseases and death of animals due to heat waves and favourable conditions for spreading viral and infectious diseases.

Droughts, especially in the southern region, are a particular concern for Moldova. According to an official report, the drought in 2003 had a negative impact on the well-being of rural households in 2004 because of rising production costs which resulted in an increased incidence of extreme poverty in rural areas[13]. The much more catastrophic drought in 2007 mainly resulted in higher poverty rates the following year because of the stocks of agricultural products available in many rural households.

At the same time, climate change may bring some positive effects to agriculture by offering the possibility of cultivating secondary crops due to prolonged periods of vegetation, as well as cultivating new crops which thrive in warmer temperatures. For example, between 1887 and 1959 an air temperature of -23C, the critical temperature for peach crown in the

Cahul area of Moldova, occurred on average once every four years, now it occurs only once every 10-20 years.

Agro-climatic conditions of winter wheat and spring barley cultivation are, overall, sufficiently favourable. The duration of the vegetation period is favourable for seasonal crops but insufficient precipitation limits yields.

It is probably that the system of water management will face increased water demand in the industrial sector and for domestic use as the conditions of decreasing water resources. Supplies of good quality drinking water may be complicated due to the loss of water in the distribution networks and reservoirs, especially in combination with more droughts during summer. Some regions will face further water scarcity.

Due to total artificial regulation of the rice-growing farms' hydraulic systems in Ukraine, they will be less susceptible to climate change. Longer vegetation period will make it possible to grow rice within an optimal period and reduce the harvest losses caused by late harvesting.

Lastly, there is a risk of nutrients being washed-out from arable lands and intense soil erosion due to increased frequency of rainstorms.

Adaptation of plurispecific systems to climate change, France

CASE STUDY

We need new ways of farming to keep European food production efficient, make it more sustainable and able to cope with the projected effects of climate change. To prepare for the effects of climate change, it is important that the agricultural sector takes appropriate adaptation measures. The current system, largely based on monoculture, is more vulnerable compared to alternatives such as plurispecific systems which cultivate a mixture of species. In France, farmers have started experimenting with the concept of agroforestry which is less vulnerable to climate change. In France, about 3,000 hectares of agroforestry systems are now planted each year and it is expected that within the next 25 years, about 500,000 hectares of agroforestry will have been implemented.

Source: Circle 2 – Adaptation Inspiration Book, 22 implemented cases for local climate change adaptation to inspire European citizens (www.circle-era.eu)

13 Ministry of Economy and Trade of Republic of Moldova, „Report on Poverty and Policy Impact 2004", Chişinău, November 2005.

3.3 FISHERIES

Fishing has been the main activity in the Delta for centuries and is the most important natural resource in the DDBR. While no relevant official statistics are available, there are around 1,500 fishermen among the 15,000 inhabitants of the Danube Delta[14]. Fishermen used to use all the areas covered with water temporarily or permanently but now most areas are abandoned, because of the decline of more economically valuable fish stocks, and appearance of exotic fish species which are less valuable. About 15% of the population pursue this career path.

In the Ukrainian part of the Danube Delta area alone 106 fish species have been registered and all 7 species of fish from the European Red List occur in the Reserve. Freshwater species most spread in the Danube Biosphere Reserve are species of carp family (29 species). Most valuable from the fishery viewpoint are migratory fish species (they can live both in fresh and salt water) such as Black Sea herring (69% of catch in Ukraine) which is caught in the Lower Danube, as well as species of salmon family[15]. Apart from indigenous species there are 11 alien or introduced fish species.

Anadromous migratory fish (lives in the sea but spawns in the river) is important to the delta fishery. Danube herring is netted as it moves upstream from the Black Sea to spawn in freshwater. Herring is caught between April and June and catches vary from season to season for example, in Romania, they are between 200 – 2,400 tonnes per annum. The catches have declined from around 15,000 tonnes (between 10,000 and 20,000) in the 1960s, to 5,000 – 6,000 tons in 1994, while in Ukraine catches are from 358 - 624.6 tonnes per year. The construction of polders in the late 1950s and 1960s, reduced the area of the “Danube meadow” available in the flood season for spawning of carp and other commercially valuable species.

Sturgeon fishery used to be important here, but with the construction of two dams, Iron Gates in 1972 and Ostrovul Mare in 1984, near Drobeta-Turnu Severin the upstream migration of sturgeon was interrupted. Even though they are able to reproduce below the dams as well, and a programme of breeding and re-introduction is being carried out to boost their numbers, all sturgeon species are on the brink of extinction. If in 1960 catches were amounting to 300 tonnes, by 1994 they had fallen to 6 tonnes. Sturgeon catch bans are established in all riparian countries, however their enforcement is weak and poaching occurs.

Climate impacts

Higher water temperature and more frequent droughts will be major drivers shaping the future of the fish stocks. However, as inter-species relations and the individual response of species are unknown, the projections are of high uncertainty and should be treated with caution.

The projected water temperature increase will affect the fishes’ biology immediately as the fishes’ body temperature differs from the ambient temperature, as a rule, by 0.5 – 10C, thus influencing growth, feeding and reproduction considerably.

An increase in water temperature during the spawning season even by 1-2 ºC is of vital importance for the start of spawning. Spawning of the Danube herring, the main commercial fish species in the Delta, has already shifted 2-3 weeks earlier over the past 50 years and is likely to occur even earlier following changes in the water temperature.

Higher water temperatures and lower oxygen concentration will first of all have negative consequences for rare and protected species, as they are the most sensitive. For example, species of salmon and sturgeon family start having breathing problems under oxygen concentration lower than 6 mg/l, while Prussian carp (*Carassius gibelio* (Bloch, 1782) needs only 0,5-2 mg/l.

Higher water temperature in summer time, especially in the water basins characterized by high content of organic matter and limited water exchange (e.g. Stentsovsko-Jabrian floodplain) is likely to cause more frequent fish kills.

The growing periods of the main commercial fish species and the number of fishing days will be prolonged which increases pressure on the population of main industrial species. Future climate changes will not trigger a considerable reduction in catches in the Danube, though their qualitative composition may deteriorate. At the same time fish production in the Danube lakes and reservoirs can decrease due to the worsening of water exchanges and lower water quality.

14 Operational Programme for Fisheries in Romania (2007-2013). Ministry of Agriculture and Rural Development
15 Matveev A. 2012, Climate change impacts on fauna in DBR. Fishery in DBR and climate change. Expert report.

3.4 FORESTRY

Forestry within the Romanian Delta has had a rather chequered history, mainly due to the use of inappropriate species to create plantations. Plantation forests cover 5,400 ha, but this area is set to decline as the trees are cropped and natural forests are encouraged to regenerate for ecological reasons. Natural forests of willow, oak, ash, white poplar and aspen cover 8,000 ha of the territory. Softwood species (95%) are prevailing[16].

Apart from providing important harbors for biodiversity (73% of surface), forests in the Romanian Delta are used for wood production (27% of the surface)[17]. Forests of economic interest are concentrated in the fluvial delta. Apart from wood harvesting, the picking of mushrooms, medicinal plants, and hunting are common. Forestry absorbs a small fraction of the labor force in reserve. Increasing the employment rate in this area can be done by promoting traditional activities (wickerwork, etc.).

The hybrid poplar plantations, black locust and green ash plantations have a strong negative impact on natural surroundings. The indigo bush which is alien species in this area, develops in the shrub layer of poplar plantations and from there spreads into natural habitats. The black locust and green ash are also invasive species spreading throughout the delta.

Climate impacts

There will be changes in forest structure and species composition. Species which are better adapted to climate pressures will benefit and advance. Forest fires will play an important role in changing species composition. Some parts of floodplain forest, for example, were damaged during the severe reedbed fires in Ukraine in 2010.

16 Danube Delta Biosphere Reserve web-site
17 Danube Delta Biosphere Reserve web-site.

CASE STUDY

WAVE: Community Woodlands and Climate festival in Somerset County, UK

The county of Somerset is one of the counties in the United Kingdom with the lowest woodland cover. Woodland can help to sequester carbon, reduce the emission of greenhouse gases and support the adaptation of those areas subject to inevitable future climate changes, including extreme rainfall events and flooding. This triggered Somerset County Council to encourage the development of what they call Community Woodlands. Since then, twelve Community Woodlands have been established with help from local residents. The woodlands are usually between a quarter and five hectares of managed (semi) wild areas with trees and shrubs located within a short walking distance to the next villages. The Community Woodlands (part of the EU WAVE project) supports Somerset in becoming more climate resilient and preparing the water system for projected climate change. In the context of the WAVE project, Somerset organised a Water Festival, which was attended by 6,000 people.

Source: Circle 2 – Adaptation Inspiration Book, 22 implemented cases for local climate change adaptation to inspire European citizens (www.circle-era.eu)

3.5 ENERGY SECTOR

One of the important steps towards promoting the higher resilience of the Delta communities is the diversification of energy sources. Currently, Odessa oblast satisfies only 60% of its energy needs from domestic energy production and the rest is imported from other regions of Ukraine. Lack of the local electric power generating capacities considerably slows down economic development and contributes to social tensions even though region has high potential to become energy independent.

Most of electricity is produced by coal and gas power plants. Both energy sources are supplied from the east of Ukraine and Russia. These types of fuel are subsidized by the government and their price does not include the costs of environmental impacts both during the extraction and use. The burning of coal and gas perpetuates climate change, leads to air pollution, contributing to higher rates of pulmonary diseases.

Table 1. Links between technologies and climate change effects

Technology	Δ Air temp	Δ Water temp	Δ Precip	Δ Wind speeds	Δ Sea level	Flood	Heat waves	Storms
Nuclear	1	2	-	-	-	3	1	-
Hydro	-	-	2	-	-	3	-	1
Wind (onshore)	-	-	-	1	-	-	-	1
Wind (offshore)	-	-	-	1	3	-	-	1
Biomass	1	2	-	-	-	3	1	-
PV	-	-	-	-	-	-	1	1
CSP	-	-	-	-	-	1	-	1
Geothermal	-	-	-	-	-	1	-	-
Natural gas	1	2	-	-	-	3	1	-
Coal	1	2	-	-	-	3	1	-
Oil	1	2	-	-	-	3	1	-
Grids	3	-	-	-	-	1	1	3

Note: 3 severe impact, 2= medium impacts, 1= small impact, -- no significant impacts

Climate impacts on energy production

If the air temperature becomes too high (generally during summer heat wave, which will be longer and more frequent under average higher temperatures) the fuel burning efficiency in power plants will decrease due to a lower oxygen concentration in the air, caused by a lower atmospheric pressure under higher temperatures. Lower difference between outside and turbine temperature will as well contribute to lower efficiency. This is mainly relevant for oil, but negligible for coal and biomass where the outside temperature would only affect demand but not power plant operation. Furthermore, the losses of electricity networks increase with rising temperatures due to increased resistance. If the air temperature gets too low it can lead to icing problems, but under a temperature increase scenario such events are projected to become less frequent.

There are also indirect effects of higher temperatures in the day to day demand patterns, where the level of demand in summer grows the quickest, which is also the period when the power plants are most vulnerable, leading to new challenges in balancing the power system. This effect can roughly be quantified as 0.1% lower efficiency for every increase in temperature by 1ºC for natural gas and oil fired power plants, which translates into more expensive power generation costs, due to higher fuel consumption, which would translate into 2%/Co loss in power generation. During heat waves operational costs may go up with more people in service (increase by 50-100%) and more material in stock (increase by 10-20%)[18].

Table 1 shows how each change in climate parameters will potentially impact various technologies. More frequent flood occurrence presents a major threat for almost all energy sources. Photovoltaic (PV) and concentrated solar power plants (CSP) will be the least impacted.

The Danube Delta region has favorable conditions for solar energy production 7 months a year. One square meter of a solar collector can produce approximately 0.35 gigacalories annually, which could substitute 50 m3 of gas[19]. Investors show high interest in Odessa oblast: the first solar power stations are already running in Belgorod-Dnestrovsky and Reni district and projects worth $700 million are in the pipeline. The capacity of the Danube solar power station is 21.5 MW and additional 21.5 MW will be added by the end of the year. As Reni needs only 10-14 Mw, the rest will be sold to the region. Currently solar power station projects are being developed next to the towns of Kilia, Bolgrad and Artsyz[20].

Biomass is another viable source of energy. Reed is abundant in the region and mosaic mowing of reeds in wetland ecosystems is an important regulatory mechanism. It allows for higher oxygen content in the water, leading to an increase in wetland's productivity up to five times that in the unmanaged sites, while at the same time minimizing fire risk. Additionally, collecting reeds is a way to support economy in the region creating considerable number of jobs (more than a 1000 in the proximity of the Ukrainian Danube Biosphere Reserve). Such new employment opportunities would take some pressure off the Delta ecosystems, provide alternatives to poaching and improve ecosystem health. Reed has lower calorific value than coal and gas but this is compensated by the abundance of the resource.

CASE STUDY

Solar panels produce energy and protect crops from excess heat, France

Providing food for a growing world population is no longer the only purpose of agriculture. Modern farmers are counted upon to deliver crops and provide raw materials for bio-based fuels and bio-energy. An additional stress factor for southern European agriculture is dealing with increasingly high temperatures, which can have a particular large impact during (already hot) summers. The French National Institute for agronomical Studies has initiated a project where they designed a so-called agri-voltaic systems. This system makes it possible to use the sunlight shining onto fields to simultaneously grow food and produce electricity. The electricity can be used to power homes, workplaces, and even as a source of extra income.

Source: Circle 2 – Adaptation Inspiration Book, 22 implemented cases for local climate change adaptation to inspire European citizens (www.circle-era.eu)

18 Final report. Investment needs for future adaptation measures in EU nuclear power plants and other electricity generation technologies due to effects of climate change. Koen Rademaekers, Jeroen van der Laan, Sil Boeve, Wietze Lise (ECORYS Nederland BV), Jan van Hienen, Bert Metz, Paul Haigh, Karlijn de Groot (NRG), Sytze Dijkstra, Jaap Jansen, Tjasa Bole, Paul Lako (ECN), Christian Kirchsteiger (DG Energy), 2011

19 MAMA-86, www.mama-86.org.ua/index.php/uk/pel/28-2009-09-30-07-34-04.html

20 http://ecoclubua.com/2011/09/sonyani-elektrostantsiji-v-ukrajini-potentsijni-proekty/




3.6 TOURISM

Tourism is highly developed in the Romanian part of the delta, while the Ukrainian side is not visited frequently. The region benefits from unique natural conditions and abundance of wildlife. Also, there are promising conditions for the agro-tourism development with important resources for the entertainment tourism development (fishing, bird-watching, kayaking). The cultural-historic patrimony of the Romanian Danube Delta is plentiful: Roman, Greek, Byzantine fortresses and monasteries, most of them located in surrounding areas of Danube Delta[21]. The Moldavian part is currently very poorly suited for tourism. The potential for its development should be evaluated.

There is a great potential for developing eco-tourism in both Romania and Ukraine, provided sufficient investment can be found for renovations and bringing existing facilities up to modern standards. The local family's life revolves around tourism during the peak season, and unlike other tourist destinations, the members of the family are the first to benefit from this business.

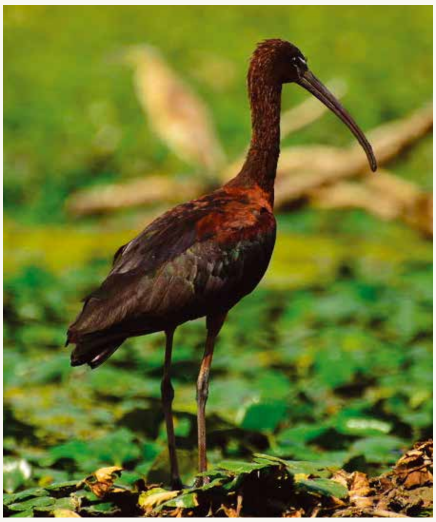
Tourism is closely connected to the main subsistence strategy - fishing. Promoted in a sustainable manner, tourism can attract a significant number of visitors of these areas, which will contribute to the income diversification for the fishing communities.

Income from tourism can become a safety net for families in the years of low yields or loss of harvest. Developing transboundary tourist routes will attract visitors to Ukrainian part of the Delta stimulating job creation in the tourism sector. On the other hand, it is important to ensure that influx of people does not cause additional pressure on ecosystems. As a preventive measure tourist routes may be diverted away from the most sensitive habitats.

Climate impacts

Due to longer summer season higher number of visitors may be expected, leading to more pressure on the environment, unless managed wisely.





21 http://www.mdlpl.ro/_documente/regiuni/2.SE.pdf

3.7 PUBLIC HEALTH

The Danube Region of Ukraine is characterized by high mortality rates, frequency of oncologic diseases, and diseases of gastrointestinal and blood circulatory systems which exceed the corresponding figures for Odessa region. Number of TBC patients increases every year[22]. High mortality in the area is caused by a low income level, inaccessible medical services and low-quality potable water.

The number of people in the entire region have limited access to health care and\or its quality is low. The health infrastructure, both in terms of constructions and endowments, is scarce.

Climate impacts

Climate change can affect health both directly and indirectly. Higher occurrence of extreme weather events, e.g. floods and heat waves, may lead to injuries and death, while new invasive species may prove to be strong allergens and cause respiratory diseases (indirect impact).

Warmer and wetter climate opens up new habitats for local species of mosquitoes that transmit arboviruses (a group of viruses that are transmitted by arthropod vectors) leading to more hot spots of fevers and encephalitis. It can be expected that the northern borders of malaria mosquitoes will shift northwards, and southern populations may substitute northern ones. Due to new more favorable conditions exotic vectors *Aedes albopictus* and *Ae.aegypti* that transmit dengue fever and yellow fever may occur on the Black Sea coast[23].

Heat waves are likely to be more frequent, increasing risks of heat strokes. They are particularly dangerous for the elderly, chronically ill and disabled people. Additionally, observed and projected climate change is associated with rapid temperature changes which, especially during the cold period of the year, exacerbate cardiovascular diseases - hypertension, angina pectoris, and heart attack. As older age groups dominate population structure in the region, the number of hospital admissions appears likely to increase.

Lack of waste water treatment facilities leads to organic pollution of water bodies where sewage is dumped. Higher water temperature will be favorable for the development of pathogenic bacteria. An increase in diseases caused by consumption of low-quality drinking water (cholera, leptospirosis, rotavirus infections) may occur. The local situation may be complicated by toxic algae blooms in drinking water sources.

22 National bureau of statistics of Ukraine (2012)
23 European Center for Disease Prevention and Control

4. CLIMATE CHANGE ADAPTATION ACTION PLAN

The Climate Change Adaptation Action Plan for the Danube Delta sub-basin links each of the above chapters to concrete adaptation actions in order for the region to better adapt to new climate conditions. The adaptation measures presented in this chapter have been identified, prioritized and described through a consultative process with key stakeholders from Romania, Moldova and Ukraine. The action plan includes information about the responsible institution for the implementation of the measures, highlighting those with transboundary dimension.

As climate change planning is a very dynamic process it is anticipated that the measures presented in this chapter will be tracked continuously and the action plan will be revised and updated every five years in line with the developing of the management plans for the Danube Delta sub-basin in Romania, Moldova and Ukraine.

4.1 CLIMATE CHANGE ADAPTATION ACTION PLAN FOR NATURAL SYSTEMS

4.1.1 WATER

Water resources will be subject to the influence of extreme weather events such as torrential rains which contribute to the formation of flashfloods or droughts and shortages of water resources, especially in summer. Flood predictions are highly uncertainty, especially at the local level in small catchments, however, most studies indicate an increase in flood events. Climate change will most likely exacerbate and prolong periods of water scarcity and drought in regions which already experience water stress. The minimum runoff will diminish as temperature and evaporation rise. Average water temperature will significantly increase, up to 2°C by 2050, in all bodies of water, especially in shallow lakes/reservoirs with regulated water regimes and poor water exchange. Due to rising water temperatures in all surface and ground waters, the water quality will decrease. By 2050 the sea level could rise by 0.15 m (the most favorable scenario) and by 0.5m (the most unfavorable scenario) leading to erosion and flooding of the coastal areas. Having all these predictions and estimated impacts, the adaptation of water management should be a central element in the adaptation strategy of any country[1] or any region. For the Danube Delta sub-basin, the adaptation measures should have as an overall goal securing enough water of good quality for people and ecosystems under new climate change conditions. To achieve this goal, the following adaptation measures have been identified and analyzed by local stakeholders and experts.

1 http://www.unece.org/index.php?id=11658

Measure	Description		Location	Responsible	Priority
Preparatory measures					
Transboundary digital model for Danube Delta and Lower Prut floodplain (including hydraulic models)	LIDAR scanning will provide the best digital model for decisions and will help identify degraded areas (floodplain and channels), high flood risk areas as well as places where flood defense measures are needed. Stakeholders consider the transboundary digital model an important basis for flood risk management, spatial planning, restoration and sustainable use of natural resources. Timeline: short term (next 5 years) Risk mitigated: lack of data on floods, droughts, sea level rise		Trans-boundary	ICPDR with support from: national water agencies, NGOs, Academy of Science in Moldova	Medium
Drought management plans including priority water uses	Design special drought plans for the Danube Delta sub-basin for the low water periods, including maintaining water level in summer if possible and not conflicting with dynamics of the wetlands and fishing industry. Timeline: medium term (until 2030) Risk mitigated: droughts, water scarcity		Trans-boundary	DRBMD, DDBRA	Medium
Preventive measures					
Transboundary ecosystem based management of Danube Delta	Ecological rehabilitation of Lower Prut floodplain	In order to reduce flood risks in the Delta region, ecological restoration along Lower Prut river is proposed. Timeline: medium term (until 2030) Risk mitigated: flood, drought, biodiversity loss, reduced habitat availability, water scarcity	Moldova Romania	Romanian Waters Administration, Moldovan Waters Administration, Lower Prut Administration	High
	Ecological rehabilitation of fishponds and agricultural polders	The Master Plan for the Romanian Danube Delta identified areas with no economical efficiency which are proposed for ecological rehabilitation: 4 fishponds (Ceamurlia, Chilia, Murighiol, Dunavat) and 2 agricultural polders (Sulina, Carasuhat). Timeline: medium term (until 2030) Risk mitigated: flood, drought, biodiversity loss, reduced habitat availability, water scarcity	Romania	DDBRA NIRDDD	High
	Improve water management in Kartal lake	Wetland restoration project to restore surrounding floodplain and inflow as well as a natural seasonal water level dynamics. Timeline: short time (next 5 years) Risk mitigated: flood, drought, biodiversity loss, reduced habitat availability, reduced water quality	Ukraine	DDRBMD with support from CRS	High
	Improve water exchange processes in Yalpug lake and river	Reconnecting Yalpug lake to the Danube will change water level but will improve water quality. This is important for local communities which obtain drinking water from there. The relocation of the water uptake point to the deeper part of the Yalpug lake might be necessary. Timeline: medium term (until 2030) Risk mitigated: flood, drought, biodiversity loss, reduced habitat availability, water scarcity	Moldova Ukraine	Apele Moldova DRBMD	High
	Designate water protection zones and improve bank protection through afforestation along small rivers and lakes	Trees along the banks will act as a filter for the runoff and create shade over open water, this way reducing water temperature and improving its quality. This measure is suggested for the following water systems: Prut (in Romania and Moldova), Siret (Romania), SZP, Yalpug - Kugurlui - Karaly system, Katlabuh and Kitai lakes Timeline: short term (next 5 years) Risk mitigated: flood, drought, biodiversity loss, reduced habitat availability, water scarcity	Trans-boundary	Forestry districts, Water authorities, Local authorities	High
	Improve water management in Kishkan-Cahul	The Kishkan-Cahul sector of Lower Prut - 9.3 km - of dikes is past its lifetime, instead of rehabilitating the dikes, the restoration of the floodplains (around 6000 ha) is proposed. This action will also reduce the risk of land slides along the Prut river due to flooding. Timeline: medium term (until 2030) Risk mitigated: flood, drought, biodiversity loss, reduced habitat availability, water scarcity	Moldova	Local authorities	Medium
	Restoration of water dynamics of Katlabuh lake	Accomplish wetland restoration project at Katlabuh lake to renew storage capacity of Katlabuh lake for flooding water, improve water quality in the lake for irrigation and technical use and improve fishery conditions. Timeline: short term (next 5 years) Risk mitigated: flood, drought, biodiversity loss, reduced habitat availability, water scarcity	Ukraine	DDRBMD, WMB	Medium
Reactive measures					
Strengthen existing protection against floods, construct new flood protection structures	Beleu lake is located in the lower Prut Basin at a distance of 20- 40km from the confluence with the Danube River. The upper part of the lake is used for oil extraction -nearly 30,000 t of oil are extracted each year. The dams have to be reinforced for flood protection of the oil extraction installations around Beleu lake Timeline: short term (next 5 years) Risk mitigated: biodiversity loss, reduced habitat availability		Moldova	Private company (the owner of oil extraction installation)	High
	The Road Reni-Ismail between Reni town and Kartal lake need investments for rehabilitation Timeline: short term (next 5 years) Risk mitigated: flood		Ukraine	DDRBMD	High

4.1.2 ECOSYSTEMS

Different climate change effects increasingly affect Danube Delta biodiversity and ecosystems through droughts, floods, and fires. The ability of species to migrate between the Danube River and floodplain wetlands and among floodplain wetlands is going to be critically important for the survival and maintenance of biodiversity. These harmful impacts also affect the utility of floodplains as spawning, breeding and nursery habitats for animals. Invasive species come are another major impact of climate change.

Higher water levels in the Black Sea will enhance wind-induced surges which entail long-term water-logging of terrestrial floodplain ecosystems of the secondary delta. In the northern part of the Delta freshwater flora, which has a low tolerance to salinity, will be substituted by vegetation typical of brackish and sea environment. Wintering conditions for most mammal species will improve.
Fewer days with snow will give competitive advantage to amphibians and reptiles but will deteriorate wintering conditions for rodents and insect-eating mammals. Changes in the life cycle and phenology of birds will result in a shift of migration timing.

Therefore, the biologists specialised in the Danube Delta proposed the use of ecosystems based measures to facilitate a naturally occurring adaptation to climate change as an overall goal. . The adaptation measures referring to removing barriers, restoring and maintaining connectivity of floodplain and all its diverse elements - meadows, lakes, streams and marshes and their connection to the Danube River - are the main adaptation measures that would increase resilience to floods and droughts and benefit biodiversity and economies dependent on natural resources. Additional to these type of measures you will find on the following action plan table other measures related to long-term monitoring, studies of climate impacts on key species and trophic chains, as well as identification of climate refugia.

Measure	Description	Location	Responsible	Priority
Preparatory measures				
Scientific research on the impacts of climate change on biodiversity and ecosystems	To facilitate naturally occurring adaptation in the ecosystems, we first need to know what's going on. Therefore, long-term monitoring, studies of climate impacts on key species and trophic chains, as well as identification of climate refugia are crucial. Timeline: medium term (until 2030) Risk mitigated: biodiversity loss, reduced habitat availability	Trans-boundary	Scientific research institutes Academy of Science Universities	High
Preventive measures				
Include climate refugia and biodiversity migration corridors in the protected areas	The main purpose of this measure is to ensure that climate refugia and migration corridors for endangered species are preserved, protected and are under minimal anthropogenic pressure. Timeline: short term (next 5 years) Risk mitigated: biodiversity loss, reduced habitat availability	Trans-boundary	DDBRA, Local authorities Romania, Ukraine and Moldova	Medium
Modify the management plans and monitoring programmes for the transboundary biosphere reserve according to new climate pattern	In response to the new threat to the integrity of Biosphere reserve, the future management actions should include: ·new conservation measures from the climate change adaptation perspective ·an electronic transboundary data base for the DDBBR biodiversity, ·a joint inventory and description of habitats in the national biosphere reserves, ·introducing early fire warning system and fire barriers Timeline: short term Risk mitigated: biodiversity loss, reduced habitat availability, wild fires	Locally and trans-boundary	Danube Delta Biosphere Reserve Administrations	Medium
Reactive measures				
Restore degraded lands (including floodplains)	Fragmentation of habitats reduces the opportunity for species movement and dispersal, a factor that will become increasingly important to species survival in a changing climate. Renaturation of degraded lands will increase the resilience of species and habitats in the Danube Delta. Timeline: medium term (until 2030) Risk mitigated: flood, drought, biodiversity loss, reduced habitat availability, water scarcity	Locally	Scientific research institutes Danube Delta Biosphere Reserve Administrations, Local authorities	Medium
Manage invasive species	Statistically, the main problem for biodiversity in the Danube Delta is the loss of habitats triggered by the spreading of invasive species. Climate change is likely to exacerbate the spread of invasive species, with serious environmental and economic consequences. An intensive management of invasive species will contribute to strengthening the Danube Delta ecosystems and economy. Timeline: medium term (until 2030) Risk mitigated: biodiversity loss, reduced habitat availability	Locally	Danube Delta Administrations Local authorities	Medium

4.2 CLIMATE CHANGE ADAPTATION ACTION PLAN FOR THE SOCIO-ECONOMIC SYSTEM

4.2.1 SETTLEMENTS AND INFRASTRUCTURE

Torrential rains are expected to occur more frequently pushing existing drainage systems to their limits. Flash floods may lead to infrastructure damages and high economic losses. Assuming the nutrient load stays the same, higher water temperature will lead to lower water quality and potential algae blooms, especially in shallow lakes/reservoirs with regulated water regimes and poor water exchange, endangering the drinking water supply. Having the climate change potential impacts on infrastructure identified and taking into account the particularities of the Danube Delta sub-basin ecosystems, the adaptation measures for infrastructures maintenance is targeting the using of green infrastructure solutions to better cope with new climate conditions. The adaptation measures identified by local stakeholders and representatives of local communities, and presented in the following action plan table are divided into three sub-sections: infrastructure (especially water-related infrastructure), buildings and spatial planning.

Infrastructure

Measure	Description	Location	Responsible	Priority
Preparatory measures				
Educational campaign for water resource utility owners and operators regarding the climate change	Implement a program to educate the water operators regarding the vulnerabilities of their assets to climate change impacts and support them to identify the proper management responses. Timeline: medium term (until 2030) Risk mitigated: drought, water scarcity	Locally	Local authorities Water authorities	High
Preventive measures				
Group water supplies for villages to adapt to droughts and water shortages in summer	Group water supply systems for the villages along the Danube with no central water supply to ensure water from the Danube river in case of severe droughts or low flows in summer when local water sources are not reliable. Timeline: medium term (until 2030) Risk mitigated: flood, drought, water scarcity	Ukraine Moldova	Local municipalities	High
Extend water supply network in Moldovan villages	For Moldavian villages Colibas, Cislita, Djurdjulesti, Valeni, Brinza it has been proposed to extend the municipal water supply service "Apa Canal". Timeline: long term (until 2050) Risk mitigated: drought, water scarcity	Moldova	Local authorities, Apele Moldova	High
Reduce nutrient flow into water bodies from cities and villages: Decentralised waste water treatment (WWT) systems on the basis of constructed wetlands and similar designs	The systems can be built on a household, hamlet or village level. These systems are relatively cheap, as they do not require large infrastructuel investments in concrete or long conduits. These systems have proven to be effective in terms of ensuring that the pollution load of the black water is significantly reduced and that color and odor are reduced. Timeline: medium term (until 2030) Risk mitigated: eutrophication	Locally	Local authorities Private	Medium
Decentralised WWT using conventional systems	In larger settlements, decentralised WWT systems with conventional treatment provide a balance between the constructed wetlands approach and the full-fledged urban systems. Their costs are low, their performance is very reliable and can be technologically simple (depending on the technology selected and effluent standards adopted). Timeline: medium term (until 2030) Risk mitigated: eutrophication	Locally	Local authorities Private	Medium
Use the cesspits	In more remote locations household cesspits are still proposed as the preferred wastewater disposal option in isolated hamlets and households. On a small scale they are cheap, and relatively effective. It is important that waste water is pumped out and treated before entering water bodies. Timeline: medium term (until 2030) Risk mitigated: eutrophication	Locally	Local authorities Private	Medium
Re-use of grey water for household level irrigation	Reuse of grey water on household level in areas where groundwater levels may drop due to decreases in rainfall will be a viable option. Sufficient for small gardens and small fields with crops, it would reduce the volumes of wastewater that would need to be treated. There are a number of re-use options for wastewater- irrigation and/or re-use in the house for e.g. flushing of toilets. Black water after tertiary treatment may be re-used as irrigation water for non-edible crops only (e.g. forage). Timeline: medium term (until 2030) Risk mitigated: drought, eutrophication, water scarcity	Locally	Local authorities Private	Medium
Black water re-use for irrigation in the areas that suffer from water scarcity	Reuse of treated waste water for irrigation is an option that could be explored, especially in Moldova. Whereas the water scarcity in the Danube Delta is not extreme, nonetheless it may provide substantial cost gains if the settlements from which the water originates are close to the agricultural fields. Furthermore reuse reduces the amount of freshwater pumped or diverted from the tributaries of the Danube Delta (e.g. the Prut). Whereas it will be necessary to use some freshwater for mixing with the treated wastewater to reduce the pollution load, this measure should nonetheless be considered as a no-regret measure. It must be noted, however, that the reuse of treated wastewater for irrigation can only be safely used for ligneous crops for fodder of animals or biomass; it should not be used for edible crops. Timeline: medium term (until 2030) Risk mitigated: drought, eutrophication, water scarcity	Locally (especially in Moldova)	Local authorities Private	Medium
Reactive measures				
Drainage systems to cope with flash floods in risk settlements	Adequate design of drainage systems in settlements will reduce the negative effects of flash floods. This system will be useful for Reni, Chilia, Dmitrovka (Ukraine), Kagul (Moldova), Tulcea (Romania). Timeline: medium term (until 2030) Risk mitigated: flood, drought, water scarcity	Locally	Local municipalities	High
Assess and relocate water extraction points in areas with risks of water scarcity	Water quality in Yalpuglake can be improved if it is reconnected to the Danube and the water exchange processes are restored. However, relocation of the Bolgrad town water extraction point in Yalpug lake may be necessary due to lower water levels. Timeline: medium term (until 2030) Risk mitigated: drought, water scarcity	Ukraine	Odesa oblast administration, Bolgrad municipality	High
	Design and build water treatment system for Bolgrad town. Timeline: medium term (until 2030) Risk mitigated: drought, water scarcity	Ukraine	raion and oblast administration, Bolgrad municipality	High
	Combining the water extraction from ground water with surface resources according to water availability. This measure is necessary for Gagauzia and partially Prut river in the Cahul district. Timeline: medium term (until 2030) Risk mitigated: drought, water scarcity	Moldova	local authorities, municipal service "Apa Canal"	High

Buildings

Measures	Description	Location	Responsible	Priority
Preparatory measures				
Public awareness raising campaign on efficient use of water in households	The households situated in the drought area should be informed about ways to minimize water use and maximize water efficiency and capture (e.g. install aerators on the taps, efficient toilets, re-use grey water etc) Timeline: medium term (until 2030) Risk mitigated: flood, drought, water scarcity	Locally	Local authorities, NGOs	Medium
Preventive measures				
Implement green infrastructure in cities	From roofs covered with grass that cool the building and collect rain water to 'green belts' that act as biodiversity corridors in the city while preventing heat island effect, green infrastructure is a network providing the "ingredients" for solving urban and climatic challenges by building with nature. Timeline: medium term (until 2030) Risk mitigated: flood, drought, heat wave, water scarcity	Locally	Local authorities	Medium
Include climate change considerations into building codes for public and private developments and construction activities	To better cope with climate change impacts special constructions measures should be envisaged: using water resistant materials, improved insulation, ensuring that drainage allows water to escape preventing floods, plant trees to decrease solar/thermal load on buildings, exceeding minimum floor levels, purchasing appropriately-sized generators and pumps to handle increased flooding and improve drainage around buildings, etc. Timeline: medium term (until 2030) Risk mitigated: flood, drought, eutrophication, water scarcity	National Locally	Authorities Private	Medium
Conduct regular risk assessment of buildings in vulnerable areas	For choosing the best measures to reduce possible damage (especially in case of flooding) and improving comfort in extreme environmental conditions (heat, strong wind) an adequate risk assessment of buildings situated in areas with high risk is needed. Timeline: medium term (until 2030) Risk mitigated: flood, drought, water scarcity	Locally	Local authorities	Medium
Recovery measures				
Create financial mechanisms to support small climate proofing investments for old houses	In areas with risk of flooding and no options of re-settlement a mechanism to promote investment in practical solution for climate-proofed households could be established. Timeline: medium term (until 2030) Risk mitigated: flood, drought, water scarcity	Locally Business sector	local authorities, departments of emergency	Medium

Spatial planning

Measures	Description	Location	Responsible	Priority
Preparatory measures				
Development of town planning cadastre on regional and local levels	On the basis of local development documentation to better manage development planning in the context of climate change, zonation and forecast of harmful impacts and disasters is needed Timeline: medium term (until 2030) Risk mitigated: flood, drought, sea level rise, water scarcity	Ukraine	Local authorities	High
Introduce climate proofing process in spacial planning	New construction projects should not be allowed in the areas with high risk of flooding. Timeline: medium term (until 2030) Risk mitigated: flood, drought, sea level rise, water scarcity	Nationally	National government	High
Development of digital flood risk and hazards map for the region	Identify infrastructure at risk of flooding and prevent further construction in flood-prone areas Timeline: short term (next 5 years) Risk mitigated: flood	Trans-boundary	ICPDR with support from local authorities and water authorities	High
Digital models of Vilkovo are created and support the establishmend of new zoning	Vilkovo is considered an area with high sensitivity to climate change impacts Detailed elevations and hydraulic digital models are necessary for the development of flood risk zones and climate smart town planning Timeline: short term (next 5 years) Risk mitigated: flood, sea level rise	Vilkovo (Ukraine)	Vilkovo municipality	High

4.2.2. AGRICULTURE

As more than half of population in the region is employed in agriculture (especially in Moldova), this sector is highly important. Future decrease in the availability of water resources due to climate change may lead to an increase in production prices and drop of competitiveness of local produce on international markets. At the same time, climate change may bring some positive effects to agriculture by offering the possibility of cultivating secondary crops due to prolonged periods of vegetation, as well as new warm-loving drought-resistant crops may be introduced. Therefore, an agriculture sector better adapted to climate change will include those measures based on environmental friendly practices: crop rotation to help to revitalize the soil and prevent pest infestations without reliance on chemical fertilizers and pesticides. The adaptation action plan for agriculture sector presented below includes measures which help to cope with drought including planting trees to provide shade, use of cover crops that enhance seedling survival, and “harrowing” of fields in early spring (which prevents evaporation).

Measures	Description	Location	Responsible	Priority
Preparatory measures				
Raise awareness about close to nature agricultural practices	Some practical examples of close to nature agricultural practices are: incorporating crop rotation helps to revitalize soils and prevent pest infestations without reliance on chemical fertilizers and pesticides. Practices helping cope with drought include planting trees to provide shade, use of cover crops that enhance seedling survival, and "harrowing" of fields in early spring (which prevents evaporation). Timeline: medium term (until 2030) Risk mitigated: eutrophication, biodiversity loss, reduced habitat availability, water scarcity	Locally	Local authorities, Farmers	High
Research on crop varieties best adapted to new conditions and potential crops of economic importance	Climate change presents opportunity to grow crops and fruit trees that are typical for warmer and dryer climates. Timeline: medium term (until 2030) Risk mitigated: flood, eutrophication, drought, water scarcity	Locally, especially in Moldova	Farmers' association, research institutes	High
Preventive measures				
Shift to organic agriculture	There is evidence that organic farming can have advantages in drought-conditions, such as higher yields compared to non-organic systems, because of the higher water-holding capacity of soils under organic management. Timeline: medium term (until 2030) Risk mitigated: eutrophication, water scarcity	Locally, especially in Moldova	Farmers	Medium
Reactive measures				
Develop polyculture	Monoculture, is more vulnerable compared to alternatives such as plurispecific systems that cultivate a mixture of species. Plurispecific systems can include: · mixtures of annual crops (intercropping), · mixtures of trees (plurispecific orchards or forest, restoration of forest belts around Delta areas in Ukrainian and Moldovian agricultural fields planted in the 20th century), · mixtures of high trees and crops (agroforestry). Timeline: medium term (until 2030) Risk mitigated: flood, drought, eutrophication, biodiversity loss, reduce habitat availability, water scarcity	Locally	Farmers, Local authorities	High
Introduction of modern irrigation and moisture conservation techniques	Implementation of modern techniques such as drip irrigation, drought resistant crops, moisture conservation measures, precipitation harvesting. Better implementation of the modern techniques, training for farmers and relevant sectorial authorities and sharing best practices in the field have been identified as necessary by stakeholders. Timeline: medium term (until 2030) Risk mitigated: flood, drought, water scarcity	Locally	Farmers	High
Adapting crop practices to new temperature and precipitation patterns	Some already known measures are: ·Seeding winter crops should be shifted 20-25 days later (October 9 - 16). ·Cultivate second crops after harvesting the primary ones (winter wheat, spring barley) ·Drought contingency, drought emergency irrigation schemes Timeline: medium term (until 2030) Risk mitigated: flood, drought, water scarcity	Locally especially in Moldova	Farmers	High

4.2.3. FISHERIES

Projections of climate change impacts on inter-species relations and individual response of species are of high uncertainty. Growing periods of the main commercial fish species and the number of fishing days may be prolonged which will increase pressure on populations of the main industrial species. Future changes in climate will not trigger a considerable reduction in catches in the Danube, though their qualitative composition may deteriorate. At the same time fish production in the Danube lakes/ reservoirs can decrease due to the worsening of water exchange and lower water quality. In summer higher levels of fish mortality can be expected due to algae blooms. The adaptation measures presented in following Action Plan is developed around the harmonizing the timing of fishing bans, fishing quotas, and norms for all three countries together with joint monitoring of fish stocks.

Measure	Description	Location	Responsible	Priority
Preparatory measures				
Harmonise timing of the fishing bans, fishing quotas and norms	To be more efficient in biodiversity improvement and boosting economic resources in Danube Delta (especially related to the fishery) establishment of harmonized legislation for fishing is needed. Timeline: medium term (until 2030) Risk mitigated: : biodiversity loss, reduced habitat availability	Transboundary	National authorities	High
Cooperation of agriculture with fishery	Rice growers may provide fish nursery services for local fisheries in ponds or lake as rice fields are perfect nursery sites for young fish as they can play a role similar to that of natural flooded meadows. Timeline: short term (next five years) Risk mitigated: flood, biodiversity loss	Ukraine	Farmers	High
Use native species better adapted to the new climate conditions in aquaculture sector	Breed native fish less sensitive to low oxygen levels and higher water temperature and use of modern technologies. Timeline: medium term (until 2030) Risk mitigated: biodiversity loss	Delta lakes and ponds	Local fish farms	Medium
Restore connectivity and water exchange between the ponds and the river	Improve habitat quality therefore allowing native fish species to spawn in the ponds, eliminating the need to restock each year. Relevant for Dunavat-Dranov and Sontea-Fortuna complex in Romania and Kartal, SZP in Ukraine. Timeline: medium term (until 2030) Risk mitigated: biodiversity loss, reduced habitat availability	Romania, Ukraine	DDBR	Medium

4.2.4 FORESTRY

There will be changes in forest structure and species composition. Species more adapted to droughts and heat will benefit and advance. Forest fires will play an important role in changing species composition. Restoration and protection of floodplain / riparian forests on small rivers and lakes is key adaptation direction for the Danube Delta sub-basin, especially for Moldovain and Ukrainian part.

Measure	Description	Location	Responsible	Priority
Preparatory measures				
Restoration and protection of floodplain / riparian forests on small rivers and lakes	Restoration of riparian forests using native species (willow, oak etc) will reduce nutrient flow, therefore improving water quality and provide migration corridor for various species. Timeline: medium term (until 2030) Risk mitigated: : flood, drought, biodiversity loss, reduced habitat availability	Moldova, Ukraine (Danube Lakes, Yalpug, Sasyk, Kogilnik, Kirigizh Kitay)	Forestry, Raion administration Danube River Basin Department	High

4.2.5 ENERGY

The losses of electricity networks will increase with rising temperatures due to higher resistance. Higher air temperatures will drive up demand, leading to new challenges in balancing the power system. This can be quantified as 0.1% lower efficiency for every increase in temperature by 1ºC for natural gas and oil fired power plants, which translates into more expensive power generation costs, due to higher fuel consumption, which would translate into 2‰/Co loss in power generation. During heat waves operational costs may go up with more people in service (an increase of 50-100%) and more material in stock (an increase of 10-20%).

The energy sector in general, including the Danube Delta sub-basin, should adapt to climate change through enhanced energy efficiency and diversification of energy sources towards use of locally available ones, as a main priority adaptation measures.

Measure	Description	Location	Responsible	Priority
Preventive measures				
Restoration and protection of floodplain / riparian forests on small rivers and lakes	The energy sector should adapt to climate change through enhanced use of local renewable energy sources. Therefore, there is need for diversification in power supply and use of renewable energy sources to satisfy local communities' needs. These include use of alternative energy sources such as biomass (especially using reeds), solar, bio-fuels. Energy efficiency is also a key measure to be promoted. Timeline: medium term (until 2030)	Locally	Local authorities Private	Medium
		Locally	Local authorities Private	Medium
Encourage energy efficiency		Locally	Local authorities Private	Medium
Educate asset owners and decisions makers		Locally	Local authorities Private	Medium

4.2.6 TOURISM

Due to a longer summer season, a higher number of visitors may be expected, leading to more pressure on the environment, unless managed wisely. Maintain tourism industry within the region's ecological and socio-cultural carrying capacity is the basis for the entire adaptation action plan for the tourism sector in the Danube Delta sub-basin. Additionally, promoting forms of tourism which are considerate of the environment, including eco-tourism, rural tourism, agritourism, outdoor activities, canoe, cycling etc. and protecting the most sensitive habitats from human disturbance are other priority measures included into the Adaptation Action Plan for tourism sector in the Danube Delta sub-basin.

Measure	Description	Location	Responsible	Priority
Preventive measures				
Maintain the tourism industry within the region's ecological and socio-cultural carrying capacity	Support forms of tourism that are considerate of the environment, including eco-tourism, rural tourism, agritourism, outdoor activities, canoe, cycling etc. Timeline: medium term (until 2030)	Locally	Tourism authority and agencies	High
Protect the most sensitive habitats from human disturbance	Human disturbance of sensitive habitats puts additional pressure on the ecosystem and decreases its resilience. Therefore, establishment of the official tourist routes and their use in organized manner is essential. Timeline: medium term (until 2030) Risk mitigated: biodiversity loss	Locally	Tourism authority and agencies	High
Sustainable development of tourism infrastructure ("climate proofing")	Diversification and improvement of the infrastructure should be the main directions for adaptation work, e.g. the construction of canoe / bike trails, new indoor and outdoor activity centers, building of storm-proofed tourism infrastructure and facilities, abandonment of coast-near buildings, adapted tourism attraction by a mixture of outdoor and weather-independent indoor activities. Timeline: medium term (until 2030)	Locally	Tourism authority and agencies	Medium
Update tourism strategy and plans for the Danube Delta to include climate change adaptation measures	Prolonged warm season will cause changes in tourist preferences related to holiday periods and for accommodation. Reductions in summer tourist numbers may be in part offset by an increased tourist flow at the beginning and end of the tourism season which is likely to become longer. For the new conditions, a new strategy and action plan for tourism in Danube Delta is needed. Timeline: medium term (until 2030)	Locally (Romania especially) and trans-boundary	Tulcea County Council and tourism agenciesw	Medium

4.2.7 PUBLIC HEALTH

A warmer and wetter climate opens up new habitats for local species of mosquitoes which transmit arboviruses (a group of viruses that are transmitted by arthropod vectors) leading to more hot spots of fevers and encephalitis. It can be expected that the northern borders of malaria mosquitoes will shift northwards, and southern populations may substitute northern ones. Due to new favorable conditions the exotic vectors *Aedes albopictus* and *Ae.aegypti* which transmit dengue fever and yellow fever may arrive on the Black Sea coast.

Heat waves are likely to be more frequent, increasing risks of heat strokes. Rapid temperature changes may exacerbate cardiovascular diseases - hypertension, angina pectoris, and heart attack. Elderly, chronically ill and disabled people are particularly at risk. Higher water temperature will be favorable for the development of pathogenic bacteria. An increase in diseases caused by consumption of low-quality drinking water (cholera, leptospirosis, rotavirus infections) may occur. The local situation may be complicated by toxic algae blooms in drinking water sources.

Raising awareness about the risks climate change poses to human health and possible preventions measures is an important pillar of the adaptation action plan for the public health sector for the Danube Delta region.

Measures	Description	Location	Responsible	Priority
Preparatory measures				
Raise awareness about the risks climate change poses to human health	Public awareness about climate change impacts on human health is still limited Information campaign on the relations between short-term climate variability and disease incidence is needed (e.g. what to do during a heatwave). Timeline: short term (next five years)	Locally	Public health authorities Local authorities NGOs	High
Develop emergency plans for effective early warning systems for health risks	The development of effective national early warning systems for heat waves, cold waves, floods and forest fires should be a priority, as well as mechanisms for detecting outbreaks of new diseases that may become prevalent as a result of climate change. Timeline: medium term (until 2030)	Locally and trans-boundary	Public health authorities Local authorities Research institutes	High
Preventive measures				
Improving access to health care and increase the number of medical facilities	With climate change already underway, there is a need to identify cost-effective intervention/adaptation options in the health sector, including improved access to health care and an increased number of medical facilities in the Danube Delta region. Timeline: medium term (until 2030)	Locally	Public health authorities Local authorities	High

4.3 CROSS-CUTTING ISSUES

Given the previously identified overarching role that the capacity of different institutions, public awareness, research and monitoring, financial planning, and transboundary cooperation are playing in enabling the adaptation of Danube Delta to new climate conditions, the following further adaptation measures are envisaged. This chapter constitutes a package to facilitate the implementation of the whole climate change adaptation action plan for the Danube Delta sub-basin. The measures identified below are closely interlinked and are designated to reinforce the measures presented in chapters presented above.

Build up institutional capacity

Lack of experience in the development and implementation of climate change adaptation measures is common to all local authorities in the region. Continuous training and the establishing of a centre of excellence where decision-makers both from public and private sector can seek guidance, hear about the best-practices, and exchange experience would stimulate discussion and keep adaptation high on regional agenda.

Capacity building should involve multiple stakeholders to draw from different sources of knowledge and experiences and develop integrated and sustainable solutions.

Measure	Description	Location	Responsible	Priority
Create position of 'Climate change specialist' in key institutions	The complex nature of climate change requires the involvement of well-trained scientific, technical and managerial staff who will not only understand climate change but also be involved in adaptation to climate change, working across different sectors. Climate change specialists will provide in-house technical expertise and liaise with other organizations. Timeline: short time (next five years)	Locally Trans-boundary	National authorities	Medium
Training program for journalists on how to communicate climate change to various target groups	Climate change is poorly understood by many sectors of society including the media (journalists), policy-makers (decision makers), natural resource managers, technicians, scientists and the general public. Target-specific actions to obtain relevant and timely climate change information (e.g. forecasts of drought) and the dissemination of such information to relevant stakeholders for appropriate action requires mass media responding to climate change adaptation. Timeline: short term	Locally Trans-boundary	NGOs	Medium
Integrate climate change basics into school curriculum	Children and youth are the ones who will experience most of the climate impacts during their lifetime. We can prepare them now to make right decisions in the future. Timeline: medium term (until 2030)	Locally, Trans-boundary	NGOs	Medium
Establish Climate Change Resource Centres	The coordinated capture, storage, retrieval system or access and distribution of information on climate change will facilitate scientific research, cooperation between various institutions and pave the way for private adaptation. Climate change resource centers can be established at regional hydrometeorological institutes or city halls. Timeline: medium term (until 2030)	Locally, Trans-boundary	Local authorities	Medium

Raise public awareness

Climate change is likely to exert its greatest impact on natural resources and hence threaten the livelihoods of the majority of local people who live in the Danube Delta. Public awareness will empower stakeholders to participate in adaptive response. In order to effectively address adaptation the public needs to have access to accurate, up-to-date information in order to make effective decisions.

Awareness campaigns are important components in the climate change adaptation science-policy-society interface which aims to increase support, stimulate self-mobilisation and action, and mobilise local knowledge and resources.

Measure	Description	Location	Responsible	Priority
Awareness raising campaign on climate change	More communication, transparency and connection between citizens and authorities is needed to facilitate private adaptation and increase acceptance of public adaptation. Moreover, any climate change materials used for awareness should be developed for specific stakeholders and communicated in a manner that is easy to understand and culturally acceptable. Timeline: short term (next five years)	Locally Trans-boundary	NGOs	Medium
Promote public participation in addressing climate change and development of adequate responses	Engaging key stakeholders and community leaders in development of adaptation response not only increases their awareness about the climate challenges but as well builds up ownership of solutions. Timeline: short term (until 2030)	Locally Trans-boundary	NGOs	Medium

Research and monitoring

Although there is scientific evidence to indicate that climate has changed significantly over and above natural variability due to man-made (anthropogenic) interference, not all future impacts are well understood. While some impacts of climate change are taking place now, there is more to come. High uncertainty in terms of variability, extremes and the mean values of climate parameters contribute to a lack of clarity surrounding adequate preparation for and adaption to climate change. Since there are so many unknowns , there is a need to increase scientific understanding in order to better quantify the likely impacts and aid in the development of practical solutions for adaptation.

Measure	Description	Location	Responsible	Priority
Collect data and model climate change on a transboundary and local levels	In order to generate more accurate climate change scenarios for the Danube Delta, it is important to develop appropriate models to allow for better simulation of future conditions under different scenarios and assumptions. Timeline: short term (until 2030)	Trans-boundary	Research institutions	High
Trans-boundary monitoring of ecosystems and changes in biodiversity	Climate change will affect ecosystems and biodiversity due to changes in temperature and rainfall regimes. If this will make some habitats unsuitable, species with poor dispersal or migratory ability may become locally extinct. For accurate information on biodiversity and ecosystems changes, an integrated monitoring programme and ecosystems is needed. Timeline: short term (until 2030)	Trans-boundary	DDBRs	High

Finance for the climate change adaptation

Adequate resources, including finances, are required in order to undertake climate change adaptation. A number of studies point to a lack of public money (and willingness) to finance adaptation on the global scale on one hand, and the importance of business solutions, including microfinance and microinsurance, on the other. The microfinance sector is developing fast in central Romania and public-private partnership may assist in bringing that experience to the region. More research should be directed towards identifying market-based solutions and incentives for businesses to act responsibly.

Measure	Description	Location	Responsible	Priority
Identify resource requirements including funding to support implementation of adaptation activities	Climate change will cause many adverse effects on various sectors in Danube Delta. In order to mobilise financial and other resources to address these impacts, an estimate of potential financial liabilities and losses due to climate change with no measures taken for adaptation should be commissioned. Timeline: short term (next five years)	Trans-boundary	Research institutions	High
Facilitate access to efficient management and use of resources (credit, education, decision-making) including funds for climate change adaptation	The cost of adaptation and the mitigation of climate change will vary widely at local level. There is a need for improved access to adequate financial resources and the provision of new and additional funding for climate change adaptation for the Danube Delta. Timeline: short term (next five years)	Locally	National and international financial institutions	High

Trans-boundary cooperation

The global nature of Climate Change effects necessitates the exchange and sharing of data, information and expertise between Romania, Moldova and Ukraine in order to enhance appropriate and effective responses. There is a strong willingness for collaboration in the Danube Delta region. In order to increase efficiency in coping with climate change, an intensive collaboration between relevant authorities in the Danube Delta region across all countries is necessary.

Measure	Description	Location	Responsible	Priority
Strengthen and enhance international collaboration among stakeholders involved in climate change related issues	Danube Delta authorities have and continue to participate in various collaborative research projects regarding biodiversity. Such collaboration, networking and linkages should be extended to include climate change. Timeline: short term (next five years)	Trans-boundary	Local and national authorities	High
Participate in cross border cooperation programs and activities on climate change	The global nature of climate change means that no single country can hold a monopoly on climate change information and solutions to adverse impacts. There is need to share such information through collaborations amongst regional stakeholders as well as internationally. Timeline: short term (next five years)	Trans-boundary	Local and national authorities	High

ANNEX 1
MAIN CHARACTERISTICS OF THE DANUBE DELTA

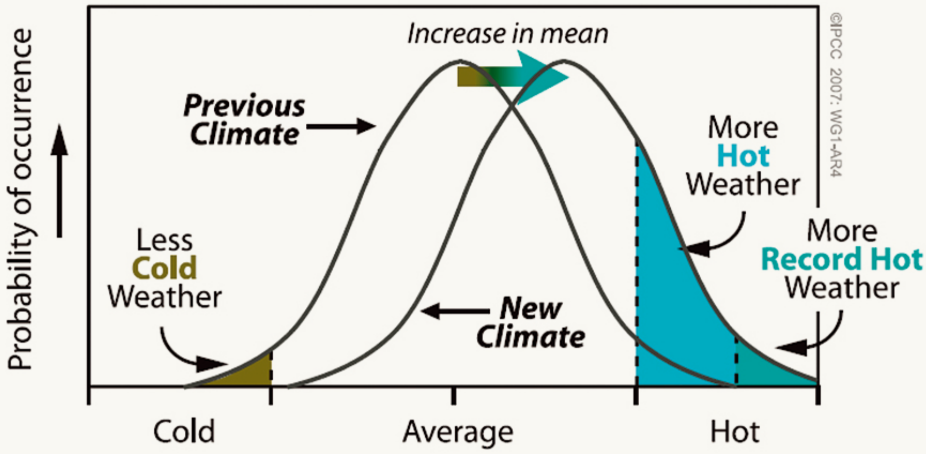
	UA	MD	RO
Area	4832 km2	4500 km2	5800 km2
Population: rural/urban	123.1/166.3 thousand people	240/130 thousand people	9.7 /4.6 thousand people.
Administrative structure	4 administrative districts (Bolgradskiy, Reniyskiy, Izmailskiy, Kiliyskiy) and the town of Izmail	4 rayons (Cahul, Leova, Cantemir, Vulcanesti) and Territorial Unit - Gagauzia	8 administrative areas and local councils (Maliuc, Crișan, Clilia Veche, Sfântu Gheorghe, Ceatalchioi, C.A.Rosetti, Sulina and Pardina) within the Tulcea County
Land transformation rate	72,2% (68,7% - agricultural lands, 3.5% - settlements)	80% of the territory (3400 km2) under different types of agricultural activities, 8% under human settlements (around 50000 households) and rest of the territory - roads, forests (around 4%) etc	The current status of land transformation is 41.8 % (agricultural polders, fish ponds, forest plantations).
Arable lands	54.5% of the total area or 79.3% of agricultural lands	2400 km2 perennial crops, 1000 km2 - orchards, grape (multiannual plantations)	The total area of arable lands is 457.7 km2.
Forest rate	3.7%	4%	Less that 1% (the total area of natural forest is 52.6 km2).
Protected area	11,2%. Total area - 54.03 km2, including the Danube Biosphere Reserve (50.25 km2)	"Prutul de Jos" - 1671 ha, Cahul district, Lower Prut lake Beleu	20 strictly protected areas representing 9.36% the total area of DDBR.
Main land use types	Agriculture	Agriculture	Fish polders, agricultural polders, forest plantations and pastures.
Potentially dangerous objects	Ports, oil storages, storages of unutilised pesticides, animal husbandry farms	Pesticide dump (Vulcanesti village, around 5,000 tons),	-
Waste water treatment	Centralised sewage and waste water treatment is fully functional only in Izmail. There are sewage systems (without treatment) in Reni and Chilia. Waste water in rural settlements is not collected and not treated.	Two stages of treatment in urban areas: Cahul, Comrat, Vulcanesti, Leova. Treatment facilities in rural localities do not function and septic tanks are mainly used for waste water collection.	No centralised sewage and waste water treatment systems are available in the settlements
Waste management	No organised system of solid household waste collection, sorting and treatment. Wastes (including hazardous ones) are accumulated on open organised and illegal waste dumps mainly without any safety measures. Estimated area of waste dumps is above 250 ha.	There are waste dumps near each locality in the region. Total area is estimated as 300 ha. Waste is deposited under open sky and aggregated. No selective waste collection and processing. According to estimations average solid waste production is 300 kg/person/year	There is no a clear waste management activity.
Main economic sectors	- Agriculture (cultivation of crops, vegetables, grapes, technical crops; sheep, cattle, geese breeding) - Transport (marine and motor) - Fishing and fish-farming - Tourism	- Agriculture - Food processing - Tourism (very poor) - Fishing from ponds (poor developed)	- Agriculture - Fishing - Wood exploitation - Tourism - Navigation,

ANNEX 2
DANGEROUS WATER LEVELS FOR KEY INFRASTRUCTURAL OBJECTS IN THE UKRAINIAN DELTA

Dangerous and highly dangerous water levels in Ukrainian part of the Danube delta, centimeters above «0» level

ГП - I Reni «0» level: 0.36 m	
Dangerous water levels, cm	Damage
535	Waterlogging of quays 1-5 in Reni sea trade port
569	Waterlogging of quays 6, 7, 9 in Reni sea trade port
579	Waterlogging of quays 22, 23, 25, 26, 30, 33 in Reni sea trade port
585	Waterlogging of quays 8, 15, 16 in Reni sea trade port
ГП - II Ismail «0» level: -0.18 m	
370	Waterlogging of unloading platform and water intrusion through the dam opening on the territory of Ismail fish-factory
380	Waterlogging of "Triton Service Ukraine" quays, Danube flooding the territory of pulp and paper mill, waterlogging of quays 1 and 5 for dry loose cargo in Ismail port (85th km)
400	Waterlogging of 3d quay in the first loading area of Ismail port, waterlogging of the road leading to bunkers on the 85th km
407	Waterlogging of quays 2 and 6 in the first loading area of Ismail port , quays 2-4 for dry loose cargo on the 85th km
430	Waterlogging of quays 4, 5, 7-9 in the first loading area of Ismail port
443	Waterlogging of quays in the second loading area of Ismail port
ГП - II Kilia «0» level: -0.33 m	
265	Waterlogging of Kilia shipyard quays and quays of dry loose cargo in Kilia/Ust'-Dunaysk port
270	Waterlogging of Kilia shipyard portal cranes' power cable
ГП - II Vilkovo «0» level: -0.75 m	
155	Waterlogging of low-lying parts of town
Highly dangerous water levels: 185	Flooding of 50% the of town
240	100% flooding of the town

GLOSSARY



Climate change
A change of climate that is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and that is in addition to natural climate variability observed over comparable time periods. **(UNFCC)**

Climate variability
(for our purposes) a short-term change in climatic conditions caused by changes in the atmosphere and ocean. (You can think of climate variability as the way climatic variables, such as temperature and precipitation, depart an some average state, either above or below the average value.)
Scientific definition: Variations in the mean state and other statistics (such as standard deviations, the occurrence of extremes, etc.) of the climate on all spatial and temporal scales beyond that of individual weather events. Variability may be due to natural internal processes (internal variability) within the climate system or to variations in natural or anthropogenic external forcing (external variability). **(IPCC WG1)**

Climate model
A mathematical representation of the climate system, based on the physical, chemical, and biological properties of its components, their interactions, and the feedback processes which account for some or all of its known properties. The climate system can be represented by models of varying complexity; that is, for any one component or combination of components, a spectrum or hierarchy of models can be identified, differing in such aspects as the number of spatial dimensions; the extent to which physical, chemical, or biological processes are explicitly represented; or the level at which empirical parametrizations are involved.**(IPCC WG1)**

Climate projection
A projection of the response of the climate system to emissions or concentration scenarios of greenhouse gases and aerosols, or radiative forcing scenarios, often based upon simulations in climate models. Climate projections are distinguished from climate predictions in order to emphasize that climate projections depend upon the emission/concentration/ radiative forcing scenario used, which is based on assumptions concerning, for example, future socioeconomic and technological developments which may or may not be realized and are therefore subject to substantial uncertainty. **(IPCC WG1)**

Climate resilience
The ability of a social or ecological system to recover from stress.
Scientific definition: The ability of a social or ecological system to absorb disturbances while retaining the same basic structure and ways of functioning, the capacity for self-organization, and the capacity to adapt to stress and change. **(IPCC WG2)**

Vulnerability
The potential to be harmed.
Scientific definition: The extent to which a natural or social system is susceptible to sustaining damage from climate change. (Schneider et al., 2001)

Exposure
The extent to which community, area or economic sector are exposed to the climate impacts. For example, houses in close proximity to a river will be more likely affected by floods.

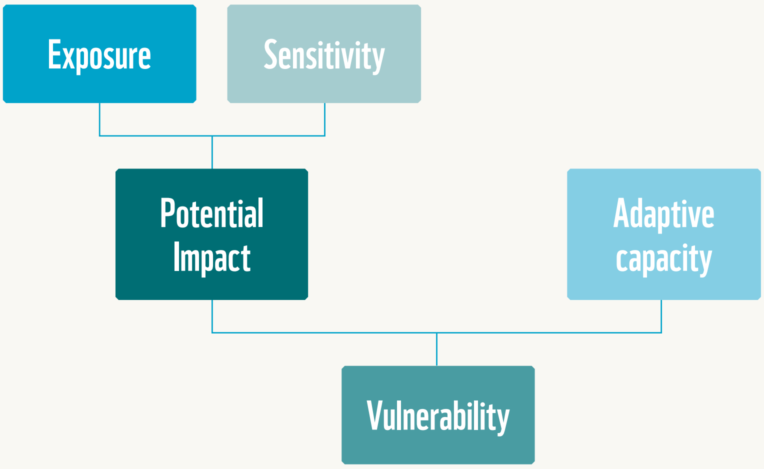


Fig. 4. Vulnerability framework

Sensitivity
The degree to which a system is affected, either adversely or beneficially, by climate variability or change. The effect may be direct (e.g., a change in crop yield in response to a change in the mean, range or variability of temperature) or indirect (e.g., damages caused by an increase in the frequency of coastal flooding due to sea-level rise). Together, exposure and sensitivity determine potential impacts for the community without adaptation action. Figure 4 graphically shows the relations between exposure, sensitivity and adaptive capacity.

Adaptive capacity
Ability of a community or an ecosystem to adjust to impacts and recover from stress.

Mitigation
Actions to reduce the sources or promote the sinking of greenhouse gases. **(IPCC WG3)**

Adaptation
Actions to reduce vulnerability to actual and expected changes in climate. Adaptation is a journey, not the destination. It's not what we do but the way we work.
Scientific definition: Via initiatives and measures, the reduction of the vulnerability of natural and human systems against actual or expected climate change effects. **(IPCC WG2)**

Types of adaptation measures:

Preventive: measures which reduce risk and the sensitivity of people, property or nature to climate change (halting construction in flood risk zones, land-use planning taking into account climate impacts)

Preparatory: measures that build or enhance awareness about effects of climate change in the region (Includes carrying out studies, awareness raising and communication exchange activities)

Reactive: measures which address changes that already happened and facilitate living in a new climate (management of invasive species, insurance, subsidies etc.)

Recovery: the measures to create mechanisms to support reconstruction or insurance systems, such as establishing a funding instrument.

Bioclimatic envelope modelling
Combines information about suitable "climate space" and dispersal capability (based on species traits) to predict the ecological consequences of different emissions scenarios.

Connectivity
A widely used term in conservation literature that in a freshwater context refers to the tendency for human infrastructure to fragment and disconnect habitats, thereby restricting the ability of species to move. The barriers may be within the water column or through some portion of the continuum of habitats between the headwaters of a river and its estuary, or between the river channel and floodplain.

Climate refugia
Areas which harboured species during past periods of changes in climate that could serve the same purpose in present and future climate change.

Mainstreaming
The incorporation of initiatives, measures, and strategies to reduce vulnerability to climate change into other existing policies, programs, resource management structures, and other livelihood enhancement activities, so that adaptation to climate change becomes part of, or consistent with, other sectorial programs. (Asian Development Bank)

Disaster Risk Reduction
Actions which aim to reduce socio-economic vulnerabilities to disaster as well as dealing with the environmental and other hazards that trigger them.

Ecosystem services
Benefits that people obtain from ecosystems. These include provisioning services such as food, water, timber, and fiber; regulating services that affect climate, floods, disease, wastes, and water quality; cultural services that provide recreational, aesthetic, and spiritual benefits; and supporting services such as soil formation, photosynthesis, and nutrient cycling. **(TEEB)**

Habitat:
An area of uniform environmental conditions which provides a living place for a specific assemblage of plants and animals.

MAINSTREAMING CLIMATE CHANGE ADAPTATION STRATEGY

Ukrainian Danube Delta case study

This chapter outlines the interrelation of adaptation measures to national and regional Ukrainian governance structures, including tools and instruments that need to be engaged in order to ensure implementation of this strategy.

The Danube Delta is a very specific natural and spatial region that needs a special planning, management and development approach.

As the Vulnerability Study showed, the region is highly vulnerable to climate change impacts as it is heavily depends on water resources and features a huge variety of water resources: the Black Sea, rivers and lakes, as well as variety of terrestrial landscapes, which are alsosensitive to weather events and the hydrological regime of the Danube.

It will be vitally important to prepare local administrative and natural units to climate changes and to ensure a good basis for sustainable development of the region by implementing every level of measures outlined in this strategy: from building up local resilience to reactive measures to studying the past impacts.

The general structure of the strategy will be important to understanding how to relate the strategy to the local development and management schemes.

The general structure of the Strategy (table 1 below) proposed several blocks.

The main block "components and directions of the strategy":

- Protection, conservation and restoration of the environment as a basis for local living and communities
- Measures of adaptation as a management component
- The priority sectors which form a basis for this region

Table 1. Strategy of the Danube Delta Adaptation to Climatic Changes in Ukrainian Context (Draft)

Priorities and Objectives of the Strategy:

- Preparedness of objects to climate change
- Timely response to emergencies
- Forecasting of phenomena and processes development
- Digital mapping of processes and phenomena
- Establishing of functional monitoring
- Risks minimization
- Management of changes processes
- Sustainable development
- 'Greening' of economic activities
- Structural modernization of economy
- Introduction of organic methods in agriculture

Objects:

- Environment
- Ecosystems
- People
- Economy
- Territories

Implementation Territory:

The Danube Delta Area

UA

Raions:

- Reni
- Izmail
- Kiliya
- Bolgrad

IMPACT FACTORS:

rising temperature	changing of onshore objects' hydrological regime	emergencies
rising sea level	general changing of economy structure	changing of weather regime
adverse natural phenomena	changing of economic environment in priority sectors	changing water balance in the area
general changing of natural and climatic characteristics and conditions of the area		

STRATEGY COMPONENTS AND DIRECTIONS

Protection, conservation and restoration of the environment	Adaptation measures (according to typology)	Priority sectors
1	2	3
Ecosystems: Wetlands, Coastal areas, Danube Lakes, Streamside areas, Steppes,	Management: (of resources, ecosystems, risks, climatic changes)	Agro-industrial complex: crop raising, cattle breeding, fishery
Nature reserve fund and development of ecological network	Engineering infrastructure and solutions	Infrastructure: - Roads and communications; - Housing and utilities infrastructure: water, sewer, wastes; - Power supply - Site improvement
Natural resources and biodiversity: Water, Forests, Soils, Flora, Fauna	Informational & explanatory and methodological work	Information technologies and automation of monitoring and risk management processes
Regulation of natural and economic activities: Restoration and modernization of dikes, Dike breaking, Bank protection, Development and planning	Monitoring and Forecasting	Transboundary cooperation and implementation of joint projects
Restoration of natural state and regimes	Planning and Modeling	Recreation and tourism
Implementation of sustainable development principles	Development of local strategies and programs	Investment activities and land relations
	Incorporation of the matters of climatic changes and objects adaptation into strategies and programs	

This strategy gives us the tools for complex planning, which needs to be comprehensive according sustainable development principles, and ensure the link between nature, population, and economies ». Implementation of the strategy may be ensured through a special algorithm, presented at the figure 1 below.

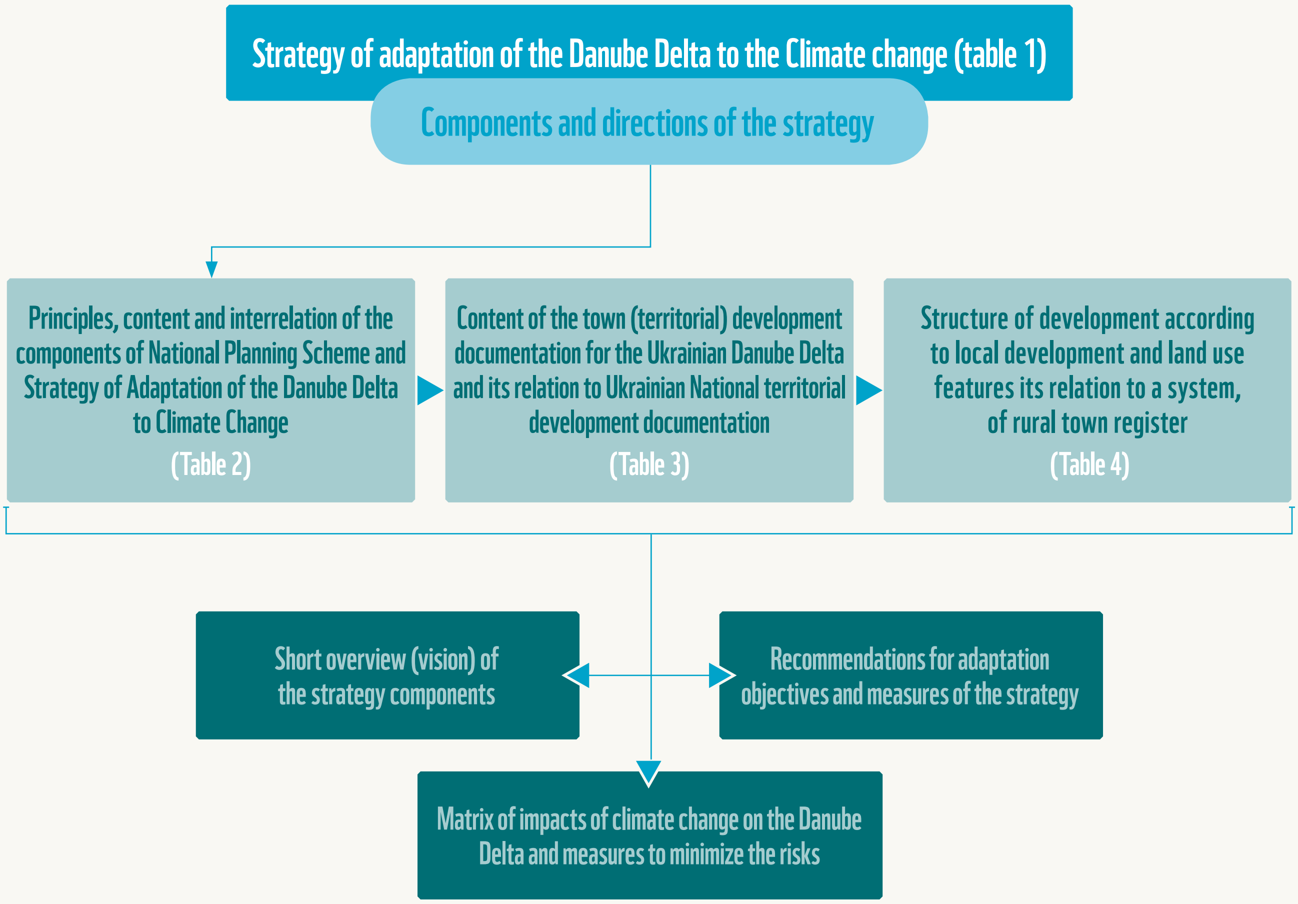


Figure 1: Algorithm of implementation of the strategy

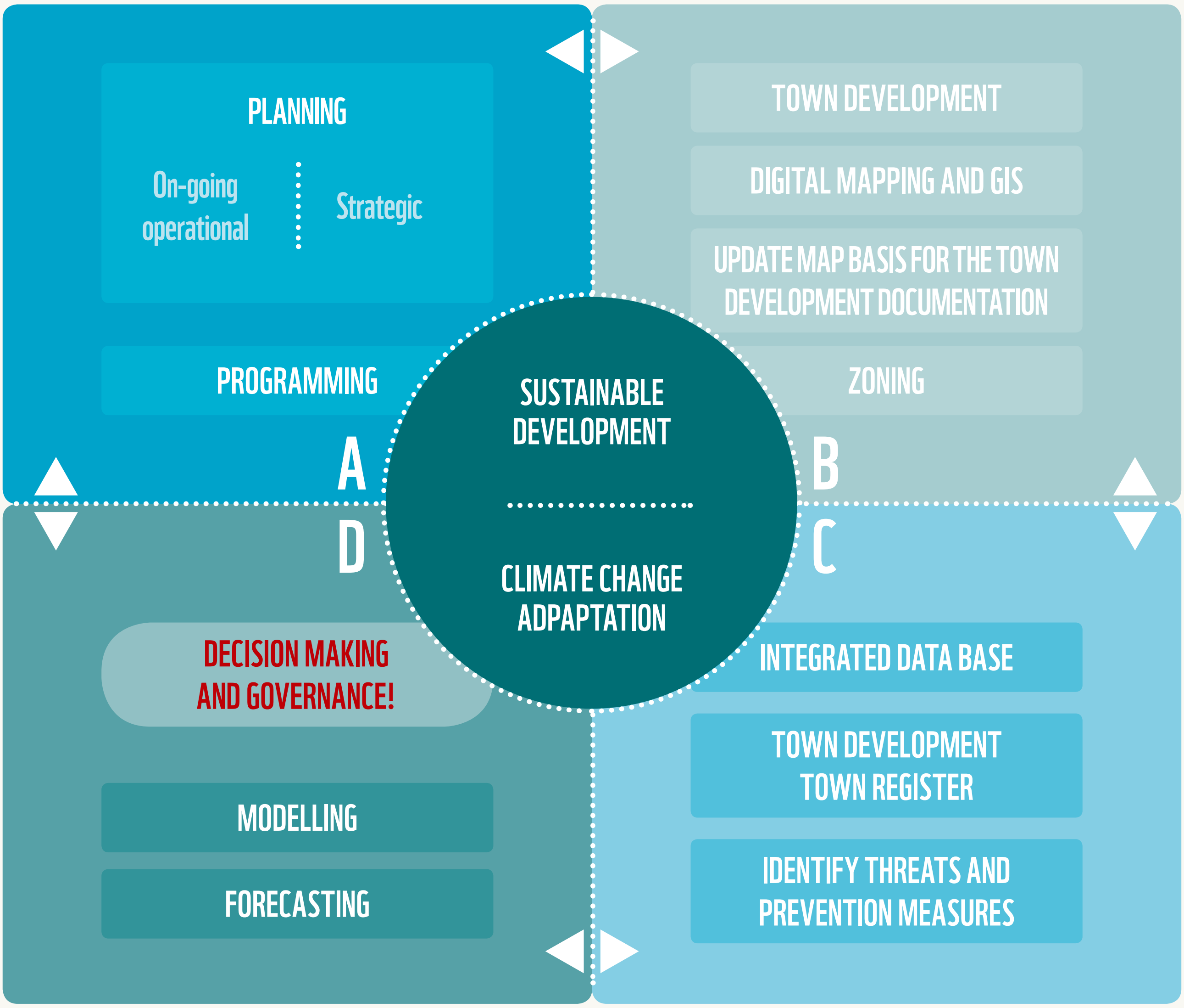
Implementation of the strategy in Ukraine needs a set of local instruments to translate the measures of the strategy into local practices of land use and sustainable development.

These instruments include:

- organizational, legal, institutional and methodological;
- technical, engineering, development and project-based;
- financial;
- informational

It will be vitally important to integrate the strategy into these instruments and ensure these instruments correspond to the principles of sustainable development and are tailored climate change impacts. The ultimate goal should be the integration of sustainable development and climate change adaptation measures into local development documents. The strategy components and adaptation instruments should have a clear and logical link to make the whole system complex and efficient (figure 2).

Figure 2: Scheme of national planning for the strategy of climate change



As the scheme on figure 2 shows, there are 4 components of the national planning system which are relevant to implementation of the strategy:

1. Identification of priorities for socio-economic and environmental policy **(sector A)**.

2. Spatial basis and information content for the development planning with use of GIS technologies **(sector B)**.

3. Identification of measures and instruments for development on the basis of GIS technologies **(sector C)**.

4. Implementation of the national socio-economic and environmental policy and livelihood safety **(sector C)**.

An example of integration of measures into town planning in Ukraine: Articles 5 and 15 of the law of Ukraine "on the regulation of town development" state that regional development programmes should correspond to town development documentation of the relevant level. Town development documentation is made by developing, endorsing and implementing socio-economic programmes (sectors A, B in figure 2 and sector C in Table 2). The programmes are the basis for governance methods and socio-economic planning. Town development documentation specifies long-term parameters and characteristics of territorial development: functional purpose of lands, land use forecast, types of land use, plans of land use and development regimes, zoning, conditions and regulations (articles 2 and 16 of the law of Ukraine on regulation of town development). Town development documentation is the basis for the system of town development town register. **(Table 3 and 4)**.

Town development town register is a modern and important instrument for planning and managing socio-economic, town development and nature conservation processes as well as the livelihoods of the population – and ultimately also for this strategy.

Therefore a key step in ensuring proper planning for the implementation of the strategy is to up-date town development town register on local and regional level.

Tables 3 and 4 present a general model of the system of town development town register for territorial planning and integration of different elements.

Conclusions

The implementation of the strategy will depend on planning and the implementation of relevant measures. Table 2 presents overview of adaptation instruments and measures through the national planning system in Ukraine.

The algorithm that demonstrates interrelation of the strategy and national planning framework in Ukraine is presented here as general model (figure 1), which links Table 1, Table 2, Table 3 and Table 4 as well as recommendations for adaptation measures, matrix of impacts of climate change on the Danube Delta and adaptation measures. Table 2 is a central part of this analysis and presents available instruments and means of planning grouped in tow blocks: socio-economic and spatial planning.

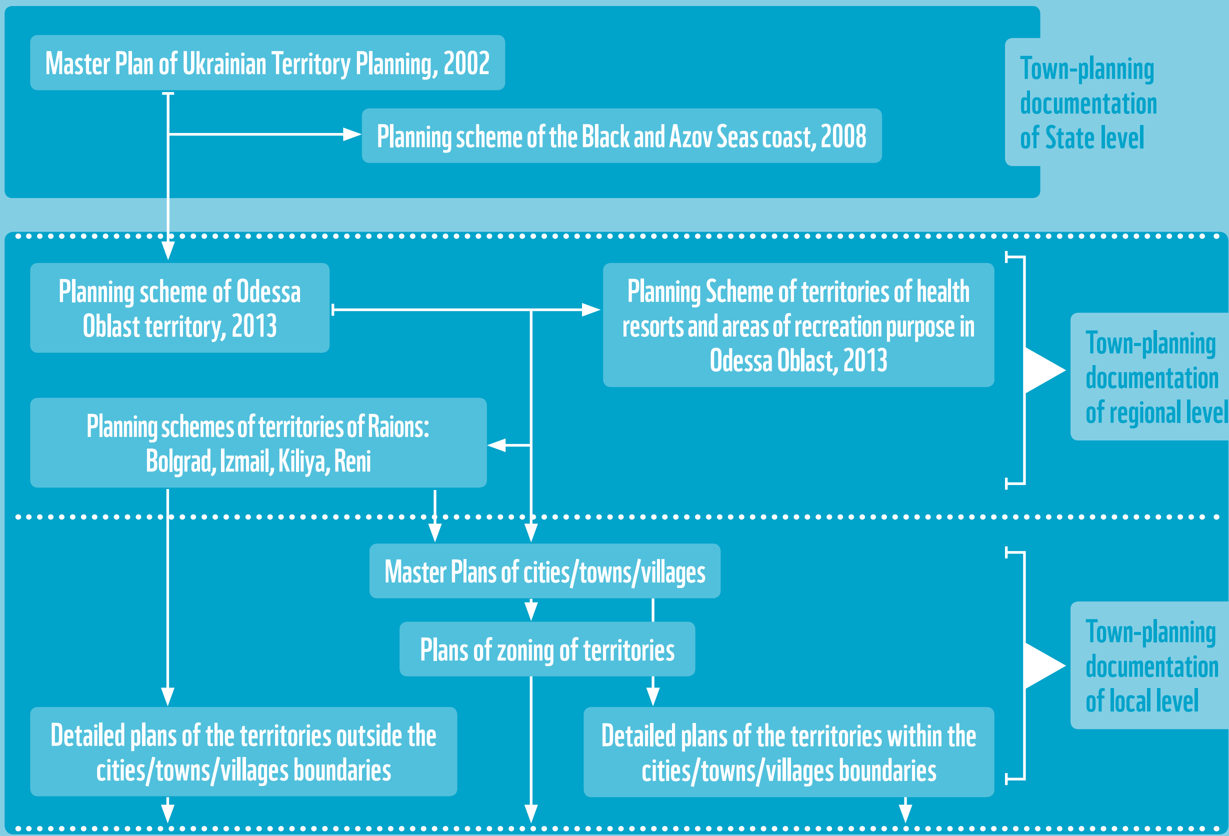
Efficient use of these instruments and the application of town development cadaster and new technologies such as digital mapping and GIS will be crucially important to ensuring the productive implementation of this strategy.

Table 2. Matrix: Principles, content and interrelation between National planning system components and the Strategy of the Danube Delta Region Adaptation to Climatic Changes

	Socioeconomic planning and budgeting							Territorial / spatial planning		2
	Planning system components:									
A	Budgeting (management by objectives)		Programming (management by objectives)		Agreements (contracts)	Strategic planning		Town planning		
	The main documents:									
	1	2	3	4	5	6	7	8	9	
B	State budget	Local budgets	Target programs/ comprehensive programs	Socioeconomic development programs (SED)	Agreements on RD between Cabinet of Ministers and Regions	Strategies of sustainable development of territories	Sectorial (branch) strategies	Territories planning schemes	Towns / villages master plans	
C	Functional aspect of planning - Interrelation between components							3		Scale (level):
	Object:									
D	a) budget programs, b) money for funding of separate measures, в) target funds		Programs (territorial or branch), measures and separate objects	Annual programs of socioeconomic development	Region and its constituents: infrastructure, environment, construction objects etc.	Ecological and socioeconomic system and its components: Environment-People-Economy	Priority or problematic sectors (branches)	Space / surroundings and their components: environment, population, economy		
	Aim:									
E	Ensuring of funding of the measures enumerated in columns 3-5		Planning of territories, branches (sectors) and objects development for a certain period with determination of amounts of activities financing	General planning of territorial development (annual)	Agreement of positions, responsibilities of central and regional authorities in ensuring of development of territories	Transformation, improvement of situation, development of territory, ensuring of positive changes in the state of components and the system in general, determination of long-term objectives	Fundamental changing (reforming) of a certain branch or sector	Arrangement of space, its perfection for ensuring of sustainable development of territories, stating of conditions and restrictions for construction, zoning, establishing of usage modes		
	Terms:									
F	Annual (1 year)		1 and more years	1 year (as a rule)	For the period of regional strategies' measures implementation	5 to 10 years and more		20 years	unlimited duration	
	Content:									
G	Funding of costs in respective directions for social, economic, environmental development of territories		Determination of measures (tasks) in development of separate territories, branches (spheres), sectors	Determination (planning) of current tasks and indicators of territories development	Determination of agreed common measures between the Cabinet of Ministers and regional authorities For development of regions in the framework of development strategies implementation	Determination of long-term milestones, aims, perspectives. Means and instruments for territories development	Determination of kind and directions of changes or reformation of a sector (branch)	Improvement of territories planning structure, determination of directions of their development and usage, zoning, distribution of territories and planning according to their functional purposes		
H	+ (Transfers)	-	+	+	+	-	+	+	-	S
I	- (Transfers)	+	+	+	+	+/-	+	+	-	R
J	- (Transfers)	+	+	+	-	-	+	-	+	L
	Principles: integrity, comprehensiveness, agreement, interconnection, practicability, justification, urgency, consistency, continuity; Additionally for budget system: unity, balance, self-sustainability, completeness, justification, efficiency, result rating etc.									
	Result: sustainable development of the system and its components									
	Peculiarity - interaction and coordination of all components in the system, need for inter-sectoral (through) character of planning									

Abbreviations: S – State, R – Regional, L – Local, RD – Regional Development; «+» - function (item) is available, «-» - Function (item) is lacking

Table 3. Town-Planning Documentation for the Territory of Ukrainian Danube Delta and its Interconnection with the System of Town-Planning Documentation in Ukraine



Transfer (provision) of land plots for implementation of concrete projects (location of objects) and construction taking into account functional purpose of territory in accordance

Table 4. Distribution of Town-Planning Documentation Referring to Peculiarities of Planning and Usage of Territories (inside and outside the boundaries of towns/villages) and its Connection with the System of Town-Planning Town register

Town-Planning Documentation:	System of Town-Planning Town register:
Master plan of Ukrainian Territory Planning, 2002 (of general character, comprises the territory of the whole country within and outside of the boundaries of cities/towns/villages) **Planning Schemes of separate parts of Ukrainian territory** (of general character and could comprise territories according to their functional purposes)	State level
Planning Scheme of Odessa Oblast Territory, 2013 (of general character and comprises the territory of the whole region within and outside the boundaries of cities/towns/villages) **Planning Scheme of territories of health resorts and areas of recreation purpose in Odessa Oblast, 2013** (of general character and comprises the territory of the whole region within and outside the boundaries of cities/towns/villages taking into account their health-improving and recreation profile) Outside the boundaries of cities/towns/villages: Planning Schemes of Raions* territories Detailed plans of territories*	Regional level
Within the boundaries of cities/towns/villages: Master Plans of cities/towns/villages* Plans of zoning of territories * Detailed plans of territories *	Basic (Local) level
- planning schemes of territories of Raions, Master Plans of cities/towns/villages, plans of zoning of territories and detailed plans of territories are of concrete character as they specify regime of territories usage (construction, location of facilities), their functional (target) purpose, current and future designation, current and future usage and distribution of territories according to their purposes. All town-planning documentation and its digital (vector) base map with respective data form the basis of town-planning town register **In accordance with the Law of Ukraine "On Regulation of Town-Planning Activities":** -Article 2: town-planning documentation shall be developed on paper and electronically based on updated cartographic base in digital form as the sets of profile geo-space data using the State geodesic system of coordinates USK-2000 and the unified system of classification and encoding of construction objects for databases in order to form town-planning town register. -Article 16: town-planning documentation on the local level shall be developed taking into account data from the State land town register on updated base map in digital form as spatially orientated information in the State system of coordinates on paper and in electronic form.	**In accordance with Article 23 of the Law of Ukraine "On Regulation of Town-Planning Activities":** the town-planning town register is the state system for storage and use of geo-spatial data on the territory, administrative & territorial units, ecological, engineering and geological conditions; on informational resources containing construction norms; on state standards and rules to satisfy the informational needs at planning of territories and construction; on formation of sectorial constituent of State information resources.
*- the main type of town-planning documentation for the territory within the scope of the project	- matters within the scope of the project