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The Tyligulskyi Lagoon

Current knowledge base and knowledge gaps

Title The Tyligulskyi Lagoon - Current knowledge base and knowledge gaps
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Report No. LAGOONS Report No. D2.1d
This report should be cited as: LAGOONS. 2012. The Tyligulskyi Lagoon - Current knowledge base and knowledge gaps. LAGOONS Report D2.1d. 54pp.
Organisation name of lead contractor for this deliverable Odessa State Environmental University
No. of pages 54
Due date of deliverable: 30.09.2012
Actual date of deliverable: 11.10.2012
Dissemination level[1] PU
Key words Tyligulskyi lagoon, coastal zone management, climate change, river basin, management
<Other>

Title of project: *Integrated water resources and coastal zone management in European lagoons in the context of climate change*
Instrument:
Contract number: 283157
Start date of project: October 2012 Duration: 36 months

[1] PU Public
PP Restricted to other programme participants (including the Commission Services)
RE Restricted to a group specified by the consortium (including the Commission Services)
CO Confidential, only for members of the consortium (including the Commission Services)

Contents

Summary

The report describes the physiogeographic, socio-economic and institutional conditions of the Tyligulskyi Lagoon and its drainage basin located in the north-western part of the Black Sea. In addition, an overview about the knowledge and knowledge gaps are given

The natural resources of the Tyligulskyi Lagoon consist of a unique coastal landscape, rich flora and fauna, mineral therapeutic muds. With regard to the importance of the Tyligulskyi Liman lagoon as a place for fattening, nesting and rest of migrant birds, it is included in the IBA (Important Bird Areas) List and in the List of Ramsar Wetlands of International Importance as a waterfowl habitat of international value. During the last decades, fish resources decreased considerably due to summer hypoxia and increasing salinity inside the lagoon. Nevertheless, catches may increase in the future if the populations of sea species increase.

The main ecological problems for the Tyligulskyi Lagoon are:

- the summer phytoplankton and bottom macrophytes bloom resulting in hypoxia and the death of hydrobionts;
- the gradual increase of water salinity caused by both decreasing freshwater inflow and sea water intake;
- the instability of hydrological and hydrochemical conditions in the lagoon.

Part of the problem is devoted to 167 artificial ponds and reservoirs (most of them illegal) that uses 50 % of total in-coming water to the lagoon. Two regional landscape parks and six wildlife preserves were established to maintain the natural resources of the lagoon; these are on the list of natural reserves in Ukraine and are protected by national laws concerning the use of natural resources. There is a need to develop a strategy for water resources management and long-term plans for socio-economical activities in the lagoons catchment and strategies for climate change impacts.

Since 2001 until the present, monitoring of hydrology, hydrochemistry and biotic components have been concentrated on the lagoon coastal zone with irregular frequency. Limited financial resources the last decade is the reason for this. This mean that the understanding of the ecological functioning of the lagoons is limited.

There exist a lot of data on the socio-economic state of the Tyligulskyi Lagoon but these data relates to the end of the 1990-th and the beginning of the 2000-th. Unfortunately, the recent data is not freely accessible and scattered in many regional directorates and departments. For example, the coastal protective strips and water protection zones are not locally defined on most part of Tyligulskyi Lagoon and Tyligul River and not included in land management records. The reasons are as follows. First, the development of land management projects defining the borders of the coastal protective strips demands considerable funds which local autonomous bodies lack. Second, in the 1990s the lands of water protection zones and coastal protective strips were shared for local residents and set aside for holiday villages. Illegal economical activity and improper land use take place in the water protection zone and coastal protective strip. The activity of economical players and residents harms appreciably the environment and natural resources of the lagoon and creates favourable conditions for water pollution in the lagoon. Also, the residents, state authorities, and local autonomous bodies are ecologically unconscious and uninformed in respect of environmental protection and conservation.

There is a lack of an integrated coastal zone management system in Ukraine, a basin management model for the catchment, river basin management plans and programmes for the monitoring of water status can be counted among the problems of natural resources protection and conservation at the Tyligulskyi Lagoon.

1. Introduction

The Tyligulskyi Lagoon is one of the largest, longest and deepest lagoons located between the Dnieper and Danube rivers in the Ukrainian part of the northwestern coast of the Black Sea (Fig. 1.1). The coast of the Tyligulskyi Lagoon is a natural reserve in Ukraine and on the List of Ramsar Wetlands of International Importance. It is a unique natural system possessing numerous natural resources that can be useful for the socio-economic development of adjacent territories, particularly for recreational purposes, eco-tourism, public health, aquaculture, and fishing.

The Tyligulskyi Lagoon is separated from the sea by an isthmus (4 km wide and 7 km long; see section 2.1 for details), and an artificial canal joining the lagoon and the sea. However, the canal is not always functional due to the accumulation of sand carried in from the sea.

The lagoon's water conditions depend on the volume of water inflow from its catchment (including the Tyligul river runoff), the precipitation-evaporation ratio, and the water exchange with the Black Sea through the canal. During the period from May to September, evaporation exceeds precipitation threefold. As a result of anthropogenic transformations in the lagoon drainage basin, a considerable amount of the Tyligul river runoff goes into artificial ponds and reservoirs; therefore, the lagoon's water level decreases by 0.5–1 m during dry summers.

The regional landscape park 'Tyligulskyi' occupies the eastern and western coasts of the lagoon. The park is home to a considerable spectrum of rare and endangered species of fauna and flora.

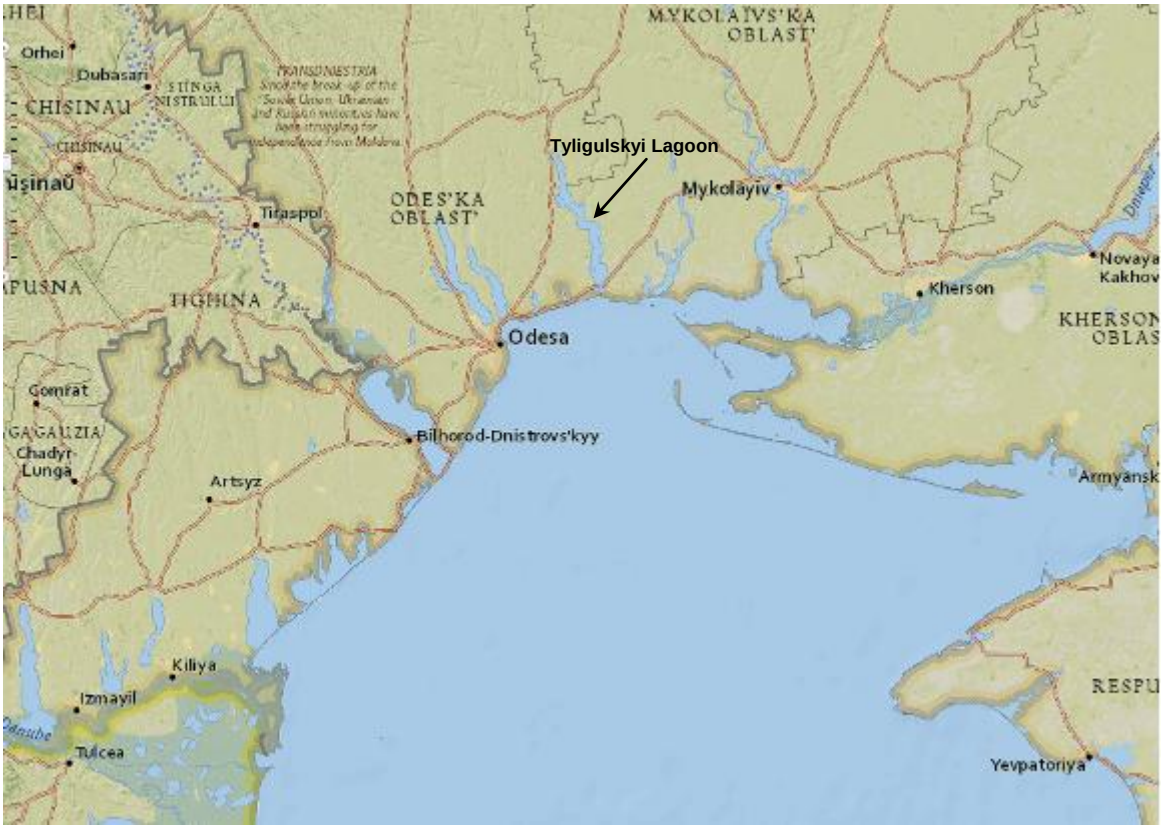

Figure 1.1 – The lagoons in the north-western part of the Black Sea including the Tyligulskyi Lagoon.

Currently, there is no integrated water management within the Tyligulskyi Lagoon catchment and various unfavourable conditions occasionally arise in the lagoon. For example, eutrophication quite often deteriorates the water quality in the lagoon during its summer isolation from the sea, resulting in the mortality of fish and other living organisms in the lagoon.

2. The Physiogeographical Story

2.1 Physical conditions of the lagoon and the drainage basin

The Tyligulskyi Lagoon (see Fig. 1.1) is located on the Ukrainian coast in the north-western part of the Black Sea, 60 kilometres from the city of Odessa (46°39.3′–47°05.3′N, 30°57.3′–31°12.7′E). The lagoon used to be a valley of the Tyligul River that was later flooded by sea water. It stretches submeridionally from north-northwest to south-southeast. It is 45 to 52.1 km long and 1 to 4.5 km wide. When the watermark in the lagoon is −0.4 m BS (meters in the Baltic system of heights and depths), the estimated volume and water-surface area are 452×10^6 m^3 and 170×10^6 m^2, respectively. In the southern and central parts, the lagoon floor has several depressions that are more than 10 m deep and that are divided by shallow spits (Fig. 2.1).

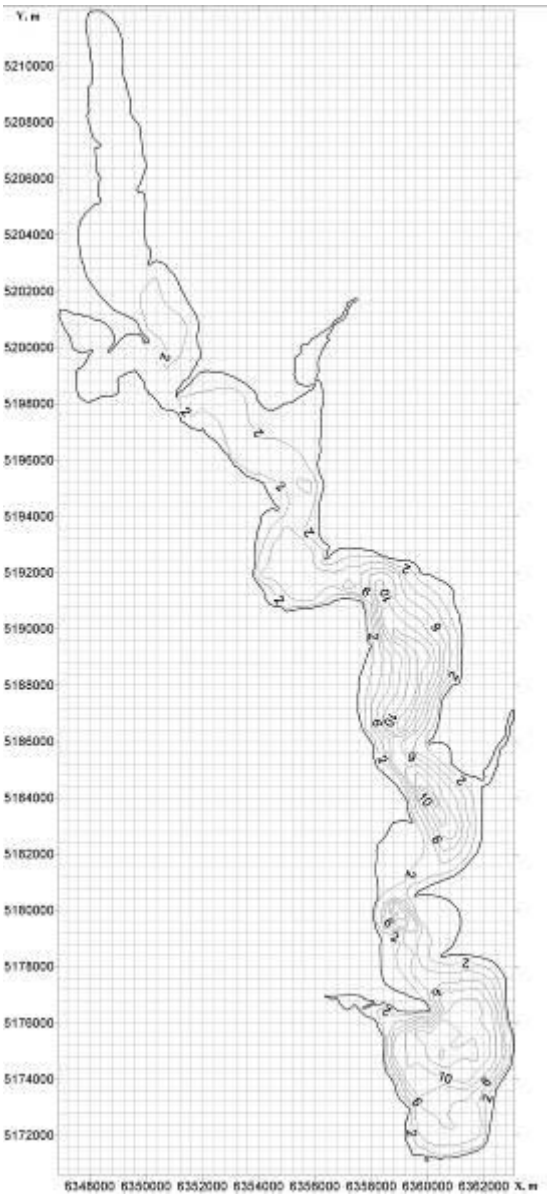

Figure 2.1 – Bathymetric map of the Tyligulskyi lagoon in isobaths under watermark −0.4 m BS. The system is of horizontal coordinates WGS-84.

The southern part of the lagoon is deepest, with a maximum depth of 15 m. Rozengurt (1974) and Polischuk et al. (1990) have even reported a depth of 21 m at a particular local point. The northern and, to a certain extent, the central part of the lagoon are relatively shallow; the average depth of the lagoon is therefore less than 3 m.

The lagoon is separated from the sea by an isthmus which is about 4 km wide and 7 km long. The isthmus formed due to the interaction of several natural events including ocean dynamics, lagoonal hydro- and lithodynamic as well as eolian transport processes. Accordingly, the cross profile of the isthmus has three landscape zones: marine, eolian, and lagoonal. The deposits in the eolian and, partly, lagoonal zone occurred due to eolian transport of sand from the beaches. From the other side, some deposits were brought to the back boundary during storms in the lagoon. The deposits divided parts of the landscape into small lakes and bays which were filled with sand over time and transformed into new parts of the isthmus.

An artificial canal, 25–30 m wide and 0.5–1.5 m deep, was built through the isthmus to connect the lagoon with the sea. Pursuant to fishery purposes, the canal has to be open in spring to let young fishes into the lagoon for fattening. However, the canal is not always functional; sand accumulates and constrains its use. Shallow (0.25–1.0 m deep) salt lakes, located in the low-lying areas of the isthmus are fed with water from the canal (Fig. 2.2).

The catchment basin of the Tyligulskyi Lagoon has an area of 5420 km^2 (Fig. 2.3). The following rivers flow into the lagoon: the Tyligul (catchment area: 3550 km^2, length: 173 km), the Balaichuk (catchment area: 586 km^2, length: 52 km), the Tsarega (catchment area: 657 km^2, length: 46 km) (Shvebs and Igoshin, 2003), and the Khutorska (catchment area: 108 km^2, length: 19 km). In addition, the lagoon receives surface water input from temporary watercourses such as gullies and ravines from an area of 349 km^2.

Figure 2.2 – Location of the artificial channel and the salt lakes.

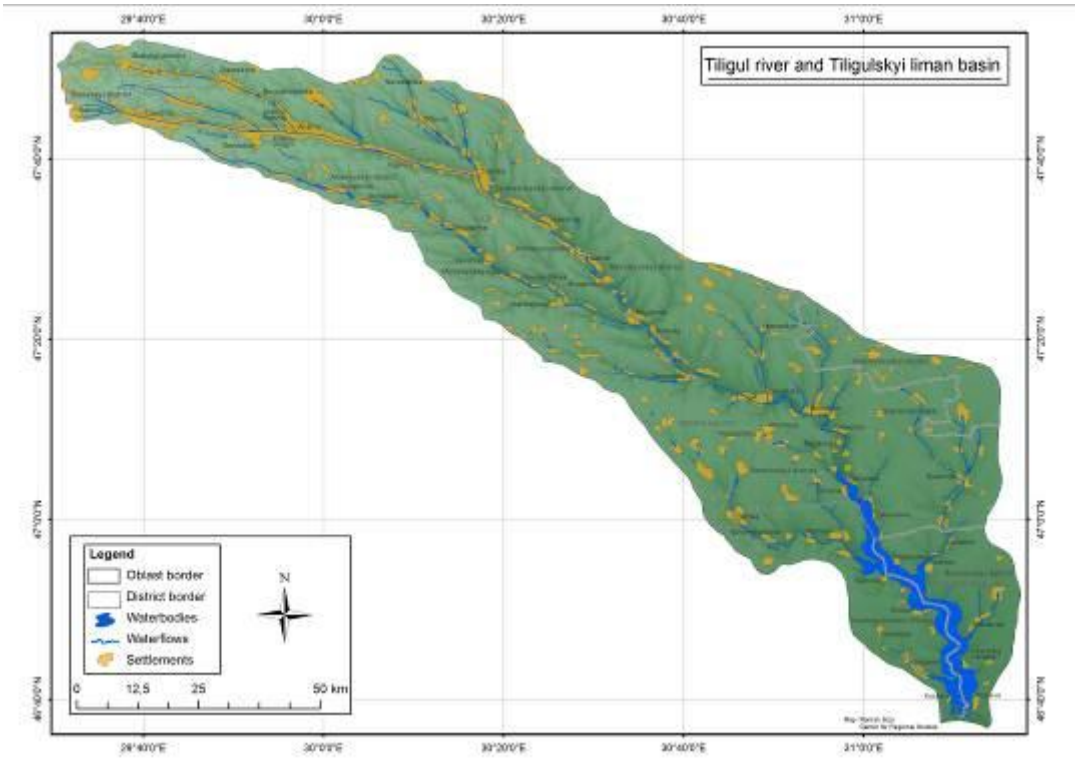

Figure 2.3 – Catchment basin of the Tyligulskyi Lagoon.

Considerable snow accumulation in the lagoon catchment during winter results in high amounts of surface runoff during spring; however, this is a seldom case. The annual norm for infiltration into underground aquifers varies from 5.0 mm at the upper part of the Tyligul river catchment to 1.5 mm at the river's inflow into the lagoon. Annual groundwater inflow for the Tyligul river catchment is 2.5 mm or about 8.8×10^6 m^3 if the catchment area (3550 km^2; see previous paragraph) is taken into account. As for the Tsarega, Balaichuk and Khutorska rivers with smaller catchment areas, the contribution of groundwater to annual runoff is less significant. For example, the groundwater inflow for the Khutorska river is about 1 mm only; as the catchment area is small (108 km^2) conditions for the aquifer drainage are unfavourable. The estimated long-term annual groundwater inflow using the regional approach approximates to zero. Due to both a water-related activity and insignificant groundwater inflow to the runoff, the rivers are frozen over during the winter and dried up during the spring and summer low water period.

Depending on annual runoff and precipitation, the downstream part of the Tyligul river can be dried up during 90–240 days per year (Passport, 1994). In high-water years this periods lasts around two months, in medium-water years 5 months, in low-water years 6 months, and in extreme low-water years up to eight months. Here, we define a high-water year as a year with the exceedance probability of the annual runoff less than 25 %, a middle-water year – less than 75 % and greater than 50 %, and a low-water year – greater than 75 %. In practice, typical years are selected from whole observational period: the high-water year with the exceedance probability of the annual runoff equal to 25 %, the middle-water year – 50 %, the low-water year – 75 %, and extreme low-water year – 95 %. Therefore, the middle-water year can be determined as a year with annual runoff close to a long-term mean value. Due to increasing air temperatures within the last two decades, the duration of drought periods increased slightly.

There are 101 artificial reservoirs with a total volume of 12.093×10^6 m^3 on the Tyligul river and its inflows; 23 reservoirs with a total volume of 3.94×10^6 m^3 are located on the Tsarega river, 29 with a total volume of 2.56×10^6 m^3 are located on the Balaichuk river, and 4 with a total volume of

0.57×10^6 m^3 are located on the Khutorska river. Every year, 80 % of these reservoirs dry up and annual filling is necessary.

Water for household purposes is taken from subterranean sources. The groundwater at the Tyligulskyi Lagoon catchment is a constituent of the Black Sea artesian basin. Upper aquifers are fed with atmospheric precipitation. As a waterproof layer is relatively deep, the Neogene sediments are fed with atmospheric precipitation as well (Tiuremina et al., 2011). The most widespread are the aquifers of Sarmatian sediments. The groundwaters of the middle Sarmatian aquifer discharge into the river valleys and directly into the Tyligulskyi Lagoon. The groundwater table in the upper part of the Tyligulskyi Lagoon drainage basin is at 5–10 m, while it is 3–5 m in the larger lower part.

Around 150 water consumers withdraw groundwater from the Tyligul river and the Tyligulskyi Lagoon basin. In 2011, 2.93×10^6 m^3 were withdrawn for household purposes and drinking water supply, 0.60×10^6 m^3 for agriculture, and 0.09×10^6 m^3 for industrial needs, respectively, totalling 3.62×10^6 m^3. After use, the impure groundwater is discharged into the Tyligul river without any treatment.

The runoff from the Tsarega and Khutorska river has been completely withdrawn for the filling of artificial reservoirs created in the respective catchment areas.

If annual surface inflow of fresh water from the catchment is calculated by using the water-heat balance approach, its long-term value for the Tyligulskyi Lagoon under natural (undisturbed by economic activity) conditions is 56.14×10^6 m^3. From this value, 46×10^6 m^3 is the annual runoff of the Tyligul river, 3.9×10^6 m^3 – of the Tsarega river, 4.1×10^6 m^3 – of the Balaichuk river, and 0.57×10^6 m^3 – of the Khutorska river; also, input through temporary watercourses is 1.57×10^6 m^3 (Loboda, 2012). However, observational data from 1953-2007 show that the actual annual runoff of the Tyligul river at the Berezivka station (near the river mouth) is 24.85×10^6 m^3 only. This fact is conditioned by the large number of artificial reservoirs formed as a result of ground (clay) dike construction. These reservoirs, in turn, intercept the runoff and, under the natural high evaporation, work as huge evaporation basins. If the long-term annual runoff under natural conditions for the small rivers is compared to the total volumes of artificial reservoirs, it is clear that 62 % of Balaichuk's annual runoff and almost total annual runoff of the Tsarega and Khutorska rivers is needed to fill the reservoirs. Thus the total annual surface inflow of fresh water into the Tyligulskyi Lagoon is estimated at 28×10^6 m^3, which is 1×10^6 m^3 less by than the findings of Polischuk et al. (1990) for the early 1980-th.

The water regime of the Tyligulskyi Lagoon is determined by the volume of water inflow from the lagoonal catchment basin, the correlation between the amount of atmospheric precipitation on the lagoon surface and the volume of surface evaporation, as well as the water exchange between the lagoon and the sea through the artificial connecting canal.

Given the lagoonal water surface area of 170 km^2, the annual rate for atmospheric precipitation of 450 mm and an evaporation rate of 722 mm (water salinity of 20 ‰), the rate of water inflow into the lagoon due to atmospheric precipitation is estimated to be 76.5×10^6 m^3; evaporation losses are estimated to be around 122.7×10^6 m^3. Consequently, even in a medium-water year, there is a deficit of fresh water input of around 18.2×10^6 m^3. Under the absence of water exchange with the sea through the artificial canal, this results in a 0.3 m decrease in the lagoon water level. In years with low atmospheric precipitation the fresh water deficit increases substantially.

The variability of the water level in the Tyligulskyi Lagoon from 1936 to 1987 is given in Fig. 2.4. Measurements have been taken at the hydrometric station in Koblevo and values are given as monthly averages. After the construction of the artificial canal in 1958, the water level in the lagoon did not subside below −1.0 m BS. In the 1980s, the fluctuations of lagoon water level reached 1 m.

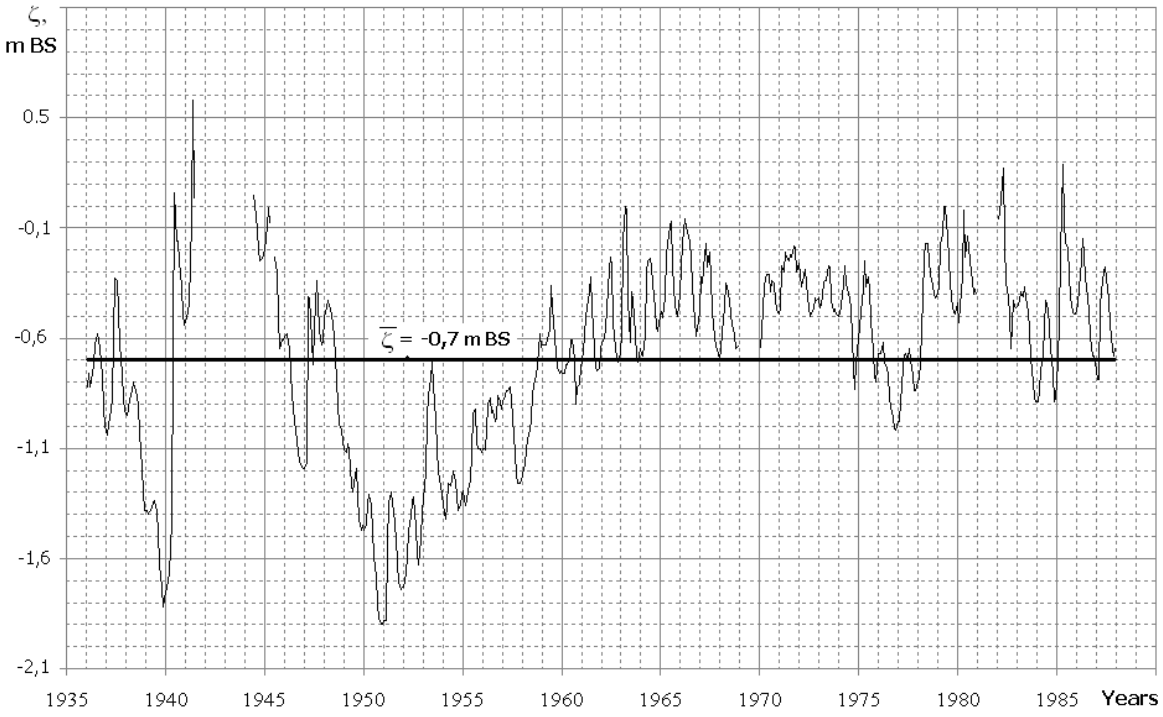

Figure 2.4 – The monthly water level (m BS) in the Tyligulskyi Lagoon for the period of 1936 through 1987.

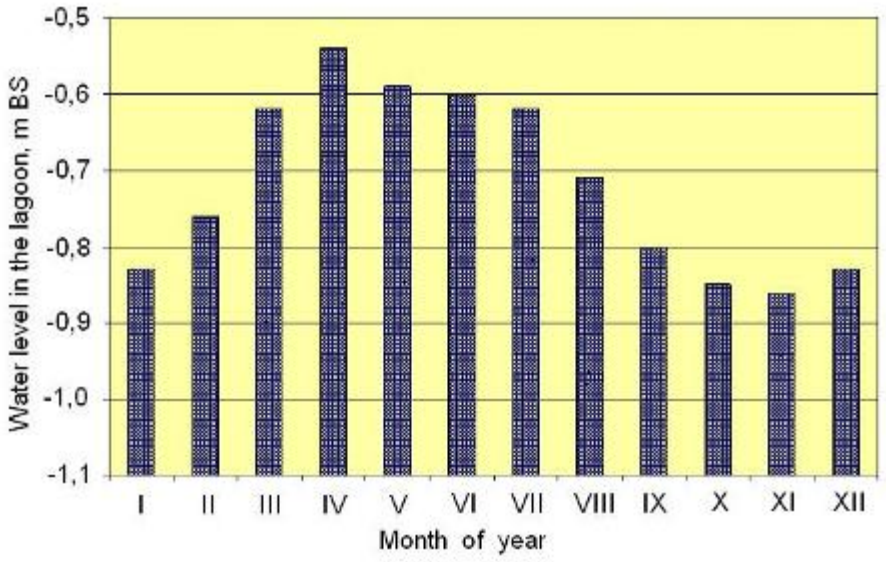

Figure 2.5 – The long-term mean monthly water levels (m BS) in the Tyligulskyi Lagoon for the period of 1936 through 1987.

Figure 2.6 shows the variability in water level in the lagoon in the modern period (since 2003). The highest levels were observed in spring of 2003 when large amounts of water entered the lagoon as surface runoff as a result of heavy floods; the lagoon's water level exceeded sea level by a few centimetres. In March and April 2003, an intensive water flow from the lagoon into the sea through the connecting canal was observed. Mid June, the canal was closed and the lagoon level began to decrease due to intensive evaporation. By the end of 2003 water levels decreased to −0.43 m BS.

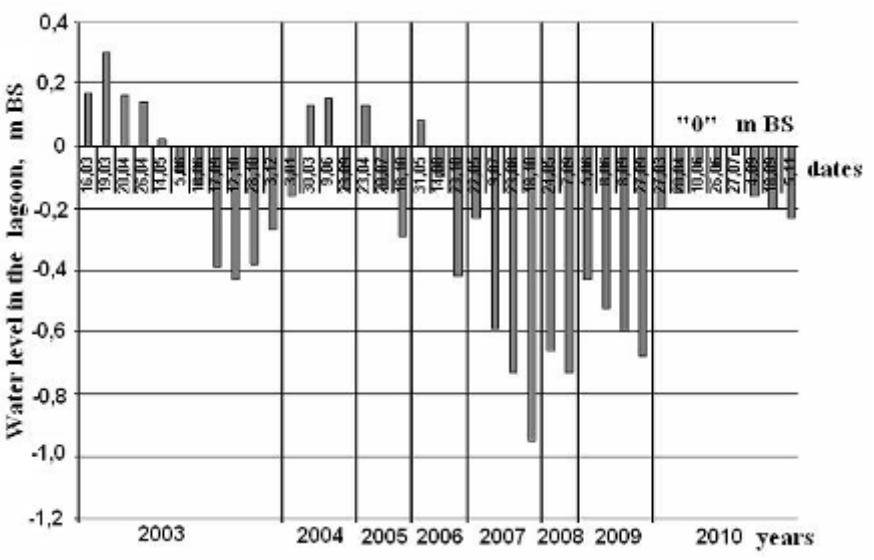

Figure 2.6 – Water level in the Tyligulskyi Lagoon (m BS) according to the data from irregular observations in 2003–2010.

The fluid dynamics in the Tyligulskyi Lagoon are very complex (Polischuk et al., 1990; Tuchkovenko et al., 2011). The currents in the lagoon are characterized by vortical formations (circulation cells) located along the longitudinal axis of the lagoon. These currents are caused by the peculiarities of the geomorphological structure of the lagoon such as shoreline configuration and variation in depth. The coastline of the lagoon is twisted and the floor in the southern and central parts features deep depressions that are separated by shallow spits. As a result, the lagoon has no strong currents alongshore, which could facilitate the mass transfer between its different parts. The vortical currents hinder the distribution of water masses along the lagoon's shore. Intensification of surface currents occurs in the downwind-oriented shallow areas of the lagoon. In the deeper areas of the lagoon the surface drift currents are weakened by the benthic gradient stream (Tuchkovenko et al., 2011).

During the year, the water temperature in the lagoon can vary widely. The lowest temperatures are usually registered in January and February (–0.1–0.2 °C). In cold winters the lagoon is covered with ice for a period of 1–2 months. The depth of the ice cover may reach 0.5 m. The waters of the Tyligulskyi Lagoon are warmest in July and August (up to 25–29 °C). Thus, in the shallow areas of the lagoon (especially in the northern part of the lagoon) the water can warm up to 30–34 °C (Polischuk et al., 1990).

Figure 2.7 shows the water temperature and salinity in the coastal zone of the central part of the lagoon. In the summer months of 2007–2009 water temperatures of 25 °C and higher were observed. Water temperatures higher than 20 °C were observed from May through September. In the exceptionally hot August 2010 a water temperature of 32.1 °C was registered. Even in the first half of September 2010, the water temperature was 24.5–24.6 °C.

The development of a massive seasonal thermocline in cavities of the southern and central parts of the lagoon in depths of more than 10 m is typical during the summer period. Provided the water temperature in the surface layer is 25–30 °C, the temperature at a depth of 14–15 m does not exceed 8–9 °C (Fig. 2.8). However after a summer severe storm, the seasonal thermocline can decay and the water mass in the lagoon mixes up to the bottom.

The water salinity in the lagoon can fluctuate between 5 ‰ during the spring flood period to 23 ‰ in autumn (Fig. 2.9). In the 1960s, when the volume of the Tyligul River runoff constituted a considerable part of the lagoonal water balance and the water exchange with the sea was maintained,

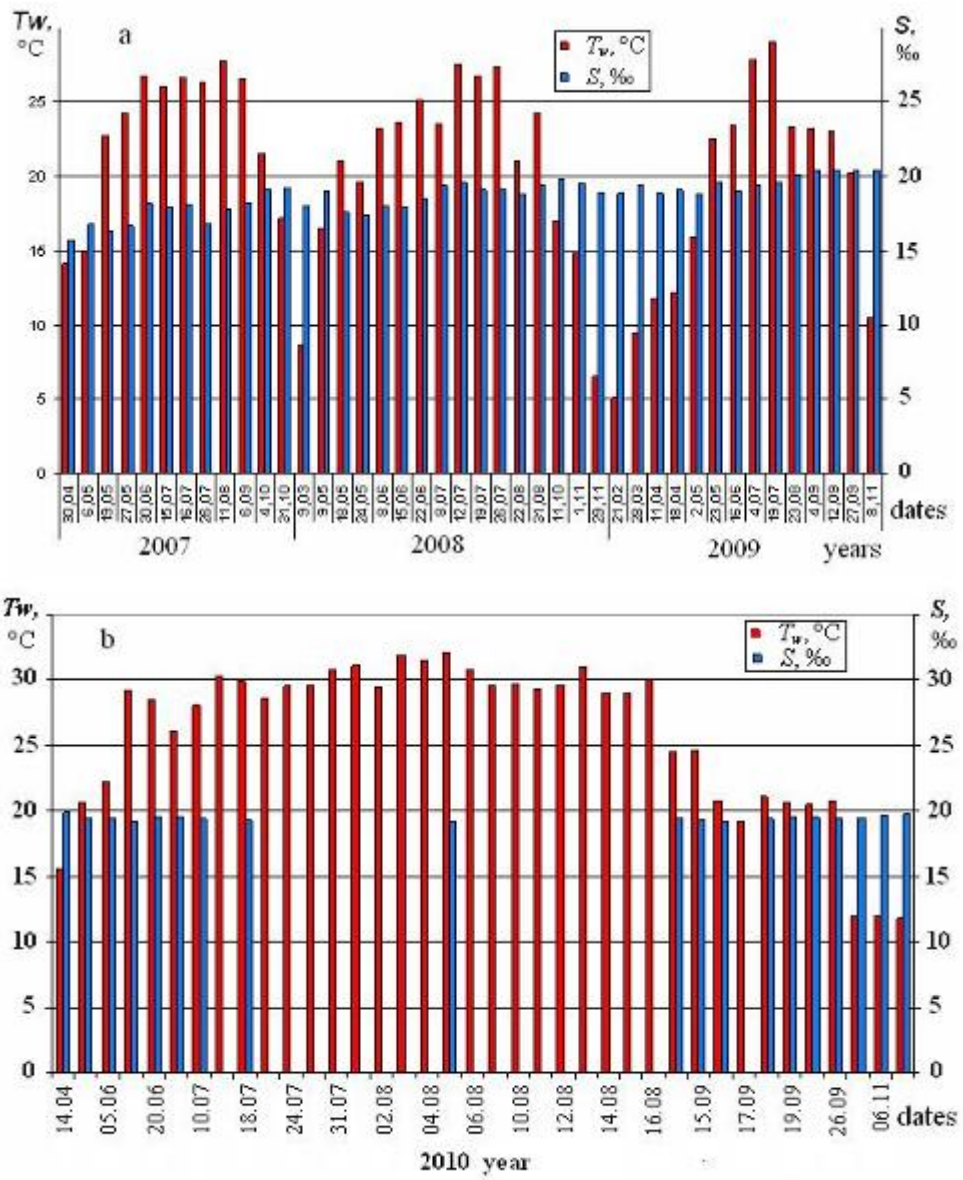

Figure 2.7 – Water temperature (*Tw*, °C) and salinity (*S*, ‰) in the surface layer of the central part of the Tyligulskyi Lagoon in (a) 2007–2009 and (b) 2010.

the average values of water salinity in the northern part of the lagoon were 8.7 ‰, in the central part 11.4 ‰, and in the southern part 13–14 ‰ (Rozengurt, 1974). Averaged over the period from 1975 through 1987, the values of water salinity in the lagoon did not change substantially and comprised 9–10 ‰ in the northern part, 11 ‰ in the central part, and 12 ‰ in the southern part (Polischuk et al., 1990). Under current conditions, water salinity in both the southern and the northern parts of the lagoon may increase to 19-23 ‰ in late summer/early autumn. Even under the heavy spring floods in 2003, when the lagoon level rose 0.4 m above sea level, there was no substantial decline in the total salinity of the lagoonal waters as the freshwater was limited to a near-surface layer and a sharp halocline arose, preventing the vertical mixing of waters. The spring heating of waters contributes to the intensification of the developed pycnocline. In spite of the fact that in the spring of 2003 the superficial layer in the southern part of the lagoon was desalinated up to 5.5 ‰, the water salinity went up to 19.5 ‰ by late autumn of that year.

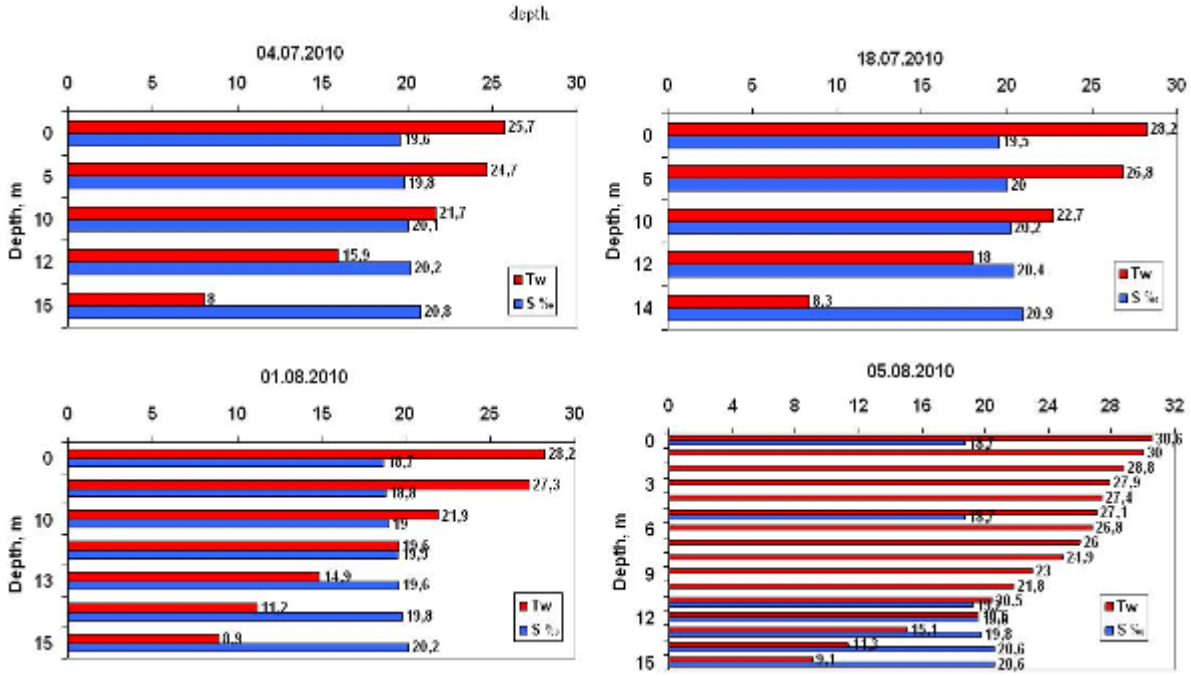

Figure 2.8 – Variability in the vertical distribution of water temperature (*Tw*, °C) and salinity (*S*, ‰) near central part of the Tyligulskyi Lagoon in 2010 on (a) 04 July 2010, (b) 18 July 2010, (c) 05 August 2010, and (d) 16 September 2010.

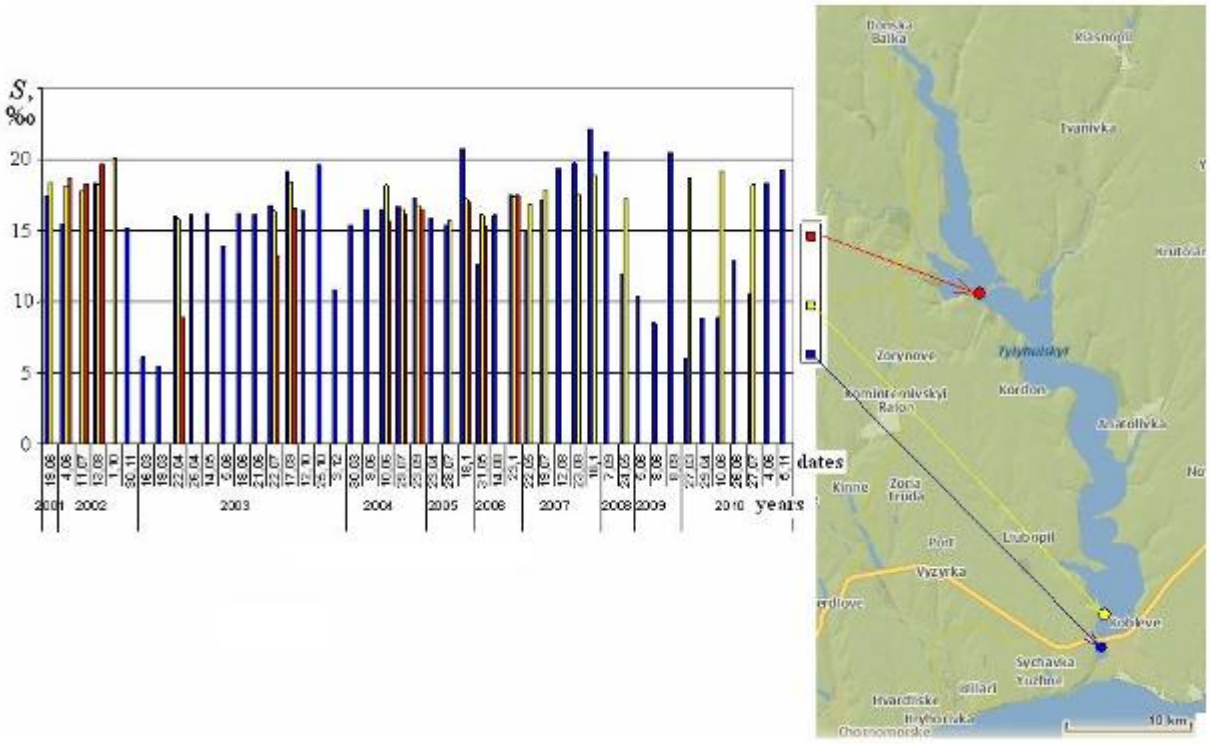

Figure 2.9 – Water salinity (*S*, ‰) in various parts of the Tyligulskyi Lagoon from the data of occasional coastal observations of 2001–2010.

From 2007 to 2009, water salinity in the central part of the lagoon fluctuated within the range of 16–20 ‰; in 2010 it did not go lower than 18.5 ‰ (Fig. 2.8). The vertical distribution of salinity in the area with deep cavities in the central part of the lagoon in summer is characterized by relative homogeneity (Fig. 2.9). The maximum difference between water salinity in the surface and the benthic layers does not exceed 2 ‰.

The Black Sea areas adjacent to the lagoon are influenced by the Dnieper and the South Bug river runoff, whose total discharge varies from 650 m^3 sec^{-1} during August to 2100 m^3 sec^{-1} during spring flood (April–May). Therefore, the salinity of sea water entering the lagoon through the canal is lower than the salinity of the lagoonal waters nowadays (6–10 ‰ during spring flood and 15–16 ‰ during low water periods).

2.2 Climate, natural resources and land-use

2.2.1 Climate

The Tyligulskyi Lagoon catchment is in the southern climate zone of Ukraine and is mainly located in the steppe zone; only the upper Tyligul river is located in the forest-steppe zone (Korotun et al., 2000). The climate is temperate and continental with low rainfall, short mild winters and long hot summers. Climatic variations can be quite extreme, but the vicinity to the Black Sea smoothes summer temperatures and humidity fluctuations. Figure 2.10 shows temperature and precipitation conditions on some sites close to the Tyligulskyi Lagoon catchment.

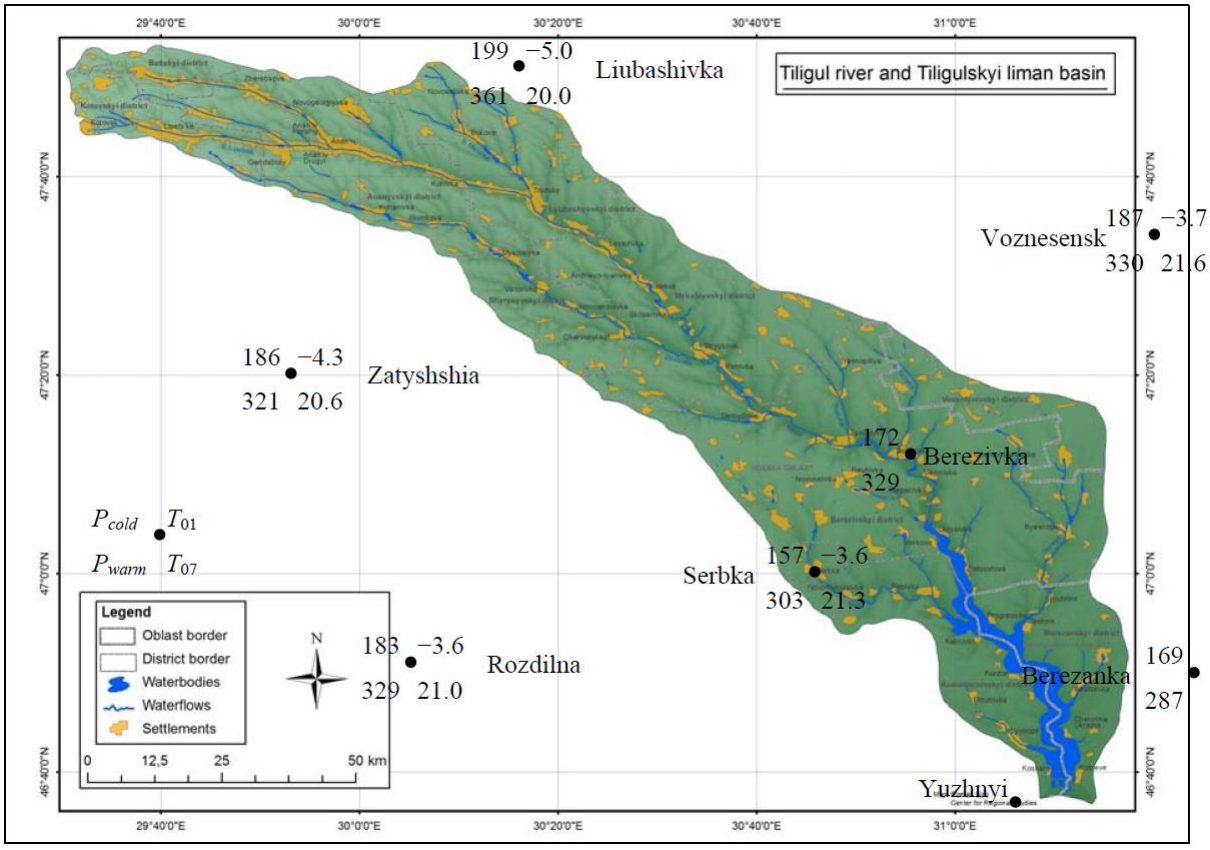

Figure 2.10 – Long term (1961–1990) mean precipitation in the cold (P_{cold}, November to March) and warm (P_{warm}, April to October) season as well as monthly temperatures for January (T_{01}) and July (T_{07}) for some sites close to the Tyligulskyi Lagoon.

Summer (130–140 days) is defined by sunny days and high air temperatures: the daily air temperature during July and August exceeds 20°C and the maximum temperature ever registered was 38.3 °C in June 1926. Also, there are long (up to two months) dry periods without precipitation. Historical records have registered a maximum rainfall of 103 mm per day on 8 June 1926. The dominant winds come from north/northwest with a frequency of up to 22 %. The number of dry days with a relative humidity of <30 % is 27 (Passport, 1994).

Autumn is rather warm and lasts about 60 days. Precipitation is low (60–70 mm) and mainly occurs in form of drizzle. Cloudiness increases in autumn and around 70 % of the days in November are overcast. Winds from the northwest, northeast, and east are dominant and the wind speed is higher than in summer.

Winter (about 80 days) is defined by very changeable weather with frequent thaws; daily temperatures range from −20 to +15°C. The period from 11th January to 10th February is coldest with temperatures reaching −28°C and a monthly mean temperature of −4.7°C. Snow cover occurs on less than 40 days during the winter with a mean depth of 50 mm. Frost can penetrate the soil to a depth of 1060 mm (Passport, 1994). Winter is also characterized by increased cloudiness (up to 77 % overcast days) and low precipitation (70-90 mm). Winds from the north dominate with wind speeds reaching 15m/s.

Spring is relatively short, about 2 months, with a rapid increase in incoming solar radiation and air temperature. Precipitation in the form of rainfall amounts to 100-110 mm. Winds from the south (about 20 %) and north (up to 15 %) dominate.

2.2.2 Natural resources

The coast of the Tyligulskyi Lagoon is distinguished for its landscape diversity: wave-cut niches, coastal benches, sandy spits and islands, shallow waters and water meadows, reed beds, steppe areas and woodlots offer favourable conditions for biological diversity. The flora of the lagoon coast numbers no less than 650 species of vascular plants, at least 70 of these are dominant plants of plant associations and 22 species are in the National and International Red Books. Of useful plants on the lagoon coast, 140 are medicinal species (including 31 dominants (D) of plant associations), 110 melliferous (23 D), 103 fodder (29 D), 93 food (22 D), 92 ornamental (18 D), 80 oil-plant (19 D), 40 dye species (11 D); some useful plants can be gathered in an organized way.

The importance of the vegetative cover on the Tyligulskyi Lagoon coast stems from its representativeness of the steppe zone in southern Ukraine, the occurrence of the plant associations registered in the Green book of Ukraine, and the species included in various protected plant lists of international, state and local importance.

The Tyligulskyi Lagoon is also characterized by a high level of faunal biodiversity. It is habitat for 70 % of the wetland avifauna in Ukraine, and, during migration, nesting and wintering period, about 300 species of birds can be found here. Among them, 26 species are registered in the Red Book of Ukraine and three species (*Phalacrocorax pygmeus Pall*., nester; *Haliaeetus albicilla*, bird of passage, wintering; *Rufibrenta ruficollis Pall*., bird of passage) in the European Red List. Beyond the nesting season, especially in the spring and autumn migration period, more than 70 species of wading birds dwell in the lagoon, the shallow waters and reaches (Integrated Land Use of Eurasian Steppes, 2008). The total number of birds accounts for 2,000 to 7,000 couples. The population of wintering birds amounts to about 10000, and the birds of passage to about 8000 (Loieva, 2011). Due to its importance as a place for fattening, nesting and rest of migrant birds, the Tyligulskyi Liman lagoon is included in the IBA (Important Bird Areas) List and in the List of Ramsar Wetlands of International Importance as a waterfowl habitat of international value.

No less than 1500 species of invertebrate animals inhabit the lagoon coast. Twenty-three species of insects are listed in the Red Book of Ukraine, and two species (*Saga pedo* (Pallas, 1771), *Zerynthia polyxena* (Denis et Schifermuller, 1775) are registered in the European Red List. Seven species of amphibia, seven species of reptiles, and 31 species of mammals, six of which are listed in the Red Book of Ukraine, can be found here (Integrated Land Use of Eurasian Steppes, 2008).

Nowadays the Tyligulskyi Lagoon is one of few wetlands that have preserved their natural seaside landscapes; its ecosystem offers unique conditions for fauna and flora, and the lagoon is of great value for the maintenance of the region's biological equilibrium.

A total of 118 species of planktonic algae, 51 species of bottom-living vegetation, including multicellular water-plants and flowering macrophytes, 30 species of meso- and macrozooplankton, 46 species of macrozoobenthos, and 25–30 species of fish are found in the waters of the Tyligulskyi Lagoon (Zaitsev et al., 2006).

The fishing capacity (as well as piscifauna diversity) of the Tyligulskyi Lagoon has always depended on its hydrological and hydrochemical regime and, first and foremost, on the salinity of its waters. In the 1930s–1950s, when the lagoon was desalinated due to abundant atmospheric precipitation and strong spring floods, the catches increased over several years. In spring, due to rising water levels, breaches of the isthmus occurred often and the water exchange with the sea was restored. Sea species of fish (*Mugilidae, Gobiidae, Pleuronectidae, Clupeidae, Atherinidae* etc.) were brought into the lagoon through occasional inrushes at the same time as freshwater fish species were taken away with the floods from the Dniprovsko-Buzkyi Lagoon (*Abramis brama L., Rutilus rutilus L., Cyprinus carpio L., Stizostedion lutioperka L., Carassius auratus gibelio Bloch., Blicka bjorcna (L), Skardinius erithrophthalmus L.* etc.) (Shekk, 2004).

Thirty-four species of saltwater and freshwater fish were registered in the lagoon in 1953. In 1959, a connecting canal to the sea was constructed in the isthmus of the Tyligulskyi Lagoon in order to increase the fishing capacity. Owing to this, 45 species of fish were registered in the lagoon in 1960 and 49 species in 1964 (Table A.1). Among them 16 (32.6 %) are brackish water[*], 14 (28.6 %) salt water and 19 (38.8 %) freshwater species. In 1953–1960 an average of 1091.8 tonnes of fish was caught in the lagoon annually (Fig. 2.11). The largest catch for the lagoon, 2349.6 tonnes (146.9 kg/ha), was registered in 1956 (Zambriborshch, 1956, 1965). However, against all expectations, in the subsequent years the catches began to decline. This was due to a decrease of freshwater fish that was usually carried from the Dniprovsko-Buzkyi Lagoon to the mouth zone of the Tyligulskyi Lagoon. This was a result of the overregulation of the Dnipro River flow by a cascade of hydroelectric power stations causing a decrease in spring flood intensity, as well as the onset of reservoir salinization. As a consequence, a gradual replacement of freshwater fish by sea species occured, with prevailing amounts of "lower value species" (Shekk, 2004).

In 1968 the canal sanded up and from the 1970s–1990s, it only functioned intermittently, often with long-term interruptions, which induced a gradual growth in water salinity. As a result, in the 1980s *Acipenser stellatus Pall., Anguila anguila L., Rutilus rutilus L.* and eleven species of freshwater fish, as well as previously abundant salt water species of fish – *Sprattus sprattus phalericus Risso (Clupeidae)* and *Engraulis encrasicolus ponticus Aeks (Engraulidae)*, which entered from the sea, were no longer observed in the lagoon (Polishchuk et al., 1990).

From 1961 to 1971, catches decreased from 877.8 to 276.1 tonnes (54.9–17.3 kg/ha), and the fishery was based on *Gobiidae* and *Atherina mochon pontica Eichw*, and since 1974 – on *Atherina mochon pontica Eichw* and *Clupeonella cultriventris Nordm.* From 1976 to 1979 the average catch in the lagoon went down to 235.5 tonnes (14.6 kg/ha). In the 1980s the predominant catches were *Atherina*

[*] Water with a salinity of 0.5 to 17.5 ‰

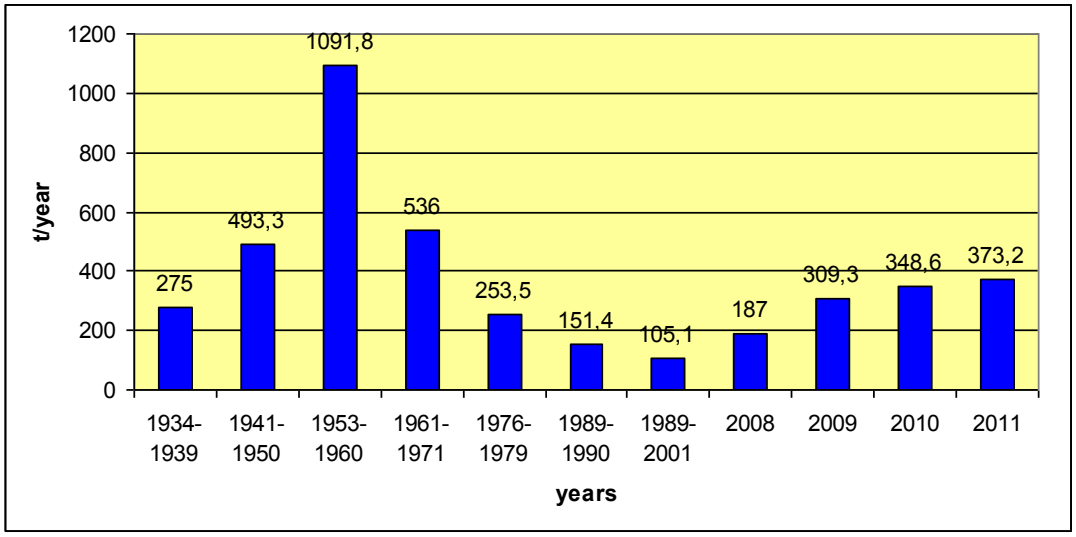

Figure 2.11 – Dynamics of the commercial catch of fish in the Tyligulskyi Lagoon.

mochon pontica Eichw and *Stizostedion lutioperka L.*. The catches ranged from 105.1 to 616.0 tonnes/year, depending on the canal function, (6.5–38.5 kg/ha). *Gobiidae, Mugilidae* and *Platichtys flescus Pall* lost their commercial value, and since 1992 *Atherina mochon pontica Eichw* became the principal commercial object in the Tyligulskyi Lagoon, with catches at the end of the previous century ranging between 107 and 178 tonnes per year (Zaitsev et al., 2006).

At the beginning of the 21st century the connecting canal to the sea was restored and was intermittently opened for a number of years in spring to provide the influx of young saltwater fish from the sea into the lagoon. However, from 2007 to 2009 the canal ceased to function again and was not opened for longer periods until 2010, when it was open from April through September. The catches of fish, though increased to 309–370 tonnes from 2009 to 2011, consisting mainly, as before, of low-value species *Atherina mochon pontica Eichw* (Loieva, 2011). In the summer of 2010, owing to hazardous weather conditions, strong thundershowers from June to July and anomalously high water temperatures in July and August, a mass mortality of fish (*Gobiidae, Mugilidae*) occurred. In some coastal areas 20 kg of dead fish per square meter were observed.

In view of the deterioration of water quality indices and the lack of necessary conditions for a sufficient influx of young fish, mainly *Mugilidae*, from the sea to the lagoon for fattening, a mere 20–30 % of the lagoon's fishing potential is currently made use of.

Under present-day conditions a workable way to increase the fishing capacity of the lagoon is through the establishment of a population of valuable saltwater fishes: *Mugil so-iuy Basilewsky, Acipenseridae, Platichtys flescus Pall*, and *Gobiidae* could be prospective species for introduction. Artificial reproduction and stocking as well as formation of self-reproducing populations are considered the most viable ways to maintain a large population size of these species. In case of aquaculture, the indigenous *Mugilidae (Mugil cephalus L., Liza aurata Risso, L. saliens Riso)* could result in substantial increases of the biomass (Shekk, 2004).

The Tyligulskyi Lagoon and the adjacent areas are endowed with considerable recreational resources. The unique coastal landscape, the abundance of flora and fauna in the lagoon, as well as in the adjacent areas, contribute to the development of sustainable ('green') tourism and restricted types of recreational fishing (see Figs. 2.12 and 2.13).

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Figure 2.12 – Natural resources of the Tyligulskyi Lagoon.

The sea side of the sandy isthmus and the coastal areas of the lagoon have very attractive wide sandy beaches. Shallow beaches are found in the coastal concavities and the bays, especially in the southern part of the lagoon. In general, the lagoon's beaches are small in comparison to seafront beaches – their width does not exceed 5–10 m and their height is around 0.3–0.5 m.

Adjacent to the Tyligulskyi Lagoon, tourist recreation centers, campsites, hotels, and seaside health resorts such as Koblevo, Rybakovka and Sychavka are situated. These resorts specialize in climatotherapy from mid-May to mid-September (about 130 days per year) and health improvement for patients with non-infectious affections of the lungs and upper air passages as well as

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Figure 2.13 – Natural resources of the Tyligulskyi Lagoon.

cardiovascular diseases. In addition, other medicinal treatments and recreational possibilities are offered such as ampelotherapy, the use of special diets for patients with endocrine system disorders, sports fishing in the Black Sea and the Tyligulskyi Lagoon, and sustainable tourism in the regional landscape parks.

Due to its balneological resources, the Tyligulskyi Lagoon has a significant potential for the development of recreational and therapeutic activities. One of the largest deposits of mineral-rich muds in the Black Sea Region is located here, with supplies amounting to 15800 tonnes distributed over an area of 23200 km^2.

In order to protect the natural resources of the lagoon, two regional landscape parks were created on its coasts and in the water area within the limits of Odessa (3973 ha of dry land and 9981 ha of the lagoon water area) and Mykolaiv (8195,4 ha). In addition, nature reserves of local importance such as the 'Kalinovskyi' botanical reserve (92 ha), the 'Tyligulska Peresyp' ornithological reserve (390 ha), the 'Kairovskyi' landscape reserve (150 ha) and the 'Novomykolaivskyi' reserve (315 ha) are located in the Odessa region, as well as the 'Lower Reaches of the Tyligulskyi Liman lagoon' ornithological reserve (120 ha) in the Mykolaiv region. Moreover, the 'Kosa Strilka' ornithological reserve of national importance (394 ha, Odessa region), created during the period from 1974 to 1985, is part of the lagoon's coast.

2.2.3 Land use

The characteristics of the soils in the catchment area of the Tyligulskyi Lagoon are determined by a steppe climate with high temperatures and low soil moisture under high evaporation. The soils are

formed on neogene-quartenary clay sedimentary rocks. Loesses, loess-type loams, dealluvial reddish-brown clays, alluvial-and-limnetic sandy loams and sands act as maternal rocks (Integrated Land Use in Eurasian Steppes, 2004).

Soils of the inter-lagoon and inter-valley watersheds are represented by highly fertile chernozems and deep dark brown soils (1.2-1.5m) with average organic matter contents around 3.3 %, and maximum contents of 5–6 %. The eroded and partly eroded chernozems can be found on the slopes of the river valleys, the gullies and the lagoon. The compound landform of the slopes, partitioned by deep ravine and gully networks and characterized by a considerable variability of soil cover and microclimate conditions for soil moisture, substantially hamper the use of slope lands.

The coastal strip of the lagoon is both aquatic (mouths of gullies and rivers, spits, beaches etc.) and terrestrial (terraces and cliffs). In periods with high water levels in the lagoon and the sea the strip can be flooded. In summer and autumn the strip is supplied with groundwater. It is here that salt marshes, meadows and marsh soils of various degrees of salinity and alkalinity are formed. As a rule, they are used as low-yield natural forage lands (Vykhovanets, 2004).

According to soil-geographic zoning, the upper two thirds of the catchment area of the Tyligulskyi Lagoon belong to the steppe zone of ordinary and south chernozems, and the lower third belongs to the dry steppe zone of dark brown and chestnut soils (Fig. 2.14).

In the first part of the previous century oak trees mixed with occasional hornbeams and gully forests grew in the upper part of the Tyligulskyi Lagoon basin. Fescue and stipa steppes prevailed in the middle and lower parts of the catchment area. Until now, near the coast of the Black Sea, wermuth and fescue steppes can be found growing on solonetzes (sodic soils). The oak trees have mostly been cut down, and the steppes have been tilled and transformed into agricultural lands (Fig. 2.15). In tilled

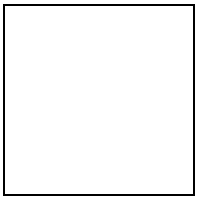

Figure 2.14 – Soil map (Atlas of the Odessa region, 2002).

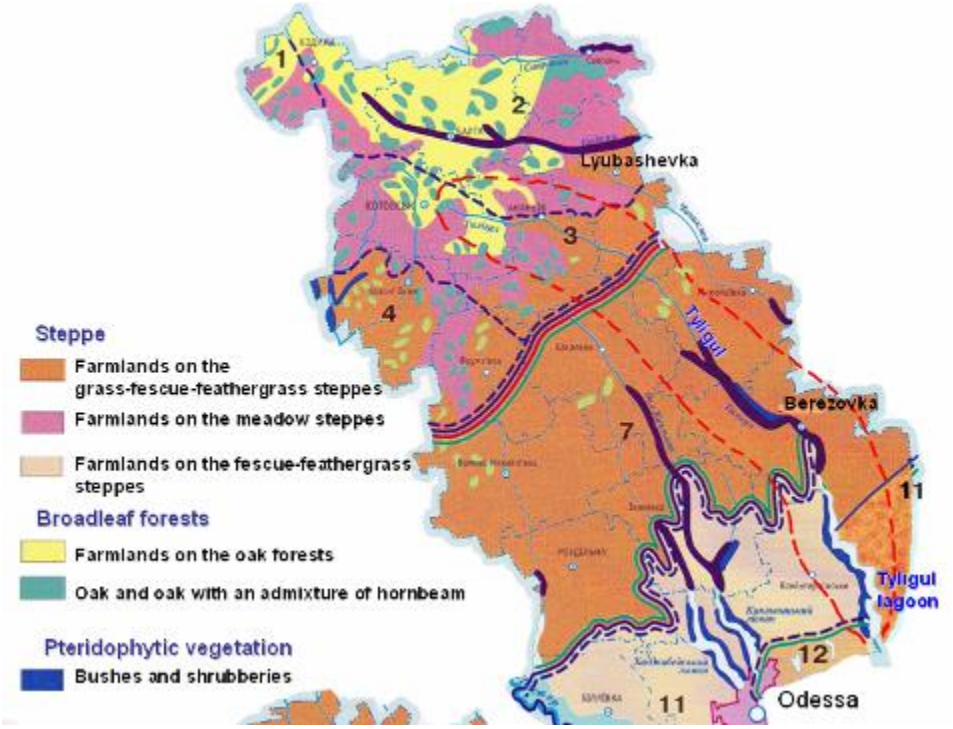

Figure 2.15 – Vegetation map (Atlas of the Odessa region, 2002).

areas, cereals and leguminous crops prevail (about 60 %), fodder and industrial crops, including sunflower and rape, take up 20 %, cucurbitaceous species comprise the remaining 20 % (Atlas of the Odessa region, 2002). The basic cereal crop is winter wheat, but areas under winter barley and corn make up a considerable proportion (Fig. 2.16).

Agricultural lands in the Tyligulskyi Lagoon basin comprise 75.4 % of the total catchment area. In the upper and lower parts of the Tyligulskyi Lagoon basin the share of agricultural lands is 70–85 %, in the middle part 86–90 % (Fig. 2.17). The percentage of the total area of agricultural lands for the tilled lands varies from 65–70 % near the Tyligul River to 80-85 % in the middle part of the catchment area and 75–80 % in the lower flow. Round the Tyligulskyi Lagoon the percentage of arable land is 75–85 %.

In 1994, 65 large collective and state farms existed on the territory of the Tyligul River basin (Passport, 1994). Presently, there are 205 agricultural enterprises registered in the catchment basin, but only 54 of them cultivate a total area of more than 1000 hectares.

In years with sufficient rainfall the potentially fertile chernozems on the watershed fields surrounding the lagoon provide high yields of cereals, cucurbits and other crops. However, the region experiences frequent and long droughts substantially decreasing crop yields; this is the principal reason for the considerable fluctuations in the gross yield of grain and other agricultural produce.

Gardening and viticulture are widespread in the territory adjacent to the lagoon's coast. A large vineyard is located in the district of Koblevo.

In the 1990s numerous suburban, horticultural and gardening associations (mainly in the territory of Kalynovskyi, Liubopolskyi and Petrovskyi village councils) consisting of lots of 0.06-0.12 ha with small buildings (summer cottages) were created along the western coast of the Tyligulskyi Lagoon (Odessa region). During spring and summer, the population of these associations can simultaneously

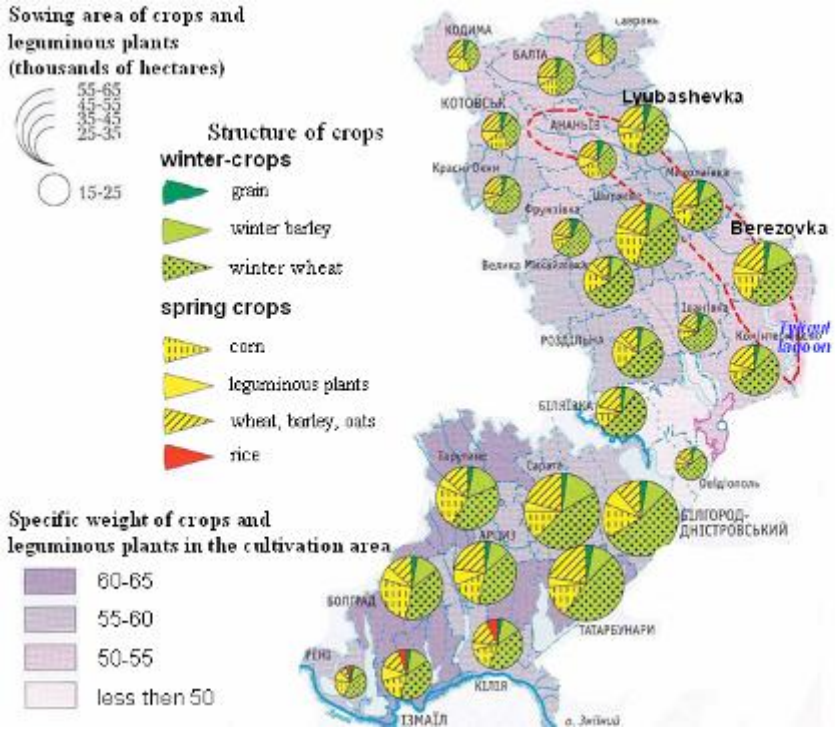

Figure 2.16 – Cereals and leguminous crops (Atlas of the Odessa region, 2002).

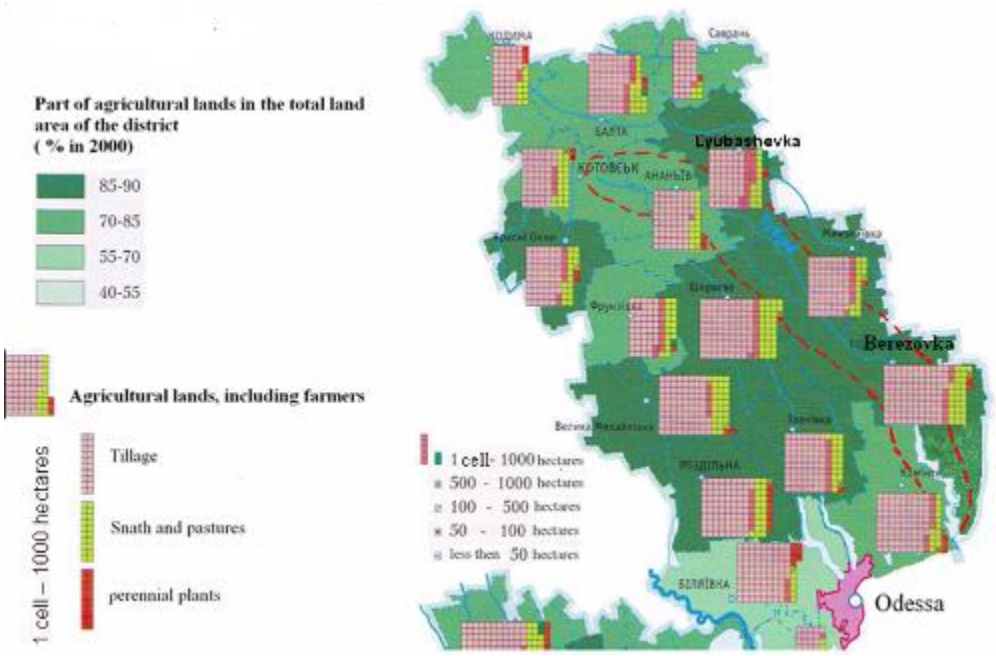

Figure 2.17 – Agricultural lands (Atlas of the Odessa region, 2002).

reach up to the 10000 persons.

Previously, dairy and beef farming were the major agricultural activity in the Tyligulskyi Lagoon basin. However, within the latest decades livestock farming in the region has declined. Pig and sheep breeding and dairy farming is limited to a few farms and local households. The lagoon slopes are used by the local community for cattle pastures.

2.3 Main ecological and environmental problems

As a result of anthropogenic pressure, climate change and the lack of reliable regulatory plans for water and environmental management, the natural resources of the Tyligulskyi Lagoon are threatened to suffer substantial damage.

Firstly, land in the Tyligulskyi Lagoon catchment is intensively used for agriculture, which has an unfavourable effect on the lagoon's water quality due to the input of fertilizers and pesticides. Table 2.1 shows that 4477 tonnes of fertilizer were applied including 2829 tonnes of nitrogen, 785 tonnes of phosphate, and 795 tonnes of potash. A considerable part of the fertilizer was found in the rivers and the Tyligulskyi Lagoon; for example, large quantities of nitrogen were measured in the Tyligul, Melanka and Zhuravka River; phosphate was found in the Tyligul River only (Table 2.2). It has to be noted that the average rates of fertilizer application for main crops are 50–60 kg/ha. Also, about 300 tonnes of pesticides, including about 25 tonnes of organophosphates were applied per year (see Table 2.1). As a result of anthropogenic activity, a considerable quantity of biogenic matter was detected in the rivers of the Tyligulskyi Lagoon catchment (Table 2.3). In the case of the biochemical oxygen

Table 2.1 – Mineral fertilizers and pesticides application in the Tyligulskyi Lagoon catchment (Passport, 1994).

Parameters	Tyligul	Lipetska	Melanka	Zhuravka	Dubova	Slipukha	Tartakai
1. Fertilizers (effective matter):							
kg per hectare	14	19	12	24	19.6	10	13.6
total, tonnes	2822	251	553	304	274	119	154
including:							
nitrogen	1769	125	401	184	188	68	94
phosphate	533	21	97	37	47	29	21
potash	522	45	55	83	39	22	29
2. Pesticides							
kg per hectare	0.85	1.14	0.95	0.93	0.76	0.65	0.81
total, tonnes	171.7	19.5	43.4	11.6	10.7	7.8	0.9
including:							
organochlorine	0.6	—	0.1	—	—	0.1	0.1
organophosphate	13.9	1.9	5.3	0.9	0.7	0.4	0.7

Table 2.2 – Intake of mineral fertilizers (effective matter, tonnes) into the rivers of the Tyligulskyi Lagoon catchment from agricultural arable lands (Passport, 1994).

Parameters	Tyligul	Lipetska	Melanka	Zhuravka	Dubova	Slipukha	Tartakai
nitrogen	74.8	0.404	42.0	64.0	4.3	4.03	3.4
phosphate	18.0	0.2	0.099	0.636	0.149	0.14	0.118

Table 2.3 – Intake of biogens (tonnes per year) into the rivers of the Tyligulskyi Lagoon catchment (Passport, 1994).

Parameters	Tyligul	Lipetska	Melanka	Zhuravka	Dubova	Slipukha	Tartakai
NH_4^+	9.74	6.62	3.15	6.94	1.42	1.49	1.26
NO_2^-	0.95	0.06	0.16	0.41	0.03	0.03	0.03
NO_3^-	16.81	60.23	38.47	56.45	2.37	2.49	2.11
BOD_5	190.16*	44.15*	14.82	64.65*	18.92*	19.87*	16.71*
total phosphorus	7.73	10.72*	0.09	0.63	0.91	0.98	0.82

* Values exceeding national water quality standards.

demand of all rivers excluding the Melanka River, the values exceeded the national water quality standards.

The main problem of the Tyligulskyi Lagoon nowadays is the 'bloom' of phytoplankton and bottom macrophytes in the summer period, which results in development of hypoxia in the deep benthic layers of the lagoon as well as in the shallow water during night-time under calm, warm waters. Development of oxygen deficit in the water causes death of the hydrobionts. In the years 1999, 2000, 2001, 2006, and 2007, fish kills were observed during summer in various areas of the lagoon.

Another serious problem is a gradual increase in water salinity (salinization) as a result of the decrease in fresh water inflow from the catchment area, and the inflow of salt waters under intensive evaporation during summer. In the 1960s, under the occurrence of occasional water exchange with the sea through the connecting canal (in spring and autumn), the salinity of waters in the northern part of the lagoon fluctuated within the limits of 1–14 ‰ (average long-term value ≈ 7 ‰), and in the central and the southern parts 10–15 ‰ (average long-term value is about 12 ‰). Under present conditions, in the absence of water exchange with the sea, by the end of summer, water salinity in both the southern and the northern parts of the lagoon increased to 19–22 ‰. The increase in water salinity resulted in a replacement of the dominating brackish water fish species by sea species; in addition, a substantially lower species diversity can be observed.

The most negative consequences for the lagoonal ecosystem are caused by the decrease in the superficial flow (of the Tyligul, the Balaichuk and the Tsarega River, and slope run-off into gullies and the ravines), due to both anthropogenic activity (creation of a large number of artificial water bodies, transformation of natural landscapes, ploughing of lands, deforestation and destruction of an overwhelming part of the vegetative cover) and climate change. For example, in accordance with the findings of Loboda (2012), the rate of natural (undisturbed by anthropogenic activity) annual runoff from the catchment area of the Tyligul River into the Tyligulskyi Lagoon, as compared to the mid-20th century, decreased due to climate change by 30 %. Furthermore, intensive water management activity is carried out in the river catchment area. According to data from the catalogues of water stock in the Odessa and Mykolaiv regions, the number of artificial water bodies located in the Tyligulskyi Lagoon basin is 157 with a total volume of about 19×10^6 m^3. The withdrawal of the river runoff for impoundment in reservoirs located in the catchment area of the Tyligul River with subsequent surface evaporation results in a 54 % decrease of natural runoff (Loboda, 2012). The decrease in water volume in the Tyligul River in the second half of the previous century led to drying of about 40 % of overflow land in the area of its inflow into the northern part of the lagoon.

Since evaporation from the lagoon surface is three times higher than rainfall in summer months, the decrease in fresh water inflow into the lagoon results in salinization and a decrease in water depth inside the lagoon, an increased concentration of biogenic substances as well as increased rates of production of organic substances by phytoplankton and bottom macrophytes in the shallow zones. The subsequent death and biochemical decomposition of algae-derived organic substances contribute to the development of oxygen deficit in the water, mortality of hydrobionts and the depletion of floral and faunal diversity. Unfavourable conditions for fishing, recreation and tourism are taking shape.

Agricultural activity in the Tyligulskyi Lagoon catchment area and especially on the coastal slopes exerts negative influences on its ecosystem. Tillage of lands and pasturing of cattle in the coastal protective strip, application of fertilizers and pesticides in crop production and gardening result in pollution of the lagoonal waters, additional inflow of suspended sediments and humus as well as biogenic substances in mineral and organic forms during spring flood and severe summer storms. This leads to reduced water transparency, increasing water temperature in the surface layer, and development of eutrophication with all its negative effects.

Additional anthropogenic pressure on the lagoon ecosystem occurs due to economic and communal activities, whose dimension has substantially grown during the last decades as a result of intensive suburban settlement in the territories adjacent to the lagoon. There are now 16000 suburban horticultural and gardening plots on the western coast of the lagoon between the villages of Kashary and Marianivka. The negative consequences of these activities include disturbance of the natural landscapes, bird habitats and nesting sites, destruction of unique flora and fauna, formation of landfills along the shore due to a lack of recycling facilities, domestic waste, discharge of untreated sewage into the lagoon and the inflowing watercourses due to the absence of a sewage system, and washout of fertilizers and pesticides during spring tide and summer storms. Discharge of untreated sewage into the surface water bodies of the Tyligulskyi Lagoon basin amounts to 350–400×10^3 m^3 per year.

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Figure 2.18 – Ecological problems in the Tyligulskyi Lagoon: (upper) ploughing within the nature-conservation coastal strip, (middle) uncontrolled grazing, (bottom) mass fish mortality due to oxygen depletion in the water.

The water exchange between the lagoon and the sea through the connecting artificial canal has both positive and negative aspects. Positive influences lie in the fact that the functioning of the canal prevents a considerable decline in the lagoon's water level at the end of the summer, and a further shoaling of the shallow areas of the lagoon (the northern part, submerged dams near spits which divide the lagoon into different parts). In addition, it contributes to the renewal of polluted lagoonal waters by relatively pure sea waters and the intensification of water exchange between the deep parts of the lagoon that are divided by shallow dams. When the canal functions during spring, young saltwater fish

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Figure 2.19 – Ecological problems of the Tyligulskyi Lagoon: (upper) illegal refuse tips, (mid) spontaneous fire caused by recreationists, tourists and local inhabitants, (bottom) natural landscape disruption – illegal sandpits.

are able to get into the lagoon for fattening, which increases the fish resources and the development of industrial and recreational fishing.

Negative impacts of the canal include the flooding of conventional bird nesting sites, acceleration of erosion and landslide processes on the lagoon's banks and an increased probability of salt water intrusion into the Tyligul River floodplain and the wetlands at high sea level. Uncontrolled water exchange with the sea through the connecting canal contributes to the accumulation of salts in the lagoon and sets a long-term trend for increasing salinity. This may result in a transformation of the lagoon into a hypersaline water body with considerably less biodiversity with regard to its present water flora and fauna.

2.4 Knowledge gaps

Since 2001 until the present, monitoring of the characteristics of hydrological and hydrochemical water regimes, as well as variability of the biotic components of the Tyligulskyi Lagoon ecosystem has been conducted by the Institute of Biology of the Southern Seas of the National Academy of Sciences of Ukraine. The generalized materials from the observations conducted in the period of 2001 through 2003 are published in the monograph (Zaitzev et al., 2006).

The major disadvantages of the hydroecological monitoring of the Tyligulskyi Lagoon waters in the previous decade is that it was carried out mainly in the lagoon coastal zone (Fig. 2.20) and that its implementation was irregular and haphazard and lacked an overall plan. The observations were sporadic, their number substantially differed from year to year and some of the years no observations were at all. The reason for that is the significant remoteness of the lagoon from Odessa (70 kilometres) and limited financial resources for implementation of the monitoring. The abovementioned lack of a monitoring system restrict the possibilities for complex analysis of interactions between hydroecological processes in the lagoon.

The observations of hydrological, chemical and biological characteristics of waters in the lagoon ecosystem are not timed and coherent in all cases. This results in a poor accuracy for the hydrometeorological impact on production and respiration processes in the lagoonal ecosystem. A substantial drawback of the database is a very small number of observations of water transparency, which is one of primary factors defining the spatiotemporal variability of primary production in the lagoon.

As opposed to the monitoring conducted in the 1980s, integrated hydrochemical observations make it possible to assess the concentration of not only mineral but also organic forms of nitrogen and phosphorus in the water. However, only one index, permanganate oxidizability, was used for assessing the content of nonliving organic substance in the water. This makes it difficult to identify the content of nonliving organic carbon in the estuarial waters or determine carbon biochemical oxygen demand (CBOD), its oxygen equivalent, and other euthrophication model variables which are important for adequate description of the dissolved oxygen dynamics in the model.

The hydrochemical conditions in the Tyligulskyi lagoon are defined by a very high concentration of inorganic phosphorus from unknown sources. We only hypothesize that the phosphates originate from bird droppings or bottom sediments during periods of hypoxia.

The main ecological problem for the Tyligulskyi Lagoon is eutrophication (high rate of organic matter formation in the primary production process) causing hypoxia and anoxia in the benthic layer as well as the death of hydrobionts. A model considering the eutrophication has to be used to develop scenarios for the water management in the lagoon under the anthropogenic and climatic forcings. In this connection, additional data on water transparency and the concentration of nonliving organic

material in the lagoon allow improved verification of the model and its ability to describe the ecosystem of the lagoon under natural and anthropogenic forcings.

The deficiency of hydrological observations consists in their basic pointwise nature (Fig. 2.20a). The spatial surveys of discreet parts of the lagoon are isolated. This results in an approximate representation of termohaline structure variability at the different parts of the lagoon.

Unfortunately, both in the previous century and the past decade, timing records for functioning of the connecting canal were kept neither in terms of years nor months and data on long-term variability in its morphometric characteristics (width and depth in various areas) are also lacking. Thus the impact of water exchange with the Black Sea on hydroecological processes in the lagoon can be estimated only on the qualitative level. Quantitative estimations can be obtained by numerical hydrodynamical modelling for some years. Also, the volume of sea water inflowing in the lagoon through the connecting canal is determined by the differences of water levels between the lagoon and sea.

There are no stationary hydrometeorological stations or monitoring sites on the lagoon coast. In 1988 observations of fluctuations in the lagoon water level at the hydrometric station in the village of Koblevo, which had been carried out since 1936, were discontinued. Presently, the lagoon water level is measured occasionally. The absolute values of the lagoon water level are determined by means of binding to the sea level data values measured at the 'Port Yuzhnyi' stationary maritime hydrometeorological station (MHMS), which is remote, situated about 10 kilometres away from the

Figure 2.20 – The stations of hydrological (a) and environmental (b) monitoring at the Tyligulskyi Lagoon.

sea coastal zone adjacent to the Tyligulskyi Lagoon (see Fig. 2.10). It is natural that certain errors creep in the measured sea level values, which could be attributed to inaccuracy of referencing to the sea level in the area of the lagoon nehrung.

Systematic observations of wind velocity and direction, temperature and salinity of the sea water, sea level, rainfall, cloud amount, air temperature and humidity are conducted at the MHMS 'Port Yuzhnyi' with the discrecity of 6 hours.

In order to bridge the above mentioned gaps in the knowledge we suggest:

- to use the monthly values of hydrochemical and hydrobiological characteristic, averaged for the observation period of 2001 through 2010, for calibration and validation of the model for lagoon water euthrophication;
- to use correlations between the estimates of dissolved organic substance in terms of permanganate oxidizability (Dissolved organic matter, DOM), BOD_5, and Corg, which were made during the monitoring of 1979-1987, for assessment of the content of nonliving organic carbon and CBOD as its oxygen equivalent in the lagoonal waters along with their seasonal dynamics.
- to use the MHMS 'Port Yuzhnyi' data series for conducting a research into interannual variability of hydrometeorological characteristics over the lagoon and the adjacent sea area with regard to the station's relative proximity to the Tyligulskyi Lagoon (about 10 km);
- to analyse the changes in the hydroecological regime of the Tyligulskyi Lagoon within the past decades on the basis of data from literary sources and the monitoring of 2001-2010 with the purpose of making an estimate of archived data employment for calibration and verification of the model for lagoonal waters.

3. The Management Story

3.1 Socio-economic, livelihood and political issues

The catchment basin of the Tyligulskyi Lagoon is located in the eight districts of the Odessa region and the two districts of the Mykolaiv region. By administrative and territorial subordination the northern part of the Tyligulskyi Lagoon belongs to the Berezivskyi district of the Odessa region, the western part – to the Kominternovskyi district of the Odessa region, and the eastern part – to the Berezanskyi district of the Mykolaiv region. These districts are hereinafter referred to as the Tyligulskyi Lagoon mezoregion.

The area of these administrative districts, including territories to be not related to the lagoon, totals approximately 5,000 km^2 and is inhabited by a population of almost 130,000 (Statistical Yearbook 2010 of the Odessa Region, 2011; Statistical Yearbook 2010 of the Mykolaiv Region, 2011). The most important indices to describe the socio-economic development of the Tyligulskyi Lagoon mezoregion as of 01 January 2011 are given in Table 3.1. In 2011 the socio-economic situation in the region stabilized, which is testified by the data in the reports of the district state administrations

Table 3.1 – The key indicators of the socio-economic situation in the administrative districts of the Tyligulskyi Lagoon zone.

Indicator	District		
	Kominternovskyi	Berezivskyi	Berezanskyi
Area, *thousand km*^{2}	1.49	1.64	1.38
Number of settlements	66	65	50
Population, *thousand persons*	69.4	34.4	24.0
urban	14.3	12.5	4.1
rural	55.1	21.9	19.9
Population density, *persons per km*^{2}	46.6	21.0	17.4
Demographic indicators, *on 1000 persons:*			
birth rate	13.3	13.2	12.3
death rate	14.6	18.2	15.1
natural increase	−1.3	−5.0	−2.8
Average wage, *UAH* *	1,773	1,313	1,708
Unemployment rate, *%*	0.5	2.2	3.5
Area of agricultural lands, *thousand km*^{2}	1.141	1.364	1.127
Sowing area, *thousand km*^{2}	0.819	0.955	0.567
Gross grain yield, *thousand tons*	124. 7	165.3	92.1
Productivity of cereals, *kg per hectare*	2480	2660	2260
Livestock population, *thousand heads:*			
cows	3.3	3.1	5.3
pigs	7.3	9.6	5.9
sheep, goats	4.0	2.2	3.7
poultry	783.2	173.5	109.8
Agricultural production:			
meat, *tons*	6,771	3,534	2,061
milk, *thousand tons*	13.4	27.6	21.6
eggs, *thousand pcs.*	183,186	15,474	7,538
Profitability of agricultural production, *%*	1.9	15.3	28.2

* Exchange rate for September 1, 2012: 100 UAH = 9.66 Euros

(The programme of socio-economic and cultural development of the Berezivskyi district in 2012, The programme of socio-economic and cultural development of the Kominternovskyi district in 2012, Socio-economic situation in the Berezanskyi district as of 2011).

Thus, in the Berezivskyi district the rate of natural population loss due to natural causes decreased by 67.6 %, which resulted from an increase in birth rate by 9.2 % and a decrease in death rate by 2.3 %.

The registered unemployment rate for the district as a whole made up 1.74 % and the employment index increased by 17.9 % as of 01 January 2012. The average monthly wage of a full-time employee, as compared to the one of 2010, increased 13.5 %.

Industrial production rates (mainly, the food manufacturing industry's expense) increased by 3.3 %, and the amount of the product sold totalled UAH 9.7 million.

An area of 27.500 hectares of winter wheat, 17.100 hectares of winter barley and 6.300 hectares of winter rape were sown in the district in 2011. The area under spring cereals totalled 15.800 hectares. The sown areas under peas, buckwheat, sweet corn, sorghum, fodder crops, namely leguminous mixtures, ensilage corn, and perennial grasses increased. According to the calculations (considering individual farms), gross grain yield comprised 6.4 thousand tonnes and exceeded the one of 2010. Average productivity of cereals in the Berezivskyi district made up 3.16 tonnes per hectare.

Gross yield of the main food crop, winter wheat, made 95.7 thousand tons, with the average productivity of 3.5 tonnes per hectare.

The farms in the district harvested considerably more forage for feeding the cattle than in the previous years, which positively influenced the livestock population; for example, the population increase in cattle made up 10.8 %, and 11.3 % for sheep and goats. The animal-breeding products also increased: the largest milk yield per cow was registered at the Pedigree Plant named after Posmitnyi – 5.4 tonnes, AF 'Maiak' Ltd partnership – 4 tonnes, 'Maria' Manufacturing Enterprise – 3.72 tonnes.

In the Berezivskyi district 12 high-power tractors and 6 high-performance grain combines were purchased in 2011. Expenditures for replacement of the fleet of tractors, tillage and sowing machines amounted to UAH 21.1 million.

A total of 379.400 passengers made use of motor transport services, which is 57.7 % more than in the previous year. This service was provided by 3 passenger hauliers which operate 23 intradistrict bus routes.

In 2011 enterprises and organizations in the district drew UAH 20.94 million of capital investments from various sources of funding, 91.7 % of which comprised investments in fixed capital with the most ponderable part, 87.3 %, invested in the development of agriculture.

Individual developers put into operation 1,000 m^2 of housing in the Berezivskyi district.

During 2011 the consumer market sector turned more active. The turnover in retail trade made up UAH 246,330,000, which is 13.5 % more than in 2010. A multibranch network of enterprises of retail trade and public catering has been created in the district, which includes 258 and 25 facilities respectively. Over 200 new jobs were created in the sectors of trade, restaurant economy and domestic service in the district within the year.

Operation of the economic complex in the Berezivskyi district influenced fulfillment of the planned revenue indices at all of the levels in 2011. Thus, UAH 32,149,000 replenished the consolidated budget of the district, including UAH 4,566,000 of the state budget and UAH 27,582,000 of the local

budgets, which exceeds the prospected indices of budgetary income for the previous year by 13.2 % and 11.2 %, respectively. Financial performance of the enterprises, organizations and institutions in the Berezivskyi district showed certain improvement: 75 % of the enterprises worked profitably with UAH 1,537,000 of the total income received.

Positive trends of socio-economic progress in 2011 were also observed in the Kominternovskyi district of the Odessa region.

The rate of population loss due to natural causes decreased almost twice as little compared with 2010. This resulted from a decrease in birth rate (0.1 %) and a decrease in death rate (18.6 %). However, the actual population size in the district declined by 59 persons.

According to the government service for employment, the registered unemployment rate in the Kominternovskyi district made up 0.3 % as of 01 January 2012, with 418 persons placed in a job. The average monthly wage rate increased almost 43 %, as opposed to the indices of 2010.

The industrial enterprises of the district sold UAH 890,645,000 worth of product, which comprised UAH 12,837.6 in per capita terms.

Grain and leguminous crops were harvested by all categories of farms in the area of 28,074 hectares and almost 76,000 tonnes of grain was threshed. The average productivity of cereals made 2.71 tonnes per hectare and grew 9.2 % as against the data of 2010. Winter crops were sown in the area of 30,264 hectares, which is 3.1 % more than in 2010.

The main types of animal-breeding product in 2011 were characterized by the following indices: total rates of meat production increased by 1.3 %, milk by 20.0 % and wool by 6 %., whereas the production of eggs declined by 76.8 %. The milk yield per cow showed a 9.3 % increase in comparison with the previous year.

The specialized enterprises of the district delivered 5,700 tonnes of goods to the consignees and 136,900 passengers made use of motor transport services, which is 409.9 % more than in 2010.

In the course of economic development of the Kominternovskyi district in 2011 the economic players drew UAH 178,616,000 of capital investments from various funding sources; the most ponderable part of them (89.3 % of the total value) made investments in the fixed capital (capital construction, purchase of machines and equipment).

During 2011 much consideration in the district was given to the construction of gas pipelines and supply of gas for the rural settlements; capital repair of social infrastructure facilities and putting them into operation; construction of preschool institutions, schools, and medical institutions; all available means were used at finding solutions to the problem of water-supply. As of 1 January 2012, the level of gas supply in the district comprised 50.4 %. Natural gas was supplied to 33 settlements, which comprised 83 % of the district population, including over 62.7 % of those who live in the rural localities. In total 603.53 kilometres of gas networks were laid and are presently in use in the Kominternovskyi district. In 2011 UAH 1,401,300 was spent on development and provision of gas supply for the settlements.

The total of direct foreign investments in the economy in the district was USD 86,575,000, with the value of direct foreign investments in per capita terms of USD 1,249.1.

The volume of retail trade turnover in the Kominternovskyi district for 2011 comprised UAH 534,178,000 and in per capita terms resulted in UAH 7,697.1. Twenty-seven new jobs were created in the sectors of trade, restaurant economy and domestic service in the district in 2011.

As of 1 January 2012, the profit of the Kominternovskyi district budget comprised UAH 308,730,000, which is 6.6 % in excess of the prospected index.

Socio-economic situation in the Berezanskyi district of the Mykolaiv region is described by the data from a report of the district state administration (Socio-economic situation in the Berezanskyi district as of 2011). 23.900 people resided in the district as of late 2011. In particular, the urban population was 4.100 and 19.800 in the rural areas. As compared to the data of 2010, the number of resident population decreased by 69 persons due to the natural (36) and migratory (33) reasons.

Unemployment rate in the Berezansky district in 2011 declined by 0.5 %, with 9 persons put in a job due to the efforts of the placement service. Thus, the employment rate for the year did not change.

The average wage in the district increased by 16.2 %.

In 2011 the enterprises of the Berezanskyi district sold industrial products (goods and services) for a total of UAH 170.2 million, which is 22 % less than 2010. The cost of the marketed industrial products in per capita terms comprised UAH 7,101.5.

In all categories of farms the gross yield of grain and leguminous crops in 2011 made up 129.84 thousand tonnes, 5.5 % more than 2010. On the average, 2.4 tonnes of grain from 1 hectare of a threshed area were obtained (60 kg more than in 2010). The total for the cattle stock comprised 7700 heads (4.3 % more than on 01 January 2011); the population of pigs increased by 4 % as against the previous year's indices, and the number of sheep grew with 15 %.

In 2011 the motor transport of the district carried over 129.500 tonnes of cargo, which is 91.6 % more than in 2010. 250,200 passengers made use of the motor transport services; which is 20.9 % more than in 2010.

Twenty-three settlements (49 % of the total number) are supplied with gas, and the gas networks are 305 km long in the district.

The annual retail trade turnover in the Berezanskyi district exceeded 13 % the level of 2010 and in per capita terms made UAH 5,525.6, which is 14.8 % more than the index of 2010.

The income of the general funds in the local budgets in 2011 comprised 104.7 %, as against 103.2 % in 2010. The profits of local budgets in 2011 (with transfers excluded) increased by 14.0 % (in 2010 the rise comprised 3.4 %). The amount of tax revenues in the local budgets in per capita terms made up UAH 950.21 in 2011, which is UAH 123.21 in excess of those of 2010.

Comparison of the indices describing socio-economic state of the administrative districts within the meso-environment of the Tyligulskyi Lagoon, indicates that it is the Kominternovskyi district that is the most developed one among them – it is in this territory that such powerful industrial facilities as Odessa Port Plant (Pryportovyi) and Yuzhnyi Mearchant Seaport are situated.

The factors to hinder the economic development of the Tyligulskyi Lagoon mezoregion are as follows:

- inadequate energy efficiency and high power inputs of the economic sectors;
- basic assets are highly depreciated and obsolent;
- the used basic assets are energy- and resource-intensive which leads to the low competitiveness for the local manufacturers' product
- insufficiency of internal funds of the enterprises for carrying out investment;
- dependence of the enterprises on foreign market conditions;
- limited access to and high cost of credit resources;

- insufficient resource provision in agroindustrial sector;
- low level of introduction of comprehensive agrotechnologies in agriculture;
- imbalance between supply and demand in the labour market as the official statistics does not include the hidden unemployment and shadow employment;
- extremely low quality of roads and obsolescence of transport and power infrastructure;
- crisis situation in housing and communal services and the exigency of carrying out reforms in the industry (dilapidated housing, missing investment, low fee for housing service);
- inefficient use of land resources and agricultural lands due to the insufficient financing as well as the failure to comply with rules of land, reclamation, erosion-preventive works resulting in the a loss of soil fertility and soil degradation.

However, the impact of the mezoregion on the Tyligulskyi Lagoon is not direct. The ecosystem of the lagoon is mainly influenced by the settlements, summer cottages, and health resort facilities located close to the lagoon coasts.

The settlements of the Odessa region are located on the western coast of the Tyligulskyi Lagoon; the settlements of the Mykolaiv region on the eastern coast (Table 3.2).

Since the 1990s large suburban areas began to come in existence near the villages of Kairy, Kalynivka, Pshenianove and Liubopol, and now they number about 37 thousand summer cottages used every season by about 115,000 people. However, according to other sources, the number of summer residents is 50,000 (Integrated land use of Eurasian steppes, 2008).

In 1995, 4,755.3 hectares of the lagoon water area and 3,440.1 hectares of the territory adjacent to the Berezanskyi district of the Mykolaiv region were given the status of regional landscape park, which

Table 3.2 – Areas and population for some settlements near the Tyligulskyi Lagoon zone.

Region	*District*	*Settlement*	*Area, km^2*	*Population*, person*
Odessa	*Kominternovskyi*	*Koshary*	*0.49*	*161*
		Liubopol	*0.3*	*833*
		Pshenianove	*0.41*	*200*
		Kordon	*0.75*	*360*
		Marianivka	*0.31*	*116*
		Chervona Nyva	*0.08*	*6*
		Shyroke	*0.28*	*61*
		Kalynivka	*0.97*	*493*
		Kairy	*1.06*	*682*
	Berezivskyi	*Volkove*	*0.64*	*135*
		Donska Balka	*0.595*	*59*
		Kosivka	*1.268*	*93*
		Stepanivka	*1.108*	*332*
		Marianivka	*1.016*	*332*
		Guliaivka	*1.58*	*418*
		Sofiivka	*1.856*	*259*
		Zlatoustove	*2.844*	*525*
Mykolaiv	*Berezanskyi*	*Progresivka*	*0.74*	*417*
		Tashyne	*1.52*	*467*
		Anatolivka	*2.2*	*872*
		Chervona Ukrainka	*2.171*	*715*
		Koblevo	*1.454*	*2385*

Note: * – data from population census of 2001.

included the lands of the Settlement Councils of Tashyne, Krasnopil, Anatolivka, Chervona Ukrainka and Koblevo. In 1997 analogous status was given to the territories located on the Western coast of the Tyligulskyi Lagoon and belongs to the Kominternovskyi and Berezivskyi districts of the Odessa region. The area of the regional landscape park in the Odessa region makes up 13,954 hectares, 9,981 hectares of which is the lagoon water area. The total area of the Tyligulskyi regional landscape park, including five wildlife reserves ('Kosa Strilka', 'Kalynivskyi', 'Tyligulska Peresyp', 'Novomykolaivskyi, 'Kairovskyi'), covers 22,149.4 hectares.

Three main pipelines run through the Tyligulskyi Lagoon. These are the 'Tolyatti – Gorlivka – Odessa' ammonia pipeline, with a rated pumping capacity of 340 tons of ammonia per hour, the 'Shebelynka – Odessa' gas pipeline and the 'Kherson – Snygirivka – Odessa' oil pipeline, with a throughput of 9.2 billion m^3 of gas and 19 million tonnes of oil per year respectively.

The agricultural specialization of the Tyligulskyi Lagoon microregion determines the extent of the ploughed-up land, which reaches 70–75 %. The land resources are used for growing cereals, vegetables, cucurbitaceous and industrial crops, gardening, viticulture, poultry farming and cattle farming. Anthropogenic impacts of agricultural activity on the natural environment of the Tyligulskyi Lagoon include washout of fertilizer nutrients into the lagoon and inflow of stock-raising waste into the water, which substantially impair hydrochemical parameters of the estuarine water.

Some indices of nature management in the Tyligulskyi Lagoon zone are given in Table 3.3.

Table 3.3 – Indicators of nature management in the Tyligulskyi Lagoon zone.

Indicator	Data
Number of population, thousand persons:	
permanent residents	10
summer residents	50
Area of the Tyligulskyi regional landscape park, hectares:	
water area	14,736.3
land	7,413.1
Catch of fish, tons / year:	
Kominternovskyi and Berezivskyi districts	limit – 72.0; actual – 348.6
Berezanskyi district	limit – 72.0; actual – 9.73
Water consumption rates (rural dwellers, summer residents)*, $\times 10^3$ *m^3 per year*	9,551
Rates of solid domestic waste production (rural dwellers, summer residents)*, *tonnes / year*	16,526

Note: * – calculated data.

Alongside climate and other natural resources, availability of therapeutic muds, supplies of which according to expert estimates make 14 million tons, is a strong factor to favour recreational development in the Tyligulskyi Lagoon zone. There is a potential for more than 100,000 guests to annually take mud therapy, which may result in a socio-economic gain at the rate of up to USD 2 million (Stepanov and Stepanova, 2004). Moreover, processing of muds and brine at a plant could become an additional income source (over USD 10 million per year). Construction of such a plant in the coastal zone, with the costs of nature protection measures taken account of, is estimated at USD 1.5 million and the corresponding evaluated payback period for investments comprises 1.5 years (Integrated land use of Eurasian steppes, 2008).

Presently, there are three distinguished types of territories within the limits of the Tyligulskyi Lagoon area: protected, recreational and economic. With the landscape peculiarities duly considered and the

need to preserve biological diversity as well as to maintain interests of the rural population and other nature users, functional zoning of the land adjacent to the lagoon is currently in a mosaic pattern, i.e. the territories of the natural reserve stock are interleaved with recreational zones and lands with economic activity, causing problems of nature conservation (ploughing-up areas in protected territories, build-up of illegal fishponds and reservoirs, uncontrolled pasturing of animals, incendiary firing of reeds, emergence of unauthorized dumps etc.). Thus, the disordered structure of the land use is one of the factors endangering the sustainability in the Tyligulskyi Lagoon ecosystem and causing deterioration of its water resources.

3.2 Institutions, laws, rights and conflicts

The management structure of the Tyligulskyi Lagoon microregion is extremely complicated and inefficient, which is one of several important reasons for disturbance to the sustainability in its ecosystem. The territory being related to the coastal zone is subject to the Odessa and Mykolaiv regional state administrations.

The issues of functioning and development of the settlements and farms are the direct responsibilities of district directorates and the elected local councils (Soviets), as well as appropriate regional directorates (of economy; labour and social welfare; infrastructure development and energy saving; regional development, town planning and architecture; culture and tourism etc.) and subdivisions of district subordination. Management of the agroindustrial sector, the transport sector and the recreational sphere is provided by sectoral structural subdivisions of the state administrations at regional and district levels.

Similar accountability lines act in the sphere of nature management (Fig. 3.1). For example, control of water resources in the Odessa region is vested in the Regional Industrial Management Directorate for Water Economy ‘Oblvodgosp’; land resources – in the Central Directorate of the State Committee for Land Resources in the Odessa Region; forest resources - in the Odessa Regional Directorate for Forestry and Hunting; resources of the natural protected stock – in State Directorate for Protection of Natural Environment in the Odessa Region etc.

The Tyligulskyi regional landscape park is divided into two administrative-territorial units and has two management centers – Odessa and Mykolaiv regional administrations, a fact that affects the quality of management in the territory a part of which, according to the Ramsar Convention, is referred to as wetlands of international value.

The socio-economic and ecological systems in the Tyligulskyi Lagoon zone function in accordance with the Constitution of Ukraine, international conventions (The Ramsar Convention on Wetlands, The Convention on Biological Diversity, The Cartagena Protocol on Biosafety, Convention on the Conservation of European Wildlife and Natural Habitats), Water, Forest and Land Codes of Ukraine, as well as the Laws of Ukraine, in particular:

- On natural environment protection (1991);
- On atmospheric air control (1992);
- On wastes (1998);
- On the natural protected stock of Ukraine (1992);
- On the ecological network in Ukraine (2004);
- On environmental assessment (1995);
- On licensing of particular economic activities (2000);
- On personal peasant economy (2003);
- On farms (2005);
- On land protection (2003);
- On state control of land use and protection (2003);

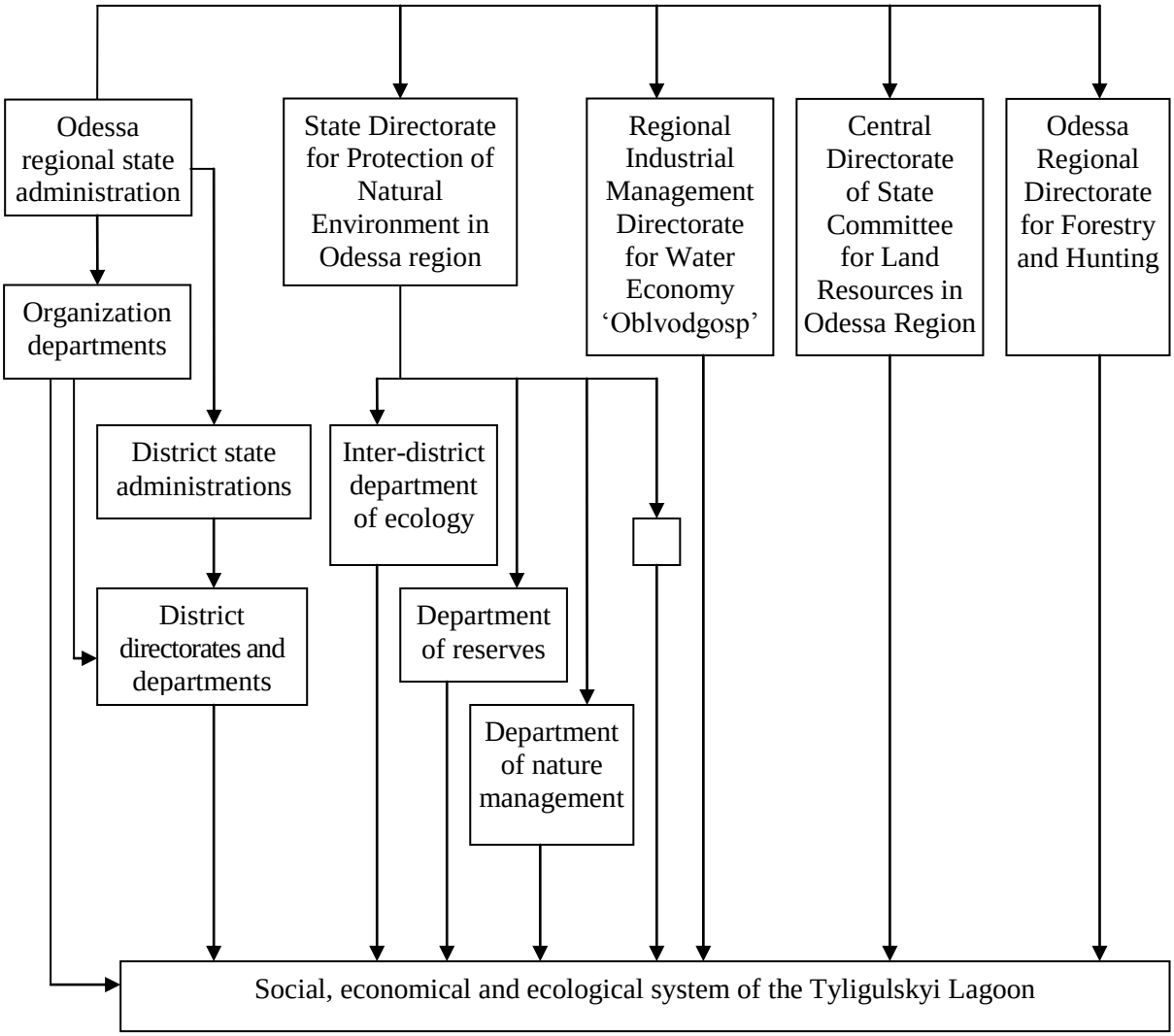

Figure 3.1 – Organizational and functional framework of the Tyligulskyi Lagoon management in the Odessa region.

- On land management (2003);
- On area planning and development (2006);
- On local governance in Ukraine (2007);
- On resorts (2000);
- On tourism (2003).

3.2.1 The relevance and applicability of international law – the regional seas conventions

The Regional Seas Programme was launched by UNEP in 1974, after the Stockholm Conference on the Human Environment. It consists now of 13 programmes under the auspices of UNEP and another 5 associated programmes. Each works through a Convention, with a series of relevant protocols, and an Action Plan. In relation to the case studies in this project, the Black Sea and the Mediterranean Sea are UNEP programmes and the Baltic Sea and the North East Atlantic are associated partners. There are similarities in the broad constructs of the treaties and the obligations they create, and of course differences in the detail. (See http://www.unep.org/regionalseas/about/default.asp).

In the Ukraine, the Convention on the Protection of the Black Sea Against Pollution, Bucharest, Romania (1992) is potentially relevant and applicable; Ukraine signed and then ratified the Convention in 1994 (www.blacksea-commission.org). The focus of the Convention is on pollution, and on protecting the environment and ecology of the Black Sea. In terms of geographical scope, the Convention applies to the "Black Sea proper" and may also apply to the territorial seas and exclusive economic zones of the parties. In the case of the Tyligulskyi Lagoon, as there is no mention of any landward areas being covered by the Convention, it will not be directly protected. However, as the Convention applies to land-based activities it may still be relevant to note its provisions.

The general undertakings (Art.V) are not as strongly worded as the Helsinki Convention. Parties "shall bear in mind the adverse effect of pollution within [their] internal waters on the marine environment…", and take "all necessary measures consistent with international law and in accordance with this Convention to prevent, reduce and control pollution…". Art.VI though requires prevention of pollution, by "substances or matter" specified in the Annex. Again, the Convention applies to land based sources (Art.VII) and from ships (Art.VIII). There is a requirement to cooperate in relation to emergencies (Art.IX) and to cooperate and take appropriate measures to address dumping at sea (Art.X). There are requirements to adopt national laws to manage activities in the continental shelf (Art.XI) and atmospheric pollution (Art.XII). Art.XIII on "marine living resources" requires states to "pay particular attention to avoiding harm to marine life and living resources, in particular by changing their habitats…". There is provision on transboundary movement of hazardous wastes (Art.XIV) and on scientific and technical monitoring and cooperation (Art.XV). The latter requires activities that may cause "substantial pollution or significant and harmful changes to the marine environment" to be assessed and notified to the Commission, but there are no specific requirements to notify other member states, nor to conduct Environmental Impact Assessment (EIA) or provide information to the public. There is specific provision for "responsibility and liability" (Art.XVI).

There are a number of protocols. The Black Sea Biodiversity and Landscape Conservation Protocol to the Convention, Sofia, Bulgaria, (2002) is an integral part of the Convention, and this applies to the Black Sea, and also to waters landward of the baseline and freshwater courses up to the freshwater limit. Hence this may not apply directly to the lagoon, but again will cover land-based activities that may also impact on the Black Sea, including activities around the lagoon that also impact on its water quality. The Protocol has its own Annexes, whereby those substances and matter specified in Annex I should be "prevented and eliminated", and those listed in Annex II, should be "reduced, and where possible eliminated". Annex II is particularly relevant to agricultural pollution, as it includes biocides, inorganic phosphorous, nitrogen, organic matter and other nutrients, as well as sewage sludge. The Protocol was ratified by Ukraine in 2007.

There is a Strategic Action Plan for the Environmental Protection and Rehabilitation of the Black Sea, Sofia**,** Bulgaria (2009). The Plan, whilst restating the boundaries set in the Convention, specifically notes that coastal states should also take action at basin level, which would include activities in and around the Tyligulskyi lagoon (para.1.4). The Action Plan establishes relevant environmental principles, including polluter pays, precautionary principle, preventive and anticipatory actions, use of clean technology and also accessibility of information, public participation and transparency. It also identifies three "key approaches" which include Integrated Coastal Zone Management (ICZM), the Ecosystem Approach and Integrated River Basin Management. Each of these will be considered further below in relation to other legal instruments and policy documents. They would be considered good practice in terms of water management and would be highly relevant to the future management of this lagoon and other lagoons in this project, as each of these approaches would integrate all aspects of the water environment, integrate land and water use and take account of social and environmental objectives as well as the importance of protecting species and their habitats. The Plan then establishes Ecosystem Quality Objectives under four headings, which include commercial fishing, biodiversity, eutrophication and water quality. There are sub-objectives and long-, medium- and short-term targets for each, making the Plan specific and measurable.

3.2.2 The relevance and applicability of international law – the Ramsar Convention and the Convention on Biological Diversity

The Ramsar Convention (Ramsar 1971 http://www.ramsar.org/cda/en/ramsar-documents-texts-convention-on/main/ramsar/1-31-38%5E20671_4000_0 revised 1982) applies to wetlands, in order to protect (primarily) migrating birds. It protects designated wetlands (Ramsar sites, designated by the relevant state party) but also promotes the "wise use" of other wetlands by that state. Wetlands are broadly defined, including marine water up to 6m deep and may also include riparian and coastal zones. The Ramsar Convention is supplemented by a series of Official Guidelines which include the incorporation of wetland management into ICZM (2002, http://www.ramsar.org/cda/en/ramsar-documents-guidelines/main/ramsar/1-31-105_4000_0). The Tyligulskyi lagoon was designated as a Ramsar site (no.766) in November 1995.

The Convention on Biological Diversity, or Biodiversity (UN 1992, CBD) was a product of the Rio Conference on Environment and Development and utilises the "Ecosystems Approach" (also found in the Black Sea Convention). A global convention, it was signed by 150 states at Rio and now has 193 parties, including the EU; the US has not ratified but is a signatory. All of the case study sites are in member countries. Hence the CBD could not be much better supported by the international community. It uses the precautionary principle, protects species by protecting ecosystems and habitats, and its objectives are conservation, sustainable use, and equitable sharing of benefits. The jurisdictional scope for "components" (species) is within national boundaries, but for processes / activities obligations extend to anywhere under the control of the state in question. There is a duty to cooperate, a duty to draw up national plans or strategies, to identify and monitor components, and establish protected areas including the rehabilitation and restoration of ecosystems. There is provision for its relationship with other Conventions, whereby other obligations are unaffected unless "the exercise of those rights and obligations would cause a serious damage or threat to biological diversity" (Art.22) and a specific requirement for the marine environment to implement the CBD consistently with the law of the sea.

The 2011-2020 is the UN Decade for Biodiversity, and the 10th Conference of the Parties established a Strategic Plan for Biodiversity 2011-2020 and The Aichi Biodiversity Targets "Living In Harmony With Nature" (http://www.cbd.int/decision/cop/?id=12268). In particular there is a target of 10 % of coastal and marine areas to be protected sites by 2020 (target 11), and protection mandated for fish, invertebrates and aquatic plants (target 6), using ecosystem approaches. All regional and national activities in support of biodiversity in member countries should come within the general aims of the CBD (http://www.cbd.int). Ukraine has both a National Biodiversity Strategy and an Action Plan, in furtherance of their international commitments (http://www.cbd.int/countries/profile.shtml?country=ua#nbsap).

Multilateral environmental agreements

The participation of the Ukraine and other Black Sea countries in multilateral environmental agreements relevant to coastal wetland conservation are shown in Table 3.4 below. Furthermore, there are a number of national institutions involved in the conservation of migrating water birds (see: http://www.unep-aewa.org/meetings/en/mop/mop4_docs/national_reports/pdf/ukraine2008.pdf).

3.2.3 Legal frameworks

As the Ukraine is not a member state of the EU it is not bound by any EU law, however as an accession country it will nonetheless be seeking to show its achievement of the environmental *aquis*. If accession takes place then it will need to meet all these requirements.

Table 3.4 – Participation of Black Sea countries in multilateral environmental agreements relevant to coastal wetland conservation (from Ounsted, 2009, p. 15).

Agreement	Bulgaria	Georgia	Russia	Romania	Turkey	Ukraine
CBD & Pan-European Biological and Landscape Diversity Strategy (PEBLDS)	P	P	P	P	P	P
Bucharest Convention	P	P	P	P	P	P
Ramsar Convention	P	P	P	P	P	P
Bonn Convention	P	P	P	-	-	P
Bern Convention	P	P	O	P	P	P
EU Directives	M	-	-	M	A	-

Note: A – accessed, M – member, O – observer, P – party, S – signatory.

As the Ukraine is not a member state of the EU it is not bound by any EU law, however as an accession country it will nonetheless be seeking to show its achievement of the environmental *aquis*. If accession takes place then it will need to meet all these requirements.

Although the Tyligulskyi Lagoon is not within an International RBD for WFD purposes, we can note that the Ukraine is a member of the Danube Convention and as such participated in the "roof report" for the Danube in relation to that part of its territory which came within that basin. Again this indicates their willingness to participate in international measures in relation to catchment management.

At present, the implementation of Water Framework Directive in Ukraine is in an initial stage. As for the Tyligulskyi Lagoon and its catchment basin, WFD's basic requirements such as the implementation of basin management model for catchment, river basin management plans, and programmes for the monitoring of water status are absent.

The Water Code assigns particular conditions for the use of water stock lands and coastal protective zones. These conditions extend to the Tyligulskyi Lagoon, rivers at its catchment with ponds and reservoirs. For the sea and lagoon coast, the Water Code assigns the coastal protective zone with the width ≥ 2 km and the beach zone with the width ≥ 100 m from the shoreline respectively. Some activity is restricted within the coastal protective zone: the use of permanent and strong pesticides, the arrangement of domestic and industrial waste landfill as well as sewage ponds, the catchpits for household and domestic waste waters with the volume ≥ 1 m^3/day, the filtration field, other facilities for the reception and disinfection of liquid wastes. The coastal protective zone can be used only for military constructions, facilities for "clean" power generation and constructions for its transmission, health-improving institutions with mandatory central water supply and sewerage and hydraulic and hydrometric structures, outside plants. Within the beach zone, any constructions are restricted excepting hydraulic and hydrometric structures, outside plants.

The coastal protective zone is part of a sea sanitary control zone regulated by the "Sanitary regulations and standards for protection of coastal waters from contamination at water use sites" (1988). The sea margin of sanitary control zone is defined within with borders of 22 km (12 miles) territorial waters, and 10 km land strip from the shoreline. The border for the coastal zone of public sea water use, with special requirements on the sea water quality, monitoring and sea water protection under economical activity, is determined at ≥ 3.9 km (2 miles) seaward and 2 km landward from the shoreline.

Finally, the Marine Strategy Directive may be of especial relevance as here, the EU is using international commitments to give effect to the MSD (Hey, 2009). In general however, the law and policy framework will be the national law and policy of the Ukraine.

3.2.4 Coastal and marine policy, planning and relevant strategies

3.2.4.1 ICZM Policy

Local authorities decreed to establish two regional landscape parks (> 20000 ha) at the Tyligulskyi Lagoon and adjacent territories as well as a few wildlife preserves: botanical "Kalinovskyi" (92 ha), ornithological "Tiyligulska Peresyp" (390 ha) and landscape "Kairovskyi" (150 ha). Moreover, the national ornithological preserve "Kosa Strelka" is located at the coasts of Tyligulskyi Lagoon. All these institutions are included in the natural reserve stock of Ukraine with relevant land use described in the law "On the natural reserve stock of Ukraine".

According to the recommendations of Pan-European Biological and Landscape Diversity Strategy as well as with a view to setting up a Pan-European Ecological Network, Ukraine has passed laws "On national program for setting up national ecological network for 2000-2015"(2000) and "On ecological network" (2004). Under these laws, Odessa Regional Council has passed "Program for setting up national ecological network in Odessa region for 2000-2015". The scheme of regional ecological network in the Odessa region was developed in 2011. According to this scheme, the southern part of the Tyligulskyi Lagoon with adjacent territories and the isthmus is included in the Azov-Black-Sea International Natural Ecological Corridor, the middle part is in the South Ukrainian State Ecological Corridor, and the Regional Landscape Park "Tyligulskyi" with Tyligul River main bed and adjacent water protection zones is contained in the Tyligul Regional Ecological Corridor. The scheme forms the basis for the development of various design documentation for land management, municipal engineering, economical activity.

Another local act is the "Strategy of social and economic development in the Odessa region for 2012" that defines strategic lines and plans of natural resources use. Some lines and plans relate to the Tyligulskyi Lagoon: preservation of Black Sea coastal limans; developing the integrated system of coastal zone use; strategic planning the coastal zone development; developing schemes of coastal zone functional zoning; optimization of coastal zone use according to ecological requirements and local priorities; estimation of impacts and developing actions for the adaptation to climate change.

3.2.4.2 Marine Spatial Planning

Marine Spatial Planning (MSP) is commonly defined as a "process of public authorities for analysing and allocating the spatial and temporal distribution of human activities in marine areas to achieve ecological, economic and social objectives". MSP is a forward looking process, based on the ecosystem approach, which should endeavour to cover and integrate all maritime sectors and their stakeholders in an open and transparent way.

The main output of MSP is a comprehensive spatial management plan (CSMP), for a particular marine area or ecosystem, frequently implemented by using zoning map(s) and/or a permit system with distinct permit decisions made within individual sectors (e.g. fisheries or tourism sector) based on the zoning maps and the CSMP (Ehler and Douvere, 2009). MSP is not there to replace single-sector planning; it is there to provide comprehensive and integrated guidance for the decision makers responsible for the relevant sectors and their stakeholders (Ehler and Douvere, 2009). A stepwise approach to the formulation of MSP is provided in Figure 3.2, which shows MSP as a continuous iterative process, learning and adapting over time rather than a 'once only' plan.

At a national level there have been significant developments on MSP in many EU Member States, while international level discussions on the development of MSP have included UNESCO/IOC, the Convention on Biological Diversity and the International Council for the Exploration of the Sea (EC, 2011). However, while the general trend is upwards for the uptake of MSP, the different

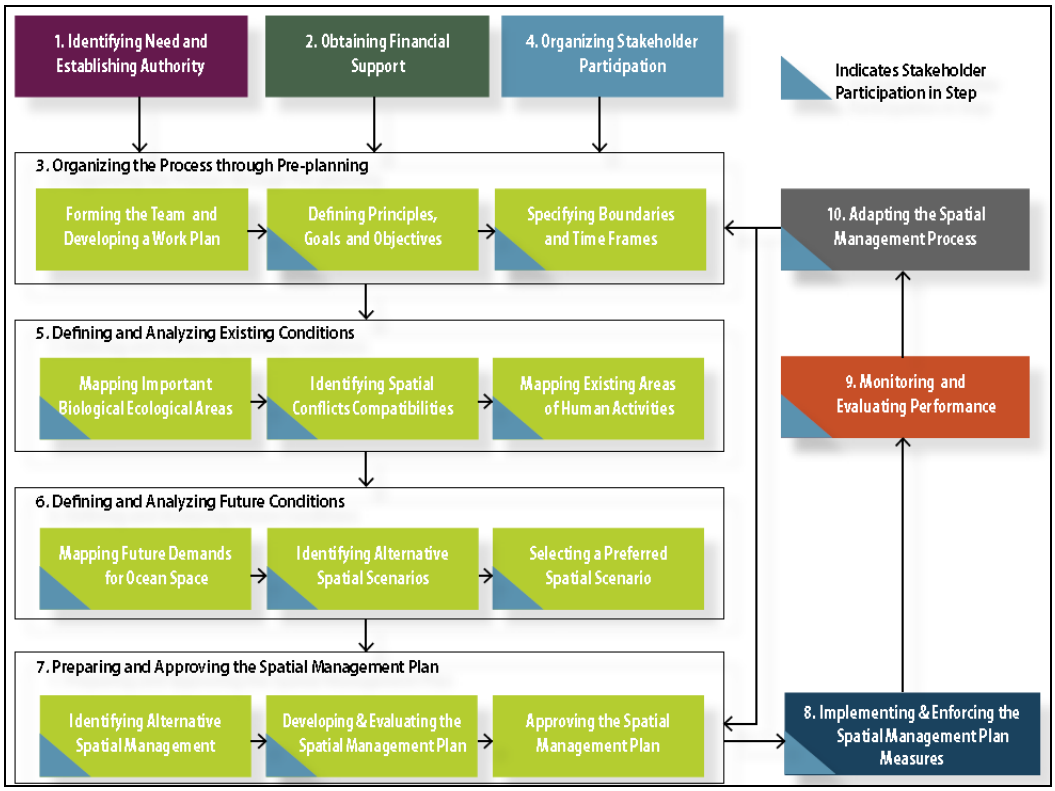

Figure 3.2 – Stepwise approach to MSP (from Ehler and Douvere, 2009, p. 14).

administrative structures, as well as legal and governance systems in place has resulted in a wide range of policies – from those with little or no policy or legislation right through to those that fully apply MSP in territorial seas and/or EEZ (EC, 2011).

Along with other Black Sea countries Ukraine was partner to the PlanCoast project, which ran from 2006 to 2008, and whose main aim was to "provide best practice examples and tools for effective integrated planning in coastal zones and marine areas" (http://www.plancoast.eu/files/handbook_web.pdf). Recommendations for ICZM and MSP development by the PlanCoast team proved useful for BSC PS particularly for the introduction of MSP initiatives, which are "rather new" to the region (Coman, 2007).

3.2.4.3 The National Environmental Strategy of Ukraine

On December, 21, 2010, Verkhovna Rada (Ukrainian Parliament) adopted the Strategy for the National Environmental Policy of Ukraine till 2020. The bill (Reg. No.7053) ratifies the National Environmental Policy Strategy of Ukraine till the year 2020 and analyses the use and protection of the natural resources in Ukraine; sets the aim and the principles of the national environmental policy, strategic aims and goals, tools and stages of implementation of the national environmental policy and expected results of implementation of the Strategy (http://portal.rada.gov.ua/rada/control/en/publish/article/info_left?art_id=227219&cat_id=105995).

The National Environmental Strategy of Ukraine (2010) includes the following actions, which are doubtless applicable to the lagoon, to be achieved by 2020:

- ensure compliance of drinking water quality and treatment of discharged water within the established norms;
- justify, preserve and assign the status of protected territories to 10.4 % of terrestrial and 10 % of marine sites where biodiversity is in its natural state;

- by 2015 to introduce measures preventing uncontrolled release of GMOs and inform the population of the GMO content in the products which are produced, imported or consumed on the territory of Ukraine;
- reduce greenhouse gas emissions by 20 % of 1990 releases and to increase the volume of electricity generated from renewable sources by 12,5 % of the total amount;
- to conduct decontamination of polluted soils which significantly impact the surface water quality and ensure appropriate level of degraded lands reclamation;
- to cease the trend of soils fertility losses;
- as from 2012 to ensure increase of the forested areas by 40 thousand ha annually;
- ensure full compliance with requirements of international treaties on protection of transboundary water courses and seas.

3.2.4.4 European Neighbourhood and Partnership Instrument

The European Neighbourhood and Partnership Instrument (ENPI) remarks that: "The integration to the European Union is one of the priorities of the foreign policy of Ukraine". At the present time the cooperation between Ukraine and the EU takes place within the European Neighbourhood Policy through the implementation of the mutually agreed EU-Ukraine Action Plan. Also, negotiations are being held between Ukraine and the EU on the new enhanced Agreement on partnership and cooperation, because the previous one expires this year. Ukraine gradually adapts its legislation to the EU standards, makes efforts to implement the relevant political and economic reforms, and to follow the appropriate social and environmental policy. However, this requires substantial funding, and the government of Ukraine doesn't have enough sources for such reforms. The EU therefore supports Ukraine's implementation of the provisions of the EU-Ukraine Action Plan by not only political but financial means, too. The EU is one of the main donors for Ukraine. Unfortunately, lack of awareness and participation of the stakeholders in the development of the programs within the ENPI and their monitoring limits the possibilities for effective cooperation with relevant stakeholders in the EU, doesn't promote resolving of problems, which exist in Ukraine, and makes the assistance of the EU not so effective as planned during creation of the new funding instrument (http://www.enpi.org.ua/en/about-the-project/).

Within the framework of the Ukraine-EU Summit, the Civil Society Forum "Ukraine - EU Summit 2011: the public dimension" was introduced by the Ukrainian national platform of the EAP Civil Society Forum, via a meeting that took place in Ukraine on December 19, 2011. At the event the outcomes of the Ukraine-EU Summit were analysed and discussed, as well as future prospects of the Ukraine's European integration. This forum included representatives from various NGOs, think-tanks, political leaders and European and Ukrainian bureaucrats (http://iwp.org.ua/eng/public/490.html).

3.2.5 Institutions, stakeholders and social groups

Table 3.5 below provides the list of institutions and stakeholders identified for the Tyligulskyi Lagoon, followed by a section listing other likely or possible stakeholders for consideration.

3.2.5.1 Nature and landscape conservation

The environmental status and high protection of the lagoon is internationally and nationally recognised with 11,000 ha of Important Bird Areas (IBA) covered by Regional Landscape Park (Tyligul, 22,119 ha) and 11,000 ha of IBA covered by a Ramsar Site (Tyligulskyi Lagoon, 26,000 ha) (Birdlife International, 2012). Tyligulskyi Lagoon has been a designated Ramsar site since November 1995 and contains two Ornithological Game Reserves ('Ornithologichni Zakaznyky) in the lower part of the wetland site, the Tyligul Sand Bank ('Tyligulska Peresyp') and the Lower Tyligulskyi Lagoon ('Nizovje Tyligulskogo Limana').

Table 3.5 – Stakeholders and institutions for the Tyligulskyi Lagoon.

Institution	Type	Description	Website
Ministry of Environment and Natural Resources (MENR)	Central body of executive power with activity directed and coordinated by the Cabinet of Ministers of Ukraine.	Central body of executive power regarding formation and realization of state policy on environmental protection, safety, waste management, pesticides and agrochemicals, rational use, reproduction and protection of natural resources including surface and underground waters, inland maritime waters and territorial sea, air, forests, animal (including aquatic resources, hunting and nemyslyvskyh animals) and flora and natural resources, territorial waters, continental shelf and the exclusive (maritime) economic zone of Ukraine (natural resources), reproduction and protection of land, conservation, restoration and sustainable use of biological and landscape diversity, formation, maintenance and use of ecological network, organization, protection and use of protected areas, conservation of the ozone layer of regulation of negative anthropogenic impact on climate change and adaptation to change and its implementation within the competence requirements of the UN Framework Convention on Climate Change and its Kyoto Protocol, the development of water management and land reclamation, geological study and rational use of mineral resources, state supervision (control) over observance of legislation on environmental protection, rational use, restoration/protection natural resources.	http://www.menr.gov.ua/
State Agency of Land Resources of Ukraine	Central executive authority	Directed and coordinated by the Cabinet of Ministers of Ukraine via Minister of Agrarian Policy and Food of Ukraine; it is included in the system of bodies of executive power and ensures implementation of the state policy in the field of land relations.	http://www.dazru.gov.ua/terra/control/en/index;jsessionid=9125DFC363C481682CC094526732B707
Odessa State Regional Administration	Regional government	Follow the weblink to access the following departments: Environmental protection Culture and tourism Economics	http://oda.odessa.gov.ua/index.php?option=com_content&view=article&id=18&Itemid=4&lang=en#

		Agriculture/industrial development etc	
Odessa Regional Water Management Department	State budgetary organization.	Right to paid services, governed by the State Agency of water resources of Ukraine. Powers include: to ensure the region addresses issues in the use, conservation and restoration of water resources, manages the engineering infrastructure reclamation systems and individual sites that are publicly owned.	http://watermd.od.ua/
Ananiv district state administration	District administration	Responsible for an implementation of regional policy in district	
Berezivka district state administration	District administration	Responsible for an implementation of regional policy in district	
Mykolaivka district state administration	District administration	Responsible for an implementation of regional policy in district	
Kominternove district state administration	District administration	Responsible for an implementation of regional policy in district	
Stakeholders	**Type**	**Description**	**Website**
Koblevo village council (Mykolayiv region)	Village Council	Responsible for an implementation of local policy	
Tashine village council (Mykolayiv region)	Village Council	Responsible for an implementation of local policy	
Autonomous bodies of cottage villages	NGO	Responsible for an implementation of environmental protection activity in cottage villages	
Ukrainian Association of Protected Areas - UN Development Programme in Ukraine and the Global Environment Facility project.	NGO - But The State Service for Protected Areas of the Ministry for Environmental Protection of Ukraine is the National Executing Agency of the Project.	The UNDP/GEF Project "Strengthening governance and financial sustainability of the national protected area system in Ukraine" is being implemented with an objective of enhancing the financial sustainability and strengthening institutional capacity of the PA system in Ukraine. Note: At present 19 of 40 protected areas of national significance (biosphere and nature reserves, national nature parks) are subordinate to the Ministry for Environmental Protection of Ukraine, others – to different government executive authorities, higher educational establishments, state academic organizations (Ministry of education, the State Committee on Forestry of Ukraine, State Executive Office,	http://www.pzf.org.ua/eng/main.htm

		National Academy of Sciences of Ukraine etc.). The State Service for Protected Areas is working on formation of the entire state system of protected areas management.	
National Ecological Centre of Ukraine (Mykolayiv branch)	NGO	National Ecological Centre of Ukraine (NECU) is a non-governmental not-for-profit organization. NECU works to bring environmental consideration into the core of any decision. NECU aims to bring concerns of local population and experts to the politicians, to redesign strategies and projects. NECU works both to save nature, by maintaining and creating new protected areas, and to decrease human impact on environment, through policy changes in energy and transport sectors. Follow the weblink for additional information.	http://en.necu.org.ua/about/
Black Sea NGO Network	NGO	The BSNN members, currently over 60, are brought together by the common concern for the decreasing environmental quality of the Black Sea and the need for the adoption of democratic values and practices in the Black Sea countries that follow the ideals of sustainability. Their mission is to contribute to the protection and rehabilitation of the Black Sea, including the Azov Sea, and to the sustainable development of the Black Sea countries through increased participation of NGOs, governments, businesses and other institutions, as well as the general public. Follow the weblink for additional information.	http://www.bsnn.org/
The Centre for Regional Studies (CRS)	NGO	The Centre for Regional Studies is a non-governmental and non-for-profit organisation in Odessa and uniting a group of researchers, public officers and experts in regional development. The main activities are regional studies and applied research; project management; consultancy to central, regional and local authorities; education and training. Follow the weblink for additional information.	http://www.crs.org.ua/en/about.html
Ukrainian Hunting & Fishing Association (UHFA)	NGO	All-Ukrainian public organization uniting hunters and fishermen in pursuit and development of amateur hunting,	http://uoor.com.ua/eng/about_organization/regional/300#

Odessa Regional Council		trapshooting, and sport-fishing and dedicated to the protection, sustainable use of animal and fish populations, and the conservation of the natural environment. NGO with private property rights to its own property and funds.	content
Ukrainian Society for Protection of Birds	Nature conservation organization and Birdlife International Partner in Ukraine.	Devoted to conservation of birds living in and migrating through Ukraine. In addition to monitoring populations of threatened and endangered bird species, USPB advocates habitat and environmental protection.	http://www.birdlife.org.ua/eng/index.htm
Association of Farmers and Private Landowners of Ukraine	NGO	NGO protecting and lobbying the interests of 40 000 farmers and 600 000 landowners on all levels. Assist in starting the farms and insure financial support for newly created farms. Provide legislative, information and consultancy support for its members. Participate in the establishment and implementation of economic development policies for rural areas.	http://farmer.co.ua/
Research Centres			
Regional landscape park "Tyligulskyi", Odessa region	Research centre	Nature conservation institute responsible for the maintenance of biological and landscape diversity	
Regional landscape park 'Tyligulskyi', Mykolayiv region	Research centre	Nature conservation institute responsible for the maintenance of biological and landscape diversity	
Ukrainian Agrarian Academy of Sciences	A self-governing scientific organization supported by the State.	Provides extension services for the development of the sectors within Ukraine's agro-industrial complex, production of elite seeds, planting stock, and animal genetics. Determines basic trends of fundamental and applied research, draws up both governmental and sector scientific and technical programs on important problems in agriculture, water management, food and processing industries, and other sectors in Ukraine's agro-industrial complex. It organizes and supervises the fulfilment of these programs, methodically supports the implementation of research and development results sets up the network of scientific institutions, carries out the training of highly qualified specialists, and conducts research and technical	http://www.aginukraine.com

		cooperation with foreign countries.	
Odessa Regional Institute of Public Administration (ORIPA)	National Academy of Public Administration, Office of the President of Ukraine, and its Regional Institutes play a central role in training as well as educating public servants and officials.	Odessa Regional Institute aims to contribute to the renewal of the personnel structures in public administrations of regional levels. The Institute works as an independent higher educational institution of the 4th level. The Institute trains state officials and public servants of the autonomous Republic of Crimea, Vinnitsa, Mykolayiv, Odessa, and Kherson regions as well as the city of Sevastopol. Since 1998 ORIPA was the first educational institution to offer future to civil servants in Master's program in Public Administration with a specialization in "Health administration". Since 2004 ORIPA within that Master's program offers specialization in "Culture Administration".	http://eng.oridu.odessa.ua/index.pl?rozd=1
Ukrainian Scientific Centre of Ecology of the Sea	Main institution of the Ministry of Environmental Protection of Ukraine in the field of marine ecological research.	The main task of UkrSCES is scientific and practical realization of public policy of Ukraine in relation to the protection, rational use and rehabilitation of natural resources of the Black and Azov Seas basin, and also providing implementation of international obligations of Ukraine, in relation to marine aspects.	http://www.sea.gov.ua/index.htm.en

To improve wetland conservation, the Regional Landscape Park 'Tyligulskyi' was established in 1995 by the local authorities, including the formation of a scientific division and zoning measures to regulate activities and guarding (http://www.wetlands.org/RSIS/_COP9Directory/Directory/3UA008.html). The park covers the coast and adjacent waters of Tyligulskiy Lagoon and lands belonging to the villages of the Berezan area within the Mykolaiv region (Tashyne, Anatolivka, Chervona Ukrainka and Koblevo) (http://imoiseev.com/regional-landscape-park-tyligulskiy).

The Visitor Centre of the Tyligulskyi Regional Landscape Park is located within the Ramsar site on the eastern and western coasts of the lagoon. Both parts of the park territory are extraordinarily attractive natural objects with a considerable range of rare and endangered species of flora and fauna. It also supports wintering, nesting, and autumn and spring migrating waterbirds, several species of which are nationally or internationally threatened. Over 25 % of the European *Egretta alba* population winters at the site (www.ramsar.org).

Ukraine has also been a contracting party to the African European Waterbird Agreement since 1st January 2003. The unanimous conclusions drawn from international workshops held in 2000 in Odessa on the conservation and wise use of wetlands and their resources along the Black Sea was that the establishment of a wetland conservation initiative for the Black and Azov Seas was 'urgently needed' and that Wetlands International should take the lead in its initiation (Ounsted, 2009).

MEPU have set up a State Service for Nature Reserves and legislation has been put in place with a view to enable further protection and expansion of protected areas. Currently only 4.95 % of Ukrainian territory is deemed as protected areas, far less than most European countries (see National Environmental Strategy of Ukraine 2010). In recent years, special training courses for stakeholders and discussions have also been organised in Odessa Oblast for six Ramsar sites (Ounsted, 2009).

3.2.5.2 Hunting and fishing

The Ukrainian Hunting and Fishing Association (UHFA), is a nationwide public organization with private property rights, ownership and funding. Members of the organisation include both hunters and fishermen who are involved in pursuing amateur hunting, trapshooting, and sport-fishing and committed to the protection, conservation and sustainability of animal and fish populations and their natural environment. Hunting is organised by the society in the upper part of the lagoon.

3.2.5.3 Association of Farmers and Private Landowners of Ukraine

The Association of Farmers and Private Landowners of Ukraine is an independent self-governing association protecting the interests of more than 43,000 farmers and nearly four million private farms nationwide. The aim of the association is to promote the development of the farming movement in Ukraine and proper public control over the authorities in safeguarding the rights and legitimate interests of farmers and smallholders – landowners. The association: lobbies all levels of government in the interests of farmers and owners of private farms; actively participates in the work of regional farmer associations and farms in all areas of economic and industrial activities; interacts with public authorities to promote agrarian reform and the formation of state support for private sector agriculture (http://www.farmer.co.ua/pages/aboutasots.php).

3.2.5.4 Tourism

The lower part of the lagoon is close to the Black Sea, where there is significant recreation (attracting around 300,000 people annually, with a potential expansion to 1 million people). The area's reputation as a health resort dates back to the 1920s due to its curative mud and hydro treatments and mild climate.

The Black Sea tourist spot of Koblevo, in the Mykolaiv region, is the most highly developed resort on the coast. Made up of a collection of about 60 resorts and lodges offering varying degrees of comfort along a 6km long strip next to the sea it is able to accommodate 15-17 thousand tourists (http://www.koblevo.com).

3.2.6 Conflicts

Table 3.6 summarizes the conflicts of nature management in the catchment basin of the Tyligulskyi Lagoon

Table 3.6 – Conflicts at the Tyligulskyi Lagoon.

Initiators of a conflict	Origin of a conflict	Essence of a conflict
Users of ponds and reservoirs in the catchment area	Uncontrolled withdrawal of water for filling of both operating and abandoned water bodies.	Considerable (up to 50 %) decrease in the inflow of fresh waters into the lagoon. An increase of water salinity in the lagoon. Drainage of the shallow areas of the lagoone water area and the wetlands in the Tyligul River floodplain and the upper reaches of the lagoon.
Agroindustrial farms	Agricultural activity	Wash-out of pollutants, biogenic substances, and organics into the lagoon owing to tillage of lands in the coastal strip, application of mineral fertilizers, chemical means of plant protection and generation of waste from animal-breeding
Local population, summer residents	Absence of a centralized system for collection of solid domestic wastes and a sewage system.	Pollution of the lagoonal water and the adjacent land with untreated household sewages and rubbish.
	Application of mineral fertilizers, chemical means of plant protection in the suburban gardening areas.	Wash-out of pollutants, biogenic substances, and organics into the lagoon.
	Unregulated mowing and burn-off of meadow vegetation and reed; collection of the protected species of flowering plants and medicinal plant crude. Unregulated pasturing of cattle on the coastal slopes of the lagoon. Disturbance to the bird habitats and the nesting sites. Poaching.	Infliction of damage to the flora and fauna of the natural protected stock areas, danger of decrease in biodiversity.
	Creation of pits for extraction of sand and clay; backfill of the gullies; cottage and business site development in the riparian areas.	Disturbance to the natural landscapes.
Vacationers	Uncontrolled stay in the territories of the natural	Infliction of damage to flora and fauna of the natural protected stock areas,

	protected stock. Disturbance to the bird habitats and the nesting sites. Littering of the area. Onset of accidental fires.	danger of decrease in biodiversity.
Industrial fishery	Fishing in the lagoon in excess of the fixed quota. Irregular provision of functioning of the connecting canal to the sea, pursuant to exclusively fishery purposes.	Significant fluctuations in the lagoon water level, instability of the lagoonal hydroecology regime, danger of decrease in biodiversity.
Bodies of state power and local self-government	Division of a unified ecosystem of the Tyligulskyi Liman lagoon and the adjacent areas into two administrative-territorial units within the limits of Odessa and Mykolaiv region.	Inefficient management of environmental protection and nature use, lack of a unified plan for water and environmental management of the lagoon, dissipation of resources, lack of a unified plan for monitoring the lagoonal ecosystem and carrying out nature protection measures.
	Water protection zones and coastal protective strips have not been established on location and are left out of account in land management documents.	The regulations of nature protection legislation of Ukraine are not met in regard to the restriction of economic activity within the boundaries of a water protection zone, coastal protective strips and on the lands of the natural protected stock.

3.3 Knowledge gaps

In spite of the fact that the previous sections contain a lot of data on the socio-economic state of the Tyligulskyi Lagoon, it has to be noted that most part of the data relates to the end of the 1990-th and the beginning of the 2000-th. Unfortunately, the recent data is not freely accessible and scattered in many regional directorates and departments.

So, making a more profound analysis of the socio-economic state of the Tyligulskyi Lagoon mezoregion is infeasible in view of the lack of recent information on:

- population of the settlements in the Tyligulskyi Lagoon zone;
- number of country cottages and holiday-makers;
- number of vacationers in the 'Koblevo' resort zone;
- indices of agricultural production in the Tyligulskyi Lagoon zone;
- indices of nature management and spending of nature protection funds on carrying out environmental measures in the Tyligulskyi Lagoon zone.

The presentation of statistical information, moreover, is to be unified for both the regions and the administrative districts.

Up to now, the borders of the Tyligulskyi regional landscape parks in both the Odessa and Mykolaiv regions are still not locally determined and not delineated by border markers. Also, the lands for nature-conservation purposes are not transferred to the parks and are still used by many other land users. The border markers of wildlife preserves "Tyligulska Peresyp" and "Kosa Strelka" are not defined either.

The coastal protective strips and water protection zones are not locally defined on most part of

Tyligulskyi Lagoon and Tyligul River and not included in land management records. The reasons are as follows. First, the development of land management projects defining the borders of the coastal protective strips demands considerable funds which local autonomous bodies lack. Second, in the 1990s the lands of water protection zones and coastal protective strips were shared for local residents and set aside for holiday villages. Moreover, proper land certificates were issued for residents but they failed to take into account the requirements of Article 88 of the Water Code. As a result, the particular conditions for the use of water stock lands determined by this article are not fulfilled, and illegal economical activity and improper land use take place in the water protection zone and coastal protective strip. The activity of economical players and residents harms appreciably the environment and natural resources of the lagoon and creates favourable conditions for water pollution in the lagoon. Also, the residents, state authorities, and local autonomous bodies are ecologically unconscious and uninformed in respect of environmental protection and conservation.

The location of the lagoon in the territories of two administrative units (Odessa and Mykolaiv regions), as well as both the lack of an integrated coastal zone management system in Ukraine, a basin management model for the catchment, river basin management plans and programmes for the monitoring of water status can be counted among the problems of natural resources protection and conservation at the Tyligulskyi Lagoon.

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5. Appendices

Table A.1 – Specific composition of the fish fauna in the Tyligulskyi Lagoon (Shekk, 2004).

Family and species of fish	Occurrence by years		
	1964	1970-1990	2001-2002
1	2	3	4
Acipenseridae			
Acipenser stellatus Pall.	+	-	-
Huso huso L.	-	+	-
Clupeidae			
Alose kessleri pontika Eichw.	+	+	-
Alosa caspia nordmanni Antipa.	+	+	+
Clupeonella cultriventris Nordm.	+	+	+
Sprattus sprattus phalericus Risso	+	-	-
Engraulidae			
Engraulis encrasicolus ponticus Aeks	+	-	+
Salmonidae			
Salmo gairdneri Rich	-	+	-
Esocidae			
Esox lucius L.	+	+	-
Cyprinidae			
Rutilus rutilus L.	+	+	-
Rutilus frisii Norton.	+	-	-
Leuciscus leuciscus (L)	+	-	+
Skardinius erithrophthalmus L.	+	-	-
Aspius aspius L.	+	-	-
Leucaspius delineatus (Heckel)	+	-	-
Tinca tinca L.	+	-	-
Gobio gobio L	+	-	-
Alburnus alburnus L.	+	-	-
Blicka bjorcna (L).	-	+	+
Abramis brama L.	+	+	-
Vimba vimba L.	+	-	-
Pelecus cultratus L.	+	-	+
Rodeus sericeus amarus (Bloch)	-	+	-
Carassius auratus gibelio Bloch.	+	+	+
Cyprinus caprio L.	+	-	-
Hypophthalmichthys molitrix Valenc.	-	+	-
Aristichthys nobilis Richard	-	+	-
Ctenopharyngodon idelia Valens	-	+	-
Coditidae			
Misgurnus fossilis L.	+	-	-
Siluridae			
Silurusglanis glanis L.	+	-	-
Belongidae			
Valenc Belone belone euxini Gunther.	-	+	+
Anguillidae			
Anguila anguila L.	+	-	-
Gasterosteidae			
Pungitius platigaster platigaster. Kessler	+	+	+
Gasterosteus aculeatus L.	+	+	+

1	2	3	4
Syngnathidae			
Nerophis ophidion teres, Risso.	+	+	+
Singnathus typhlo argentatus P.	+	+	+
Syngnathus abaster Risso	+	+	-
Mugilidae			
Mugil cephalus L.	+	+	+
M. so-iuy Basilewsky	-	+	+
Liza aurata Risso	+	+	+
L.saliens Risso	+	+	+
Atherinidae			
Atherina mochon pontica Eichw	+	+	+
Percidae			
Stizostedion lutioperka L.	+	+	-
Perka fluviatilis L.	+	+	+
Percarina demidoffi Nordm	+	+	-
Gobiidae			
Pomatoschistus microps leopardinus Nordman.	+	+	+
P. caucasicus Kawrajsky	+	+	+
Gobius ophiocephalus Pall.	+	+	+
Mesogobius batrachocephalus Pall.	+	+	+
Neogobius melanostomus Pall.	+	+	+
N. cephalarges Pall.	+	+	-
N. fluviatilis Pall.	+	+	+
Proterorhinus marmoratus (Pallas)	+	+	-
Benthophilus stellarus	+	+	-
Knipowitschia longicaudata. Kessler	-	+	-
Neogobius rattan	-	+	-
Gobius niger L.	-	+	+
N. syrman (Norman)	+	+	+
N. gymnotrachelus Kessler	+	+	-
Scophthalmidae			
Psetta maeotika Pall.	-	-	+
Pleuronectidae			
Platichtys flescuc Pall	+	+	+
Solea solea	-	-	+
Blenniidae			
B. sphinx	+	+	+