TECHNICAL TRANSACTIONS 1/2019
ARCHITECTURE AND URBAN PLANNING
DOI: 10.4467/2353737XCT.19.001.10041
SUBMISSION OF THE FINAL VERSION: 17/12/2018

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Preservation methods and revitalisation of river ecosystems in coastal territories

Metody konserwacji i rewitalizacja ekosystemów rzeki w terytoriach przybrzeżnych

Abstract

This article examines the prevalent state of river ecosystems in the forest-steppe area of Ukraine with special focus on preservation methods and revitalisation of river ecosystems in the coastal territories.

Keywords: coastal territories, river ecosystem, natural factors, urban development, revitalisation measures

Streszczenie

W artykule przeanalizowano powszechny stan ekosystemów rzecznych w leśno-stepowej części Ukrainy, ze szczególnym uwzględnieniem metod konserwacji i rewitalizacji ekosystemów rzecznych na obszarach przybrzeżnych.

Słowa kluczowe: terytoria przybrzeżne, ekosystem rzeczny, czynniki naturalne, rozwój obszarów miejskich, działania rewitalizacyjne

1. Introduction

The river ecosystem in the coastal area of Ukraine is an integral complex. It comprises of flood meadows, ravines, gullies, fields and forests. As a result of paracentesis and paradigmatic bonds, the natural river-flood complex is extremely sensitive and vulnerable to human activity in the river basin. The distinctive feature of this river ecosystem is that each district in the coastal area is interdependent on the adjacent natural systems, particularly the districts through which the river flows. At the same time the river ecosystem also has an impact on the complexes which are below the river. In this article we have made a modest attempt to examine and understand the river ecosystem in the coastal belt of Ukraine.

2. The structure of the small river ecosystem

The river is the active component of the ecosystem, whereas the coastal area is the passive: it arises in the process of channel deformation and is formed under the influence of flow-forming mechanisms. The floods indirectly have an impact on the river: they determine its boundaries, its speed and the course of the flow during the flood, and cause an active interchange of substances and energy between the river and the floodplain. Coastal forests facilitate the balance of biocoenosis and the nutrient elements of the river ecosystem. It determines the hydrological regime of the rivers, and promotes the transfer of organic substances to other subsystems. Fields are a vehicle and carrier of organic and mineral fertilisers. Excessive cultivation requires watering and results in the diminishing of river water levels, soil erosion, and soil washing into the river floodplains. Row earth is a barrier between the river and other elements of the ecosystem. Luke is a battery and transformer of compounds of biogenic elements moving from the catchment area directly to the river.

In the 'vertical' structure of the river ecosystem, there are three main functionally distinct areas: upper, middle and lower. These natural, territorial complexes of the river basin are characterised by homogeneity of physico-geographical, hydrological and hydrobiological features. The upper plots, which are usually the tiniest, are the most vulnerable complexes with regard to anthropogenic impact due to the fact that the tributaries originate here and the main river runoff is formed; hydrobiocoenoses are characterised by their low self-cleaning potential. The middle and lower areas comparatively play a lesser role in the formation of river runoff, but they are more affected by the river. These areas are characterised by well--developed, large flood plains, with densely populated areas with a favourable hydrological regime and fertile soils, which are extremely conducive for agriculture [1].

Coastal territories belong to area of direct interaction of the lithosphere, hydrosphere, atmosphere and biosphere and is the ecotone of the littoral belt. Due to the similar climatic conditions, within the limits of coastal areas, the intensity of physical and geographical processes is much higher than in other landscapes. Any changes in the components of the river's ecological system lead to a violation of the ecological balance. The ecological equilibrium is dynamic due to constant cyclic or irreversible transformations of elements of

the river ecosystem and the interaction of its constituents by means of paradigmatic bonds. The ecosystem of the river is holistic, self-sufficient, interconnected, and dynamic due to the constantly operating links between its constituents. Thus, in the horizontal and vertical structure of the river ecosystem, there are certain features that need to be taken into account in the urban use of the coastal area.

3. Recent problems of coastal area usage

The modern practice of urban planning is unable to solve the problems of protecting the balanced, rational and harmonious use of smaller rivers in the urban areas of the coastal belt. Construction near the rivers is bereft of scientific planning; the aesthetic considerations of industrial and warehouse development in the vicinity of the river are significantly lacking. As a result the residential areas and community living is much below the desired standards i.e. the factors which constitute the panoramic core of any city.

Green plantations along the coastal protective strips are very scarce. Despite warning signs construction activity is on the increase. The coastal belt, although a narrow strip by and large consists of solid concrete cover, embankments with lanes along the highways, but lawns and woody vegetation is a rarity.

The lack of a felled shore, the existence of a built-up and ploughed floodplain deprives coastal areas of their natural water protection function. In such modern realities, the coastal area itself needs protection [Fig. 1 & 2].

Today, the river basins are virtually devoid of natural bio-filter. Their water intakes or ploughed almost to the bottom of the water, or destructively exploited by other means. This provides unobstructed access for the surface runoff with a variety of pollutants to the channel.

Fig. 1. Abandoned state of the coastal area of the river Stugna in the Borov village (photo by Olga Mykhailyk, 2018)

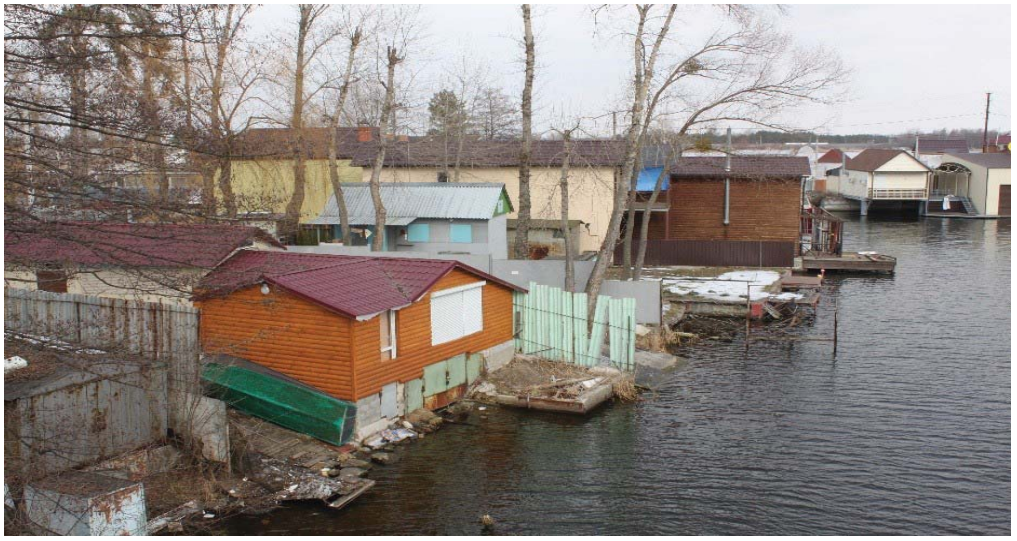

Fig. 2. Coastal area of the river Stugna in the Kozin village (photo by Olga Mykhailyk, 2018)

Many small rivers in settlement areas perform sewage function: the rivers are polluted with runoff domestic waters in settlements and livestock complexes, as well as runoff from roads and agricultural fields. Plots of land in the small rivers basins cover an area of almost 80%. The overgrown coastal areas of small rivers result in increased soil erosion and sedimentation.

Urbanisation of floodplain in the coastal areas has resulted in climatic changes. In built-up flood areas, humidity is lower than on an unfinished floodplain. To be precise 0.2–0.8 mb or 7% higher than in other parts of the city. Near the edge of water this difference increases to 3.2 mb, or up to 10–12%. In built-up areas, soil moisture is 4-8% higher than beyond its borders [2]. The construction substantially changes the soil moisture of the foundations and under conditions of deep groundwater contamination, which prevents the moisture exchange of the atmosphere with the soil. Due to the destruction of natural drainage (falling of ravines, beams, drainage of marshes, creation of artificial barriers for underground drainage) the groundwater level is raised and watering of forest species occurs, which leads to many negative phenomena. During construction work the artificially covered urban area increases. This reduces natural soil evaporation. The impact of Dnieper and Desna and their influx in the coastal territory is manifested in the permanent destruction of the floodplain and its wetlands. It also results in the accumulation of alluvium, especially during the spring flood. The construction work in the floodplains leads to an increase in water intakes. Consequent to which the natural regime of rivers is violated, thereby creating conditions for the formation of runoff change. Floods become more frequent and losses caused by them increase. Straightening the channel of small rivers is accompanied by frequent catastrophic floods which lead to the flushing and blurring of soils, flooding and water logging of a number of reclamation systems, and the destruction of the coastal belt. Due to the decreasing of channel's throughput, floodplains are flooded with gradual degradation of meadows and their replacement with low-value reindeer marsh. Such processes are most actively manifested in the forest-steppe Rivers, where the hilly relief is predominant.

Large-sized garbage sites are located in the coastal areas adjacent to urban roads, industrial enterprises, and rural areas, where garage-construction cooperatives, parking lots and territories are used for warehousing for construction and household. The sanitary norms, with regard to landscaping, in the coastal areas that border the residential and industrial buildings are in a precarious state.

Every year, recreational activity increases in suburban and urban areas. Due to allocation of Plots of land to country estates in the coastal areas, the pollution of communal and industrial sewage increases which results in the reduction of water purification levels. Many rivers (for example, the Lybid – Fig. 3) have undergone drastic changes because of construction work taking place in the river supply areas. The river bed is straightened, entangled in trays or into an underground tunnel. Existing coastal protective strips are erected to 1–2 rows of trees along the shores and often consist of such tree species that are not conducive to the coastal protection.

Fig. 3. The Lybid river, Kyiv (photo by Olga Mykhailyk, 2018)

The construction of agricultural complexes in the coastal belt not only intensifies soil erosion, but also results in the clogging of natural phytocoenoses and the removal of organic and inorganic substances (from farms and from mineral fertiliser storage, respectively) along with the sewage. The placement of landfill sites, gas stations etc. in a river valley or in adjoining yards pollute rivers and their coastal areas. With the increase of cultivation in the coastal areas, the soil erosion also increases.

The drying up of small rivers mostly results in drainage reclamation, which involves rectifying the channel and removing water from the swamps located in the floodplains of the rivers. As a result of the construction of drainage and irrigation systems, the length and density of the network and its drainage role have increased due to the creation of channels that provide a rapid outflow of thaws and rainwater. Widespread reclamation in Polissya led to the disappearance of unique wetlands. Excessive cultivation of the territories almost

led to total destruction of forests in the forest-steppe. Oak forests of Polissya and the forest-steppe replaced low-productivity birch, hornbeam and maple forests. In general, the average forestry in Ukraine (14.3%) is the least in European countries [1]. The use of large-scale drainage reclamation had negative repercussions: rivers that were fed with groundwater disappeared, and rivers that feed on groundwater increased their water content. Reducing the area of mires, the deepening of reclamation canals lead to lower levels of groundwater and the drainage of mires. This directly impacted the reduction of the number of certain species of birds.

The self-cleaning ability of rivers due to chemical contamination has significantly decreased. Extensive overregulation of small rivers lethally effected water-purifying microorganisms. The construction of dam had repercussions on coastal microclimate (humidity increased and the peak of the rainy season shifted from autumn to summer), stability of the coastal areas (abrasion, appearance of landslides) was disturbed, the fish breaks up, the plant cover is destroyed. Rocks violate the flow and continuity from leakage to the mouth. This resulted in increased accumulation of sediments, deterioration of water quality, impacted the flood regime and prevented periodic discharge of water to the floodplain. While controlling the river, rocks inhibit the flow of sand, mud, and other bottom sediments, thereby impoverishing flood plains and swamps below the flow. This is a major factor in the devastation and deterioration of all processes of river life. Construction of hydroelectric power stations contributed to raising the level of groundwater. The rise of the Dnipro River level in Kiev increased from 91.9 m to 1.5 m. This in general is true for all rivers and streams. A significant number of existing treatment facilities is ineffective. There is deterioration in water quality. The minimum indicator of technogenic loading on water (up to 5 t/km^2) is observed in the western regions of Ukraine, while in the eastern regions the maximum is (more than 20 t/km^2). There are no clean rivers in the lower Dnieper River today. Underground water bodies are extremely limited and or unsuitable for water use.

Presently, in the case of smaller rivers, five parts of all sewage are discharged, and overregulation reaches almost three hectares per km of river. There is a negative trend to increase the excessive uncontrolled regulation of the rates of small rivers. This leads to the loss of the river's qualities and the acquisition of lake-pond qualities. To save rivers, it is necessary to eliminate unnecessary artificial stakes that are in poor condition [3]. Coastal areas – floodplain meadows, swamps, fields, and forests forming constitute an integral ecological system along the river. It requires active revitalisation measures. This entails multiple factors, such as organisational, architectural and planning, engineering and biotechnical works, taking into consideration the individual characteristics of each river ecosystem.

Destruction of the coastal areas results in the anthropogenic effect on land, pollution of water bodies which endanger human settlements, environment and cause irreparable harm to the regional economy. Strengthening anthropogenic impact leads to unification (simplification) and the destruction of coastal vegetation. Excessive ploughing of coastal areas and excessive cattle grazing caused the penetration of weeds into the vegetation group. This implies that the annual plants with weakly developed root system are not capable of forming turf and performing coastal and water protection functions.

4. Preservation methods and revitalisation of coastal areas of river ecosystems

The revival or revitalisation of rivers, particularly by linking small rivers, with medium-sized and large rivers, is very much on the agenda of ecologists, architects and urban planners. The riot crash is observed in almost all countries. All developed countries of the world pay special attention to coastal areas, by adopting through legislation, programs of rehabilitation and revitalisation of coastal areas. In Germany, for example, the federal law 'On water', brings all water objects under government control, and any activity on the banks of rivers and lakes is possible only by taking special permission from the concerned authorities. However, in practice all over the world, there is no single, generally accepted norm for the formation of special regimes with regard to the use of coastal areas of small rivers.

Fig. 4. Revitalisation of areas surrounding rivers

The concept of the European project REURIS (Revitalisation of Urban River Spaces) is to carry out measures on the revitalisation (reproduction) of pre-urban areas, their rational management and the preservation of cultural heritage. The goal of the RRC (River Restoration Centre) in UK is to create a centre for exchanging experiences on river rehabilitation and the spread of successful basin management practices. The REURIS and RRC programs are based on the basic premise of preserving natural environment and reducing anthropogenic effect on river basins [4].

Providing places for public life in the developed coastal area (the Ljubljana river in Slovenia), the landscaping and greening of the underdeveloped coastal belt (Prague suburb (Fig. 5), the central part of Krakow, Obolonskyi embankment in Kiev). The construction of walking 'fresh air' bridge on piles along the river bank in Lensing, Detroit (USA) (Fig. 6) contributes to the conservation of coastal biocoenosis and is an example of successfully developing river coastal areas. In USA during the last decade, 350 dams have been dismantled. Somewhat similar process has taken place in Ukraine at the end of the 20th century: hundreds of small hydroelectric plants were decommissioned so as to restore natural qualities of their highly regulated rivers and thereby revive them.

Fig. 5. Development of green belt along the coast line. Prague suburb
(photo by Olga Mykhailyk, 2018)

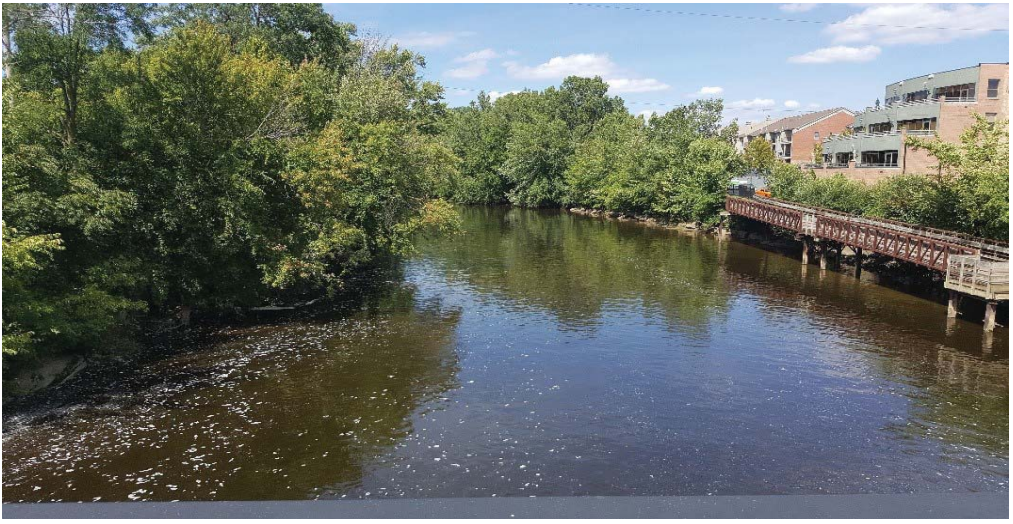

Fig. 6. Walking 'fresh air' bridge along the riverbank in Lensing, Detroit, USA
(photo by Olga Mykhailyk, 2016)

State Building Standards DBN B.2.2-12: 2018 'Planning and Building Territories' conceived the concept of a green line that ensures conservation of landscaped lands. This is a basic concept in urban planning documentation. On page 8 of DBN B.2.2-12: 2018, the concept is defined as follows: "Prohibition of disposing garbage and waste products in all green areas: recreational forests and forest parks (existing and reserved) and provision is made for funds for preserving nature, creating zones for protecting landscapes" [5]. Establishing a green line in the coastal areas will help to protect the natural conditions of the river ecosystem, maintain the livelihoods of the coastal and aquatic flora and fauna, ecotones, and improve

its self-cleaning and self-regulating ability. Protected zones, hedged by green line are water reserves and coastal biodiversity, protection of river with coastal areas from anthropogenic loading and from dangerous erosion processes.

Each ecosystem of the small river is a unique natural phenomenon, so the definition of the green line should be individual in nature. For each small river, it is necessary to carry out ecological and urban development investigation of the coastal area, taking into account individual natural features and the nature of anthropogenic loading.

5. Conclusion

The coastal area remains insufficiently defined as a holistic object of urban planning and exploration – this entails many unsolved problems for its urban development. Existing legislative and regulatory documents have a simplified way of defining protected areas for water bodies. They do not comprehensively take into account the natural features of small river ecosystem or the local factors of small river ecosystems, which leads to degradation and dying of small river ecosystems. Legislative documents need to be meticulously worked out in order to develop methods, structures and quantitative parameters that should form the basis for a comprehensive analysis and assessment of the coastal area for various types of functional use, taking into account the conservation and revitalisation of river ecosystems.

Translated by Yaroslav Boiko and EvgenVasiliev

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If you want to quote this article, its proper bibliographic entry is as follow: Demin N.M., Mykhailyk O.O., *Preservation methods and revitalisation of river ecosystems in coastal territories*, Technical Transactions, Vol. 1/2019, pp. 5–14.