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RIVER ECOSYSTEMS OF POLISYA: NATURE, CAUSES OF DEGRADATION, METHODS OF URBAN PLANNING AND LAND REGENERATION

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Summary. *In this article we have analyzed the current state of the ecosystems of Polesye rivers in Ukraine, the causes of their degradation. We have primarily made recommendations for urban planning and the reclamation of coastal areas of Polesye rivers in urban and suburban areas. Ukrainian rivers are classified into 3 categories: Polesye rivers, mountain rivers and rivers in river-cut valleys. In this article we analyzed the natural features of Polesye river ecosystems and the reasons and factors of their degradation. We have made some recommendations with respect to town-planning and the reclamation of coastal territories: in both urban and suburban zones.*

The river ecosystem is a naturally balanced formation - disturbance of the coastal area directly affects the state of the riverbed. Maintaining the natural (optimal) functioning of the river ecosystem and its catchment area helps to increase their self-cleaning capabilities and minimize the impact of extreme situations, including low-water years. Any measures for the preservation or reconstruction of the ecosystem of the river and river valley should be aimed at the reproduction of natural complexes, originally characteristic of the area and the landscape.

In order to maintain, preserve, protect and restore the ecological balance, the urban organization of coastal areas of Polissya rivers in urban and suburban areas should take into account the presence of wetlands of coastal areas, the number of wetlands, small number of aquatic and air-water plants. features of Polissya river ecosystems. The dominance of the landscape direction of the urban organization of the coastal areas of Polissya will help maintain the natural balance, which is the key to maintaining the purity of Polissya rivers and the stability of coastal areas.

Key words: *ecosystem of Polesye rivers; the Polesye lowland; environmental problems; coastal technogenic system; landscape principle of coastal area organization.*

Analysis of investigations and publications

Environmental improvement of river ecosystems in Ukraine has a direct impact on improving the quality of life in urban and suburban areas. This article is a continuation of the study of the Ukrainian rivers ecosystems and the focus is made on their conservation and reclamation. In the previous research works the author had endeavored to investigate the state of Kyiv water areas [4], of the rivers Lybid [5], Stugna [6], Dnieper floodplains [7], coastal areas of Kyiv region [8], the problems of small river ecosystems [9], proposed methods for the revitalization of small river ecosystems [10,11]. The experience of developed countries in the improving of coastal areas is very interesting and useful [12]. In the comparative analysis of environmental principles of urban planning in the Ukrainian and Japanese traditions many common features have been found [13]. Recommendations with respect to

town-planning principles and methods of reclaiming the public space of the coastal territories to the citizens have been made [14]. Natural characteristics, the problems of transformation and necessary measures for the rehabilitation of the river ecosystems in Ukraine have been analyzed [14].

The purpose of this publication is to study the natural features of Polesye rivers ecosystems and make recommendations for town-planning and improving the environment of the coastal areas.

Main part

Natural state. The Polesye lowland with the predominant heights of the earth's surface 150-160 m is located in the northwest - partly within Ukraine, partly in Belarus (Photos 1, 2). The lowlands are characterized by significant wetlands, wide floodplains, and widespread forests. The Polesye lowlands are characterized by sand hills, the origin of which is connected with the activity of the glacier. A characteristic feature of the Polesye lowland, which affects the regime of river ecosystems, is the concavity of the relief, the presence of wetlands [1].

The river ecosystems of Polesye have weakly expressed wide valleys with a significant width of the floodplain. The height of river valleys is small (about 1 m), which contributes to frequent flooding and waterlogging. Strands mostly composed of sand are common in the riverbeds. In curved coastal areas ravines are formed, and in convex coastal areas spits. The speed of the river flow is insignificant (0.2-0.3m/ s).

The water is transparent and brownish in color due to the presence of swamp water. Polesye rivers do not dry up. There is relatively little aquatic and air-water vegetation in Polesye rivers. The forest cover of Polesye rivers is 20-40%; there is a significant part of wetlands and reclaimed areas. The coastal areas of Polesye rivers are covered with coniferous and mixed forests dominated by pine with a significant share of birch on sandy and loamy soils, chernovshnyak on swampy soils of the terraced depressions [2].

Photos 1, 2. Maps of the Polesye lowland

Photos 3, 4. River ecosystems of the Pripyat, the Desna

Photos 5.6. River ecosystems of the Sluch, the Snov

The biggest Polesye rivers are the Pripyat and the Desna; the Berezina and the Sozh rivers are somewhat inferior to them. Most of the Polesye lowland belongs to the basin of the Pripyat river, which originates within the Volyn region, then it passes into the territory of Belarus and again in Ukraine. Sod-podzolic soils of sabulous and sandy composition are widespread in the basin and that contributes to high filtration capacity.

Within the boundaries of Chernihiv Polesye there are islands with forest species that rise above the sandy plains to 40-50 m. Novgorod-Severskoe Polesye is split more intensively in the eastern part where the steep right banks of the Desna river reach 100 m. The groundwater stands high, often at a depth of less than 1.0 m from the surface. The existence of large forest areas, the prevalence of swamps, the humidity of the basin, the flow in the latitudinal direction from west to east is a feature of the river ecosystem of the Pripyat (Photos 3-4).

The Desna is the second biggest river in the basin area in Polesye. The river has its source near the Russian town of Yelnya. It has a fairly wide floodplain in most parts of Ukraine. The proximity of the river mouth to Kiev determines the health and recreational function of the coastal area of the Desna. Its water is the main source of water supply in Kyiv. Desnyanskaya waterworks was launched in 1961; it soon became the main waterwork for Kyiv, as it is significantly ahead of Dniprovska waterwork in terms of design capacity (1.0 million m³). The supply of water from the Desna river to the right-bank part of Kyiv is carried out by a pipeline laid on the Moscow Bridge of the city. Another pipeline across the Dnieper river is located near the Metro Bridge. The water supply system in Kyiv is looped – the water is supplied simultaneously from all sources. In case of water pollution at the Desnyanskaya waterwork, there is no alternative in the existing water supply system of Kyiv. That means that maintaining the purity of the Desna water is the key to the health of the people of Kyiv.

The distinguishing feature of the valleys of the small rivers of Polesye is their insignificant depth of water intakes, gradual transition from intensively swampy floodplains and floodplain terraces to low and swampy watersheds. The ravine-cavin relief and geomorphological distinctiveness of the valleys are common in the area. Developed eolian formations (hills, ridges, dunes) are mostly fixed by pine forests. The average length of tributaries does not exceed 3.5 km (the rivers Turia, Snov, Oster, Stviga). The vast majority of rivers with a length of more than 10 km have a

water intake area of 20.1 to 500 km² (average area - within about 10 km²), the density of the river network - 0.31 km / km², steepness 0.7-0.8%. The width of the river basin varies from 10 to 15 km. The annual water level change is characterized by high spring floods with several peaks. The network of small rivers is extremely extensive, the banks are gentle and expressive. Some riverbeds are indistinctly branched and overgrown with aquatic vegetation and shrubs (the Stohid River) (Photos. 5-6). [3]

Reasons and factors of degradation

Widespread reclamation in Polesye has led to a reduction of unique wetlands. Directional logging of oak forests in the area has been substituted by low-yielding birches, hornbeam and maple forests. The implementation of agricultural activities has resulted in the penetration into the plant groups of weed species (ruderal types of plants) - these are mostly annuals with underdeveloped root system, unable to form turf and perform coastal and water protection functions.

The floodplains of most small rivers of Polesye have been developed under agriculture by almost 50-60%. The plowing of the coastal area to the water's edge and the destruction of meadow turf led to increased coastal erosion, washing away and erosion of the soil up to the full depth of the arable horizon, removal of significant amounts of organic and inorganic substances into the water currents, even in the case of light rains. Consequently, there is siltation and shallowing of the rivers, as well as the deterioration of water quality. The decrease of the water flow in the riverbeds results in flooding of the floodplains as well as further degradation of the meadow and its replacement by economically insignificant reed swamps. Intensification of arable farming without conforming to the rules of water protection regime has led to almost universal shallowing and drying of small rivers. Destruction of natural vegetation cover at the water intake on the coastal slopes causes catastrophic events during floods and inundations.

The construction of agricultural complexes in the floodplain increases soil erosion. The location of landfills and gas stations at the coastal areas also causes pollution of the river. Excessive amounts of organic matter entering the river results in excessive water-logging. The presence of treated and untreated municipal, industrial and agricultural effluents in the river ecosystems is an extremely dangerous phenomenon, particularly in the case of small rivers. The volume of these effluents can be the same or even more than the volume of a small river runoff.

The construction of a system of ponds leads to the emergence of lake elements in the landscapes of floodplains and lake-like biocoenoses. Excessive over-regulation (over 40% of the length of the riverbed) causes disappearance of the river complexes and the transformation of the river into a system of shallow lakes. The grave consequence of the construction of unauthorized ponds on the rivers is rapid shallowing, overgrowth of the riverbeds, redistribution of groundwater levels, flooding and waterlogging of meadows. Numerous ponds on the rivers intercept flood water, prevent flooding of the floodplain, which also hinders the enrichment of floodplain meadows. But, if properly planned and utilized, the ponds take on the functions of a powerful biofilter for polluted water. Pond fisheries, to some extent,

are biodiversity reserves - due to the protection regime and their inaccessibility. Many species of waterfowl build nests and a great deal of wildlife live in the thickets of coastal and aquatic vegetation. When the rivers of Polesye were in a natural state a significant amount of silt was brought to the floodplain. It was accumulated in wetlands or in the thickets of aquatic plants and provided the existence of meadows. But now in the straightened and deepened sections of the river during floods all the excess water without encountering any natural obstacles quickly passes along the riverbed; the water hardly comes out on the floodplain and hence does not enrich the meadows. The regulation of the riverbed significantly changes the living conditions of aquatic inhabitants and the disappearance of animals and fish in small rivers is a common phenomenon.

Regeneration methods

The river ecosystem is a naturally balanced formation. The disturbance of the coastal area directly affects the state of the riverbed. Maintenance of the natural (optimal) functioning of the river ecosystem and its catchment area helps to increase its self-cleaning capabilities and minimize the impact of extreme situations, including dry years. Any measures for the preservation or reconstruction of the ecosystem of the river and the river valley should be aimed at the rebuilding of natural complexes, which originally are natural to the area and landscape. These measures should be applied to water protection zones and coastal protection belts of rivers. The sources and headwaters of the river are its most vulnerable areas; their slightest change can be detrimental for the river. The reclamation of the swamp from where the river begins, siltation of springs in its upper reaches, deforestation can result in partial drying of the river or its complete disappearance. The following scientific methods of protection and regeneration of meadows, forests, fields of the coastal area will enable to maintain the natural balance of the river ecosystems of Polesye.

Highly productive grasses should be used to facilitate vegetation growth in meadows. The best time for planting grass in meadows is autumn, for the slopes is spring. On acid soils of Polesye to create herbal mixtures liming needs to be done first. The following types of grass and legumes are the best for planting in the coastal areas of Polesye: meadow and narrow-leaved bluegrass, meadow timothy grass, meadow fescue, red, plowed and sheep fescue, high ryegrass, common ryegrass, perennial fenugreek, common fenugreek cane, meadow rank, white and medicinal clover, blue-hybrid and yellow-hybrid alfalfa, creeping and meadow clover, mouse peas, horned lollipop, esparcet. Sowing grass on the hillsides should be done across the slopes.

Each natural zone of Ukraine has its own specific (zonal) type of forest. The pine forests and shrubs (mixed forests of pine and deciduous trees) on sandy coastal terraces, birch groves and alders in wetlands are typical for Polesye. Afforestation (wind forest strips) in the coastal area must take into consideration the natural wood composition. It is possible significantly reduce the negative impact of anthropogenic pressure on the river ecosystem by specially selected types of vegetation. The following protection wind forest strip design is optimal: several rows of wood species (not less than 3) separated from one side of the river by 1-2 rows of water-resistant

bushes (viburnum, willow, elderberry, etc.) and from the other side by 1-2 rows of hedges (shrubs - dog rose, thorns, hawthorn, etc. to protect from the livestock). The shore close to the water is fixed by planting willow cuttings. It is advisable to plant fruit and berry orchards on the borders of settlements to prohibit the livestock from entering into the water protection zones. Phytomelioration in the river valley should be aimed at the formation of plant communities that will maximally carry out coastal and water protection functions. Selection of plants for phytomelioration should be based on local species which are specific to the area.

The impact of forests on the full-flow of rivers is sufficiently differentiated and balanced: in Polesye, an increase in forest areas by every 10% the influence is in the range of 10-60% in dry river basin types where the average annual runoff increases by 15-20 mm; in river basins with a predominance of swampy and waterlogged areas decrease in full-flow has been found. The flood peaks decrease by more than 10-20 times under the influence of the forest. This happens due to an increase in the precipitation and a decrease in evaporation from the soil. In the areas with a high risk of flood-flow the forest, like a sponge, absorbs excess moisture, thereby preventing destruction. Thus, the tree belt with a width of only 20-30 m absorbs almost all the moisture flowing down the gentle slope. The protective forest belts retain and transfer to the soil more than 70% of the surface runoff. In the 30-year-old oak-ash plantations the moisture capacity of the litter is about 200% of its mass in the air-dry state. The optimal value of the forest cover of watersheds of small rivers for Polesye is considered to be ≥50% (Fig. 1-2) [15].

Urban planning organization of the coastal territory of Polisye rivers in urban and suburban zones

Analysis of international practice proves the superiority of the urban type organization of coastal areas with a predominance of engineering and technical structures, shore-fixing structures and beautification features. In so doing, the preservation of ecological balance and uniqueness of the river ecosystem contributes to landscaping and aims at maximizing the preservation of natural Polesye landscapes, creating unique architectural and landscape objects of urban and suburban areas using natural resources (wood, stone). Most often, the natural contour of the coastline is preserved. In the urban zone, the coastal landscape should be as close as possible to nature; the inclusion of urban features should not dominate over the natural constituents, they should harmoniously complement the natural environment, become an organic part of the coastal landscape. This kind of a landscape environment is formed in park areas, common public placed, in public spaces and recreation zones.

The suburban area of Polesye with high humidity in coastal territories, numerous wetlands, small number of aquatic and air-water plants requires organization of coastal territories with embellishment of sites for observation of wetland flora and fauna, air-wooden scaffolding to hide ecotones, paving ecological paths and tourist routes with information boards and creation of protected wetlands - especially at the sources and upper reaches of Polesye river ecosystems (Photos 7-9).

Photos 7-9. Coastal infrastructure organization of the coastal territory of Polesye rivers outside the suburban zone

Conclusion

River ecosystems of Polesye have their own natural features. In order to maintain, preserve, protect and restore the ecological balance, the urban organization of coastal areas of Polesye rivers in urban and suburban areas should take into account the presence of water-logged coastal territories, the number of wetlands, a small quantity of aquatic and air-water plants, the significant flood plain width and other features of Polesye river ecosystems. The dominance of the landscape tendency in the town planning organization of the coastal areas of Polesye will help maintain the natural balance, which is the key to maintaining the purity of Polesye rivers and the stability of coastal areas.

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