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## Assessment of the ecological status of small rivers in urban areas.

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### ARTICLE INFO

**Article history:** Received 12/06/2018; Accepted 12/29/2018; Available online 12/29/2018

**DOI:** <https://doi.org/10.32557/useful-2-4-2018-0006>

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**Key words:** small river, urban area, urban river

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### ABSTRACT

Rivers are important components of many urban systems, and research into urban rivers are considerable research. The object of the research is technogenically transformed aquatic ecosystem of small rivers passing through urban areas of Kyiv city. These small rivers are tributaries of the Irpin River. The study used an ecosystem-basin approach, statistical processing of data. The complex research on patterns of their development for the long-term period were made, the quality class of water and indexes characteristic were ostended.

### 1. Introduction

The majority of the world's population, according to the UN Population Fund, lives in cities. In Ukraine this number is 29.5 million people, which is 69.23% of the population. Given the importance of cities for the life of the population, there is a need to study urban systems, to understand the main aspects of the structure and processes that develop in the urban environment, in the interaction of man with the components of the environment. According to European experts (Sukopp, 1987), the area that is affected by the city is a thousand times bigger than its own size. The negative impact of urbanization is manifested in the concentration of a large number of industrial enterprises in a small area, in the pollution and consumption of resources. Moreover, this influence extends to all components of the natural environment - the air basin, soils and water bodies, it also affects the health of the population.

## 2. Literature revive and problem statement

The urban river network plays a key ecological and social role in the functioning of cities. Most cities have historically been built on the banks of rivers, for example, such large as the Dnieper river, on the basis of which 40% of the economic complex of the country operates, or on the banks of numerous small rivers and streams, there are more than fifty of which in Kyiv and all of them belong to the Dnieper basin. The change of their flow in the direction of reduction began already in 1948, and almost half the decline in water quality is observed. According to the characteristics of ecosystems of small rivers of the Dnieper basin, their condition can be described as critical [1]. Their difference from other components of the biosphere lies in the small size and discreteness of placement. At the same time, they play an important role in the life of cities, have great recreational and aesthetic value. Therefore, such natural objects as small rivers deserve more detailed study.

The difference between small rivers and large or medium rivers is not only in their length and area of the basin, but primarily in the degree of dependence of their biological processes on the surrounding catchment area [2]. The vulnerability of the ecosystem components is due to the concentration of runoff from the entire catchment area in the small, narrow space occupied by the river bed. And the closer one or another territory is to the water's edge, the more significant is its importance for the processes taking place in the watercourse itself [3]. On small rivers, which are located in the same landscape and have low water consumption, the resulting effect of natural and economic factors is faster and more clear.

During the development of cities, rivers undergo changes: straightening, backfilling, lining the banks, flow in the collector, sewage or creating a cascade of ponds.

Small rivers in urban landscape perform the following functions [2,3]:

- redistribution and maintenance of moisture balance, regulation of the water regime of landscapes;
- collectors of the surface runoff collectors, that is, objects where, due to the significant self-cleaning ability, the pollutants coming from the surrounding catchment area are removed;
- natural drainage system of technogenic changed territories;
- indicators of changes in environmental (ecosystem or landscape) situation of flat areas;
- key elements in the formation of the living environment of people, recreational and sports areas of the city, rehabilitation areas, territories of hospitals and sanatoriums;
- support biodiversity of native plant and animal species in a megalopolis.

Due to the influence of urbanization and industrial development on the river basin, there is a transformation of flow, changing morphometric characteristics of the channel and floodplain, creating a

qualitatively new composition of sediments, there are new conditions for the interaction of the flow with the channel [4]. The use of water of the city rivers for industrial and municipal water supply reduces the carrying capacity of the flow. Discharge of heavily polluted and chemically active wastewater into the river, even with relatively weak mechanical impact on the riverbed, can significantly change the nature of channel deformations. As a result, rivers lose their water management and recreational importance. A characteristic feature of the anthropogenic impact on river beds in cities is the simultaneity and diversity of forms, which often leads to irreversible changes, and violate the ecological balance [2,5,6].

The essence of the protection of a small river is to create certain conditions that preserve the natural or close to the natural functioning of a balanced ecological system of a particular watercourse. In Central Europe, due to the joint effort of Germany, Poland and the Czech Republic in 2008 the project REURIS [5] was created, the main task of which is to activate the river space in urban areas. The common set of methods and procedures has been developed that facilitate coordinated work by multidisciplinary teams and ensure effective involvement of relevant social groups.

In the United Kingdom was create The River Restoration Centre (RRC). This Centre help river managers identify potential restoration techniques for use in river restoration and sustainable river management. It provides detailed examples of innovative and best-practice river restoration techniques.

In Kyiv, too, the revitalization of rivers, starting with the river Lybid started. A project for the reconstruction of hydraulic structures with the restoration of ecological and sanitary conditions of the river was created. A competition was held for the best architectural project of the coastal zone improvement, creation of recreational and park zones.

### 3. Materials and Methods

In general, the features of the interaction of riverbed processes and urban areas, and as a consequence - the emergence of environmental tensions, are very specific in each case. Therefore, the authors conducted a study of the condition of small tributaries of the Irpen river flowing through the territory of the city of Kyiv. Such rivers include: Liubka, Horenka, Koturka and Nyvka (Fig.1).

The best ecological condition, high percentage of protected areas and the lowest percentage of agro-industrial land among the studied river basins is inherent to the Liubka river. Its length is 9 km, and it flows West of the city. In 2002, the river valley was declared a general zoological reserve of local importance "Liubka River" as an anthropogenically unloaded area, which preserved the animal world typical for Polissia representatives. In addition, the lower part of the river is within the natural reserve Romanov swamp. Almost the entire length flows beyond the boundaries of the building area, through a pine forest, so of all the rivers of Kyiv Lyubka river experienced the least anthropogenic impact.

Gorenka river flows North-Western outskirts the city of Kyiv and flows beyond its border. The chamber has an inflow – Koturka length 6 km, width – 2 m. the river is known by a cascade of ponds, most of which fulfils a recreational function, the beach is considered one of the best in Kyiv. The river flows through the territory of the Kyiv forestry near the sanatorium complex "Pushcha-Voditsa" [6].

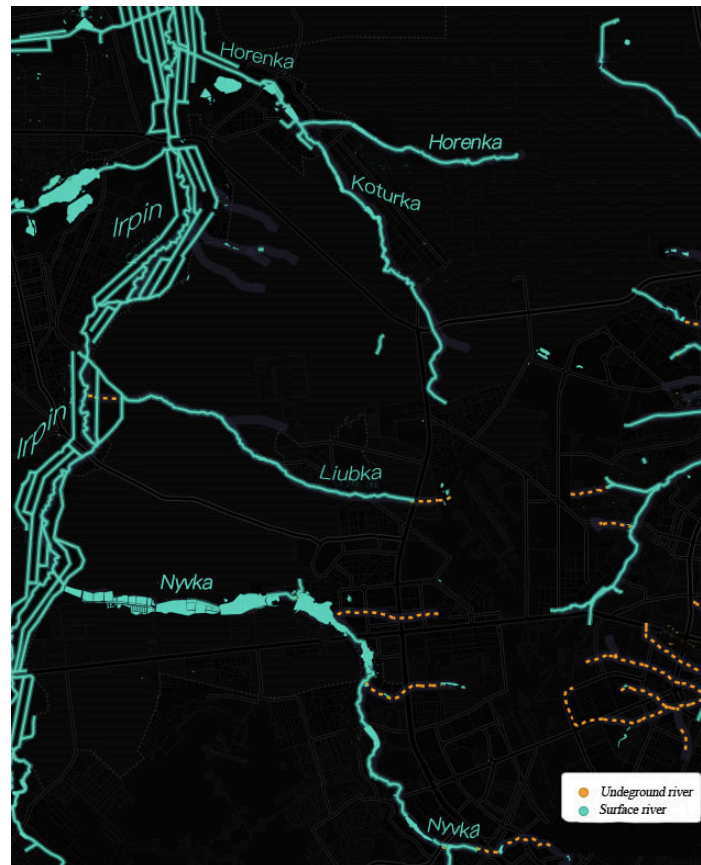


Fig.1. Hydrological network of the study area

The length of Horenka is 20 km, the catchment area is 56 km<sup>2</sup>, the channel is slightly winding, regulated. The river is characterized by artificial straightening of the channel, the transformation of the banks as hydraulic structures of open and closed type. However, in comparison with other rivers its channel is considered to be the most natural within Kyiv. A cascade of ponds and a reclamation system were built on the river. The river is a source of technical water supply. It has a significant recreational value - there are beaches and a sanatorium complex "Pushcha-Voditsa" on the places of formation of ponds [6].

The length of Nyvka is 23 km, the catchment area is 92 km<sup>2</sup>. It is one of the biggest “small” rivers in Kyiv. The Nyvka river flows in the Kyiv city, mainly in the collector, occasionally coming out on the surface with a narrow stream, or in the form of ponds in the Golosevsky district, and then flows in the

reservoir. The Nyvka river is characterized by an artificial direction, deepening of the riverbed, artificial transformation of the banks by open and closed hydraulic structures [2,6,7]. The flow velocity is negligible, due to regulation of runoff (in backwater there is a 42% of the total profile of the river). Its banks placed about 60 businesses, and communities that have no centralized sewer systems. The river accepts several collectors created to provide drainage of the Western outskirts of the city and the territory of residential areas. However, in the village of Zhuliany, through which the river flows, there is no sewerage system. More than 16 ponds have been built on the river, some of which are used for fish farming as recreational areas.

#### 4.Results

Horenka river has the best ability to self-clean polluted wastewater and self-regulation, among all the small rivers of Kyiv. However, there is an inclination to increase the area of agricultural and residential land (Fig. 2), since a significant part of the river basin recently became part of the city of Kyiv.

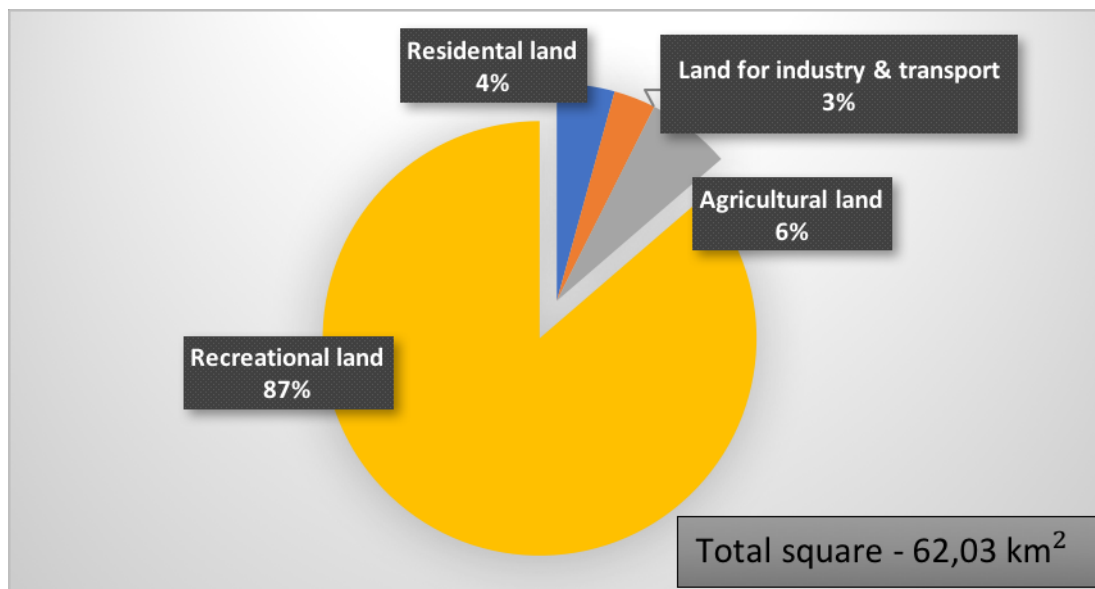


Fig.2. Percentage distribution of the type of lands of the Horenka River basin

The research results show that there is an expansion of residential areas and transport network. Due to the asphaltting of roads, bridges, there is a change in the composition and volume of solid runoff, this is the reason that large areas of floodplains within the catchment areas turn into waterproof areas (table 1). There is a decrease in groundwater supply by precipitation and a change in the structure of runoff [6,7]. The water quality class of the river, according to the general ecological index, corresponds to the III class of quality (contaminated).

Table 1

## Characteristic of the river basin

Indicator	Horenka river	Nyvka river
Average long-term runoff, mln.m <sup>3</sup>	3,27	5,40
Volume of solid runoff, 10 <sup>3</sup> m <sup>3</sup> / year	1,00	1,15
Volume of annual flow of sewage water mln. m <sup>3</sup>	0,04	0,403
Index of urbanization catchment	10,3	31,0
Index of forest watershed	82,1	27,0

In Nyvkas water value of wastewater to natural 2:1. The water quality class of the river, according to the general ecological index, corresponds to the IV class of quality (dirty).

The Nyvka River has a low percentage of protected areas (0.5%) in comparison with other reservoirs of the city of Kyiv, the weak ability of the geosystem to self-regulation, in addition, the river is characterized by an average level of man-made pollution.

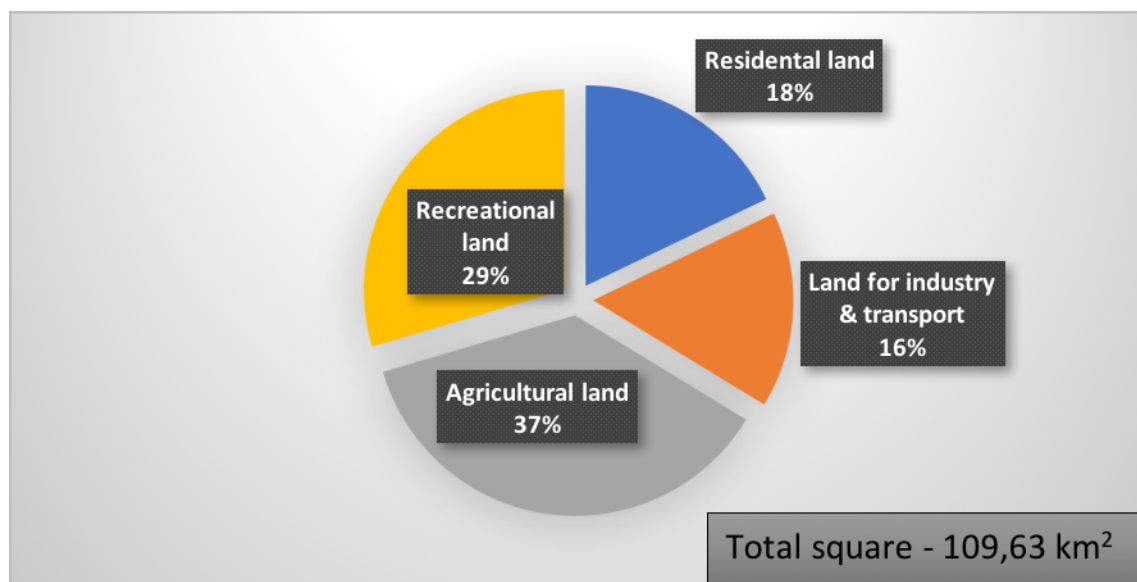


Fig.3. Percentage distribution of the type of lands of the Nyvka River basin

From Fig. 3 it can be seen that the largest share of land in the basin of the river Nyvka is under agricultural land, which explains the transformation of the river bed. However, also 29% of the land is reserved for recreational land in need of improvement.

The area of park areas, which are the main recreational areas of the city and have a positive impact on the health of the population, in the basin of the Nyvka river is 6.60 km<sup>2</sup>, the best green area is Sviatoshynskiy district; in the basin of the Horenka river is 0.98 km<sup>2</sup>, and Obolon district has the best greenery. In the basin of the river Horenka a much larger area is occupied by forest plantations – 44,5 km<sup>2</sup>, compared with 0.96 km<sup>2</sup> for the river Nyvka.

## Conclusions

The analysis of the ecological and hydrological state of the tributaries of the Irpin river and their coastal areas within the city of Kyiv suggests that the Horenka and Nyvka rivers need further revitalization. The water quality class of rivers corresponds to the IV class of quality (the Nyvka River) and III class of quality (the Horenka River).

It is necessary to identify priority areas in water activities, focusing on the successful experience of European countries. Management of natural components of the city should begin with the restoration of small rivers, bringing their technogenic transformed state to the natural improvement of coastal areas.

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