

GeoTerrace-2020-050**Monitoring of coastal protective strips of the Velykyi Kuyalnyk River and recommendations for their state improvement in the future**

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SUMMARY

The paper collected and summarized information about the current state coastal protective strips of watercourses (rivers, gullies, streams) and artificial reservoirs (ponds, reservoirs, quarries in the floodplain of the river etc.) in the basin of the Velykyi Kuyalnyk River. By 2018, there was practically no information on the state of lands of coastal protective strips and water protection zones in the basin of the Velykyi Kuyalnyk River. This created significant misunderstandings and abuses during their use and has led to intensive degradation of the ecosystem river and the Kuyalnytskyi Lyman. According to monitoring in the river basin (expeditionary surveys and the decryption results of satellite images for the period from 2007 to 2018) the authors compiled a comprehensive map (of 56 sheets) of the basin of the Velykyi Kuyalnyk River. On this map are marked: network of watercourses, artificial reservoirs, dikes and dams and plots of shores where the requirements are violated the Water and the Land Code of Ukraine regarding the state and mode of economic activity within the coastal protective strips. For practical application a detailed description of the state and boundaries of coastal protective strips along both banks of the modern riverbed of the Velykyi Kuyalnyk River is prepared. The width of the coastal protective strips is most often violated. It is established that significant parts of the coastal protective strips occupy the plowed land and private grounds. There are no coastal protective strips on some parts of the river. In some cases, coastal protective strips and even riverbeds are plowed. It has been determined that 44% of coastal protective strips do not meet the requirements of the Water and the Land Code of Ukraine. The authors prepared general recommendations for measures to improve the status of coastal protective strips of water objects in the basin of the Velykyi Kuyalnyk River. These recommendations include organizational and economic measures, agrotechnical measures, measures for melioration of meadows and forest plantations, as well as hydraulic engineering measures. Implementation of these measures contributes to the future restoration of the natural hydroecological regime of water facilities in the basin of the Velykyi Kuyalnyk River. The indicated measures allow to restore or strengthen the protective (buffer) role of vegetation of coastal landscapes within the limits of coastal protective bands in the basin of the Velykyi Kuyalnyk River.

Introduction

According to the Water Code of Ukraine (WCU), coastal protection strips (CPS) are part of the water protection zone (WPZ) of a water body with appropriate width, where a stricter regime of economic activity is established than in the rest territory of the WPZ. The strict regime of economic activity in territory of the CPS means that it is forbidden to plow the land, to engage in gardening and horticulture, to organize summer camps for cattle, recreation centers, cottages, garages, parking and car washes, etc. Only hydraulic, hydrometric and linear structures are allowed to be built on the territory of the CPS. In accordance with the requirements of Article 88 of the WCU, the CPS is installed along both banks of rivers, streams and trickles and around reservoirs along the water's edge during the low water period. If the water body is a source of drinking water supply, the CPS is included in the sanitary protection zone. On the locality (in kind) the boundaries of CPS and WPZ are fixed with special water protection signs. For small rivers, including the Velykyi Kuyalnyk River (V. Kuyalnyk River) and ponds with an area of less than 3 ha, the width of the CPS should be at least 25 m. If the slope is more than 3°, the minimum width of the CPS is doubled. For ponds larger than 3 ha, the minimum CPS width is 50 m. Despite the special measures to minimize the negative impact of anthropogenic development of coastal areas, which are implemented within the settlements (arrangement of embankments, creation of drainage and water treatment systems, including domestic and rain sewerage), the size of the CPS in the cases provided urban planning documentation (general plans of settlements, detailed plans of territories) may be subject to reduction (Martyn et al., 2009).

CPSs are installed on land plots of all land categories, except for land of sea transport. According to Article 88 of the WCU, CPS lands are in state and communal ownership and may be provided for use only for the purposes specified by the WCU. The transfer of such land to private ownership is not envisaged. V. Kuyalnyk river basin is located within the Odessa region. The river is part of the Prichernomor'ya river basin. The length of the river is 170 km, the catchment area is 1860 km² (Loboda et al., 2017). The river is the main tributary of the Kuyalnytskyi Lyman – a resort of national importance (Loboda et al., 2016). Under natural conditions, river runoff accounts for more than 90% of the total inflow of water into the Kuyalnytskyi Lyman (Loboda et al., 2018). Today, the river basin contains about 162 significantly altered and artificial surface water bodies – ponds and reservoirs, the remains of locks and quarries, etc., which accumulate almost all runoff, leading which leads to shallowing and drying of the Kuyalnytskyi Lyman and deterioration of his ecological condition (Loboda et al., 2018). Until 2018, there was almost no information on the state of the CPS and WPS lands in the V. Kuyalnyk River basin, which created significant misunderstandings and abuses during their use and led to intensive degradation of the ecosystem of both the river and the Kuyalnytskyi Lyman into which it flows. (Hryb et al., 2018). In this regard, the purpose of the work is to monitor the state of CPS watercourses and reservoirs in the basin of the river V. Kuyalnyk and provide recommendations for measures to improve it in the future in accordance with the requirements of water, land and environmental legislation of Ukraine.

Method of investigations

Among modern methods of monitoring the state of CPS, one of the most effective is a combined method based on decoding remote sensing data of the Earth (SDE) and the implementation of periodic expeditionary research. The use of this method is also relevant if regular field research is difficult and expensive (Tomiltseva et al., 2017). For determine the state of the CPS in the basin of the V. Kuyalnyk River, which occurred as a result of anthropogenic transformations, topographic maps of various scales, satellite images of the area and materials of expeditionary research of Odessa State Ecological University (OSENUE) were used. Due to the fact that the available cartographic material (maps of scales 1: 100000 and 1: 50000, etc.) is outdated and does not cover the current state of the CPS in the basin of the river V. Kuyalnyk, for assess the boundaries and condition of the CPS in the river basin, space images from Landsat and Sentinel radiometers and the results of expeditionary research for the period from 2009 to 2018 were used (Hryb et al., 2018).

USGS Land Look (United States Geological Survey) and Google Earth Pro (version: 7.3.25491) were used to decrypt, process and interpret of SDE data. It should be noted that the river V. Kuyalnyk and

other watercourses in its basin dry up at the low water period, so when determining the width and boundaries of the CPS measurements were performed from the middle of the channel (in the inner boundary of the CPS coincided with the river center). For assess the size and current state of the CPS at the first stage, according to the SDE data, the location of the channels of all watercourses (rivers, beams, streams) and water bodies (ponds, reservoirs, abandoned quarries in the floodplain, ditches) in the basin of the V. Kuyalnyk River. Then all watercourses and water bodies were plotted on satellite images and only after that the size and condition of the CPS were determined. Clarification of information on the state and boundaries of the CPS was carried out during OSENU expeditionary research in the river basin in 2018 (Loboda et al., 2018).

Results of investigations

As a result of deciphering the SDE data, a map of the V. Kuyalnyk River basin was obtained (**Figure 1**) with the designation of the channel network, artificial reservoirs, dikes and dams, boundaries of the sections of channels with disturbed CPSs, settlements and other data. For detailed visualization, the entire map with the corresponding symbols was divided into 56 separate sheets. Each sheet covers an area of 50 km².

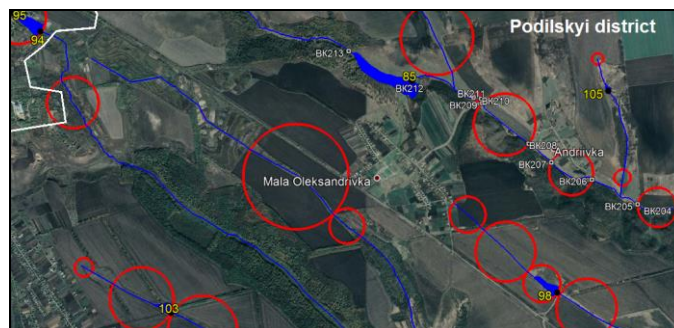


Figure 1 Fragment of sheet 1 of the map of the V. Kuyalnyk River basin with designation of the channel network (—), artificial reservoirs (●), dikes and dams (●85), boundaries of sections of the channel with disturbed CPS (●, BK204), settlements (●Andrivka), names and boundaries (white lines) of administrative districts

Given the fact that the steepness of the slopes of the river V. Kuyalnyk almost the entire length of the channel exceeds 3°, and all channel ponds (except one) have an area of more than 3 hectares, the minimum width of the CPS along the banks should be at least 50 m. The exceptions are two sections of the main riverbed, where the width of the CPS is 25 m. One section, 9.5 km long, is located within the mouth of the river, and the second section, 1.1 km long, is located in the upper reaches of the river (including one pond with an area less than 3 hectares). It is determined that the total length of the CPS along the bed of the V. Kuyalnyk River is 340 km (170 km – along the right bank of the river, 170 km – along the left bank of the river). It was established that 44.0% of the CPS along the right bank of the modern V. Kuyalnyk river bed and 44.1% of the CPS along the left bank do not meet the requirements of Article 88 of the WCU and Article 60 of the Land Code of Ukraine (LCU).

The main violations of Ukrainian legislation identified along the current course of the V. Kuyalnyk River are non-compliance with the width of the CPS established in Article 88 of the WCU and Article 60 of the LCU. The area where the boundaries of the CPS along the modern riverbed (including the floodplain) are violated is most often occupied by plowed lands and gardens. On two sections of the river within the CPS and floodplain there are summer camps for cattle – within the village of Severynivka (Ivaniv district) and the village of Kachurivka (Podilskyi district). Artificial earth embankments and trenches, reinforced concrete slabs and other structures left after the dismantling of the gas pipeline pipes were found in the mouth of the V. Kuyalnyk River (on the territory of the Lyman district) within the CPS and floodplain. In the upper reaches of the river near the village of Kuyalnyk (Podilskyi district) natural garbage dumps were found within the CPS. It should be noted that in some sections of the rivers in the river basin there are no CPSs at all, and the riverbed is completely plowed, for example, the area near the village of Fedorivka (Podilskyi district). All this is

a direct violation of the requirements of Articles 88 and 89 of the WCU. Thus, based on the results of deciphering space images and field expeditionary inspections of watercourses and reservoirs in the basin of the V. Kuyalnyk River, it was determined that within the CPS – lands where any economic activity is prohibited – today there are significant violations of the CPS regime.

Recommendations

Improving the CPS of V. Kuyalnyk River is one of the most important components of a set of measures for the rational use, protection and reproduction of aquatic, land and living biological resources to ensure the proper level of ecological status of aquatic river ecosystems (Pokydko et al., 2012). Measures to regulate the CPS in the river basin should consist of organizational and economic, agro-technical, meadow and forest reclamation and hydraulic measures aimed at improving surface runoff, reducing the intensity of erosion, reducing the removal of pollutants into water bodies. CPS vegetation should be tiered and consist of trees, shrubs, perennial grasses and cereals (Kosiak, 2012). It is desirable that the plantings as much as possible shade the water from solar radiation. On the other hand, in order to shade less agricultural land, tall vegetation should be placed closer to the riverbed. Trees, in addition, with their root system fix the channel and soil, promote water regulation (Tomiltseva et al., 2017). The width of riparian forest belts within the CPS is taken depending on the stability of the river banks, landscape and structural part of the river and its length.

In order to regulate the current state of CPS and WPS within the framework of compliance with the provisions of WCU, it is necessary to take out in nature and fix the appropriate signs of CPS (**Figure 2**) with subsequent inspection of compliance with WCU and LCU on their operation (Osypchuk et al., 2013). Special information signs are installed at the places of entry (exit) to the territory of the CPS, traffic (at the intersection of the water body with roads, paths, etc.). The introduction of such compensatory measures minimizes the anthropogenic impact on water, land and other natural resources of the river in the future.

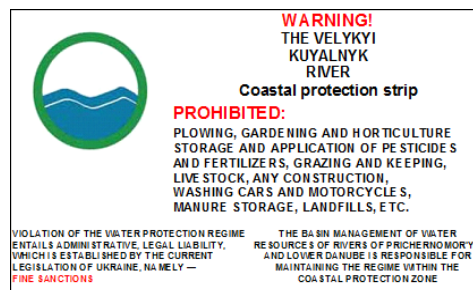


Figure 2 Sample of a special information sign for placement in the CPS near by V. Kuyalnyk River

Water users and land users whose lands are located in the basin of small rivers (including in the basin of the V. Kuyalnyk River) must ensure the implementation of comprehensive measures to preserve the water content of rivers and protect them from pollution and clogging.

Conclusions

According to the results of the monitoring, the information on the current state of the CPS of watercourses and reservoirs in the basin of the V. Kuyalnyk River is generalized.

According to expeditionary surveys of 181 sites in the river basin and the results of deciphering satellite images, a detailed map (of 56 sheets) of the V. Kuyalnyk River basin was compiled, on which the channel network, artificial reservoirs, dikes and dams, areas of shores with identified violations of the requirements of WCU and LCU on the state and mode of economic activity within the CPS. For practical application, a thorough description of the state and boundaries of the CPS along both banks of the modern bed of the river V. Kuyalnyk is given.

It was revealed that the main violation of the legislation on CPS along the modern bed of the river V.

Kuyalnyk and other watercourses and around reservoirs in the river basin is non-compliance with the width of CPS established in Article 88 of the WCU and Article 60 of the LCU.

It is established that a significant part of the territory of the CPS is most often occupied by plowed lands and gardens (in some areas of rivers and beams CPS are completely absent, and the channel is completely plowed). It was determined that 44% of the CPS along the modern bed of the V. Kuyalnyk River does not meet the requirements of the WCU and LCU.

Recommendations for measures to improve the condition of the CPS in the basin of the river V. Kuyalnyk, which include organizational and economic, agrotechnical, meadow and forest reclamation and hydraulic measures. The planning and implementation of these measures will contribute in the future to the restoration of the natural hydroecological regime of watercourses and reservoirs and the protective (buffer) role of the vegetation cover of coastal landscapes (including within the CPS).

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