

Influence of the extraction of channel alluvium on the state of the young river landscape in the upstream stretches of the Prut and Siret rivers

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The problem of the negative influence of river channel alluvium extraction on the condition of rivers, namely on their downcutting, lowering of the channel position is known from the 70-80s of the XX century. In this regard, a number of powerful scientific studies were funded and performed, which revealed the patterns of deformation of riverbeds, the peculiarities of the functioning of the “flow-riverbed” system under the influence of riverbed quarries. Significant negative consequences, in particular on the rivers of Precarpathian, led to the ban on quarries in the late 80's. Some of the work was carried out within the floodplains. However, at the turn of the millennium, a new stage of channel alluvial extraction begins, which is characterized by a diffuse, local impact on riverbeds with a gradual increase in alluvial extraction. Currently, the work is carried out under the slogan “riverbed regulation”. This only exacerbates the problem of rivers downcutting. Unfortunately, for decades no effective system of accounting for alluvium extraction has been created. Much of the work is not authorized, either inconsistent with the projects. An effective system for monitoring the condition of riverbeds, floodplains, adjacent territories, alluvial environment, groundwater, and ecosystems has not been created. All this significantly complicates the task of analysing the processes and consequences of the impact of riverbed alluvium extraction on the young river landscape.

In this situation, actual, scientific and methodological developments that would contribute to solving a complex problem become relevant and necessary. At the same time, the relevance of such research is significantly enhanced in the context of sustainable development planning, implementation of European approaches, including those related to the EU Water Framework Directive, other Directives, Carpathian Convention provisions, development of integrated river basin management plans. An integral part of the latter is the planning of the management of river and related ecosystems, the young river landscape in order to achieve their good status, ecological potential.

The downcutting of the Prut and Siret rivers was analysed using primary information of qualitative and quantitative nature, in particular hydrological observation data and GNSS surveys. The main downcutting of the Prut riverbed near Chernivtsi appeared in the period 1970-2000. The average rate of downcutting was up to 100 mm / year. Later, the rate dropped to 50-30 mm / year, probably due to the achievement of low-erosion rocks. The total size of the cut for the period from 1970 to 2017 is more than 3.5 m.

On the Siret River, a stream gauge in the piedmont flow is located in the town of Storozhynets. Analysis of cross sections of the river showed that the total value of the river downcutting for the period 1969 -2019 is approximately 2 meters. The average cutting rate is 40 mm / year. This value is less than on the Prut River and is explained by the different intensity of the main factors of incision. Also, the rate of downcutting is more smoothly distributed over time. The

lower power of the processes on the Siret River can be explained by the lower relative anthropogenic impact, lower relative needs for construction and other works using alluvium. To obtain a sufficiently accurate amount of information about the altitude of the riverbed and floodplain of the Prut and Siret rivers in 2019-2020, we conducted GNSS surveys. Their results showed an uneven distribution of the total value of the downcutting along the rivers. On the Prut River, the size of the downcutting is between 2,6 and 4,4 m. On the Siret River, the total values of the downcutting in the areas relatively close to the Carpathian border and the absence of large settlements (villages Lukavtsi, Zhadova, Komarivtsi) are 0.6 -0.8 m. Downstream in the area of Storozhynets, Ropcha, Karapchiv the total size of the cut reaches 1.9-2 m, which corresponds to the data of hydrological observations. There is more active work on the alluvial mining on riverbed. But their most significant result was manifested in the area of the mouth of the river Maly Siret and water intakes of Hlyboka. Here the total size of the downcutting reaches 3.3 m. Downstream, to the border with Romania (near the village of Cherepkivtsi), this value decreases to about 2 m. We also note a sharp decrease in the size of the cut against the current of the river Maly Siret. Already in the village of Kupka, at a distance of about 8 km from the mouth, it is 1 m.

Summing up the analysis of different types of information about the processes of downcutting of the Prut and Siret rivers, we can draw some general conclusions. In the case of a combination of downcutting with the river straightening and the concentration of the flow, it is accompanied by the part aggradation of floodplain and formation of new river banks. In cases of a winding or branched river, the downcutting processes are visually, morphologically less noticeable. The downcutting processes are described by different temporal and spatial characteristics. Changes associated with river straightening and flow concentration are relatively localized and, by virtue of this, cannot have a significant total result of the downcutting (They are also difficult to distinguish in the case of a combination with the influence of extraction of riverbed alluvium). In general, the modern downcutting processes (50 years) manifested themselves on almost the entire length of the objects of study (more than 50 km. each), are characterized mainly by a total value of several meters and an intensity of 30 - 100 mm / year.

Analysis of factors that may affect changes in the altitude of the Prut and Siret riverbeds (river inflow) showed that the factor of neotectonic movements also cannot be recognized as the main cause of modern river downcutting due to low intensity, and the factor of flow direction and concentration due to localization in city of Chernivtsi and relatively small amplitude. Therefore, the main factor should be recognized as the river bed material extraction. It should be considered in the analysis of the consequences of the downcutting and in the planning of integrated management of the young river landscape. The processes of anthropogenically caused downcutting of rivers lead to changes in the entire river landscape and in the adjacent parts of the first floodplain terrace, hydro-ecological safety and hydromorphological quality of rivers, the quality of the river landscape at the incision sites is significantly reduced.

In terms of riverbed science, hydromorphological, the criticality of the situation is emphasized by hydroeconomic processes, exacerbated in areas of erosion, deterioration, destruction of various structures. It is necessary to timely identify hydromorphologically dangerous areas and conduct appropriate research.

Significantly anthropogenically altered sites of rivers, their channels and floodplains (water bodies) can occur as a result of downcutting. They need special public attention to restore the ecological properties and capacity building. This is an integral part of the culture of interaction between society and rivers, which primarily includes objective quality monitoring, availability and quality of all necessary information (its system, system analysis) as a basis for effective decision-making. An important conclusion is the feasibility of monitoring changes in the

vertical position of channels and floodplains, as well as changes in alluvial deposits as part of hydromorphological monitoring in general. In particular, GNSS surveillance.

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