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Assesment of minor rivers flood-plain and stream-way complex condition (case study of the Berezhnytsya River, Dniestr basin)

Abstract: The methodological and practical issues in respect of assessment of the flood-plain and stream-way complex of the Berezhnytsya river are presented in the article. Researched river is one of the Ukrainian Carpathians minor rivers and constituted the right-bank tributary of the Dniester river. The presented study typify the stream-way segments. Furthermore were shown identification of the reasons of decreasing the qualitative characteristics of the Berezhnytsya flood-plain and stream-way complex. The set of works to stop processes that are destructive for the river and its ecosystem should be made.

Keywords: flood-plain and stream-way complex, minor river, degradation, agrophytocenoses, recovery

1. Introduction

Minor rivers are a watercourses and an integrated result of mutual influence of climate and withdrawal landscapes components, where each element, located close to the river, influences it with the growing rate (Marushevsky, 2005). This pattern makes it clear that the main part of a withdrawal area, which has a decisive influence on a river, are its flood-plain and river valley slopes, in particular, their condition and the nature of processes taking place on site. When examining the issue of anthropogenic impacts affecting flood-plain and stream-way complex, the flood-plain and stream-way should be considered as interrelated elements since according to E. V. Shantser (1951) any part of a flood plain was once occupied by a stream-way, which then shifted sideways subject to the lateral erosion influence. From this perspective, studying the condition of flood-plain and stream-way complexes of minor rivers located in mountains and at foothills is a topical task.

Flood-plain and stream-way complexes were studied by soil scientists and geobotanics (Williams, 1951; Elenevsky, 1936), geol-

ogists (Shantser, 1951), hydrologists and geomorphologists (Makkaveyev, 1955; Chernov, 1983; Chalov, 2000; Kovalchuk *et al.*, 1992; Baryshnikov, 1978; Obodovsky, 2001, 2010; Obodovsky, Jaroshevich, 2006; Jushhenko, 2005), physical geographers (Zlotina, Berkovich, 2012; Denisik, Lavrik, 2012) and others. A considerable amount of work aimed at studying flood-plain and stream-way complexes for various stream-way-related purposes was carried out by O. Konovalenko (2006), L. Gorshenina, V. Smirnova (2007) and S.M. Kiriljuk, O.V. Kiriljuk (2009). Aspects of anthropogenic load on a river flood-plain and stream-way were scrutinized in several landmark works (Shiklomanov, 1979; Antropovskij *et al.*, 2003; Chalov, 2000; Bridge, 2003; Berkovich, 2001). In respect of big and medium rivers, the said problems are considered in more details. As minor rivers respond to altered conditions of flood-plain and stream-way complex faster and more typically, the study of fore-mentioned is relevant and important while assessing the geocological river-basin system condition.

2. Methodology

The main aim of study is assessment of present flood-plain and stream-way complex condition of the Berezhnytsya river – right-bank tributary of the Dniester river. The Berezhnytsya flood-plain and stream-way complex condition was studied through a visual assessment approach suggested by R. V. Himko *et al.* (2003). The approach is based on an analysis of parameters and indicators marking the condition and preservation of landscapes and biotic assemblages found in the river valley. These indicators are suitable to perform practical plain and non-assisted monitoring of a river valley condition and river contamination. They gave grounds to obtain basic information on the Berezhnytsya flood-plain and stream-way complex and to identify a number of environmental problems.

The assessment of river condition included three procedural steps as follows: the first involved the assessment of condition per the stream-way parameters, the second addressed the assessment of river condition per flood-plain parameters, and the third one outlined the assessment of river condition based on information with respect of the flood-plain and stream-way complex condition obtained by interviewing local residents and clarifying their viewpoints concerning the depth and focus of changes happened to the river during the last decade. The first part contains important information on current speed, stream-way condition, its regulation, contamination and mudflats, river water quality and aquatic species diversity, condition of banks and protective bank-line zones.

The next stage of assessment is to specify the flood-plain condition parameters, which the minor river condition chiefly depends on. Undisturbed river valley landscapes include well-developed grassland ecosystems serving an ideal biotic filter that prevents ingress of contaminants into the river system. But, these highly-efficient grassland areas, adapted to increased moisture levels, become easily broken and can hardly be recovered in full when get drained or due to other types of anthropogenic impacts. Transformed flood-plain are incapable neither to slow down the runoff flow coming into stream-ways, nor filter it. It should

be noted that the quantitative and qualitative composition of this flow is defined by the overall withdrawal antropogenization.

Natural degradation of flood-plain biocenoses and river bank soils is a trigger for chemical and organic river pollution. Prevalence of agrophytocenoses in the basin-river systems, which are often represented by mono-cultural groups with a weak root system unable to perform the soil protective functions, is believed to be the most characteristic feature of such degradation. Weeds, accompanying agrophytocenoses, also usually have weak root system. The degree of natural biocenoses degradation in the given part of the river valley can be assessed by their number and variety of species in vegetation cover. Slopes and river flood-plain ploughing is the major cause of sediment load and incoming of organic substances into the stream-way.

The main task of study of the flood-plain and stream-way complexes of river valleys is to assess the condition of river valley landscapes and biocenoses preservation. To this end, following indicators as the ratio of landscape biocenotic elements of flood-plain and terraces, the level and nature of transformation and degradation of the river valley natural landscapes; the description of flood-plain made with the reference to vegetation species diversity, presence or absence of bank-line protective zones and water protective river zones, compliance with state standards of the Water Code of Ukraine; the pollution level of bank-line protective zones and manifestations of banks outwash were considered.

The type of river valley economic use, the presence of urban objects or objects creating a direct negative impact on the river and considerably complicate geo-ecological situation in the river valley are important parameters in assessing the degree of water body natural condition. Its functioning is significantly affected by water production, which leads to the reduction of water content in rivers. It is also affected by sewage waters discharge, and entering of untreated sewages from households or due to poorly filtered wastewater from sewage treatment and sewage facilities. Along with this, it is

important to note the high level of soil ploughing and recreation load serving as an additional anthropogenic factor negatively affecting the hydro-ecological river condition and geo-ecological river-basin geo-system condition.

The third component of river assessment, namely collecting information from local residents on the depth and focus of changes happened to the river as compared to the condition that the old-timers remember, is important for summarizing and developing a coherent vision on the flood-plain and stream-way complex condition. As the assessment of stream-way segments condition is performed per a rating scale, it is offered a key to determine the river condition, which actually is the base (in combi-

nation with water hydro-chemical analysis) for devising remedies to recover the river complex, and a forecast of irreversible changes that may result from the passivity of local population.

The examined water body was divided into twelve study areas (Figure 1). Their boundaries were determined subject to the set of uniform features. Each of these segments was assigned a passport. Based on the total number of points the conclusions on river condition and its flood-plain complex were made. Defining the like segments of flood-plain and stream-way complex allowed to assess the condition of each of them and on this basis to identify the most problematic river segments requiring urgent environmental protective measures.

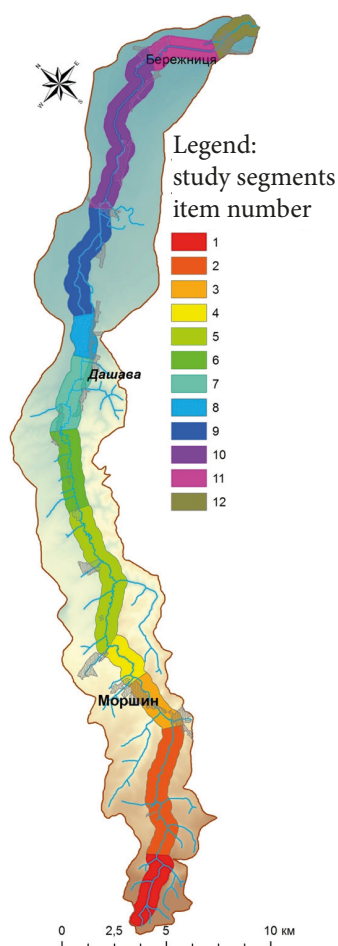


Figure 1. Location of the study river segments at examining the flood-plain and stream-way complex within the Berezhnitsya river basin geosystem

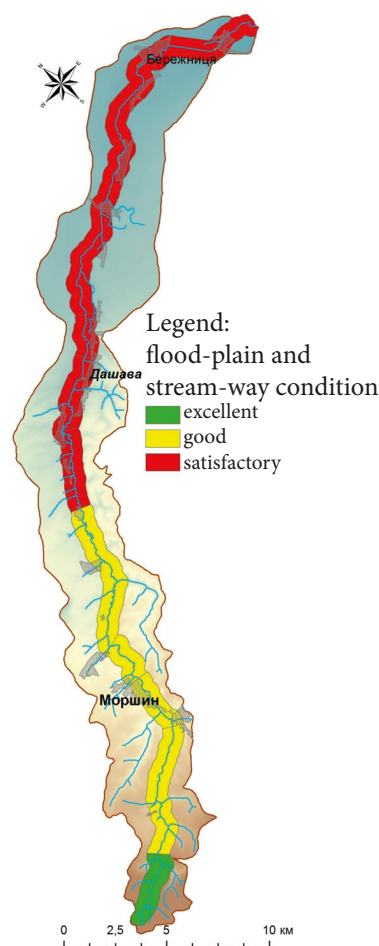


Figure 2. Flood-plain and stream-way complex condition within the Berezhnitsya river basin geosystem

3. Results and discussion

According to the observations and assessment of twelve river segments there was a map chart showing the Berezhnitsya condition drawn

(Figure 2). The picture shows that only a segment close to the riverhead may be assessed as "excellent" since in this part the Berezhnitsya



Figure 3. Aquatic and flood-plain vegetation at the first study segment along the Berezhnytsya river



Figure 4. Product pipeline under the Berezhnytsya river stream-way

sya is a true the Carpathian mountain torrent. Its stream-way is of natural character and possesses elements peculiar to mountain rivers, i.e. shallows and broads, meanders, slow flow parts are interchanged with fast flow ones, in the stream-way one may find bars and other natural stream-way formations. Water is clear and transparent up to the bottom (1 m depth), slightly muddy, has no smell and is tasteless. Large variety of aquatic vegetation (with no clear predominance of one species over the others) is present in the stream-way. Fish fauna is diverse; there are several favourite places of fishermen here. The banks are natural, undestroyed, the forest areas take over 50% of the flood-plain (Figure 3). Rest of the flood-plain is used as grasslands, there is no plough land here but there are small farming plots occupying a little flood-plain part. Protective bank-line zone is in a good condition. However, a product pipeline crosses the river stream-way in this area (Figure 4). In 2002 as a result of illegal oil uptake its great amount entered from a pipeline into the river. This led to an environmental disaster downstream and, consequently, small ponds contaminated by oil products remained on the flood-plain. The second study segment is located downstream (from the bridge at Bolekhiv-Tanyava highway to the highway bridge in the Morshyn city). Its condition was assessed as "good" but degradation processes have been developing here actively. The stream velocity along this segment becomes slower, water is characterized by less transparency, in the stream-way and along the bank-line individual unnatural objects and garbage dumps are observed.

As compared to the first area, the variety of flora and fish fauna significantly decreases. The behaviour mode and limits being obligatory for water protective zones are not observed, urban territories dominate in the flood-plain, there are hayfields and motor roads here. The flood-plain is disturbed from both banks. Water intake for technical needs is also performed at this part of the river. The river needs public attention. In particular, it is necessary to clean the bank-line out of garbage. Within the limits of Morshyn city the river flow becomes slower, several natural stream-way and flood-plain formations were changed due to human activity (Figure 5). These facts make it impossible to decelerate the flood wave move. For this reason, during floods houses built in the region of flood-plain become drowned. Water is of swampy smell and muddy. Overgrown of channelled stream-way is noticeable as well. Fish fauna diversity has been decreasing. The banks are not destroyed, but there is scarce natural vegetation and it also degrades. Livestock systematically grazes at the flood-plain, the boundaries of bank-line protective zones within the city limits are violated.

Downstream the Morshyn city, waters of the Berezhnytsya river receive discharges from improperly working treatment facilities, thus causing river contamination. Following this, water gets unpleasant smell especially perceived close to the river, its colour is dark-brown. The stream-way along the segment from Morshyn city to Dovge village was affected by changes and now it is channelled, flow is decelerated. The stream-way gradually becomes overgrown, there are minor spots of domestic waste accumulation, livestock often grazes at the flood-

plain. Other parameters remain in their natural condition and for this very reason this river

part is related to segments being in a “good” condition.



Figure 5. Disturbance of limits of bank-line protective zone, Morshyn city

Carrying its water farther, the Berezhnysya river flows through unpopulated territories from Dovge village to Lotatnyky village, for this reason the anthropogenic impact is subtle, though river runoff is being regulated by ponds. Natural biocenoses somehow degraded under the human activity. The above data allowed to assess the condition of this area as “good”.

Between Lotatnyky village and Oleksychi village the river flows through a swampland. The flow is decelerated, the stream-way is limited to a natural canyon 5-6 m depth. In this part, the stream flow is regulated by a pond and the bed is covered with solid silt, water is hardly transparent and muddy, no strong smell is felt. The species composition of aquatic vegetation is represented by five-seven kinds, but some of them significantly predominate over the others. Filamentous algae are present, the river features several fish species (mostly juveniles). On the banks there are individual trees and bushes affected by a water flow, herbaceous covering is considerably transformed. The natural biocenoses degrades (up to 20% are weeds). Recreation spots are located here. The limits of bank-line protective zone are disturbed. This zone as well as the stream-way are bestrewn with domestic waste. Several flood-plain parts are ploughed up, the livestock regularly grazes here, within the territory motor roads are laid down, and construction works are being performed. Discharge from farm households enters the waters.

The next study segment is similar to the previous one. The differences are unregulated flow and worse condition of natural biocenoses. The condition of both segments is assessed as “satisfactory”. This means that negative hydroecological changes have happened to the river. It is necessary to implement urgent measures to slow down the processes being destructive for the river and its ecosystem, and to rehabilitate the river.

The worst condition of the Berezhnysya river was established within the Dashava urban settlement as the stream-way is partially canalized here and the bank-line protective zone regimen is not observed (Figure 6). Domestic garbage is found both within the protective zone and in the stream-way. Almost all flood-plain is built up or ploughed up. Natural biocenoses are disturbed, there is scarce fish in the river and aquatic vegetation is depressed. The manifestations of erosion processes are visible. Also, there are cases of untreated sewage discharge that enters the river bypassing wastewater treatment facilities. The river condition is assessed as “satisfactory” but for all that only one point parts it off from the “unsatisfactory” category. To cease the river destruction there is an urgent need to apply a wider range of short- and long-term measures aimed at stopping the degradation processes both in the stream-way and in the flood-plain.



Figure 6. Disturbance of bank-line protective zone limits, Dashava urban settlement



Figure 7. Degraded flood-plain vegetation, the Berezhytsya river (Yosypovychi village)

Next two segments are very similar to each other and for this reason we consider them as one. These segments stretch from Yosypovychi village to Berezhytsya village. Their condition is assessed as “satisfactory” because most of the flood-plain is covered with damaged or degraded agrobiocenoses, and the livestock permanently grazes here (Figure 7). The aquatic vegetation is very poor. The limits and regimen of bank-line protective zone is disturbed.

The last study segment extends from Berezhytsya village up to the place where the Bere-

zhnytsya river runs into the Dniester. It also received a “satisfactory” score, but per the quantitative parameters its condition is worse than of the previous one because the stream-way is canalized here, water is muddy, dirty, non-transparent, with a strong swamp smell and the stream-way is regulated by ponds. Vegetation species diversity is very poor, river overgrowth is observed, there is almost no fish in the river. Flood-plain is covered with significantly impaired agrobiocenoses formed by continuous livestock grazing. Sewages from several private households enter the river.

4. Conclusions

Based on the assessment results it is possible to state that the condition of study segments of the Berezhytsya river flood-plain and stream-way complex was marked as “excellent”, “good” and “satisfactory”. “Unsatisfactory” and “catastrophic” river and flood-plain condition has not been detected yet, although within Dashava urban settlement the river area condition is close to the “satisfactory” grade. The best situation is at the riverhead as human impact is minimized here and natural vegetation is preserved. Downstream we trace the tendency of condition worsening as anthropogenic load on the basin system and flood-plain and stream-way complex increases. Its negative impact is balanced by large forests, thus in segments limited by Banya Lysovytska village and Lotatnyky village the river and flood-plain condition is rated as “good”. So, downstream the named village the value of such an

important natural barrier as forest reduces and anthropogenic load on the river significantly increases. The latter manifests in an intensive agricultural reclamation and housing development of flood-plains.

Since degradation processes are rapidly developing over a considerable part of the Berezhytsya river, negative changes are visible. Only the study area located close to the river head is in almost optimal condition. However a set of urgent measures to stop processes that are destructive for the river and its ecosystem should be made, to rehabilitate the river and to preserve its resources. Primary measures to improve the river condition should be conducted: to clean off the stream-way and bank-line protective zone from domestic garbage and natural waste; to comply with behaviour requirements in respect of the bank-line protective zone and

setting its limits; to fix eroded banks; to limit alluvium extracting from the bed and banks; to organize watering sites for animals; to better treat wastewater at municipal wastewater treatment plants located in Morshyn city and Dashava village, industrial effluents of Dashava production office of underground gas storage, Dashava composites plant, and Dashava plant management of construction materials through their renovation; to reduce

possibilities of getting water, contaminated with the toxic waste from toxic waste landfill “Shkirianyuk”, into the river and to ensure the oil pipelines crosses the stream-way under the due protection. It is also important to reduce the regulation of the runoff, because ponds are mainly lifeless and used for purposes other than intended ones. It is necessary to reduce the intensity of agricultural activity over the flood-plain lands.

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