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HYDROMORPHOLOGICAL AND LANDSCAPE VALORISATION OF RIVER VALLEYS BASED ON THE CARPATHIAN POPRAD RIVER VALLEY STUDY

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Abstract: When Poland became a member of the European Union, the country committed to achieve a good ecological status of surface waters and care for the quality of the landscape. Carpathian river valleys are distinctive natural and socio-economic systems that should be correctly used to preserve their values. To take appropriate protective actions, it is necessary to identify already existing hydromorphological and landscape elements in the area. Valorisation of these elements was carried out using an author's method. This method was established by merger and modification of two existing procedures, assessment of the hydromorphological quality of rivers and ECOVAST method to evaluate the landscape. The object of the study was the Poprad River valley in the Polish Carpathian Mountains, Lesser Poland Voivodeship. Based on the fieldwork and appraisal studies, it was found that this valley is characterized by landscape of regional importance, with a very large, but not fully exploited tourist potential.
The aim of the presented method is to identify valuable areas of the river valleys and indicate the directions of theirs socio-economic development without exposure to the devastation of the natural ecosystem.

Keywords: hydromorphological and landscape evaluation, landscape, river valleys, Carpathians, Poland

1. INTRODUCTION

The Carpathian Mountains area is characterised by unique natural and landscape qualities as well as a rich cultural heritage. The area encompasses parts of Poland, Slovakia, Czech Republic, Ukraine and Romania and is a core biosphere area, in the European meaning – it provides for the migration of species with an ecological corridor and habitats for multiple species, including endangered ones (Angelstam et al., 2013a; Csagoly et al., 2007; Framework Convention, 2003; Oszlányi et al., 2004, Witkowski et al., 2003). Currently, between 9 and 32% of the Carpathian Mountains area in these countries are protected by the creation of reserves, national parks, UNESCO biosphere reserves (Oszlányi et al., 2004; Toader & Dumitru, 2005), as well as Natura 2000 protected areas (Csagoly et. al., 2007; Kucharzyk, 2009; Webster et al., 2001). This natural heritage contains unique forest ecosystems, meadows, water ecosystems, habitats and biotopes which are of great significance to: maintenance and protection of the biological diversity, creation of a healthy environment, natural sources of renewable resources, areas used for leisure, research, science and education (Csagoly et al., 2007; Oszlányi et al., 2004).

Due to the natural and landscape qualities, the Carpathian River valleys are of particular interest – they are places where the first settlements were established, later converted into towns and the locations of first trade routes (Nowacka-Rejzner, 2009). Elevated areas were used to build fortified castles and towers. The valleys were used for farming and their rivers – for shipping and fishing (Nowacka-Rejzner, 2009). The river valleys housed the industry, drawing power from the flow of water.

The water was also used for leisure purposes. Despite the anthropogenic impact, they are still a valuable part of the ecosystem. Due to their natural difference, the river valleys are very distinct among open landscape (Nowacka-Rejzner, 2009).

The problem of the landscape of the Polish Carpathian Mountains was noted at the beginning of the 20th century. The description of the formation of the Carpathian landscape provided by Smoleński (1912) contains passages dedicated to the fluvial network. The discrepancy between two prominent features – contract between the landscape development stadium and the appearance of the water network was observed (Smoleński, 1912).

The changes in the area of the Polish Carpathian Mountains intensified after 1989, when the economic transformation facilitated human activity (Bucała, 2014; Bucała et al., 2015), which also resulted in a larger degree of landscape fragmentation in the area (Pătru-Stupariu et al., 2015). Similar changes could be observed in the remaining Carpathian countries (Kucharzyk, 2009). After the political transformations, the Carpathian countries made significant changes to their national legislation systems regarding environmental protection and land use, providing multiple new forms of protection and increasing the number and surface of protected areas (CERI, 2008; Kucharzyk, 2009; Oszlányi et al., 2004). Despite the changes, the instruments of the local land use plans are not used to their full potential in the matter of landscape protection (Salata et al., 2015).

The effect of these changes is the increase of forest areas over arable land (Bucała, 2014; Bucała et al., 2015; Kucharzak, 2009). The consequence of the abandonment of farming lands are changes in the geomorphology, soil properties, land managements and plant communities. In relation to the erosion and flood protection, the conversion of arable land to pastures and forests facilitates the decrease in deluvia outwashing as well was as the amount of the suspended load (Żelazo & Popek, 2014). The consequence is the break in the supply of material for accumulation from the flood areas to the watercourse (Bucała, 2014; Bucała et al., 2015).

Poland, by becoming a member of the European Union, ratified the Water Framework Directive (Directive 2000/60/EC) and European Landscape Convention (2000). According to the requirements of the Water Framework Directive, water management should primarily provide for a good ecological status of waters and prevent their deterioration to 2015. The good condition of surface waters is proven by biological and physicochemical elements of quality, supported by hydromorphological elements (Directive 2000/60/EC). According to the European Landscape Convention (2000) the landscape should be provided with a legal status and be considered a basis for: quality of living, shaping of regional and local awareness as well as the introduction of natural and cultural diversity. Landscapes should be provided with protection, management and planning, regardless of its type – natural, cultural, urban, degraded, whether characterised by unique beauty or being one of the "typical" landscapes (Stoeglehner & Schmid, 2007). Currently, the areas with valuable landscapes can face a problem of adequate and responsible management. The presence of valuable cultural landscapes should in no way limit, prevent or hinder the economic use of the area (Hernik, 2008). They cannot, however, be subject to uncontrolled appropriation. Until now, the actions affecting landscape, especially in Polish rural communities, were often uncoordinated (Hernik et al., 2013). The decisions regarding these measures were typically random and often reflected the particular interests of various small groups. In order to correctly implement the assumptions of the European Landscape Convention (2000), the landscape must be identified and assessed.

The Poprad river valley is one of the Carpathian valleys where anthropogenic activity caused the degradation not only of the natural environment but also of the whole landscape of the valley (Nowacka-Rejzner, 2009); Pawlak, 2007). Human activity is mostly directed towards the modification of the earth surface and changing the area cover for individual or social reasons (Klaučo et al., 2012).

The purpose of this article is the presentation of a hydromorphological and landscape valorisation of river valleys based on the Carpathian Poprad river valley study. The proposed method was created by a combination and modification of two existing methods: the hydromorphological assessment of the quality of rivers method and the ECOVAST landscape assessment and identification method.

The method was created for the Carpathian river valleys – valuable natural and landscape systems. The Carpathian river valleys should be duly protected, while maintaining the social and economic development. One of the methods of development for areas with valuable natural, landscape and cultural qualities is tourism. As an economic activity, tourism has a low footprint on environmental transformation, while using the natural resources (Kałamucka, 2007).

The created method is used for the assessment and identification of valuable areas in river valleys

as well as proposing the possible method of development for these areas.

2. MATERIAL AND METHODS

The Poprad River (Fig. 1) is a river flowing in the area of the Carpathian Mountains, through North-Eastern Slovakia and Southern Poland – through Beskid Sądecki (Lesser Poland Voivodeship) and flows into Dunajec at km 112+600, as its right-bank tributary (Kobiela et al., 2012). The sources of Poprad flow from the Veľké Hincovo Pleso lake, as the Hincov Potok stream in the Slovakian part of the High Tatras. The length of the river is 170 km, within the territory of Poland – 63 km (including border sections – 30.5 km). The surface of the Poprad River catchment area is 2083 km^2, including the Polish part of 482 km^2 (Kobiela et al., 2012).

The hydromorphological and landscape valorisation was performed in May 2014, in the area of the Carpathian Mountains, Poprad River valley, from Piwniczna-Zdrój (km 20+650) to Rytro (km 14+100). Poprad river was divided into twelve sectors shown in fig. 2. These sectors have been separated based on the synthesis of landscape, in a holistic perspective (Pietrzak, 2008). For the criterion adopted homogeneity of the landscape and hydromorphology of the river. The criterion consisted in identify the homogeneous sectors of the river characterized by quality of homogeneity.

Between towns: Piwniczna-Zdrój and Rytro, the Poprad river splits the Beskid Sądecki into two parts: the Pasmo Radziejowej and Pasmo Jaworzyny ranges. A railroad line and national road no. 87 from Nowy Sącz to Piwniczna-Zdrój are located along the studied section, on the left bank of the river (Kobiela et al., 2012; Pawlak, 2007).

Poprad is a mountain river, characterised by sudden water level raises and dynamic fluvial processes (Bartnik, 2006; Radecki-Pawlik, 2011). The Poprad valley, along its entire length is has unique landscape and ethnographic qualities, the towns and villages located by the river are characterised by health improvement, tourism and historical properties.

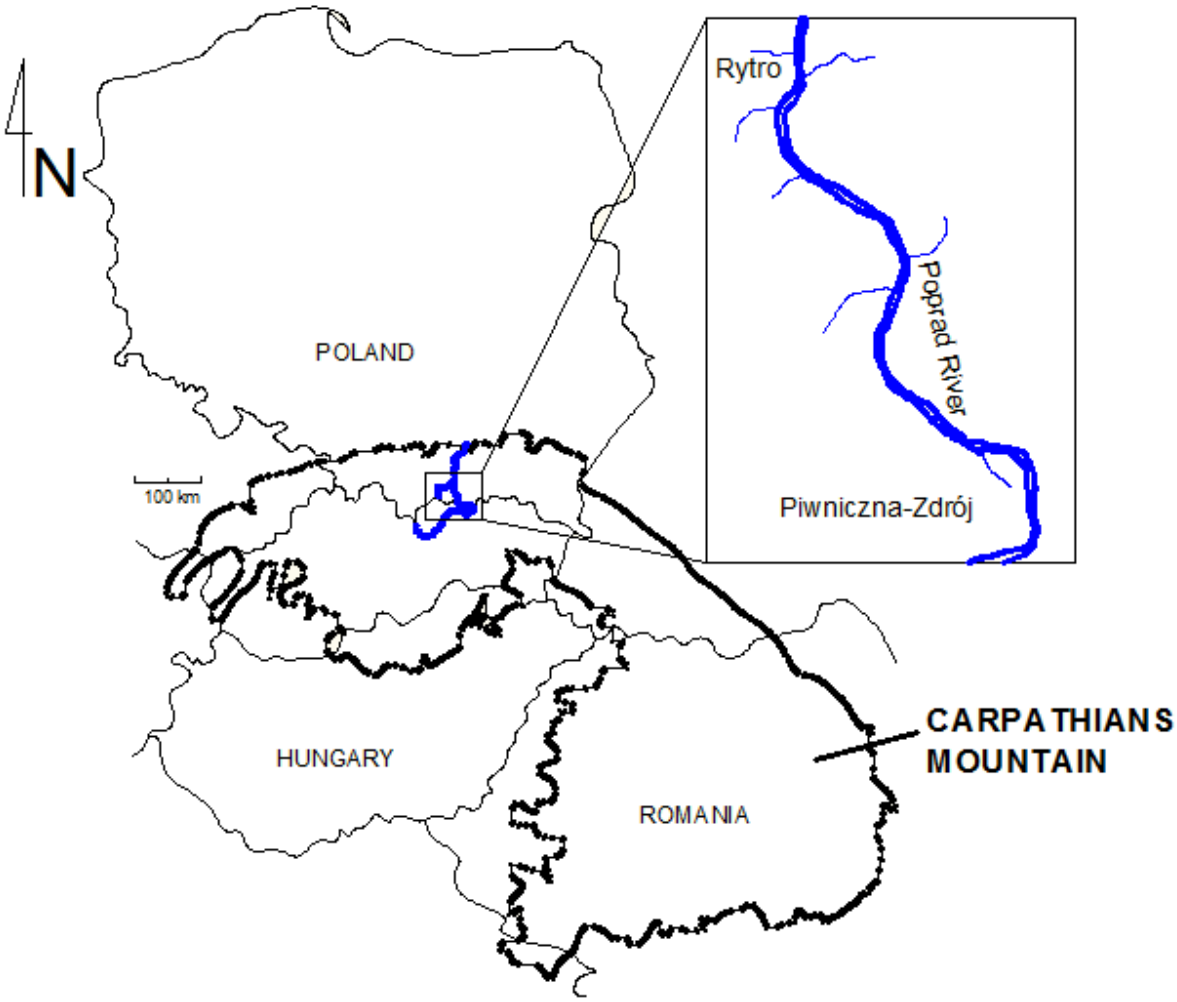

Figure 1. Location of the Poprad river on the background of the Carpathians

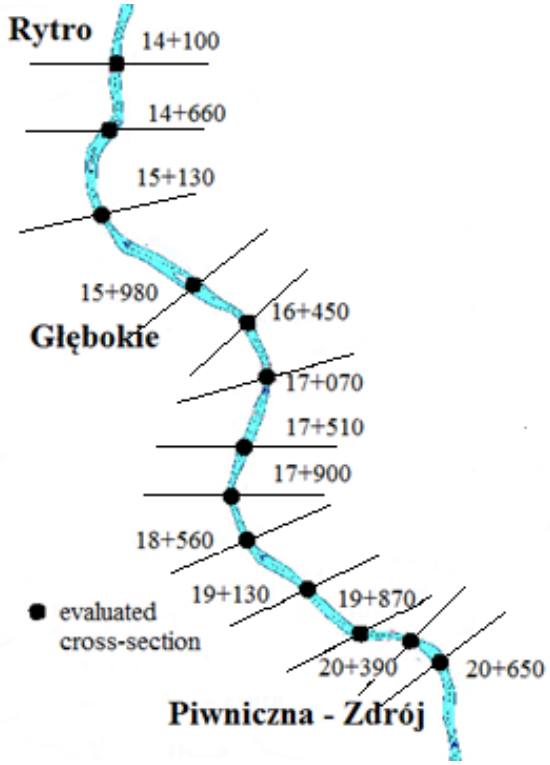

Figure 2. Cross-section of Poprad river from Piwniczna-Zdrój (km 20 + 650) to Rytro (km 14 + 100) with research sectors

Currently, the Polish side of the Poprad valley is under landscape protection within the Poprad Landscape Park. The Park with the area of over 54,000 ha was created in 1987. The surface area of the park and its buffer is approx. 79,000 ha, making it one of the largest landscape parks in Poland (Wiśniowska-Węglarz, 2008). The objective behind the creation of the Poprad Landscape Park is the comprehensive protection of its natural, landscape and touristic qualities, implemented by the adjustment of the economic activity to the requirements of environment protection (Pawlak, 2007). However, the strategic targets and criteria for the creation of the spatial structures of protected areas should be defined in the local land use policy (Raszka & Kalbarczyk, 2015). The creation of the Poprad Landscape Park in a developed area, however with significant landscape values, was supposed to be an example of the co-existence of forest and tourism economies, based on the rational use of the existing natural resources. The main road transport routes in the park are created in the narrow river valleys, due to the landscape. The primary difficulty is the nuisance resulting from the concentration of the rail and road infrastructure in the most beautiful landscape areas of the Poprad gorge. This results in high degrees of air pollution and cutting off the upper parts of the Poprad valley from the river and the riverfront (Pawlak, 2007).

According to the assumptions of the Water Framework Directive (Directive 2000/60/EC), the management of the water resources is provided in the catchment-based system. Poprad is a trans-boundary river – the requirement for the protection and development of this area resulted in a Polish-Slovakian cooperation. On the one hand, the cooperation is focused on the hydrological aspects of the Poprad, due to the created Polish-Slovakian Border Waters Committee and the Permanent Polish-Slovakian Border Committee (Owsiany, 2009; PL-SK, 2007). On the other hand, not only the hydrological aspects are the reason for the cooperation. It is also facilitated by the matter of development of the Poprad river valley areas. For this purpose, the PL-SK Trans-boundary Cooperation Programme was created. It will contribute to the sustainable development and protection of border areas (PL-SK, 2007). The purposes of the programme are also the spatial integration of the area and increasing its availability and attractiveness to residents, investors and tourists as well as the stable socio-economic, cultural and natural development of the area (Owsiany, 2009; PL-SK, 2007).

The hydromorphological and landscape method was created by a combination and modification of two existing methods: the ECOVAST landscape assessment and identification method (Spiegler & Dower, 2006) and the hydromorphological assessment of the quality of rivers method (Wyżga et al., 2009; 2010; 2012; 2013).

The ECOVAST (European Concil of the Village and Small Town) group was initiated in 1984, in order to increase the well-being of the rural communities and protect the heritage of rural areas in Europe (Spiegler & Dower, 2006). On of its achievements is the introduction and verification of the landscape assessment and landscape elements identification method. By using the new method, the landscape units can be described with information regarding the special care which should be provided for the area – a starting point for understanding the landscape. The method is based on a matrix containing a series of landscape features. These are: rocks, climate, terrain form, soil, area cover, characteristic features and forms of farming and forestry, characteristic features of houses and settlements, other anthropogenic elements, historical features as well as emotions and associations (Spiegler & Dower, 2006). The matrix also enables recording the meaning and intensity of each aspect under assessment as well as adding a short description of the landscape with own comments.

The objective of the ECOVAST method is the assessment and identification of areas with diverse landscape value, in particular the most valuable and the least valuable landscapes – in need of landscape quality improvement (Spiegler & Dower, 2006).

The hydromorphological assessment of the quality of rivers was created as a support element for the ecological status of waters evaluation, imposed by the WFD (Directive 2000/60/EC). The modified method for the hydromorphological assessment of river quality was based on the evaluation of 10 categories of bed, banks/bank area and flood area features. The group of features related to the river bed included the assessment of the following parameters: river bed geometry, construction material, plant life and wood debris in the river, occurrence of erosion and deposition forms, flow regime naturalness degree and watercourse continuity modifications. In the case of banks, the assessed areas included: naturalness degree, and in the case of bank area – the naturalness degree of the plants and the method of use of the area. The flood area evaluation involved the assessments of its method of use and the presence of small reservoirs and wetlands in the area as well as the evaluation of the possibility of lateral migration of the river bed and the hydraulic connection of the river to its flood area (Wyżga et al., 2009; 2010; 2012; 2013).

The newly developed method includes the distinction of three main groups of factors: hydromorphological (H), landscape (L) and integrated elements (I). The first group of elements, in accordance with the hydromorphological assessment of river quality, pertains solely to the river bed (Wyżga et al., 2009; 2010; 2012; 2013). The second group is directly related to the landscape identification method ECOVAST (Spiegler & Dower, 2006) and pertains solely to the elements of landscape.

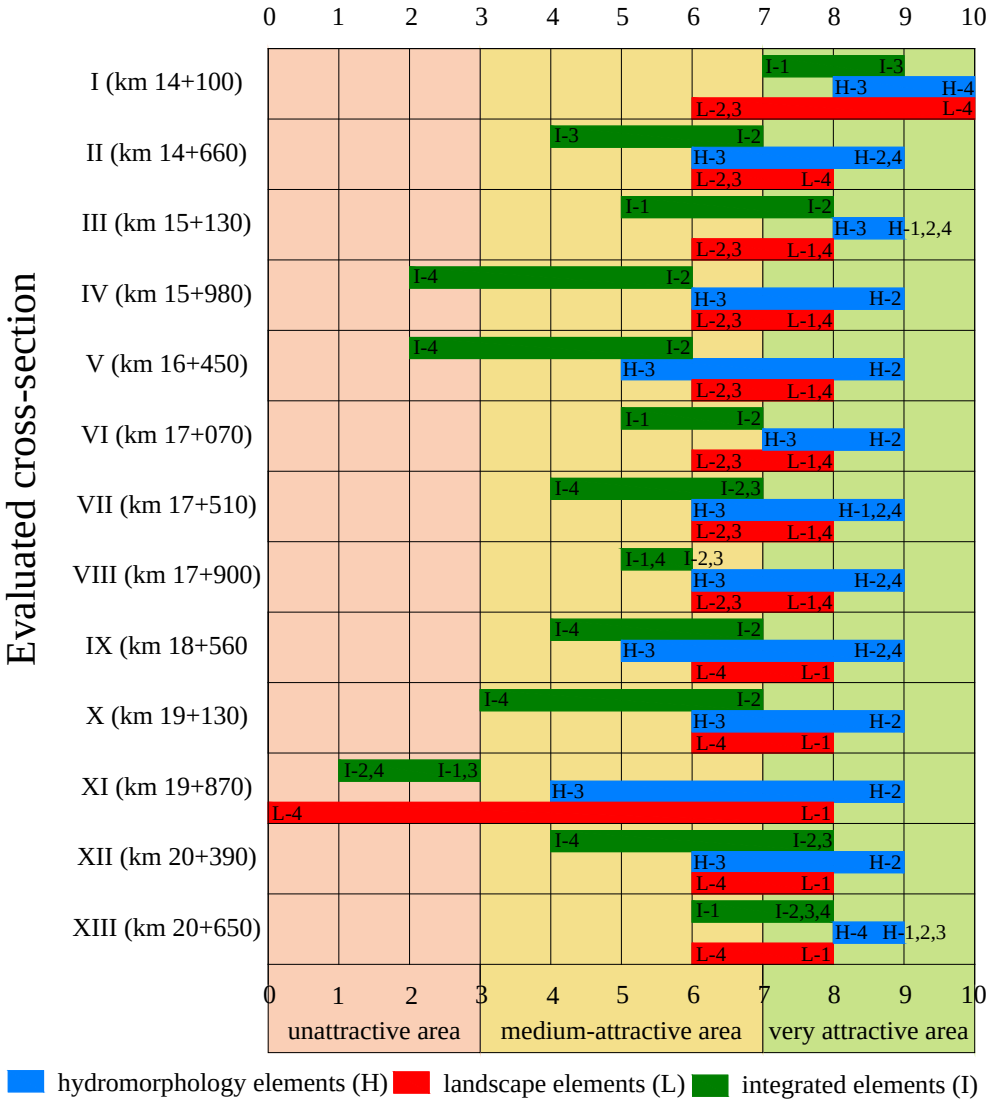

Figure 3. Diagram of the results of the hydromorphological and landscape evaluation of valley of the Poprad River

Table 1. Hydromorphological elements (H)

Scale	Evaluated elements			
	The geometry of the river channel (H – 1)	Material of the river bed (H – 2)	Plant life in the bed (H – 3)	Erosion/ deposition (H – 4)
9 – 10	0 – 5% of the section of the river channel changed, no human impact (or minimal interference) in the course of the river channel, no change in the longitudinal profile and cross sections of the river, any changes are slight, almost imperceptible	natural river bed, a very large diversity of the material forming the river bed, the natural occurrence of oversized grains	river channel is unregulated, presence of the various species of plant life on the sandbanks and the banks of river, natural wood blockage	presence of erosion and deposition in the river channel, presence of many side and central backwaters, existence of natural pockets and rapids, the forms of erosion do not cause undue damage associated with side erosion
6 – 8	5 – 40% of the section of the river channel changed, visible changes in the geometry of the river channel, the longitudinal profile and cross sections are transformed	river bed regulated using natural materials - rush plants, turf, grass	river channel is unregulated, noticeable vegetation on the sandbanks is, evident presence of vegetation on the banks of the river	existence of pockets and rapids in the river channel, presence of a few forms of the deposition (single backwaters)
3 – 5	40 – 70% of the section of the river channel changed, large and very large changes in the position of the river channel, a large change in the longitudinal profile and cross sections of the river	river bed regulated using technical natural materials - stone (broken grasshopper), gravel, pebbles, gravel, sand, fascine, wood, natural fibers	river partially regulated, evident presence of vegetation on the banks of the river	existence of pockets and rapids in the river channel, no backwaters deposition, occurring side erosion causes uncontrollable and dangerous slides to the edges – escarpments
1 – 2	70 – 90% of the section of the river channel changed, majority of the river channel is changed, a very large changes in the longitudinal profile and cross-sections of the river	artificial river bed regulated using technical industrial materials – metal, steel (mesh, wire rods, steel components, gabions) and plastic (wire, foil, nonwovens)	river channel is regulated, artificially introduced vegetation located on the banks of the river	regulated edges of the riverbed, presence of the deep erosion
0	90 – 100% of the section of the river channel changed, change in the entire geometry and course of the river channel (straightened), complete change and lack of the natural variation in the longitudinal profile and cross sections of the river channel	river bed is entirely artificial – a concrete river bed	river channel is completely regulated (concrete) - absence of vegetation	the river channel completely regulated (concrete) – absence of erosion or deposition forms

Table 2. Landscape elements (L)

Scale	Evaluated elements			
	Terrain topography and cover (L – 1)	Open landscape (L – 2)	Settlement areas (L – 3)	Historic features/ buildings (L – 4)
9 – 10	widely varied terrain shape and the land cover, presence of hills and valleys, forests, meadows, cultivated fields; perfectly synchronized landscape – coexisting elements perfectly match with each other, without causing an eye strain of the observer	evident spatial order, a clear boundary between cultivated fields and forest, high feelings and associations, visible distinguish features and patterns of the agriculture and forestry, preservation of the traditional system of the farmland	evident spatial order, preserved building regionalism, high feelings and associations, visible distinguish features of the houses and settlements, buildings preserved in the good condition	presence of the historic buildings (castles, ruins of castles, walls), which clearly attract observer's attention
6 – 8	varied terrain shape – presence of hills and valleys, visible diversity in the land cover	visible spatial order, noticeable boundary between cultivated fields and forest, as well as distinguish features and patterns of the agriculture and forestry, preservation of the traditional system of the farmland	visible spatial order, preserved building regionalism, noticeable distinguish features of houses and settlements, most of the buildings preserved in the good condition	presence of the historical buildings (castles, ruins of castles, walls,), which do not catch observer's attention
3 – 5	rather varied terrain shape – visible diversity in the land cover	imperceptible spatial order, noticeable boundary between cultivated fields and forest, hardly noticeable distinguish features and patterns of the agriculture and forestry , absence of the traditional system of the farmland	imperceptible spatial order, building regionalism and hardly noticeable distinguish features of the houses and settlements, the buildings preserved in the bad condition	absence of the historical buildings, but visible distinguish features and patterns of the cultural landscape
1 – 2	terrain shape very poorly varied, diversity in the land cover is marginal	absence of spatial order, imperceptible boundary between cultivated fields and forest, almost invisible distinguish features and patterns of the agriculture and forestry, absence of the traditional system of the farmland	absence of spatial order, building regionalism negligible, a very large part of the buildings preserved in the poor condition	absence of the historical buildings, hardly noticeable distinguish features and patterns of the cultural landscape
0	not varied terrain, absence of diversity in the land cover	a total absence of spatial order, absence of boundary between cultivated fields and forest, as well as the distinguish features and patterns of the agriculture and forestry, absence of the traditional system of the farmland	a total absence of spatial order, absence of building regionalism, the buildings preserved in the poor condition with no distinguished features.	absence of the historic buildings and absence of distinguish features and patterns of the cultural landscape

Table 3. Integrated elements (I)

Scale	Evaluated elements			
	Flow characteristics (I – 1)	Anthropogenic elements/ modification (I – 2)	Exploiting and vegetation in the areas adjacent to the river channel (I – 3)	Mobility and connection of the bed to the flood area or adjacent open space (I – 4)
9 – 10	wide presence of the different hydromorphological units/ elements in the river channel, the sound of the flowing water is unobstructed by any anthropogenic activities, a clear unique landscape of the sound	river bed: completely natural river channel, no anthropogenic elements, river valley: a few anthropogenic elements perfectly integrated into the landscape, the presence of a harmonious landscape	the area directly adjacent to the river channel is a wide belt covered with a natural vegetation, the presence of the alluvial forests	the river channel has an unlimited ability to move (meandering, creating structures with multiple river channels), a very good channel communication with the area of the floodplain and/ or the adjacent open area, absence of the high flooding risk areas
6 – 8	presence of the different hydromorphological units/ elements in the river channel, the sound of the flowing water is partly disturbed by anthropogenic activities, noticeable unique landscape of the sound	river bed: modifications in the river channel limited to the edges and the bottom - made from the natural materials, river valley: anthropogenic elements are noticeable in the landscape	the area directly adjacent to the river channel is a wide belt, which is used for agriculture and/ or forestry	the river channel has an ability to move (meandering, creating structures with many riverbeds), a good channel communication with the area of the floodplain and/ or the adjacent open area where the acreage of the high flooding risk is limited
3 – 5	episodic presence of the different hydromorphological units/ elements in the river channel, the sound of the flowing water disturbed by anthropogenic activities, imperceptible unique landscape of the sound (despite of the real presence)	river bed: modifications in the river channel limited to the edges and the bottom - made from the natural materials, river valley: anthropogenic elements disturb the structure of the landscape	the area directly adjacent to the river channel is a wide belt, which is partly used for agriculture and/ or forestry, and partly for the technical infrastructure	the river channel has a slight possibility of the movement (meandering, creating structures with many riverbeds), noticeable channel communication with the area of the floodplain and/or the adjacent open area where the acreage of the high flooding risk is large
1 – 2	rather inconspicuous hydromorphological units/ elements in the in the river channel, the sound of the flowing water is extensively disturbed by anthropogenic activities, completely unnoticed unique landscape of the sound	river bed: modifications in the river channel limited to the edges and the bottom - made from the technical materials, river valley: a lot of anthropogenic elements disturb the structure of the landscape	the adjacent area directly to the river channel is narrow and partly used for the technical infrastructure	the river channel is unregulated, absence of mobility, absence of channel communication with the area of the floodplain and/or the adjacent open area where the acreage of the high flooding risk is extensive
0	absence of hydromorphological units/ elements in the river channel, the inaudible sound of the flowing water flow (completely disturbed by anthropogenic activities), absence of unique landscape of the sound	river bed: the presence of hydraulic and concrete structures that partition the river bed, as well as all kinds of fortifications of the edge and bottom made of plastics, river valley: the presence of a great number of unnatural, anthropogenic elements that disturb the spatial order and harmony of the landscape (e.g. highway, dumps)	the area directly adjacent to river channel is very narrow and used for the technical infrastructure	the river channel is completely settled and unable to move, absence of channel communication with the area of the floodplain and/ or the adjacent area open where the acreage of the high flooding risk is very extensive

Integrated elements are those, which could not have been clearly assigned to one of the former two groups. They are the elements combining the hydromorphological features and the landscape.
In order for all the elements of the groups to be correctly evaluated, the available archival materials should be analysed prior to field studies (Bender et al., 2005; Bender et al., 2009). This activity is required to determine any possible modifications, in particular – changes in the river geometry. All elements within these three groups should be evaluated in a ten-point scale, using the key presented in tab. 1–3.

3. RESULTS AND DISCUSSION

Each of the elements was assessed in accordance with the presented methodology, along the studied section of the Poprad river from Piwniczna Zdrój (km 20+650) to Rytro (km 14+100) (Fig. 2). The assessment also included walking along the river valley of the section and noting the changes (improvement or deterioration) of the changes in the three groups of parameters in cross-sections.

The results of the assessment are presented using the measure of dispersion – range – a difference between the highest and lowest grades. These ranges were drafted on a diagram with the scale for measuring the attractiveness of the area (Fig. 3). Additionally, the diagram also includes markings of the lowest and highest values for each of the elements in each of the cross-sections.

Figure 4. I cross-section (km 14 + 100) with visible forms of erosion/ deposition (photo by M. Nawieśniak)

When considering each of the elements separately, in therms of hydromorphology, the studied section does not show much variation. The least advantageous is the H-3 parameter – plant life in the bed. The highest ranking parameter in almost all cross-section is H-2, related to the material of the river bed. Cross-section I (km 14+100) shows the highest value of parameter H-4 describing erosion/deposition (Fig. 4).

Then, the analysis of the landscape elements, found that the cross-sections from I (km 14+100) to VIII (km 17+900) show the lowest and highest values for the same parameters. The value of 6 was awarded to L-2 and L-3, describing the open landscape and settlement areas (Fig. 5).

The highest ranking was awarded to L-1 and L-4 parameters related to the terrain topography and cover as well as historic features/ buildings. The L-4 parameters is clearly dominant in cross-section I (km 14+100), due to the caste remains located on the hill (Fig. 6). From cross-section IX (km 18+560), the lowest scoring parameter was L-4, and the highest – L-1.

Figure 5. Open landscape of housing estate areas (IV cross-section 17 + 070) (photo by M. Nawieśniak)

Figure 6. The ruins of the castle on the hill in section I (km 14 + 100) (photo by M. Nawieśniak)

Much variability was observed for the integrated elements. Despite the fact that in most cases, the I-4 element (mobility and connection of the bed to the flood area or adjacent open space) was ranked the lowest, in one cross-section the value of

the parameter was 1 and even 5 in another – the lowest score in both cases. The highest value was presented by element I-2 – anthropogenic elements/modification, with exception to one special case. In cross-section XI (km 19+870), the river bank on the right side and the height of approx. 3 m contains a reinforcement using a concrete bank (Fig. 7). This type of reinforcement was provided in order to protect the road located directly adjacent to the river bed. This resulted in a complete modification of the river bank character and breaking the connection between the watercourse and its flood area.

Separated studies concerning landscape, river bed morphology or socio-economic development do not yield visible results and do not show new, complex patterns and processes, when compared to integrated studies (Angelstam et al., 2013b; Liu et al., 2007).

Changes occur in the landscape all the time, we are unable to stop them. We can only make sure that the direction of these changes is appropriate. The basis of landscape managements should be the integration of landscape management with the land use and urban planning policies. Cultural landscapes will be a potential for local and regional development if they are taken into appropriate consideration in the broadly defined environment shaping and spatial development (Linke & Hernik, 2010). The greatest threat of underestimation and not utilising their potential can come from the spatial development policy.

It should be remembered that water is one of the most important elements of landscape, both natural and cultural. In addition to the spatial and landscape aspect, the river, as a part of the environment has also the socio-economic aspect. And it is water management, following the settlement development, affects the landscape transformation.

The river valleys are a key element of the landscape, with multiple valuable qualities (Kałamucka, 2007). However, we often do not realist that even the simplest of reinforcements or technical intervention in the river bed affect the whole river valley landscape, in which the river is an important part of the whole ecosystem. These areas are sources of life, shelter and food to many rare and endangered species. River valleys are characterised by one of the highest values of biological production, biodiversity of species and number of organisms. They are the locations of valuable natural habitats, many of them protected. When considering river valleys in a holistic approach, one cannot leave out the anthropogenic activity, directly impacting the landscape of the valleys. Tourism and leisure are also parts of the landscape of the given area (Klaučo et al., 2012).

Should areas such as the Carpathian river valleys remain unchanged due to their valuable landscape qualities? Surely, they cannot be devastated, however – having in mind the technological progress and in order to maximise the tourism opportunities – their protection should not be based on their complete "closure". Due to the dynamics of changes in these areas, their protection should be accompanied by sustainable development. The development which would include economic growth, protection of natural resources and the environment as well as social development. In order to specify the appropriate course of development of the river valleys, the elements in the area must be carefully identified and assessed. The assessment should also take into consideration the occurrence of flood risk, which according to Directive (2007/60/EC) means the combination of the probability of a flood event and of the potential adverse consequences for human health, the environment, cultural heritage and economic activity associated with a flood event. The flood risk is an element which can and should be managed as well as limited (Directive 2007/60/EC).

The Poprad river valley is located within the Poprad Landscape Park with multiple natural, cultural and landscape qualities together with social and economic activity as well as high degree of urbanisation – this results in multiple conflicts and problems, requiring solutions. This is the reason why the area should have a specific strategy of protection should be provided together with directions for development with preference for the protection of the environment and cultural resources against detrimental transformations. At the same time, the area requires the emphasis of the strongest and most visible elements proving its regional identity (Pawlak, 2007).

The studies of the landscape of the Carpathian Mountains have a history originating in the early 20th century – when Smoleński (1912) described the characteristics and processes changing the Carpathian landscape. The Poprad river valley itself, located in the current Lesser Poland Voivodeship was categorised by Gawroński (1993) as the dominant agricultural-forest-leisure landscape type. According to Gawroński (1993), the area was characterised by a relatively sparse construction development, well-developed tourism and emerging industry. However, the area was transformed in the following 20 years. The introduction of small-scale technical measures related to the regulation of the

Poprad river valley caused the decrease in the landscape value of the area. A god example is the construction of the concrete bank on the river (Fig. 7) – a drastic discord in the local landscape.

Figure 7. Cross section XI (km 19 + 870) with the strengthening of the right edge with a concrete wall (photo by M. Nawieśniak)

Until now, the landscape valorisation has taken into account the areas adjacent to the river, without the river itself. The hydromorphological assessment on the other hand, focused solely on the river and its bed. However, the hydromorphological and landscape valorisations are complementary. Capturing the full extent of the changes requires long-term, coordinated studies, projects which would compare and described elements of multiple disciplines (Angelstam et al., 2013b; Liu et al., 2007).

The combination and modification of these two methods enables a broader perspective of the area in question. In order for an area to be considered valuable, the assessment of all the elements in the three defined groups should be consistent.

Furthermore, the combination of the two methods revealed another significant elements – the sound landscape. The sound heard when walking close to the watercourse. The sound of flowing water, resulting in a positive association with the area and proves its high value.

Due to the proposed new method, it can be checked which of the evaluated elements should be improved so that the general impression of the area confirms its attractiveness. Furthermore, one should pay attention to the highest evaluated elements as those which need particular protection against deterioration. The proposed method will contribute to the reduction of conflicts related to the land use in river valleys – noted as a significant problem (Tudor et al., 2014).

After the assessment of all the elements, a proposal can be formed regarding the socio-economic and touristic development of river valleys.

4. CONCLUSIONS

The completed hydromorphological and landscape valorisation of the studied section of the Poprad river, using a new, original methodology, enabled the identification of areas valuable in terms of hydromorphology and landscape. The section of the Poprad river from Piwniczna-Zdrój (km 20+650) to Rytro (km 14+100) is characterised by a variation in integrated elements. This variation is the result of larger or smaller scale of anthropogenic activity in the area. The Poprad river valley is characterised by a landscape of regional importance, with a very high touristic potential.

The presented method was created in order to evaluate and identify areas of the Carpathian river valleys. The areas, which are valuable in terms of hydromorphology and landscape.

The method enables the identification of sections which require improvement due to hydromorphological and landscape-related elements in order to increase the attractiveness of the area as well as sections which do not need such improvement. This will enable the observation of the social, landscape and hydromorphological advantages of the area in the fields of tourism and leisure.

Additionally, the assessment using this methodology provides the possibility of identifying the borders of river-dependent areas. The specified zone of river-dependent areas will be characterised by the dominance of hydromorphological elements over the landscape-related ones. The identified zones can be presented in a graphical form – using mapping.

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