Scientific Review – Engineering and Environmental Sciences (2019), 28 (1), 72–81
Sci. Rev. Eng. Env. Sci. (2019), 28 (1)
Przegląd Naukowy – Inżynieria i Kształtowanie Środowiska (2019), 28 (1), 72–81
Prz. Nauk. Inż. Kszt. Środ. (2019), 28 (1)
http://iks.pn.sggw.pl
DOI 10.22630/PNIKS.2019.28.1.7

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The environmental and landscape values of the small lowland river valley and their threats on the example of the Kraska river (Masovian Voivodeship)

Key words: river valley, natural values, human influence, regulation works, threats

Introduction

Contemporary impacts on the river valleys are differentiated and dependent on, among others, the river size or the purposes and the type of the undertaken activities. The small rivers were – and still are – being changed on the largest scale, most often due to the necessities of agriculture and anti-flood purposes. Results of the mentioned impacts are the vanishing or decreasing in range of valuable habitats, plant and animal species and the ecological corridors, essential for the migration and genetic differentiation of the communities (Callow & Petts, 1992; Dlamini, Hoko, Murwira & Magagula, 2010). The small river valleys (according to the Water Framework Directive, small river is the one of the catchment area in the range from 1,000 to 10,000 km^2) cover a significant part of Polish lowlands, creating the “base” of the river network (Błachuta, Picińska-Fałtynowicz, Czoch & Kulesza, 2010). They also play the role of ecological (free migration) corridors for some plants or animals (for example the bur cucumber *Sicyos angulatus*, the European beaver *Castor fiber*, the bluethroat *Luscinia svecica* or the muskrat *Ondatra zibethicus*), refugia or spawning grounds for fish as well as the breeding grounds for some invertebrates (Rinaldo, Gatto & Rodriguez-Iturbe, 2018). Undoubtedly, they also contribute to increasing of biological diversity and maintaining the ecological stability of the region (Beisel, Usseglio-Polatera, Thomas & Moreteau, 1998; Sender & Maślanka, 2018). However, continuous pressures on rivers originating from urban sprawl and expanding intensive agriculture entail significant threat of losing particular ecosystem values and biological diversity of these rivers (Bączyk, Wagner, Okruszko & Grygoruk, 2018).

The authors determined the impact of the regulation and maintenance works, conducted in various periods on various Kraska river reaches, on the eco-systems of the valley and its eco-morphological zones; and to analyse the range of mentioned impact in the horizontal pattern, taking into consideration the environmental demands of peculiar invertebrate and vertebrate taxa. The necessity or even the sense of the regulation/maintenance works in the river valley undertaking for flood protection was also discussed.

Study area, materials and methods

The Kraska river is situated in the Masovian Voivodeship, in the communes of Belsk Duży, Jasieniec, Grójec and Chynów. The total length of the river is 28.9 km. The drainage area covers 211 km^2 and is divided into 25 elementary catchment areas. Kraska's springs are located near Belsk Duży (178 m a.s.l. – GPS directions 51.826401, 20.795642) and it confluences the Jeziorka river near Gościeńczyce (124 m a.s.l. – GPS directions 51.912891, 20.948335). The channel width is 2–8 m and the average flow velocity is about 0.1 $m \cdot s^{-1}$ (Jagiełło, 2014).

The river is regulated on about 90% of the total length. The longest unmanaged reach drains the final 1.5 km of the Kraska river. The maintenance of an existing channelization structures is associated with a number of detrimental activities, such as: disturbing natural river banks and the channel bottom, removing beaver dams and accumulations of the wood debris as well as the macrophytes from the channel bottom, the removal of the fallen trees, logging the small trees and the shrubs, desludging and the implementation of the fascine. There are 49 channelization structures on the Kraska course, mainly the small bridges and culverts.

The catchment area is threatened by eutrophication from the municipal sources, but not highly threatened by the contamination with nitrogen compounds from agricultural sources (Breń, 2018). The Kraska river is supplied by three right-bank tributaries and nine left-bank ones. About 90% of the catchment area is covered by orchards, plantations, gardens, meadows or pastures, forests, copses and cultivated fields.

Field studies were carried out from June 2016 to October 2018 and covered complete evaluation of the river valley using the index WULS-SGGW (Oglęcki & Pawłat, 2000). The method bases on the evaluation of four valley zones: riverbed, riverbank (about 20 m of both sides), scarps and terraces and the up-valley (about 100 m of both sides) ones. The total score of the evaluation considers the relative importance (weights) of peculiar zones in the total valley pattern. The final results were compared with the five-point scale of the environmental value categories, where 1 means very low, and 5 very high. The evaluation of each zone was performed on the bases of the identification lists of the environmental state, where each partial element is of relative importance and was estimated in the five-point scale. The results between 4.21 and 5.00 points very high environmental values (class I); 3.41–4.20 – high environmental values (class II);

2.61–3.40 – average environmental values (class III); 1.81–2.60 – low environmental values (class IV) and 1.00–1.80 – very low environmental values (class V).

Studies on the fauna were carried out using the following methods:

– macroinvertebrates: the samplings were made using the Ekman grab, the triangular dip net, mosquito dipper and tweezers, in dependence to the habitat conditions in particular sites, in order to collect as many taxa as possible. The catches were done in the following time line: 7 July 2016, 29 September 2016, 5 April 2017, 27 May 2017, 14 October 2017 and 12 February 2018; the macroinvertebrates were identified in the laboratory, partly from non-preserved material during 2–3 days after the sampling and partly from the samples preserved with 70% ethanol;
– amphibians and reptiles: visual observations in commode habitats, especially during the breeding season;
– birds: audiovisual observations during all the year, the observations from the points and alongside the transects;
– mammals: catches in the restraining traps (controlled every 3–4 h) – in April and May 2018 – five two-day cycles in total, visual observations, analyses of their leads and traces (basically in the wintertime).

Results

The results of the whole river valley evaluation range from 2.32 (low environmental value) to 4.04 (high environmental value). The percentage share of the reaches of peculiar value is as follow: class I – 0%; class II – 27.7%, class III – 60.4% ; class IV – 11.9%; class V – 0%.

For the riverbed zone (the lowest value – 2.15; the highest one – 4.43) the respective share is: class I – 0.7% (just very short reach in the proximity of the mouth); class II – 22.8%; class III – 64.6%; class IV – 11.9%, class V – 0%.

For the bank zone (the lowest result – 2.00; the highest one – 5.00) the results look as follow: class I – 0.7% (the same reach as in the case of the riverbed zone); class II – 36.5%, class III – 50.9%; class IV – 11.9%; class V – 0%.

For the scarpes and terraces zone (the lowest result – 2.60; the highest one – 3.60) the following results were calculated: I class – 0%; II class – 11.6%, III class – 76.5%; IV class – 11.9%; V class – 0%.

For the up-valley zone (the lowest result – 2.25; the highest one – 4.50) the share looks as follows: class I – 4.2%; class II – 15.8%; class III – 56.8 %; class IV – 23.2% and class V – 0%.

The results of the Kraska valley evaluations (the total one and the ones calculated for the peculiar zones) are shown in the table and Figure 1.

Generally, it is hard to determine any scheme of the environmental values' differentiation alongside the valley. The intensity and unintended randomness of the conservation/regulation works have disturbed the stability of the natural river course and determined the disorder in the biocenosis. That results are similar to the ones achieved by authors during the evaluation of others small lowland river valleys for various purposes (Oglęcki & Komorowski, 2004).

TABLE. The results of the evaluation for individual zones of the Kraska River valley (using 1–5 point scale – the index WULS-SGGW method)

The chainage of the valley															
0+000-0+198	0+198-1+417	1+417-3+532	3+532-5+326	5+326-5+780	5+780-6+910	6+910-9+215	9+215-11+340	11+340-12+663	12+663-13+415	13+415-17+368	17+368-18+167	18+167-21+429	21+429-23+448	23+448-25+132	25+132-28+500
Riverbed zone															
4.43	2.80	3.10	3.13	3.40	3.20	3.85	3.85	3.65	3.50	3.40	2.88	3.15	3.40	3.25	2.15
Bank zone															
5.00	2.70	3.00	3.10	2.60	2.40	3.45	3.45	3.45	3.30	3.70	3.50	2.90	4.00	3.50	2.00
Scarps and terraces zone															
3.10	3.25	2.80	2.95	3.20	3.10	3.40	3.35	3.60	3.30	2.90	3.00	3.10	3.50	2.90	2.60
Up-valley zone															
3.35	4.50	2.25	2.35	2.58	2.58	3.35	3.35	3.35	2.43	3.50	3.50	3.10	3.10	2.80	2.80
Whole river valley															
4.04	3.09	2.91	2.99	3.10	2.95	3.59	3.57	3.57	3.29	3.32	3.10	3.08	3.52	3.15	2.32

Forty eight invertebrate taxa were identified during all surveys carried out on the Kraska river. Forty-six taxa were noted on the lowest, close-to-nature (unregulated) reach, 30 taxa on the reaches regulated before 2015, and 12 taxa on the ones regulated or maintained in the years 2015–2018 (Fig. 2).

Amphibians were represented by 12 species: the smooth newt *Lissotriton vulgaris*, the European fire-bellied toad *Bombina bombina*, the common toad *Bufo bufo*, the European green toad *Bufo variegata*, the natterjack toad *Bufo calamita*, the European tree frog *Hyla arborea*, the common spadefoot *Pelobates fuscus*, the edible frog *Pelophylax* kl. *esculentus*, the pool frog *Pelophylax lessonae*, the marsh frog *Pelophylax ridibundus*, the common frog *Rana temporaria* and the moor frog *Rana arvalis*.

All the amphibian species were noted in the close-to-nature (unmanaged) and regulated reaches as well, but the densities – in the sense of specimen concentrations – were much more higher in the unregulated reaches because of the presence of the spawning grounds in the bank zone.

Three reptile species (the grass snake *Natrix natrix*, the sand lizard *Lacerta agilis* and the common lizard *Lacerta vivipara*) were noted during the field investigations in the valley and in that case only the grass snake seemed to prefer the unmanaged reaches of the river and its close surroundings – it was often seen in the river, while swimming or hunting

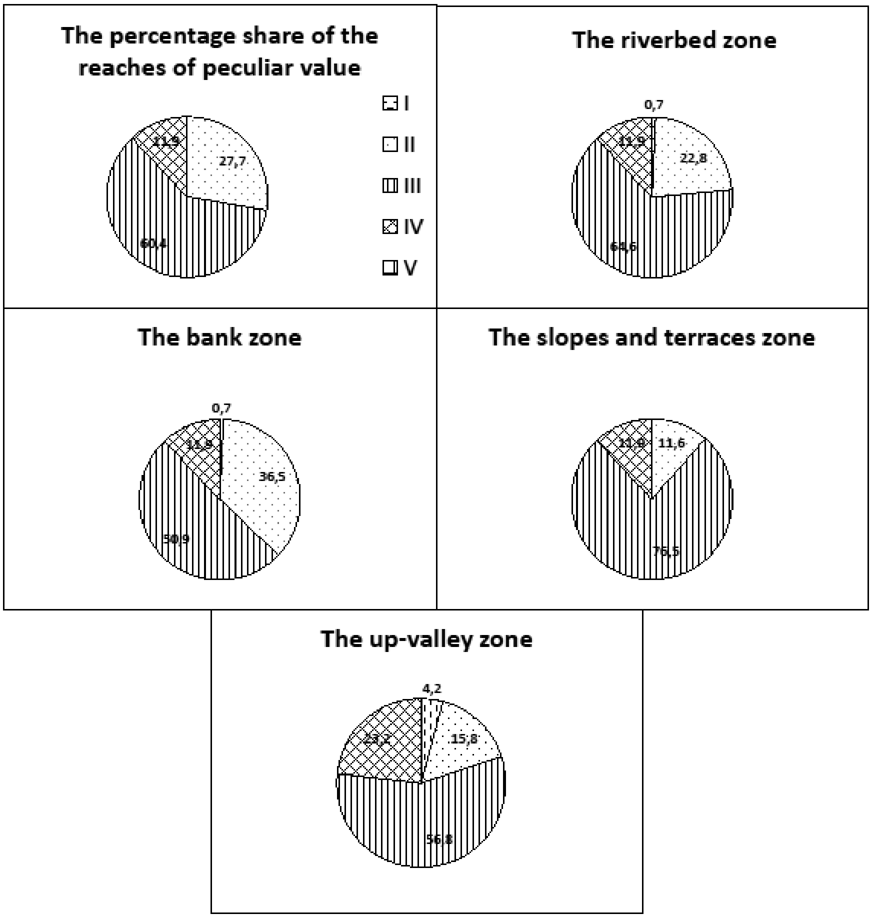

FIGURE 1. The results of the Kraska valley environmental evaluation

frogs. Lizards preferred the dry places alongside all the study area.

The total number of 38 bird species were observed in the valley – 36 on the close-to-nature reaches and 34 on the regulated ones, but the disproportion between the shares of the reaches of both types in the total valley area should be taken into consideration. In this context the "advantage" of the close-to-nature reaches seems to be symptomatic. The most important – because of their rarity and unique biology – were the kingfisher *Alcedo atthis*, the hen harrier *Circus cyaneu*s, the white-tailed eagle *Haliaeetus albicilla*, the Eurasian hobby *Falco subbuteo* and the bluethroat *Luscinia svecica*.

Thirty species of mammals were noted – directly or in the indirect manner – in the Kraska valley. Amongst them 6 – the muskrat *Ondatra zibethicus*, the water rat *Arvicola amphibious*, the Eurasian otter *Lutra lutra*, the Eurasian water shrew *Neomys fodiens*, European beaver *Castor fiber* and American mink *Neovison vison* – are strictly connected with the riverbed zone and the bank zone. Among

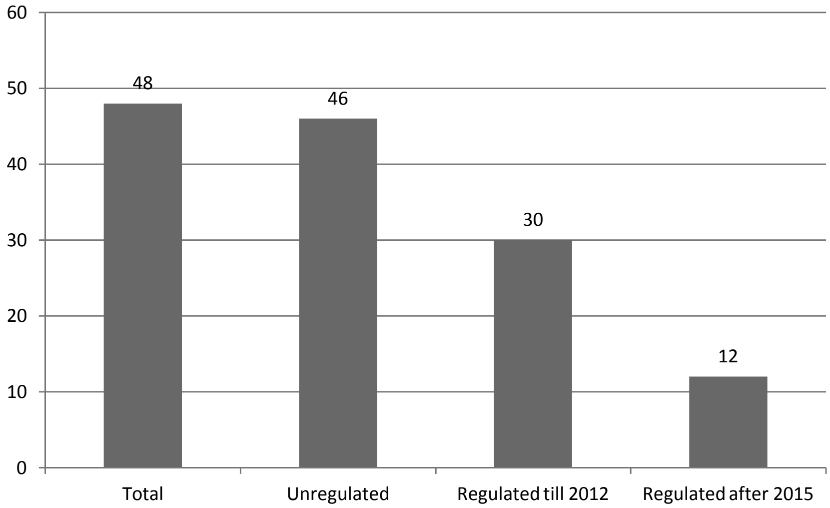

FIGURE 2. The number of invertebrate taxa in the peculiar types of the river reaches

them only a beaver – quite common and very expansive, considered nowadays as a problematic species – was noted on the regulated reaches. Five others were found in the close-to-nature reaches (mainly in the outlet) despite the fact, that about 90% of the river is regulated. In the case of other species that normalcy was not such noticeable, although some big mammals, for example the wild boar *Sus scrofa* and the European roe deer *Capreolus capreolus*, were much more common in the "natural" parts of the valley – probably due to, mentioned before, tendency to destroy the high green coverage (trees and shrubs) during the regulation.

Discussion

Negative impact of the channel regulation or maintenance activities for the diversity of the invertebrates is absolutely certain and connected with the looses of proper habitats, such as gravels, fallen trees and twigs, breaches and dents, roots etc. (Bączyk et al., 2018). The significant decreasing in the invertebrate fauna composition is especially distressful because of the great importance of that group for many food webs and the whole ecological balance.

The presence of the amphibians in all the river valley is strictly connected with the number and area of the breeding reservoirs (Baker, Beebee, Buckley, Gent & Orchard, 2011). Such water bodies – situated very close to the river itself – are being permanently destroyed during the maintenance works, what seriously limits the possibilities of spreading out of the amphibians (Collins, 2010). The number of shallow water bodies in the scarps and terraces zone was very low and in many cases just the individual specimen of the frogs or the toads were observed.

In the case of reptiles it should be taken into consideration that it is just the grass snake *Natrix natrix* (highly connected with the river) what it seems to be the most important species of that class connected with the river valleys eco-systems. It is still relatively common in Poland, but strictly protected and the possibilities of free migration alongside the river valleys – even just in local scale – should be saved.

The case of the birds seems to be most controversial in the aspect of the conservation works undertaking on small river – only two species (kingfisher *Alcedo atthis* and – to a lesser extent – common sandpiper *Actitis hypoleucos*) – observed in the Kraska valley are strictly connected with the riverbed and might be seriously affected by the destruction of the bank structure (sandbars or slopes). However, it has to be taken into consideration that a lot of bird species – especially most valuable ones – are shy and the disturbances connected with the works in the valley (especially the noises) may discourage them to nest or even visit such sites (Wiącek, Polak, Kucharczyk & Zgorzałek, 2014). It seems to be very important in the aspects of the arguments given by the supporters of the regulation/maintenance that the spatial range of such works do not affect the taxa linked to the outer fragments of the valley (basically the slop-and-terraces zone). The results of the birds inventory in the Kraska valley point out the opposite relation – the rarest and more valuable species unconnected directly with the river: the hen harrier *Circus cyaneus*, the white-tailed eagle *Haliaeetus albicilla*, the Eurasian hobby *Falco subbuteo* and the bluethroat *Luscinia svecica* were observed only on close-to-nature reaches, despite their low share in the total river length. Probably it is connected with the lack of human activity on "natural" reaches and the presence of quite dense trees and shrubs coverage. Such enclaves are usually destroyed or damaged during the maintenance/regulation works.

The spatial distribution of mammals also confirms the negative impact of the regulation/maintenance works on the eco-system, although that group of animals are highly mobile and may quickly react for sudden changes in the environment. The exact horizontal range of the effects of mentioned human activities is hard or impossible to determine, because it depends on individual preferences of the species or even the specimen. But the obtained results point out that such range is much wider that it is generally considered. The large accumulation of the impacts should be taken into account (the destruction of the vegetation, the noise, the change of the landscape structure). Generally, in the case of corridors of free migration, in many cases they are strictly connected with the rivers, even when the migrating species are not dependent on water – for example the Eurasian wolf *Canis lupus* migration in north-eastern Poland (Huck et al., 2010). The small river valleys acts like the capillaries in the blood system and are especially important in the processes of the short-distance, as well as the long-distance migrations (Naiman & Rogers, 1997; Nowak & Mysłajek, 2010).

The environmental threats of the great importance, even in the small-scale, connected with the maintenance/ /regulation of the rivers, are the fragmentation of habitats and habitat loss. On its total length of 28.9 km, the Kraska has 49 hydraulic structures (the majority of them are the bridges and the culverts).

The similar situation is frequent on other Polish small rivers, what impairs their ecological values, as well as the migration possibilities of various animals (Cieszewska, 2004).

The most common misconception about the impact of the regulation/maintenance works on the river valley is that such works change only the structure of the riverbed and perhaps the bank zone, without any influence on the organisms living in outer parts (Żelazo, 2009). However it is very hard to determine how particular species would react on changes in its environment – especially in the case of the birds and the mammals, which need the shelters such as waterholes, continual fragments of the high and low vegetation or other covers. Changes of the river surroundings triggered by the use of heavy equipment and associated pollution and noise are also to be considered as pressures on riverine environment on top of defined impacts of river maintenance to the riverbed itself. The example of Kraska valley convincingly demonstrates strong negative impact of the regulation/maintenance works on the vertebrates living in the scarps and terrace zone, especially birds and mammals.

It is commonly noticed that the regulation works, performed on the small rivers, do not fulfil their flood protection tasks (Kiedrzyńska, Kiedrzyński & Zalewski, 2015). They may and should be realized in the populated areas or the ones with intensive farming/gardening, but in major part of the Kraska valley the terrace-and-slopes areas are mostly wastelands, low-class pastures and the uninhabited areas covered by the seminatural vegetation. There are perfect for the natural retention purposes, which would be linked to the increasing in the general flood safety and the environmental values of the valley. The program of the regulation/maintenance works seems to be inadequate to the real necessities of the surrounded area and incompatible with the idea of sustainable development. Even where it must be realised – for various purposes – it should be taken into consideration that such activity should be performed in the least invasive manner, with leaving even the smallest "natural" structures, which may be the ones of great importance, for example for invertebrates or fish, and in consequence contribute to maintenance of ecological balance and average landscape attractiveness. It is very important in the aspect of sustainable development.

Conclusions

1. The small lowland river valleys, such as the Kraska's valley, are valuable eco-systems which can be considered as an enclaves for rare animal species (biological diversity hotspots). The maintenance/regulation works perturb their functioning and cause the decreasing in the biological diversity.
2. Unmanaged river reaches are characterized by higher biological diversity and the abundance of valuable taxa than the regulated/maintained ones.
3. The small river valley is able to recover its invertebrate fauna diversity in a relatively short time, especially when the valuable structures of the riverbed were remained.

4. The regulation or maintenance works in the small rivers, undertaken for flood protection, should be preceded by the careful environmental surveys.

References

Baker, J., Beebee, T., Buckley, J., Gent, A. & Orchard, D. (2011). *Amphibian Habitat Management Handbook*. Bournemouth: Amphibian and Reptile Conservation.

Bączyk, A., Wagner, M., Okruszko, T. & Grygoruk, M. (2018). Influence of technical maintenance measures on ecological status of agricultural lowland rivers – systematic review and implications for the river management. *Science of the Total Environment*, *627*, 189-199.

Beisel, J.N., Usseglio-Polatera, P., Thomas, P.S. & Moreteau, J.C. (1998). Stream community structure in relation to spatial variation: the influence of mesohabitat characteristics. *Hydrobiologia*, *389*, 73-88.

Błachuta, J., Picińska-Fałtynowicz, J., Czoch, K. & Kulesza, K. (2010). Abiotyczne typy wód płynących w Polsce. *Gospodarka Wodna, 5*, 181-191.

Breń, Ł. (Ed.) (2018). *Miejscowy plan zagospodarowania przestrzennego dla części wsi Jeziórko – Ustanówek i Ustanów – rejon PKP – Etap I*. Prażmów: Usługi Urbanistyczne Łukasz Breń.

Callow, P. & Pettes, G. (Ed.). (1992). *The River Handbook*. Vol. 1, 2. Oxford: Blackwell Scientific Publications.

Cieszewska, A. (red.). (2004). Płaty i korytarze jako elementy struktury krajobrazu – możliwości i ograniczenia koncepcji. *Problemy Ekologii Krajobrazu 14*.

Collins, J.P. (2010). Amphibian decline and extinction: what we know and what we need to learn. *Diseases of Aquatic Organisms*, *92*(2-3), 93-99.

Dlamini, V., Hoko, Z., Murwira, A. & Magagula, C. (2010). Response of aquatic macro-invertebrate diversity to environmental factors along the Lower Komati River in Swaziland. *Physics and Chemistry of the Earth, Parts A/B/C*, *35*(13-14), 665-671.

Huck, M., Jędrzejewski, W., Borowik, T., Miłosz--Cielma, M., Schmidt, K., Jędrzejewska, B., Nowak, S. & Mysłajek, R.W. (2010). Habitat suitability, corridors and dispersal barriers for large carnivores in Poland. *Acta Theriologica*, *55*(2), 177-192.

Jagiełło, J. (2014). *Jeziorka, Świder, Wilga, Okrzejka oraz ich dopływy*. Warszawa: Wydawnictwo Ciekawe Miejsca.

Kiedrzyńska, E., Kiedrzyński, M. & Zalewski, M. (2015). Sustainable floodplain management for flood prevention and water quality improvement. *Natural Hazards*, *76*(2), 955-977.

Naiman, R.J., Rogers, K.H. (1997). Large animals and system-level characteristics in river corridors. *BioScience*, *47*(8), 521-529.

Nowak, S. & Mysłajek, R.W. (2010). Habitat suitability, corridors and dispersal barriers for large carnivores in Poland. *Acta Theriologica, 55*, 177-192.

Oglęcki, P. & Komorowski, H. (2004). The environmental evaluation of the Kwacza River mouth-reach in the light of sustainable development. *The natural spawning of Atlantic salmon and sea trout – the protection and forms of supporting* (pages 63-68). Krzynia.

Oglęcki, P. & Pawłat, H. (2000). The index method of small lowland river environmental evaluation. *Annals of Warsaw Agricultural University. Land Reclamation*, *30,* 37-43.

Rinaldo, A., Gatto, M. & Rodriguez-Iturbe, I. (2018). River networks as ecological corridors: A coherent ecohydrological perspective. *Advances in Water Resources*, *112*, 27-58.

Sender, J. & Maślanka, W. (2018). Natural Values of the Urban River Valley and the Possibilities of its Development – Bystrzyca River Valley Study Case (Poland). *The Journal of Lucian Braga University of Sibiu*, *20*(2), 85-102.

Wiącek, J., Polak, M., Kucharczyk, M. & Zgorzałek, S. (2014). Wpływ hałasu drogowego na ptaki. *Budownictwo i Architektura*, *13*(1), 75-86.

Żelazo, J. (2009). Wybrane problemy zabudowy rzek o szczególnych wartościach przyrodniczych. *Nauka, Przyroda, Technologie*, *3*(3), 110.

Summary

The environmental and landscape values of the small lowland river valley and their threats on the example of the Kraska River (Masovian Voivodeship). The environmental and landscape values of the Kraska River Valley as the typical example of small lowland water flow path were analysed. The WULS-SGGW method, allowing to the estimation of whole valley reach as well as its peculiar eco-morphological zones, was used. The unregulated, regulated in the years 1990–2012 and continuously maintained from the year 2015 reaches are present in the valley. It was stated that the unregulated reaches characterise themselves by higher environmental values and biological diversity, especially in the case of invertebrate fauna. The invertebrates, as the key element of the river community, quickly rebuild their structure after the termination of maintenance works. The vertebrate fauna, even unconnected strictly with the riverbed, shows higher values on the unmaintained valley reaches.

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