

Practical and environmentally significant method of hydromorphological assessment of rivers

Méthode pratique et significative en termes d'environnement pour l'évaluation hydromorphologique des rivières

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RÉSUMÉ

Les méthodes d'évaluation de la qualité hydromorphologique des rivières s'appuient soit sur des procédures de type « River Habitat Survey » (basée sur un grand nombre des paramètres d'habitat évalués in situ) soit sur une approche cartographique (type « Norme Européenne EN-15843 »). Nous présentons une méthode basée sur l'approche « Norme Européenne EN-14614 », offrant un compromis entre les besoins pratiques de son application et la signification environnementale des résultats. La qualité hydromorphologique de la rivière Biała (dans les Carpates polonaise) a été déterminée pour 10 paires des sections transversales (naturelles et canalisées), situées entre les affluents importants par des spécialistes des disciplines suivantes : géomorphologie fluviale, hydrobiologie et ingénierie. La qualité hydromorphologique est dégradée dans les sections canalisées de la rivière à cause des modifications de la géométrie du lit fluvial et des berges, de la limitation de la mobilité latérale du chenal et l'interruption de la connexion latérale entre la rivière et la plaine d'inondation. En effet, de moindres différences dans la qualité des habitats entre sections naturelles et sections canalisées ont été identifiées comme liées au substratum du lit, à la végétation du lit mineur et aux débris organiques, et à la modification de la continuité longitudinale de la rivière.

ABSTRACT

Methods used to assess the hydromorphological quality of rivers vary between procedures requiring field-based evaluation of a large number of habitat parameters (River Habitat Survey) and map-based assessments of the river state (European Standard EN-15843) which are fast but of little use for river restoration practice. We present a method based on the European Standard EN-14614, which compromises between the needs for practical application and the environmental significance of the results. Based on the assessment made by specialists in fluvial geomorphology, hydrobiology and river engineering, the hydromorphological quality of the Biała River, Polish Carpathians, was determined in 10 pairs of unmanaged and channelized cross-sections located between significant tributaries. Degradation of hydromorphological quality in the channelized cross-sections mostly reflected constraints on lateral channel mobility, disruption of lateral connectivity of river and floodplain, and modifications to channel geometry, bank structure and land use in the river corridor. In turn, the lowest differences in habitat quality between both cross-section types were identified with respect to bed substrate, in-river vegetation and organic debris, and modifications to longitudinal river continuity.

KEYWORDS

Human impact, hydromorphological evaluation, hydromorphological river quality, mountain river, reference conditions.

1 INTRODUCTION

During the last two decades it has become increasingly evident that loss of the ecological integrity of rivers results not only from the degradation of water quality but also from human alterations to the physical structure of the riverine ecosystems. Physical habitat conditions for riverine biota were termed hydromorphology and a number of methods were developed to assess hydromorphological quality of rivers, including modifications to the flow regime, impacts of artificial barriers on biota migration, water flow and sediment transport, and modifications of river channel and floodplain features. Most of these methods require field-based evaluation of a large number of physical habitat features (e.g. River Habitat Survey in UK) and neglect processes and channel adjustment trends. On the opposite side there is the recently published European Standard EN-15843 (CEN 2010) providing methodology for map-based assessments of the river state which are fast but of little use for river restoration practice. Below we outline a method based on the European Standard EN-14614 (CEN 2004), which compromises between the needs for practical application and the environmental significance of the results. Results of the application of the method are presented for 10 pairs of closely located unmanaged and channelized cross-sections of the Biała River, Polish Carpathians.

2 METHOD DESCRIPTION

Hydromorphological river quality was assessed through scoring of 10 groups of features of the channel, river banks, riparian zone and floodplain, according to their specification in the European Standard EN-14614 (CEN 2004). With considerable land use changes in the Biała catchment since the 19th century, reference hydromorphological conditions were not derived from historical information. Instead, they were considered as those which exist or would exist under present environmental conditions in the catchment but without human influence on the channel, riparian zone and floodplain of the river (cf. Wyzga et al. 2009). The hydromorphological assessment was preceded by field inspection of the cross-sections and presentation/discussion of three types of information. First, a near-natural and extremely modified state of each evaluated feature of the Biała was indicated, with the whole spectrum of conditions between these extreme states left for expert evaluation. Second, the contemporary state of the river was indicated by presenting diagrams of the evaluated cross-sections and river appearance in particular cross-sections on orthophotos and ground photos. Third, the river change, which occurred in the vicinity of the cross-sections over the past few decades, was analysed using aerial photos and maps from the second half of the 20th century. This was intended to indicate both artificial modifications to the river and trends of channel adjustment.

The assessment was made simultaneously by specialists in fluvial geomorphology, hydrobiology and river engineering. Each assessed feature was scored on the scale from 1 (for near-natural conditions) to 5 (for extremely modified conditions). The aggregated scores for evaluated cross-sections, averaged from the scores of particular experts, were calculated as a mean of the scores for 10 assessed categories. These aggregated scores allowed each of the cross-sections to be associated with a particular class of hydromorphological quality.

3 RESULTS

The evaluated cross-sections are located in the reaches of the Biała where erodible river corridor is to be established. It was therefore important to determine the hydromorphological state of the river at the beginning of the restoration project and to identify which features of the Biała especially need improvement. The unmanaged cross-sections obtained scores between 1.36 and 2.14, with the mean of 1.85 allowing to classify them into Class 2 of hydromorphological quality. Scarce occurrence of vegetated islands and woody debris in the river as well as modified land use structure on the floodplain were the features mostly responsible for the lowered quality of the river in the cross-sections (Table 1). Channelized cross-sections were scored between 2.90 and 3.55, falling into Class 3 (mean score: 3.18). Degradation of hydromorphological quality in the channelized cross-sections mostly reflected constraints on lateral channel mobility, disruption of lateral connectivity of river and floodplain, and modifications to channel geometry, bank structure and land use in the river corridor (Table 1). Unmanaged and channelized cross-sections differed significantly in the overall hydromorphological quality and statistically significant differences were also found for all assessed categories of the river state (Table 1). The most pronounced differences between both types of river

cross-sections related to changes in channel geometry and flow hydraulics, the occurrence of erosional and depositional features in the channel, changes in bank structure, vegetation in riparian zone and the degree of lateral connectivity and channel mobility. In turn, the lowest but still significant differences in habitat quality between both cross-section types were identified with respect to bed substrate, in-river vegetation and organic debris, and modifications to longitudinal river continuity (Table 1).

Table 1. Mean scores given in particular assessment categories to unmanaged and channelized cross-sections of the Biała River and the results of a Wilcoxon test for the significance of difference of mean scores between both cross-section types

| Assessment category | Mean score for unmanaged cross-sections | Mean score for channelized cross-sections | p value of Wilcoxon test |
|--|---|---|--------------------------|
| Channel geometry | 2,22 | 4,05 | p = 0,005 |
| Substrate | 1,54 | 2,18 | p = 0,015 |
| In-river vegetation and organic debris | 3,01 | 3,69 | p = 0,008 |
| Erosion/deposition character | 1,68 | 3,30 | p = 0,005 |
| Flow | 1,73 | 2,63 | p = 0,005 |
| Longitudinal river continuity | 1,04 | 1,64 | p = 0,02 |
| Bank structure | 1,44 | 3,43 | p = 0,005 |
| Vegetation/land use in riparian zone | 1,69 | 3,05 | p = 0,005 |
| Land use in the river corridor | 2,44 | 3,45 | p = 0,009 |
| Lateral connectivity/channel migration | 1,68 | 4,41 | p = 0,005 |
| Average score | 1,85 | 3,18 | p = 0,005 |

4 CONCLUSIONS

The above presented method of hydromorphological assessment utilizes information derived from field inspection, contemporary river images and aerial photos/maps from the past decades. The latter source of information does not provide historical reference conditions but enables to place contemporary physical river features in the context of ongoing processes and trends of river adjustment. The evaluation requires professional knowledge and gathering specialists in various disciplines. As the opinions of particular experts reflect views from different perspectives, their averaging yields more objective results than it would with a single surveyor. As a consequence, the method gives reliable results and indicates precisely which features of the river ecosystem require improvement at a given location, hence providing a basis for informed decisions about river restoration.

This study was performed within the scope of the Research Project N N305 097239 financed by the Polish Ministry of Science and Higher Education.

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