

Hydro morphological assessment of the Porubka river

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Abstract: Results of monitoring hydromorphological assessment of the Porubka watercourse, use the method HEM - Hydroecological monitoring, are presented in this article. HEM is based of the evaluation not only of main stream, as morphology and hydrology parameters, but of the same evaluation flood plain. The ecological status of river ecosystems is usually evaluated following hydromorphological features of riverbed, flow regime and river continuity, and was applied for the effect of proposed restoration measures. Ecohydrological quality by the method HEM classes was established from 1 (high) to 5 (bad), characterizing the state of the water course.

1. Introduction

The issue of hydro morphological assessment of watercourses is based on scientific disciplines such as fluvial geomorphology, whose foundations are in the monograph Demek [1]. Today, the authors follow him as Králová [2] ; Šindlar [3,4] ; Hradecký [5] ; Máčka [6] and foreign authors as Rosgen [7]; Goudie [8]; Naiman [9]. The Czech Ministry of the Environment approved individual binding methodologies to monitor and evaluate the components of surface water ecological status: Kokeš, Němejcová [10]; and Langhammer [11,12]. The European Water Framework Directive (WFD) became the fundamental basis for any water policy-related action of the European Community[13].

The method Langhammer [11,12] is complex assessment method integrating morphological, hydrological elements, of river basin and of flood plain for evaluating eco hydrological quality river and its basin. The analysis of hydrological alterations that occur at shorter time scales, that have very important effects on ecological communities.

2. Materials and methods

2.1. Locality selection

Hydromorphological monitoring data are collected in case study areas river basin Porubka. The Porubka River is one of the smaller tributaries of the left-middle portion of the Odra. It ends into the Odra in the city of Ostrava-Svinov at an altitude of 210m above sea level, and rises in 390m below the village Pusta Polom. The total length of the river Porubka, from it's source to the mouth, is 20.1km. The length of mapping main stream, in case study areas, is 11.00 km, from 8.46 flow km to 19.46 flow km. It was mapping 29 river sections, were selected according the method Langhammer [11,12]. There are the key criteria for mapping homogeneity of river sections, as typology of watercourse and channel route and the character of the riparian zone and the floodplain. The gradient changes were selected as a new river section.



2.1.1. The Porubka watercourse in select section 016, HOD_0170_POR_016 (cadastral area Dolní Lhota – Ostrava)

The section 016 (figure 1) (the 16th sections from the source Porubka, upper section in river basin) has the length section 550m, because the change homogeneity is after 550 m. Channel flows parallel to the tram line, in this section watercourse branches two parallel channels (016a and 016b) and its left branch supplies the ponds system. The land use in this section are meadows, line vegetation, forests.

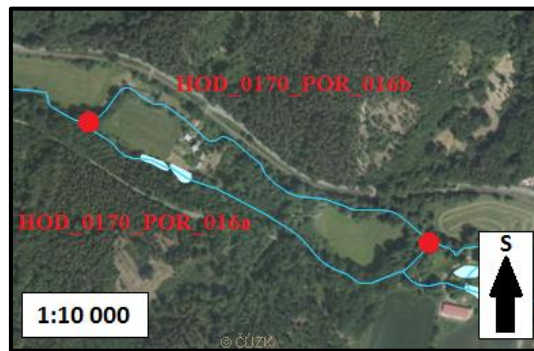


Figure 1. Locality select section 016 - 016a and 016b, (geoportal.gov.cz, 2015).

2.2. Methodology HEM

HEM methodology considers 17 parameters in 3 mapped zones (channel, bank zone, inundated land). An overview of parameters assessed according to HEM, weight of individual parameters and zonation, see Table 2. The different weight is set to represent the impact of parameters that are of major importance to hydromorphology of rivers. Then the overall hydromorphological quality value for each reach is calculated as the arithmetic mean of 3 zones.

2.2.1. Laboratory practice

These assignments were suggested for laboratory practice (inside). Preference a suitable watercourse, evaluating significance, diversity, availability, overall status of suitable river. To assign of the watercourse type according to the Langhammer methodology [14], which is combination of 4 parameters (sea level, altitude, geological subsoil, Strahler stream order - numerical measure of its branching complexity). Its necessary theoretical determine of the river sections, according the river length in topography maps (1:10000) of the case study areas: minimum size of the river length is 100m, for a small watercourses, the channel width up to 10m. Theoretical preparation for stream evaluation (e.g. river curvature or sinuosity or braiding), use of distance data (e.g. historical maps of I and III Military mapping, orthophotomaps, geoportals) [11,12].

2.2.2. Terrain practice

These assignments were suggested for terrain practice (outside). Terrain mapping is for verification of map data, measuring with GPS (eTrex Vista HCx, Garmin, and laser rangefinder (PMDL 5 A1 Multifunction Detector), camera (Olympus FE-46). Mapping to prescribed forms, these forms are in the method HEM [11,12]. Prescribed forms design morphological parameters, e.g. channel route (TRA), depth variations (VSK), type of profile (VHL), depth of profile (VHP), width variation (BMK), substrate type (DNS), bed-fixing (UDN), dead wood (MDK), special bottom structures (STD), bank impairments (UBR), bank vegetation (BVG), land use in flood plain (VNI). Prescribed forms design hydrological parameters, e.g. flow variations (PRO), hydrological regime discharge (OHR). Necessary to design river continuity, e.g. migration barriers (PPK) and flood plain barriers (PIN) [11,12].

Hydro morphological characteristics, by method HEM, All 29 river sections were mapping from May 2015 to November 2016.

Table 1 (complete 17 parameters, e.g. morphological conditions, e.g. hydrological regime, e.g. continuity equation) were mapped in three zones of the Porubka watercourse, as channel, riparian zone - outside banks and widens its valley, respectively flood plain. The selected parameters are evaluated for the right bank and the same for the left bank. The mapping results must be written to prescribed forms [11,12]. All 29 river sections were mapping from May 2015 to November 2016.

Table 1. Mapping parameters of the method HEM, modified [11,12].

Zone	Parameter	RSV Quality Components
Channel	Channel way adaptation (TRA)	morphological conditions
	Variability channel width (VSK)	morphological conditions
	Variability recess longitudinal profile (VHL)	morphological conditions
	Variability depths cross profile (VHP)	morphological conditions
	Bottom sediment (DNS)	morphological conditions
	Bottom upgrade (UDN)	morphological conditions
	Dead wood in channel (MDK)	morphological conditions
	Bottom structures (STD)	morphological conditions
	Flow stream (PRO)	hydrological regime
	Hydrological regime influence (OHR)	hydrological regime
Bank zone	Longitudinal permeability (PPK)	continuity equation
	Bank management (UBR)	morphological conditions
	Bank vegetation (BVG)	morphological conditions
Inundated land	Land use outside bank (VPZ)	morphological conditions
	Land use in flood plain (VNI)	morphological conditions
	Permeability flood plain (PIN)	continuity equation
	Bank stability and lateral migration of the channel (BMK)	morphological conditions

2.2.3. Evaluation methodology

The method HEM calculated as the weighted mean of all parameters, as morphological conditions, as hydrological parameters, as continuity equation. The different weight is set to represent the impact of parameters that are of major importance to hydromorphology of rivers. The quality of the river section is calculated as HMS (hydromorphological score), see equation (1), weighted average of individual indicators. The methodology accurately determines either universal or specific evaluation matrices (universal for all types of watercourses, specific to the typology of the river stream, e.g. k_{dns_typ} , matrix value based on the river stream type of the bottom substrate. For parameters where left bank and right bank are evaluated in particular, the worst score value is used higher number. The weights of individual pointers for different watercourse typology groups are set based on expert estimation and subsequent calibration, based on sample flow mapping of each type [11,12]. The weight variability for weight scoring shows the importance of each parameter.

Calculation of hydromorphological score **HMS**

$$HMS = \frac{TRA \cdot k_{tra_typ} + VSK \cdot k_{vsk_typ} + VHL \cdot k_{vhl_typ} + VHP \cdot k_{vhp_typ} + DNS \cdot k_{dns_typ} + UDN \cdot k_{udn_typ} + MDK \cdot k_{mdk_typ} + STD \cdot k_{std_typ} + PRO \cdot k_{pro_typ} + OHR \cdot k_{ohr_typ} + PPK \cdot k_{ppk_typ} + UBR \cdot k_{ubr_typ} + BVG \cdot k_{bvg_typ} + VPZ \cdot k_{vpz_typ} + VNI \cdot k_{vni_typ} + PIN \cdot k_{pin_typ} + BMK \cdot k_{bmk_typ}}{4} \quad (1)$$

$$HMK_{VU} = \frac{\sum_{i=1}^n HMS_i \cdot Li}{\sum_{i=1}^n Li} \quad (2)$$

HMKVU is the hydro morphological quality of the watercourse, see equation (2), which is calculated as the weighted mean of the HMS value but the weight is channel width (L) and (n) is the number of the assessed sections within the water[14]. The overall state of the watercourse, water body is ranked in the grade of 1-5, where the score $\geq 1 < 1.5$: close to nature (grade 1), $\geq 1.5 < 2.5$: poorly

modified (grade 2), $\geq 2.5 < 3.5$: moderately modified (grade 3), $\geq 3.5 < 4.5$: highly modified (grade 4), $\geq 4.5 < 5$: strongly modified (grade 5) [11,12].

3. Results

The testing of this methodology HEM, took place in the Porubka watercourse, at 8.46 flow km to 19.46 flow km, overall 29 sections with a gradient of change of the above mentioned parameters were mapped. The type of watercourse is 222, rivers of medium heights (200-500m.n.m), the Baltic, the sedimentary rocks (sandstone, claystone, quaternary). A sample of mapping and scoring of the Porubka watercourse is shown in the example of the section 016, see Table 2. It isn't possible to describe all results, because there's limit length of the article.

Table 2. Example of the scoring section 016 (016a and 016b), of the Porubka watercourse.

Section number			016a	016b
Lenght [m]			548	550
Zone	Parameter	Weight		
Channel way	TRA	1	1	1
	VSK	0.10	1	1
	VHL	0.10	1	2
	VHP	0.10	2	2
	DNS	0.10	2	2
	UDN	0.25	1	1
	MDK	0.10	2	3
	STD	0.15	3	3
	PRO	0.10	1	1
	OHR	0.10	1	1
	PPK	0.50	1	2
	UBR	0.25	1	3
Riparian zone	BVG	0.15	2	2
	VPZ	0.40	2	2
	VNI	0.30	2	2
Inundated land	PIN	0.15	1	5
	BMK	0.15	2	3
HMS			1.400	1.888

HMSPOR_016a, section 016a, has a value of 1,400, see Table 2, which puts in the first class, its status is close to nature. HMSPOR_016b, section 016b, has a value of 1,888, see Table 2. **Chyba! Nenašel sa žiaden zdroj odkazov.,** which puts in the second class, its state poorly modified. The worse quality is given by the parallel tramway, respectively limitation of the floodplain and water management of the right bank. The best results were given in individual zones, respectively channel and the Porubka planform, classified in quality class 1 and quality class 2. The worst quality status is on the banks, where all the quality classes are represented as well as class 5, because the banks impairments. If it was scored by scoring of individual sections, the worst quality class is 3, in the intravilan. 13 sections are assessed by quality class 1. The Porubka watercourse is generally evaluated by the second class of hydro morphological quality (HMS), with a total length of 11.3 r.km [15].

4. Conclusions

The problem of the methodology [11], is with the scoring assessment, where the quality class is up to 1 point higher, it is necessary to perform field practice. That are time consuming, because the seemingly the same sections, e.g. extravillan, may have different weight parameters that affect the quality of these parameters. Due to the size of the article, it is not possible to describe all in detail. It is possible to simplify such a comprehensive methodology by summarizing the positive and negative aspects of this methodology.

Positive aspects are: Implementation of legislation and standards, already mentioned above. Mapping form is brief, clear. Well-handed manual for prescribes forms. Calculation of the score uses weighted average method. Negative aspects are: Name of the methodology, it isn't hydro-ecological monitoring but its suitable title as hydro morphological monitoring, because this method maps mainly hydro morphological quality. Mapping period recommended according to methodology (September-October), but to map hydrological regime inappropriate due to minimum depths. Mapping parameter (only supplemental) as invasive species poorly identifiable, some species are without inflorescence. Estimates of some parameters – e.g. depth variability can't be estimated, but must be measured. Determination of bottom substrate fractions is required by grain analysis. Scoring principle - according to the methodology the higher the number of categories, the higher the quality, which may not be relevant. For example, natural flows may not be such variability and the quality of morphological and hydrological parameters is high. HMS has RSV significance in the environmental assessment of watercourse quality. This methodology, mainly in the mapping form, doesn't distinguish small river as torrent. The main objective of this methodology is the creation of documents for revitalization studies, as part of flood control measures. The method seems to be applied to all water bodies at least in CR. The Czech HEM method that additionally comply with the requirements of the European Standard EN 14614 [16].

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