UDK 502.1

HYDROMORPHOLOGICAL ASSESSMENTS AT THE IRPIN RIVER – METHODOLOGICAL HINTS AND FIRST FINDINGS

M. HOFFMANN, Doctor of Natural Sciences
A.F. SALIUK
Institute of water problems and land reclamation NAAS

Practical hints are given to ease the planning and implementation of habitat assessments in terms of hydromorphological elements as described in the WFD. A reach of the r. Irpin, located between 2 impoundments, was classified as partly moderate and partly good
Keywords: *hydromorphological assessment, WFD, Irpin River, meander migration, HMWB*

Background information. The implementation of the Water Framework Directive (WFD [1]) in Ukraine creates a big amount of problems including lack of sufficient funding and technical and scientific questions of its practical realisation. As a consequence, officially monitored data related to the chemical water quality are still insufficient and results of hydromorphological assessments and regular WFD-compatible hydrobiological investigations are even missing or restricted to random investigations. So far, assessments of the hydromorphological *elements* have been applied only at a few selected rivers as, for example, at the Kyiv City Rivers [2] and the Tisza River and its tributaries [3].

Methods. For the methodological approach instructions are given in the WFD and more detailed in the related CIS Guidance Documents EN 14614:2004 "Water Quality – Guidance standard for assessing the hydromorphological features of rivers", and EN 15843:2010 "Water quality – Guidance standard on determining the degree of modification of river hydromorphology". This includes, among others, the initial characterisation of the type of water-bodies [4], reference conditions and a description of the river (applying "system A" or ".. B") as lined out in the WFD.

For the hydromorphological classification further decisions are made to determine the optimal investigation approach. In particular, it is possible to support and complete field investigations by aerial and satellite imagery and by GIS-based eco-hydrological modelling. For the here described assessments, a 5.6 km long reach of the Irpin River between Didivshchyna and Tomashivka (Kyiv Oblast) was selected. Before beginning with field observations (in July 2015), Google Earth has been used to register first characteristics related to river course, vegetation on the river bank, in its proximity and land uses in the river valley. Besides, Google Earth provided the possibility to compare landuse changes over the years. SRTM imagery [5] was used to determine topography and possible location of water resources, Landsat 8 satellite imagery [6] to register spreading of impoundments and wetlands.

The final results have been integrated into a GIS and GIS-based modelling to better recognise the context with anthropogenic impacts like the change of water flow in the river basin, changes of impoundment sizes, erosion risks and land uses that have been mapped earlier. Maps were also used to more accurately determine the meander migration rate being important for the classification (method described in [12]).

Hydromorphological elements that should be investigated *in support of the biological elements* (WFD) can be summarised into 6 main groups that have been investigated as indicated in table 1.

The article has its focus on field investigations being the main and most accurate information source. A rough literature review has shown that the methods used in various EU member states are only slightly different. The German system, described hereinafter, is just an example. It uses 25 parameters for each 100-meter section of a water body that can be aggregated to 6 main parameter groups, like channel development (e.g. meandering, longitudinal profile, cross profile, sole and bank structures, river surrounding). To ease the investigations, a protocol was prepared on the basis of the German Guidance Document (LAWA [9]). The protocol section concerning river course and profiles is shown in figure 1. It contains text and graphical elements to ease the choice of answers. For the final ranking a MS Access program [10] was used that differentiates 7 classes; for a preliminary assessment and comparisons, these classes have been converted into 5, similar to the scheme used in [11].

1. Main groups of hydromorphological elements (left) [7] and methodological approach (r.h.s.)

Quantity and dynamics of water flow	Analysis of river discharge data (station Yablunivka) and SWAT modelling results
Connection to groundwater bodies	Measurement of groundwater levels in 6 village wells, calculations based on topography [8]
River continuity	Use of Google maps, field visit
River depth and width variation	On-site investigation
Structure and substrate of the river bed	On-site investigation
Structure of the riparian zone	On-site investigation

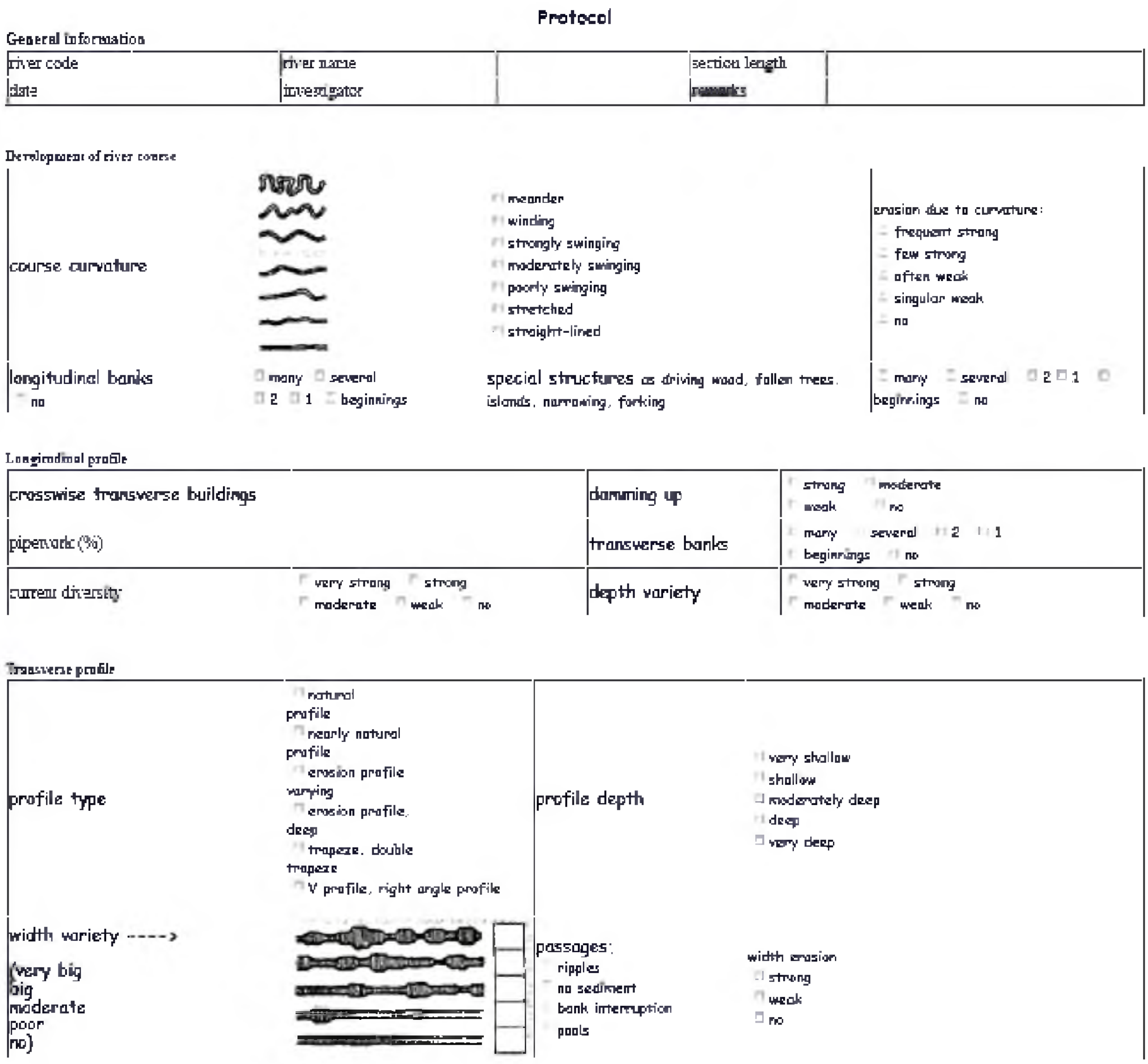

Fig. 1. First part of a field protocol for hydromorphological assessments (mainly derived from [8])

Research results. The final results of hydromorphological classification are presented in figure 2; individual monitoring results have been composed exemplary in table 2. As outlined earlier the focus of the hydromorphological assessments is on the river channel and nearby habitat structures. It is obvious that the river course has been changed in the first km section beginning at the weir in Didivshchyna while thereafter the river meanders downstream until it reaches the next impoundment near Tomashivka. This is one of the main reasons why the ecological potential of the river reach was classified as moderate (white/black striped on figure 2) and further downstream as good (white colour).

Fig. 2. Hydromorphological classification of the river reach between Didivshchyna and Tomashivka, Kyiv Oblast (colour codes: striped line – moderate, solid white line – good potential)

2. Extract of results logged during on-site investigation

General information			
Date	15.07.2015	15.07.2015	15.07.2015
Section code	2	8	20
Section length	100-200 (100m)	800-900 (100m)	4000-4200 (200m)
Development of river course			
Course curvature	poorly swinging, no erosion due to curvature	moderate swinging, singular weak erosion due to curvature	winding, strong erosion due to curvature
Longitudinal banks	no	no	no
special structures (driving woods, fallen trees, island, narrowing, forking, etc)	2	several	few

Продовження табл. 2

Longitudinal profile			
Current diversity	weak	moderate	strong
Damming up	no	no	no
Transverse banks	no	no	no
Depth variety	no	moderate	moderate
Transverse profile			
Profile type	wide trapezoid	nearly natural profile	nearly natural profile
Profile depth	very shallow	shallow	moderately deep
Width variety	weak	moderate	strong
Passages	not detected; no width erosion	pools; no width erosion	pools; weak width erosion
River bed structures			
Substrate	sand	sand	sand
Artificial structures	no	no	no
Extraordinary structures (high current velocity, pools, back flowing, wooden matter, detritus, root squares, macrophytes, cascades)	no	several	partly
Substrate diversity	weak	weak	weak
Bank structures			
Bank vegetation	reed, bushes, meadow	natural bushes, high growing herbs, meadows	natural bushes, high growing herbs, meadows
Special structures	few	no	no
Constructions	stones	no	no
Nearby river valley/flood plain			
Type of use	houses, gardens	agriculture, gardens	forest, gardens
Natural biotopes in %; (L-l.h.s.; R- r.h.s.)	L:<10-50, R:10-50	L:<10-50, R:>10-50	L:10-50, R:>50
Unused land, %	L:<10-50, R:>50	L:10-50, R >50	L:>50, R: >50
Grassland, %	L:10-50, R:>50	L:<10-50, R:>50	L:<10-50, R:>50
Fields, gardens, forest, %	L:<10-50, R:<10-50	L:10-50, R:<10-50%	L:10-50, R:>50

Agricultural landuse is unevenly distributed in the subbasin. As can be seen on figure 3 and 4, the share of forest has decreased during the last 22 years, while settlements have grown. A rough overview of landuse shares in the investigated subbasin is given in table 3.

3. Percentage shares of landuse in the selected Irpin River subbasin

	Landuse	ha	%
1	Subbasin	174329	100
2	Agriculture	~ 115057	~ 66
3	Forest	32298	18.5
4	Settlements	23779	13.6
5	Lakes and impoundments	1748	1.0
6	Wetlands	1014	0.6

66% of the landcover could not further be classified and must be considered as agricultural landuse mainly consisting in meadows and crop fields. The two Google Earth images (fig. 3 and 4) suggest however that the share of pastures has significantly decreased over the last 22 years (1992-2015).

Fig. 3. Google Earth image taken on December 1992, converted to black and white colour
The starting point of the investigated reach (in the image centre) is marked with "A" (coordinates: UTM (35) 5'559'083 mE; 698'224 mN), the end point is "B" (UTM (35) 5'561'150 mE; 700233 mN), height difference ca. 5m. Forests are in dark gray or black colour, agricultural areas in white or light gray, villages are speckled.

Fig. 4. Google Earth image taken on December 2015; coordinates as in figure 3

Conclusions. The river reach between Didivshchyna and Tomashivka (Kyiv Oblast) did not include the existence of the nearby weirs and impoundments upstream and downstream of the section. When considering a bigger part of the Irpin, it is obvious that the river, according to the WFD, must be considered already as *heavily modified water body* ("HMWB"), mainly because of the interruption of the longitudinal continuity. Frequency of weirs and impoundment sizes by far exceed the tolerable level: the distance between impoundments should be at least 10 km, their length not more than 300 m, but some of them reach several kilometers. As a consequence the natural sediment transport capacity is strongly reduced, leading to sedimentation of inorganic and organic materials, oxygen depletion in deeper water layers, methane formation and impacts on biodiversity. Migration of fish and aquatic insects up and downstream are restricted. Resulting ecological pressures and ways of their avoidance are also described in Guidance Documents as in [13, 14] and in other literature [15, 16, 17].

Additional problems and risks of reaching a good ecological potential or status are due to the high share of agricultural land use in several subbasins while buffer zones are rather small or sometimes missing.

References

1. *Водна Рамкова Директива ЄС 2000/60/ЕС. Основні терміни та визначення. Переклад з англ. В. Лозанського. – К., 2006. – 240 р.*

2. *Хоффманн, М , Раков, В. Определение экологического состояния малых рек в черте г. Киева в соответствии с европейской водной рамочной директивой. Гидробиологический Журнал 42, 5эж, 2006; УДК 556.114:576.63+546.76; р. 46-56.*

3. *Ободовський О. Г. Гідроморфологічна оцінка якості річок басейну Верхньої Тиси / Ободовський О. Г., Ярошевич О. Є. — К. : Інтертехнодрук, 2006. — 70 р.*

4. European Communities Guidance Document No. *4 – Identification and Designation of Heavily Modified and Artificial Water Bodies*, *2003*

5. *USGS Shuttle Radar Topography Mission (SRTM); [online]: https://lta.cr.usgs.gov/SRTM*

6. *USGS Landsat Missions; [online] http://landsat.usgs.gov/*

7. *European Communities Guidance Document No.10. Rivers and Lakes – Typology, Reference Conditions and Classification Systems, 2003*

8. *Haitjema, M. and Mitchell-Bruker, S. Are Water Tables a Subdued Replica of the Topography? GROUND WATER **43**, 6, 2005, p.781–786*

9. *Laenderarbeitsgemeinschaft Wasser (LAWA) Gewaesserstrukturguetekartierung in der Bundesrepublik Deutschland – Ed. Kulturbuch; 1998; ISBN-10: 3889612334*

10. *Bay. Landesamt fuer Wasserwirtschaft MS Access program GSK-Eingabe version 1.4c; 2002*

11. *Руденко, Л.Г., Разов, В.П., Жукинський, О.П. и.д. Методика картографування екологічного стану поверхневих вод України за якістю водию, 1998– ISBN 966-95095-3-X*

12. *Hickin, E.J. and Nanson, G.C. Lateral migration rates of river bends - Journal of Hydraulic Engineering 110, 1984, p. 1557–1567*

13. *WFD Guidance Document N° 30 - Procedure to fit new or updated classification methods to the results of a completed intercalibration exercise- Techn. Report 2015 -08, 33 p.*

14. *UK Tech. Advisory Group Guidance on Morphological Alterations and the Pressures and Impacts Analyses (Final Working Paper), 2003; [online] http://www.wfduk.org/sites/default/files/Media/ Characterisation%20of%20the%20water%20 environment/ Morphological%20alterations% 20and%20the%20 pressures %20and%2 0impact%20 analyses_Draft_251103.pdf*

15. *Scotland and Northern Ireland Forum for Environmental Research. Management Strategies and Mitigation measures required to Deliver the Water Framework Directive for Flood Defence Impoundments. – Project WFD76; edition SNIFFER 2007*

16. *Lejon, A. G. C., Malm Renöfält, B., and Nilsson, C. Conflicts associated with dam removal in Sweden. Ecology and Society **14(2)**: 4; 2009 [online] http://www.ecologyandsociety.org/vol14/iss2/art4/*

17. WFD and Hydromorphological Pressures -Technical Report; November 2006. [online] https://circabc.europa.eu/sd/a/68065c2b-1b08-462d-9f07-413ae896ba67/HyMo_Technical_Report.pdf

М. Хофман, А.Ф. Салюк

Оцінка гідроморфологічного стану р. Ірпінь: методичні підходи та результати

У статті наведено методичні підходи та практичні результати оцінки гідроморфологічого стану ділянки р. Ірпінь, згідно положень ВРД ЄС. За наведеною методикою стан ділянки річки, яка розташована поміж двох штучних водоймищ, оцінено як частково добрий та задовільний.

М. Хофман, А.Ф. Салюк

Оценка гидроморфологического состояния р. Ирпень: методические подходы и результаты

В статье приведены методические подходы и практические результаты оценки гидроморфологичого состояния участка р. Ирпень, согласно положениям ВРД ЕС. Согласно приведенной методике состояние участка реки оценено как частично хорошее и удовлетворительное.