Hydromorphological inventory and map of the Drava and Mura rivers (IAD pilot study)

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Introduction

The availability of harmonised base data on hydromorphological features supporting the biological and physico-chemical parameters became a new importance under the European Water Framework Directive (WFD) to assess the ecological status of surface waters. Especially the lack of information for large rivers is evident. The pilot study reviews the existing hydromorphological inventory and assessment methodologies within European countries and highlights the recent European CEN guidance standard (CEN 2004), which offers a methodological framework for hydromorphological inventories.

Based on the reviewed methods, in particularly those for large rivers such as developed by the German Federal Institute of Hydrology (BfG) and the CEN Standard from 2004 an adapted method was prepared. From the beginning the approach was embedded in an ACCESS-Database and GIS environment. The Drava and Mura Rivers were selected for the pilot study due to the already existing data for the upper river reaches in Austria and the good data situation concerning base maps and data (historical, morphological, topographical maps as well as multitemporal satellite images) and hydrological information for the lower reaches in Croatia and Hungary. Basically the rivers are characterised by modified upper and middle course reaches by chains of hydropower plants and still free-flowing lower courses which partly high ecological values. Additionally the two rivers cover a broad range of different river types and bioregions from Alpine landscapes down to Illyric and Pannonian lowland elements.

The morphological reference conditions were extracted based on main fluvial-morphological parameters related to the river types, the sinuosity, meander development, island development and hydrological data. In summer 2005, over 350 river km of the lower Mura and Drava rivers were surveyed continuously by boat, and additionally (sampling) stretches along the middle and upper courses by surface.

Methods

Hydromorphological data for water bodies, especially for rivers, became more relevance since the European Water Framework Directive (WFD) includes hydromorphology as an additional parameter evaluating the status of surface water bodies. For the reference conditions, for the water body delineation as well as for the typology, selected hydromorphological data are already used. In addition, the designation of “Heavily Modified Water Bodies (HMWB)” as described in the WFD is depending on hydromorphological conditions. The assessment of HMWB’s requires harmonised hydromorphological inventories. Although the WFD requires only the morphological characterisation of water bodies, hydrological and sedimentological changes in river systems induced, e.g. by dams and water abstractions must also be part of hydromorphological inventories used for the risk assessment (risk of failure to achieve the

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environmental objectives) and the further management planning. First risk assessments in Europe indicate the importance of hydromorphological alterations and the need for harmonized base data. The relation between biological and chemical quality elements and the hydromorphological parameters have to be evaluated more precisely.

The development of the CEN Guidance Standard 14614 on the assessment of hydromorphological features of rivers, which was firstly published in Great Britain in 2004, is based on the experience of several national methodologies (England (RHS River Habitat Survey, Raven et al. 2002), Austria (different approaches after Werth 1992), Germany (LAWA, Verfahren für kleinere und mittlere Gewässer der Länderarbeitsgemeinschaft Wasser 2000), France (SEQ Physique)) as the most important methods and European research programmes such as the STAR which was in charge of the standardisation of freshwater methods in different fields or the AQUEM project. The following list provides a standard check list of hydromorphological features for survey and assessment according to the CEN Standard. These are grouped in 10 categories and cover the three broad zones (a-c) of river environments:

a) Channel: Geometry, substrates, vegetation and organic debris, erosion deposition character, flow, longitudinal continuity as affected by artificial structures
b) River banks / riparian zone: Bank structure and modifications, vegetation type / structure on banks and adjacent land
c) Floodplain: Adjacent land use and associated features, degree of lateral connectivity of river and floodplain and lateral movement of the river channel

1. Dividing rivers into reaches based on changing geology, valley form, slope, planform (cross-section), discharge, land use and sediment transport, 2. Survey strategy (entire stretch or sampling within a reach), 3. Scale of survey and evaluations, 4. Timing and frequency of field survey, 5. Reference conditions, 6. Bed and bank character, 7. Planform and river profile, 8. Lateral connectivity and freedom of lateral movement, 9. Free flow of water and sediment in the channel and 10.Vegetation in the riparian zone.

The CEN Standard is formulated as a guidance standard based mostly on the experiences for small and medium size rivers. The standard allows a sampling site oriented, on detailed profile data based inventory (e.g. according to the British RHS) or the continuous inventory such as in Germany, Austria or France. There is also space to adapt surveys concerning the length of surveyed river reaches and the individual assessment for left and right channel, bank and floodplain features.

Under the lead of Germans LAWA, DVWK and BfG several pilot studies on large rivers were carried out (e.g. BfG (2001) for the Elbe). On the one hand these approaches offer feature extensions for bank- and bed-building processes including specific alterations for waterways and a more precise description of the floodplain, on the other hand they need simplifications because of the reduced visibility and accessibility of under water features and the sediment characterisation. Finally they will need much more secondary input data such as hydrological and waterway transport background data or continuous remote sensing data and the portion of field work will be reduced to less than 30% in comparison to smaller rivers (60-70%).

The developed approach for the pilot study is based on the inventory for large rivers developed by the BfG (2002). Adaptations were made in the field of a more flexible individual definition of the right and left bank sections, in the rearrangement of feature groups to allow the easy extraction of WFD relevant data for the “Impact and Pressure Analysis” as well as a clear fife class evaluation system allowing summarizing screening scores to enhance the transparency and comparability. The data validation is one of the most important tasks for

the future in particularly to minimize errors of the individual estimations and to increase the comparability (a new CEN Standard is under preparation).

The field survey was prepared upon the field experience of about 2.000 river kilometers in Austria and Croatia. A lot of background material was collected since 1998 for different other projects allowing the preparation of morphological reference conditions for the lower Mura and Drava rivers. The developed ACCESS database and GIS application allow the continuous data evaluation and visualization.

Selected results

The results will focus on the definition of the morphological reference conditions and first results of the overall evaluation. Detailed feature based evaluations and statistical evaluations will be given in the final pilot study report by Schwarz (2006).

The morphological reference conditions were derived from the available historical map data since the 17th century and recent geological and geomorphological data. The reference conditions are described comparable to LUA (2003) and Rommel (2000) with the following parameters: Channel width, valley form, slope, channel morphology (development and sinuosity), channel type, lateral erosion / shifting behaviour, stream characteristics and depth variance, channel structure, channel substrate, cross sections (width variance, incision and profile depth), bank structure and floodplain. Based on the continuous data evaluation two River-Section-Types for the Mura and three river section types with sub-types for the Drava were defined (figure 1).

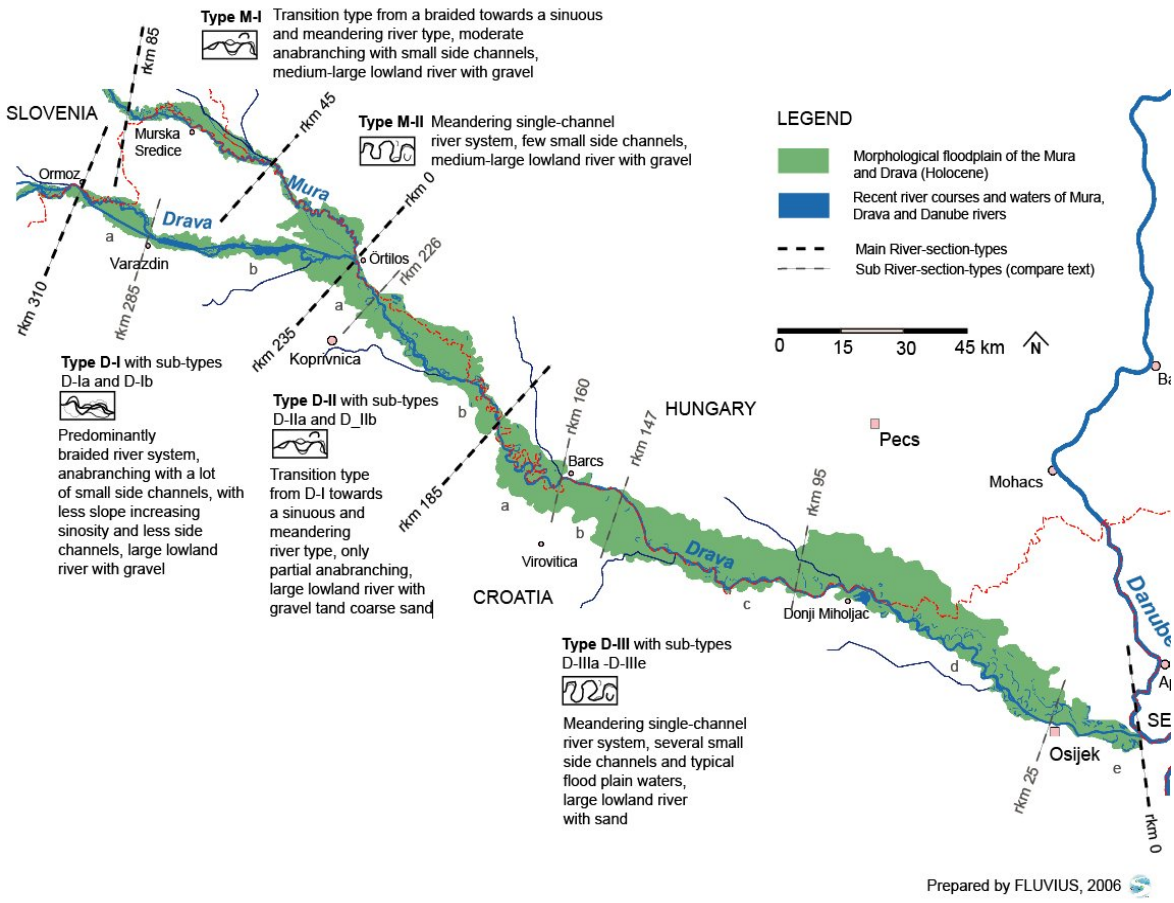

Figure 1: River-Section-Types for the lower Mura and Drava rivers

The detailed reference conditions allow the assessment of hydromorphological features according to the CEN Standard or the WFD. As an example the overall floodplain loss for the entire Drava and Mura rivers can be given with about 75% with large regional differences. The largest intact floodplain forests are concentrated on the lower river reaches.

The hydromorphological evaluation shows a high differentiation for the three main parameter groups “channel”, “banks / riparian zone” and “floodplain” divided into the right and left side. The preliminary overall evaluation indicates that about 35% of the entire river stretches fall into the class two or better (mostly along the lower stretches in Hungary and Croatia) whereas the remaining 65% contributes to the classes 3-5 (over 26% are completely modified). For the five classes (and colors) compare figure 2.

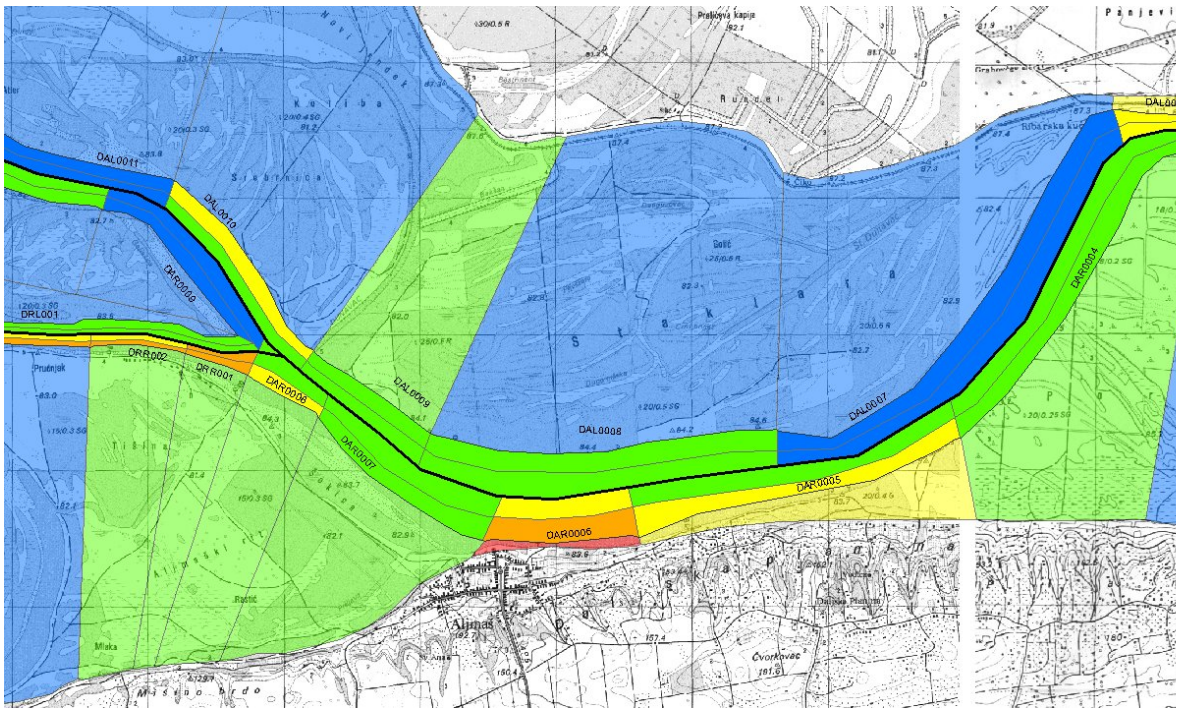

Figure 2: Map example 1: 50,000 indicating the different colors of the evaluation classes 1-5 (blue (high value), green (good), yellow (moderate), orange (poor), red (bad)) and the three main parameter groups “Channel, Banks/riparian zone and floodplain” indicated as color ribbon map (divided in the middle of the main channel by a bold black line) with transparent polygons for the recent floodplain for the left and right side.

Still impressing is the existing lower river corridor of the Drava and Mura rivers: It is evident that the rivers are able to start self- revitalisation processes of lateral erosion and shift even if there are impacted by hydrological and sedimentological deficits in the upper courses. This can be approved with comparisons of selected reference sites with the historical situation which indicate the existence of all typical morphological features today, but in considerable less quantity, as described by Schwarz (2006).

Beside a generalised overview map for the entire basin (1:1,350,000) including the Austrian data a separate map will show the hydrological alterations which are mostly visible for the hydropeaking (daily water oscillation down from the last Croatian plant Dubrava about 1.8 m, which will be reduced mostly by the good hydromorphological conditions and flow retention in side channels on the stretch downstream to Barcs (120 km) to about 30 cm, but causing colmation and a lot of problems for bank and gravel species as described by Tockner et al. (2004) and diversion stretches for hydropower generation (allocation of water). The

hydropower and the resulting hydropeaking influences the most valuable parts of the whole lowland river system as described by Schwarz (1998).

Summary

Based on a method review of existing hydromorphological inventories across Europe, an adapted method for large rivers was developed according to the CEN Standard and WFD requirements. Substantial morphological reference conditions were derived from historical data and the Drava and Mura were subdivided into River-Section-Types. A field survey by boat and surface was carried out in 2005. The reference conditions, field forms and maps were extracted from a GIS and ACCESS application accomplishing the whole project. The results show for a first time concise quantitative hydromorphological parameters for the lower Drava and Mura rivers (also in comparison with the upper reaches in Austria) and allow the assessment into five classes relevant for the WFD.

References

BFG (Bundesanstalt für Gewässerkunde) (2001): Methodenentwicklung und ökologische Kartierung von tschechischen und deutschen Elbeabschnitten. Gemeinsamer Bericht. Im Auftrag der IKSE/MKOL, Koblenz.

BFG (German Federal Institute of Hydrology) (2002): Ecomorphological Survey of Large Rivers-Manual. Koblenz.

CEN 2004: EN 14614, Water quality- Guidance standard for assessing the hydromorphological features of rivers.

LAWA (Länderarbeitsgemeinschaft Wasser) (Hrsg.) 2000: Gewässerstrukturgütekartierung in der Bundesrepublik Deutschland – Verfahren für kleine bis mittelgroße Fließgewässer, Berlin.

LUA (Landesumweltamt Nordrhein-Westfalen) (2003): Merkblätter Nr. 41: Morphologisches Leitbild Niederrhein. Essen.

RAVEN P.J., HOLMES N.T.H., CHARRIER P., DAWSON F.H., NAURA M., BOON P.J. (2002): Towards a harmonized approach for hydromorphological assessment of rivers in Europe: a qualitative comparison of three survey methods. Aquatic Conservation: Marine and Freshwater Ecosystems Volume 12, Issue 4, 2002. Pages 405 424.

ROMMEL, J. (2000): Studie zur Laufentwicklung der deutschen Elbe bis Geesthacht seit ca. 1600. Bericht im Auftrag der Bundesanstalt für Gewässerkunde (BfG), Koblenz.

SCHWARZ, U. (1998): Einfluß der Wasserwirtschaft auf den Flusslauf der Drau zwischen Botovo und Ferdinandovec. In: International Conference Sustainable Economic Use of the Lowland Rivers and the Protection of Nature and Environment“ , May 1998, Zagreb, Proceedings of Papers, Hrvatsko Sumarstvo Drustvo & Eurontur, Zagreb, pp. 118 – 134, English Summary pp. 165-166.

SCHWARZ, U. (2006): Hydromorphological Survey and Map of the Mura and Drava Rivers 2005. Pilot study for the IAD (International Association for Danube Research). Publication planned for September 2006, Vienna.

TOCKNER, K., KARAUS, U., PÄTZOLD, A., BLASER, S. (2004): Ökologischer Zustand der Rhone: Benthische Evertebraten und Uferfauna. In: „Wasser Energie Luft“ 96. Jahrgang, Heft 11/12, CH-Baden.

WERTH, W. 1992. Ökologische Gewässerzustandsbewertung in Oberösterreich. In: Friedrich, G. and Lacombe J. (Hrsg.): Ökologische Bewertung von Fließgewässern. Limnologie aktuell, Band 3, Gustav Fischer Verlag, Stuttgart, S. 67-77.