7.10 Hydromorphological Features (2001)

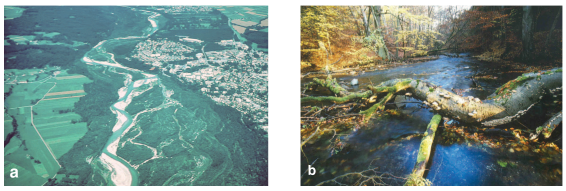

Fig. 1 **Examples of near natural water bodies: (a) Isar in its gravel flood plain near Geretsried, Bavaria – typical braiding of rivers rich in bedload, (b) Nebel – river in the moraine landscape of Mecklenburg-Western Pommerania**

Rivers are more than just running waters. Under natural conditions rivers and streams are showing typical patterns of hydromorphological features, such as gravel bars, riffles, pools, islands and cliffs. They depend on the discharge of water, the transport of solids like gravel, sand, wood and debris. The morphodynamic processes rebuild the hydromorphological features and these offer the living conditions for plants and animals in rivers and streams and along them. Today, many rivers and streams lost their natural hydromorphological features, for example due to hydraulic engineering measures, river channelisation, and flood control. Such canalised rivers are ecological impoverished, habitats are lost.

Assessing the hydromorphological features of natural rivers and streams (except for ditches and channels) includes the river bed and the floodplain. The reference condition for assessing hydromorphological features is the potential natural status. This status reflects completely or nearly undisturbed conditions and eliminates current uses. In Germany the hydromorphological features were surveyed between 1999 and 2001 by the Länderarbeitsgemeinschaft Wasser (LAWA, Working Group of the Federal States on water issues). In line with the map of biological water quality (Map 7.9), impressively demonstrating the improvement of oxygen content during the last 35 years, now the map of the hydromorphological features underlines the need for restoration of hydromorphological features in our rivers and streams.

The survey of hydromorphological features is represented in seven classes, comparable to the map of biological quality of rivers and lakes. For everybody in charge for development and maintenance of rivers the assessment of hydromorphological features is a programmatic working tool to improve them. This includes the commitment of communal, State and Federal responsibilities and helps implementing the Water Framework Directive (EG 2000/60 2000).

Hydromorphological features include all the morphological elements characterising the geometry of river reaches (planform, cross-sectional profiles and long sections, bed and bank substrates, submerged and riparian zone vegetation). In relation with the landuse of the floodplains and their retention abilities, hydromorphological features enable us to draw conclusions relating to the ecological functionality of running water systems. Hydromorphological features are subject to natural laws. Driving factors are discharge and bedload. They are determined by the specific environmental conditions in the catchment area (geology, tectonics, climate, vegetation, land-use, etc.). The geometric and hydromorphological features of rivers and their floodplains are modified by any change of a bed-forming parameter (e. g. channelisation of the watercourse).

Table 3 **Classes of hydromorphological features**

class	classification of hydro-morphological features#	short description	year 2001
1	not affected	The hydromorphological features are comparable to the potentially natural state.	2%
2	slightly affected	The hydromorphological features are slightly affected by singular, local influences.	8%
3	moderately affected	The hydromorphological features are moderately affected by several local influences.	11%
4	significantly affected	The hydromorphological features are significantly affected by several impacts, e. g. in bed, banks, by impoundments and/or uses in the floodplain.	19%
5	strongly modified	The hydromorphological features are modified by a combination of impacts, e. g. in course, by bank impairments, transverse bars, impoundments, flood protection measures and/or uses in the floodplain.	27%
6	severely modified	The hydromorphological features are severely changed by a combination of impacts e. g. in the course, bank impairments, transverse structures, impoundments, flood protection measures, and/or uses in the floodplain.	23%
7	completely modified	The hydromorphological features are completely modified by impacts on course, by bank impairments, transverse structures, impoundments, flood protection measures and/or uses in the floodplain.	10%

#At certain stretches, the hydromorphological features cannot be changed substantially because of the degree of utilisation for shipping, settlements, hydropower or flood prevention measures.

Assessment of Hydromorphological Features

The benchmark for evaluation is the natural functionality or near-naturalness of a running water body: its potential natural state. Such a body may be termed natural or near natural, respectively, when a free lateral movement of the course is possible. That implies

- longitudal continuity as well as lateral connectivity of the riverbed (riverbed dynamic),
- mobility of the bank (bank dynamic),
- natural flooding and lateral movement of the river channel in the floodplain (floodplain dynamic).

Table 1 **Parameters of the overview method**

recording parameters	intermediate assessment	sub-value	total value
planform	structure modification capacity	riverbed dynamics	hydromorphological features
bank impairment			
artificial barriers			
regulation of discharge			
riparian vegetation			
flood protection/ constructions	retention	floodplain dynamics	
flood capacity			
floodplain use	lateral connectivity		
river corridor			

Table 2 **Parameters of the on-site method**

individual parameters	functional unit	main parameters	area	
sinuosity, longitudinal bars, special structures of the course	curves	planform	channel	total assessment
curve-based erosion, profile depth, bank impairments	mobility			
transverse bars, current diversity, depth variation	natural long section elements	long section		
weirs, piping, traffic crossings, backwaters	artificial wandering barriers			
substrate types, substrate diversity, special bed structures	type and distribution of substrates	bed substrates		
bed impairments	bed impairments			
profile depth	profile depth	cross-sectional profile	river banks/ riparian zone	
width erosion, width variation	width development			
profile form	profile form			
special bank features	form typical for the river type	bank substrates		
riparian vegetation	natural vegetation			
bank impairments	bank impairments			
river corridor	river corridor	lateral connectivity	flood-plain	
land use, other local structures	floodplain corridor			

Each river is an individual ecosystem with regard to discharge, to solid transports and to hydromorphological features, too. River types with their reference status had to be defined for surveying and assessing hydromorphological features. These reference models could be developped from natural river reaches, historic, topographic or technical maps (geology and soil maps, aerial views). For defining such reference models, the map of river landscapes is a guideline which exists in most of the Federal States. It is in print for the Federal Republic of Germany.

Survey methods

Two methods were used for surveying hydromorphological features: first a strategic method (overview procedure, Table 1), which is limited to programmatic statements and the ascertaining of a limited number of parameters from maps, aerial photographs, etc.; second an operational method, which surveyed over 25 individual parameters on site (Table 2). The data from the on-site procedure can be aggregated for programmatic statements, the results of both methods are comparable and repeated surveying can be avoided. The choice of parameters of both methods is largely identical with the CEN Guidance Standard for assessing the hydromorphological features of rivers (CEN 14614, 2003).

Assessment

Modifications of hydromorphological features are recorded in terms of deviation from a natural or a potentially natural status (reference status).The classification in seven degrees (from "not affected" to "completely modified") is comparable to maps of biological water quality.

Results

In the 16 Federal States a total of some 33 000 km of rivers including large and significant rivers were mapped. In terms of river network of over 300 000 km this corresponds to just about 10% of running water bodies in Germany. Table 3 shows the proportional distribution of the classes.

The assessment results reveal significant differences among the individual Federal States, respectively the individual landscapes. These are chiefly due to natural conditions, climate, cultural background, density of population and the economic development in the 19th and 20th century.

The Water Framework Directive demands good status for surface waters. This status consists in "good ecological status" and "good chemical status". If good ecological status cannot be achieved and if structural deficits are chiefly responsible, the measures needed to achieve good ecological status shall be laid down in measure plans and implemented within a given period. The assessment of hydromorphological features is a tool for such measure plans.

Implementation

In the Federal States, measures for improving or restoring hydromorphological features in rivers have already been specified and implemented in river maintenance or development plans since about 10 years. Their success depend on the available land along the river. This precondition of available land for a river corridor depends on concerned landowners, but is not connected within individual assessment classes.

Examples of restoration projects show, that interdisciplinary planning can help to get more space for the rivers and to find cost-effective and ecological attractive solutions. Many flood protection projects include the improvement of hydromorphological features and also of ecological conditions in general in canalised rivers.

The potential to improve hydromorphological features most cost effective is an approriately oriented maintenance of rivers. The terms of the Water Framework Directive reiterate this and call for a commitment to use such potential more intensively than before.

Reassessment

The reassessment of hydromorphological features should be done if there are changes which can be documented. It depends on restoration projects which will be under way and finished in the next years, from big floods which may occur and their hydromorphodynamic proccesses and the way maintenance work is done in future. More land (more space) for the river needs less maintenance, reduces the flood damages and is a precondition to improve the hydromorphological features. In that view a time frame of 6 years is the minimum before a reassessment should be done.

Fig. 2 **Sustainable development of water courses: cross-sectional profile (a,b) Saynbach in Westerwald uplands – replaning a weir by a ramp to restore the river connectivity for migrating animals, (c,d) Ems in North German Lowlands – near-natural development of a steep bank after removal of embankments**