

02.06.1 Morphology of water bodies – Overall assessment (WRRL) (Edition 2012)

Overview

Over the last decades, significant efforts have been made in Germany to improve the quality of surface waters. These measures have led to significant improvements in the water quality of most rivers and lakes. However, comparably little attention has been paid so far to the enhancement of the morphological structure of surface water bodies such that water of good quality is now often flowing through or residing in water bodies characterised by poor morphological conditions. Consequently, in spite of all the improvements already achieved, the ecological functioning of many water bodies in Germany is still limited.

The European Water Framework Directive (EU-WFD) which entered into force in 2000, aims at improving the ecological state of the European water bodies by the year 2015 (WRRL, 2000; BMU, 2011).

It has been implemented into national German law in 2002 („*Novellierung des Wasserhaushaltsgesetzes*“) and again in 2010 („*Neufassung des Wasserhaushaltsgesetzes*“).

The ecological state is assessed by a number of biological criteria such as the occurrence of a number of sensitive species. The morphological structure plays a key role in this context and a number of methods have been developed in Germany to assess the morphological state of rivers and streams as well as lake shores.

Mapping activities

In this context, a number of mapping activities have been commissioned since 1999 by the environmental authorities of the Federal State of Berlin in order to assess how far the current morphological state of rivers, streams and lakes deviates from the potentially natural conditions.

The following mapping activities have been commissioned (see section “Methods” for a short explanation of the methods applied):

- 1999: Morphology of the rivers Havel, Spree, and Dahme using the desktop survey method (ÜV) (SenStadtUmTech, 1999)
- 2000: Morphology of selected smaller streams using the desktop survey method (ÜV) (SenStadt, 2000)
- 2002: Morphology of selected segments of Tegeler Fließ and Fredersdorfer Mühlenfließ using the on site survey method (VOV) (ILAT, 2002)
- 2003: Morphology of selected smaller streams using the on site survey method (VOV) (SenStadt, 2003)
- 2006: Morphology of Tegeler Fließ, Panke, and Seegraben using the on site survey method (VOV) (SenGesUmV, 2010)
- 2007: Lake shore morphology of the lakes along the Spree and Dahme as well as the Pfaueninsel/Havel using the lake shore survey method (SUK) (SenGesUmV, 2009a)
- 2009: Morphology of Wuhle and Neuer Wuhle using the on site survey method (VOV) (SenGesUmV, 2010)
- 2010: Lake shore morphology of the lakes along the Havel as well as the Tegeler Sees using the lake shore survey method (SUK)

Methodology

Three different methods have been applied to determine the morphological state of the water bodies.

1.) **Desktop survey method** for rivers and streams (ÜV, LAWA, 2002). The ÜV is based on the interpretation of aerial images as well as current and historic maps, mainly topographic and geological maps. The ÜV provides a broad overview on the morphology of rivers and streams at comparably low cost. However, not all relevant parameters can be derived, especially those characterising the river bed. This method has therefore not been applied in Berlin after 2001.

2.) **On site survey method** for small rivers and streams (VOV, LAWA, 2000). The VOV is based on information obtained on site. Therefore, it provides a more precise and thorough assessment of the relevant parameters, including those characterising the river bed.

3.) **Lake shore survey method** (SUK, LUNG, 2004). Similar to the ÜV, the SUK is also based on aerial images and maps (especially topography, geology, bathymetry, habitats). Additionally, all lake shores are observed from a boat in order to allow for the assessment of parameters not easily accessible from aerial images.

All applied methods classify the morphology of individual river or lake shore segments into seven classes (see Table 1) ranging from “unmodified” (class 1) to “totally modified” (class 7).

Table 1: Designation and description of the morphological quality classes for watercourses

Class	Degree of modification	Description
1	unmodified	Watercourse morphology corresponds to the natural state.
2	marginally modified	Watercourse morphology marginally affected by a few minor measures.
3	moderately modified	Watercourse morphology moderately affected by several minor measures.
4	distinctively modified	Watercourse morphology distinctively affected by a number of moderate measures.
5	strongly modified	Watercourse morphology strongly affected by a number of significant measures.
6	heavily modified	Watercourse morphology almost entirely modified by a combination of partly heavy measures.
7	totally modified	Watercourse morphology entirely modified by a combination of severe measures.

Table 1: Designation and description of the morphological quality classes for watercourses. Source: Länderarbeitsgemeinschaft Wasser (LAWA). The scheme is also applied to the assessment of lake shore morphology.

All three methods (ÜV, VOV, SUK) are based on similar principles: Individual parameters are assessed and then combined to provide an overall assessment of the morphology for individual river or lake shore segments. Further information on the assessment procedure can be obtained from the respective user handbooks (LAWA, 2002; LAWA, 2000; LUNG, 2004).

Assessment of the Methodology

The methods applied to determine the morphological state of water bodies are relatively new and do not yet consider all conditions naturally occurring in the various landscapes in Germany. This may lead to “unjust” assessments.

For example, the on-site survey method for watercourses (LAWA, 2000) does not always properly account for the typical conditions encountered in the North German lowlands, especially as regards the river beds. This may lead to overly negative assessment of certain river bed parameters and in consequence to an incorrect assessment of the overall morphology. Based on more than ten years of operational experience, the on site survey method for watercourses has been recently fully revised, offering an improved differentiation between the morphological types of watercourses naturally occurring in Germany (LANUV, 2012).

Similarly, it is intended to also revise and harmonise the various existing methods for mapping the lake shore morphology in order to achieve a “fairer” assessment for the wide range of morphological lake shore structures encountered in Germany as well as to provide a better interface with biological surveys.

Despite their deficiencies, the methods applied to determine the morphology of water bodies already allow for a meaningful identification of watercourse or lake shore segments with problematic morphology and therefore constitute a very valuable source of information for management and planning purposes.

Map description

Watercourses

Due to the urbanised character of large areas of the federal state of Berlin, the morphology of Berlin’s watercourses is mostly strongly to totally modified (see Table 2).

Table 2: Morphological state of investigated watercourses in the federal state of Berlin					
Watercourse	Method	Year	Mapped length [km]	Average assessment	Morphological state
Bullengraben	VOV	2003	4.5	5.8	heavily modified
Dahme	ÜV	1999	16.0	4.8	strongly modified
Fließgraben	VOV	2003	8.8	6.7	totally modified
Gosener Graben	VOV	2003	3.4	4.7	strongly modified
Havel	ÜV	1999	27.0	4.1	distinctively modified
Hellersdorfer Graben	VOV	2003	3.7	6.9	totally modified
Kuhlake	VOV	2003	7.0	3.6	distinctively modified
Laake	VOV	2003	4.7	6.4	totally modified
Lietzengraben	VOV	2003	7.2	5.5	heavily modified
Neue Wuhle	VOV	2009	8.1	5.5	heavily modified
Panke	VOV	2007	24.3	6.0	heavily modified
Plumpengraben	VOV	2003	11.1	6.3	totally modified
Rudower Fließ	VOV	2003	2.3	4.0	distinctively modified
Seegraben	VOV	2007	2.6	4.1	distinctively modified
Spree	ÜV	1999	45.0	6.0	heavily modified
Tegeler Fließ	VOV	2007	17.2	3.9	distinctively modified
Wuhle	VOV	2009	16.6	5.7	heavily modified

Table 2: Morphological state of investigated watercourses in the federal state of Berlin

The best overall assessment has been assigned to the Kuhlake, a little stream located in a forested area (Spandauer Forst) which has been “remodelled” back into a more natural state a few years ago. It is the only watercourse in Berlin that encompasses a number of unmodified segments.

Among the natural watercourse of relevance to the EU-WFD, the best average morphological assessment (3.9, distinctively modified) has been found for the Tegeler Fließ. A better overall assessment is often hampered by the poor assessments of the river bed morphology. Figure 2 shows two examples representing marginally modified and totally modified watercourse segments.

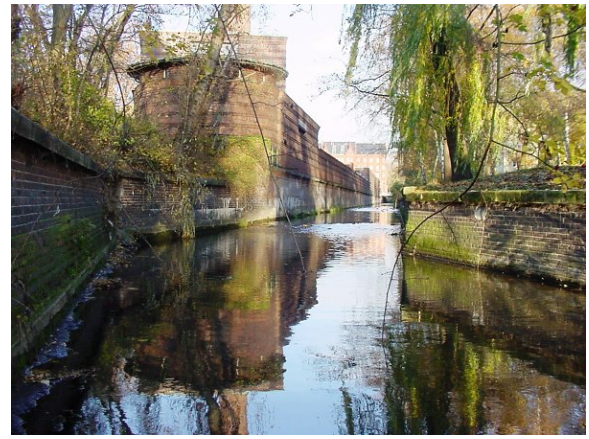


Figure 1: Left: Tegeler Fließ, segment 85 near the district of Lübars characterised by a “marginally modified” morphology. Right: Panke, segment 22 in the district of Wedding (near Badstraße), characterised by a “totally modified” morphology.

Lake shores

The morphology of the Berlin lake shores is mostly “moderately modified” or “distinctively modified” (see Table 3). Morphology-wise, Berlin’s lake shores are thus in a significantly better state than the watercourses. This may be partly due to the fact that the lakes are often located outside the most heavily urbanised areas. Additionally, a significant amount of the lake shores is under specific protection regimes, resulting in reduced constructional activities in the shore zones. A problem area concerns ship-induced wave action which has a significant potential for morphology degradation. A specific reed protection program has been in force for many years to counteract these negative effects.

Table 3: Morphological state of the lake shores in the federal state of Berlin. The division into lakes, basins and sub-basins was adopted from the Gewässeratlas Berlin [SenStadt, 2002].

Watercourse	Method	Year	Mapped length [km]	Average assessment	Morphological state
Berliner Oberhavel 1	SUK	2010	3.3	4.2	distinctively modified
Berliner Oberhavel 2	SUK	2010	5.7	4.5	strongly modified
Berliner Oberhavel 3	SUK	2010	11.7	4.7	strongly modified
Berliner Unterhavel 1	SUK	2010	11.1	3.3	moderately modified
Berliner Unterhavel 2	SUK	2010	9.2	3.2	moderately modified
Berliner Unterhavel 3	SUK	2010	6.8	3.5	moderately modified
Berliner Unterhavel 4	SUK	2010	4.3	2.4	marginally modified
Dämeritzsee	SUK	2007	2.6	4.2	distinctively modified
Großer Müggelsee	SUK	2007	12.0	3.5	moderately modified
Großer Wannsee	SUK	2010	8.0	4.7	strongly modified
Langer See	SUK	2007	13.5	4.1	distinctively modified
Nieder-Neuendorfer See	SUK	2007	3.4	4.3	distinctively modified
Pfaueninsel	SUK	2007	4.8	2.3	marginally modified
Scharfe Lanke	SUK	2010	2.1	5.3	strongly modified
Seddinsee	SUK	2007	15.4	3.0	moderately modified
Stößensee	SUK	2010	3.2	5.2	strongly modified
Tegeler See	SUK	2010	21.9	3.7	distinctively modified
Zeuthener See	SUK	2007	7.6	4.1	distinctively modified

Table 3: Morphological state of the lake shores in the federal state of Berlin. The division into lakes, basins and sub-basins was adopted from the Gewässeratlas Berlin [SenStadt, 2002].

Contiguous areas of “marginally modified” lake shore segments are mostly found on the Unterhavel around the Pfaueninsel, in the northern parts of Seddinsee and along the southern shore of Müggelsee. Figure 3 shows two examples representing marginally modified and totally modified lake shore segments.



Figure 2: Left: Seddinsee, “marginally modified” segment 98 located on the south-eastern shore. Right: Müggelsee, “totally modified” segment 5 on the northern shore in the district of Friedrichshagen.

Action planning

Watercourses

Information on the morphological state of the watercourses plays a fundamental role when planning measures aimed at improving their ecological status. Concrete measures are implemented through so-called water body development concepts (*Gewässerentwicklungskonzeptionen*). Of special interest in this context is the pilot project “Panke 2015” (SenGesUmV, 2009b; SenStadtUm, 2012) acting as a test bed for the development of measures to arrive at watercourses of good morphological status, including the colonisation of relevant invertebrate and fish species, in a highly urbanised environment.

Lake shores

Information on the morphological state of lake shores is required to assess the conditions for the colonisation of invertebrates (Aeshna method) as well as to develop concepts to arrive at or secure the good ecological state of lake shores. These concepts will need to address both the requirements of the EU-WFD and nature conservation (e.g. EU Flora-Fauna-Habitat and Birds Directives).

Analysing the deficits of biotic or abiotic parameters along the lake shores or the adjacent shallow waters will enable the derivation of lake shore development concepts (*Uferentwicklungskonzeptionen*) to improve the morphological status.

These measures will also have to consider the various usage patterns encountered in urbanised environments (Lake Müggelsee is a prominent example) so as to arrive at sustainable solutions.

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