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A new procedure for comparing class boundaries of biological assessment methods: A case study from the Danube Basin

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ABSTRACT

For the implementation of the European Water Framework Directive class boundaries of biological assessment methods need to be intercalibrated. The most commonly applied intercalibration approach of national river assessment methods in Europe requires data on near-natural reference sites; however, these data are generally scarce. We developed an alternative approach based on sites impacted by similar levels of disturbance and tested it with national assessment methods based on diatoms and benthic invertebrates from countries in the Danube River Basin. Using environmental variables we screened for sampling sites of at least good environmental status. Relations between different assessment methods were established by common metrics, and we standardized these metrics by "biological benchmarks" obtained from the screened datasets. This approach allows for intercalibration even if near-natural reference sites are absent; relatively few and easily available data are required.

1. Introduction

Monitoring the biological quality of rivers has a long tradition in the Danube River Basin. In communist times the evaluation of saprobic water quality was standardized in Eastern Europe (Helešic, 2006) and several countries supported research on bioassessment and monitoring (e.g. Zelinka and Marvan, 1961; Rothschein, 1962; Sládeček, 1973; Uzunov, 1979). However, compared to chemical water classification biological assessment played a minor role also in the pan-European context (Newman, 1988). Against this background, the European Water Framework Directive (WFD) 2000/60/EC has set new requirements for water policy. Besides integrated and coordinated river basin management for all European river systems it stipulates ecological quality assessment against near-natural reference conditions specific to each type of water body. For rivers, fish, benthic invertebrates, macrophytes and benthic algae, and phytoplankton are assessed. Results are given in relation to the near-natural reference conditions, thus expressed as numbers between 0 (worst status) and 1 (near-natural reference status), i.e. the 'Ecological Quality Ratio' (EQR). The EQR range is split into five classes (high, good, moderate, poor, and bad).

Although individual countries are in charge of modifying their national assessment methods or of developing new methods, the quality classification at the European level is harmonized by intercalibration (Heiskanen et al., 2004). Intercalibration is a legally binding requirement of the WFD. It guarantees the consistent quality classifications despite still diverse assessment methods that countries are applying. European Member States are obliged to compare the results of assessments among countries that share common water body types in similar biogeographical regions. For this, countries are organized in so-called Geographical Intercalibration Groups

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(GIG). A major policy objective is to achieve good surface water status throughout Europe by 2015. Intercalibration therefore focuses on the EQR values that define good ecological status, i.e. the high–good and good–moderate class boundaries. A list of the main terms and definitions connected with the intercalibration process as meant in the present paper is given in Table 1.

There are three methodological options for intercalibration (European Communities, 2005): Option 1: boundaries are compared directly between countries that are using identical assessment methods (e.g. CB GIG Lakes, 2008). Option 2: the results of national assessment methods are translated into a comparable format using common metrics (e.g. Buffagni et al., 2006). Unlike national methods, common metrics are not optimised for quality assessment but are conversion tools for biological assessment indices. Option 3: different national methods are compared directly by assessing the same sampling sites using the participating countries' national assessment methods (e.g. Birk and Hering, 2006; Borja et al., 2007).

All these options require data on sites covering the whole range of quality classes to secure statistical robustness of intercalibration results.

In Central Europe, Member States recently intercalibrated river diatom and invertebrate classifications by common metrics (Option 2) (CB GIG Rivers, 2008). These metrics were correlated with the national assessment methods and regression analyses inferred the values of the common metrics that corresponded to the national quality class boundaries. To compare common metrics between countries they had to be standardized. For this purpose the participating countries provided data on undisturbed reference sites, which were selected with harmonized criteria (CB GIG Rivers, 2008). The biological community of these undisturbed sites yielded the reference value of the common metrics and provided EQR scales that were comparable between countries. The principal problem with this approach was the scarcity of reference sites, since unimpacted conditions no longer exist (e.g. Birk et al., 2007; Gabriels, 2007) or data were not available as monitoring focuses on impacted sites. Several countries could therefore not intercalibrate their methods, especially those applied for large rivers. Therefore, the question arises: Does intercalibration of class boundaries necessarily require data on reference sites or are there alternative approaches?

In this study, we developed a new method for river types of five countries in the Danube River Basin (Fig. 1), for which reference data were almost completely unavailable. Benchmarks were therefore established with data from similarly impacted river sites. This approach was tested for both, assessment methods based on benthic diatoms and methods based on benthic invertebrates.

2. Materials and methods

2.1. *National assessment methods and intercalibration common stream types*

We intercalibrated two multimetric diatom indices used in Austria and the Slovak Republic (Table 2). The Austrian method classifies the EQRs of the Trophic Index (TI) (Rott et al., 1999) and Saprobic Index (SI) (Rott et al., 1997) separately and the overall quality status is determined by that index delivering the worst result. The Slovak method integrates the results of three diatom metrics (Indice de Polluosensibilité Spécifique (IPS): CEMAGREF, 1982; Eutrophication/Pollution Index–Diatom-based (EPI-D): Dell'Uomo, 1996; Diatom Index by Descy and Coste (1991) (CEE)). The absolute index values are classified by a fivefold, stream type-specific classification scheme. The overall status is expressed as the averaged class values of each index divided by the maximum obtainable score.

Five invertebrate methods were intercalibrated (Table 2). The multimetric indices of Austria and the Slovak Republic appraise various aspects of the river invertebrate community such as faunal composition, abundance, richness, diversity, sensitivity and ecosystem function (BMLFUW, 2006). The Bulgarian and Hungarian methods integrate information on taxonomic composition and tolerance to general disturbance, while the Romanian method is a modification of the Saprobic Index. The Saprobic Index indicates biodegradable organic

Table 1 – Definition of main terms dealt with in the present paper

Main term	Definition
1. Intercalibration	Process by which European countries compare and harmonize the quality class boundaries of their biological assessment methods (high–good and good–moderate boundary).
2. Harmonization	If the comparison of biological assessment methods reveals differences between national class boundaries, these differences are harmonized. This is done by adjusting the national boundaries with reference to biological benchmarks.
3. Biological benchmark	Condition of the biological community that represents the trans-national reference point for harmonization. The biological benchmark is defined for selected aspects of the biological community measured by common metrics.
4. Common metric	A biological metric widely applicable within a GIG or across GIGs, which can be used to derive comparable information among different countries/stream types (Buffagni et al., 2007).
5. Standardization	Normalization of metric values via transformation to unitless scores. Metrics are divided by the values representing the near-natural condition or the biological benchmark condition.
6. Threshold value	Value of selected environmental parameters/common metrics that influence/indicate the biological condition at the stream site, e.g. conductivity or agricultural land use in the catchment. Threshold values were used to screen for stream sites of at least good environmental status.