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SEVENTH FRAMEWORK PROGRAMME

WISER

Water bodies in Europe: Integrative Systems to assess Ecological status and Recovery

DELIVERABLE

Deliverable D6.2-4: Key Findings and recommendations on combining classification results across biological quality elements

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PU	Public	X
PP	Restricted to other programme participants (including the Commission Services)	
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Content

Non-technical summary

This Deliverable summarises the main findings of WISER work package 6.2 "Combination of BQEs into a complete water body assessment", in the form of two key messages for end users:

1. There is a lack of consistency across Member States in how they combine classification results of multiple BQEs at water body level. This has negative consequences for comparability of Water Framework Directive classification outcomes at EU level
2. The 'one-out all-out' principle for combining multiple BQEs into a water body assessment should not be applied uncritically. Its strict application is not always recommended because of the risk of downgrading sites too easily. The 'one-out all-out' rule works best if the redundancy between BQEs is as low as possible.

Introduction

This report presents key messages from WISER work package 6.2 “Combination of BQEs into a complete water body assessment”. It is based on presentations and discussions with end users during the WISER Final Conference held in Tallin in January 2012; a report of the end-user workshop is available as WISER Deliverable 6.2.3.

Key message 1: There is a lack of consistency across Member States in how they combine classification results of multiple QEs at into a complete water body assessment. This has negative consequences for comparability of Water Framework Directive classification outcomes at EU level

Evidence

The WFD requires the use of multiple BQEs in ecological assessment of surface waters. In the context of a common strategy for supporting a coherent and harmonious implementation of the WFD, a Classification Guidance (2003) was produced in order to assist Member States in developing ecological assessment and classification systems. According to the WFD the ecological state is determined by the quality element with the worst class value, or the so-called 'one-out all-out' principle.

WISER deliverable 6.2-1 'Review on approaches for combining BQEs in WFD assessment' (Caroni & van de Bund, 2010) provides an overview of classification approaches adopted in different Member States. While many technical reports and scientific papers have been produced at BQE level (selection and combination of biological metrics into BQE), less information is available and few papers have been published on the combination of multiple BQEs into an overall water body assessment. Although it was not possible to provide a full picture of all Member States, because of limited documentation, the available information showed that Member States in Europe have developed, or are developing, different methods to combine BQEs into ecological assessment of water bodies.

From the information gathered, it appeared that two general approaches are adopted. Some Member States seem to follow strictly the 'one-out all-out' principle as required by the WFD, classifying the biological status of the water body on the basis of the BQE with the worst class score. Other Member States are instead already applying, or are considering applying, alternative systems.

For example, some Member States have proposed multimetric methods (Czech Republic), others (Sandin & Wasson, 2007) proposed to average the EQRs results of each biological element or to use classification grids. The Finnish classification system for lakes (Alahuhta *et al*., 2009; Rask *et al*, 2011) calculates the final lake status as a median score value across all quality elements and then requires a weigh-of-evidence approach. Other methodologies proposed to weight different biological quality elements (for example Italy for rivers, Nardini *et al*. 2008), having particular consideration for a BQE regarded as particularly sensitive to a pressure. An example is found in Borja *et al*. (2009; 2010), considering macrobenthos as a determinant element in the assessment of coastal and transitional waters. In this integrative classification system thus macrobenthos has a more important weight for the determination of the biological status because it is considered the most reliable BQE, with the most accurate methodologies, and with a relatively rapid response to pressures.

Implications

A lack of consistency in classification systems across Member States means that there will be a lack of comparability in the final classification outcome. The intercalibration process has put much attention at BQE level, in order to harmonize methodologies for individual BQE assessment. However, intercalibration at BQE level does not guarantee comparability of classification outcome at water body level.

Because the consequences for differences in classification outcome are not known, we recommend carrying out a comprehensive analysis which will include information from all Member States.

Further reading

Alahuhta, J., K-M., Vuori, S., Hellsten, M., Järvinen, M., Olin, M.Rask, and A., Palomäki, 2009. Defining the ecological status of small forest lakes using multiple biological quality elements and paleolimnological analysis. Fundamental and Applied Limnology, Archiv für Hydrobiology 175/3: 203-216.

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Borja, A., & J.G. Rodriguez, 2010. Problems associated with the 'one-out, all-out' principle, when using multiple ecosystems components in assessing the ecological status of marine waters. Marine Pollution Bulletin 60: 1143-1146.

Classification Guidance, Working Group 2A, 2003. Guidance Document No 13 Overall Approach to the Classification of Ecological Status and Ecological Potential. Office for Official Publications of the European Communities, Luxembourg, 47.

Caroni, R. & W., van de Bund, 2010. Review on approaches for combining BQEs in Water Framework Directive assessment. Deliverable D6.2-1, Wiser Project, www.wiser.eu

Rask, M., K.M., Vuori, H., Hämäläinen, M., Järvinen, S., Hellsten, H., Mykrä, L.,Arvola, J., Ruuhijärvi, J., Jyväsjärvi, I., Kolari, M., Olin, E., Salonen, and P., Valkeajärvi, 2011. Ecological classification of large lakes in Finland: comparison of classification approaches using multiple quality elements. Hydrobiologia, 660: 37–47.

Key Message 2: The 'one-out all-out' principle for combining multiple BQEs into waterbody assessment should not be applied uncritically. Its strict application is not always recommended because of the risk of downgrading sites too easily. The 'one-out all-out' rule works best if the redundancy between BQEs is as low as possible.

Evidence

The 'one-out all-out' (OOAO) is the required principle by the WFD, classifying the biological status of a water body on the basis of the biological quality element (BQE) with the worst class score (Classification guidance, 2003). This rule is very precautionary, based on the assumption that different BQEs respond to pressures in different ways and that there is a need to protect the most vulnerable biological group.

However, its strict application is not always recommended because there is a risk of downgrading sites too easily.

In WISER WP 6.2 this was demonstrated using monitoring data sets and modeled data. Monitoring datasets from Swedish lakes assessed with up to four BQEs (phytoplankton, macroinvertebrates, macrophytes, fish) and Austrian rivers with two BQEs (macroinvertebrates and fish) were used to demonstrate the effect of different combination rules on classification outcome. In all cases, the OAOO rule gave the highest probability of classifying water bodies in moderate or worse status compared to using the average or median (Fig, 1). Uncertainty in estimates of ecological status class for water bodies was calculated using the software WISERBUGS (Clarke 2010).

Simulations with artificial data demonstrated that, when combining multiple BQEs that are sensitive to the same pressures or combination of pressures, the OOAO rule produced unbiased results and good class agreement only when metrics had a low level of uncertainty ($SD \leq 0.01$), which in practice is very difficult to achieve. The reliability of the classification was already compromised at a moderate level of metric uncertainty ($SD > 0.05$) (Figure 2A). An alternative rule tested for combining the same set of BQEs was the average rule, producing better results for high uncertainty metrics (Figure 2B). However this is not in accordance with the WFD guidance, as averaging among BQEs is not recommended.

Implications

The uncritical application of the 'one-out all-out' (OOAO) principle could pose the danger of downgrading status class of water bodies too easily. In particular, water managers should be careful when multiple BQEs that are redundant for detecting the same pressure, or combination of pressures, need to be combined into a water body assessment. It has been demonstrated that the OOAO approach only gives acceptable and comparable results if the different BQEs are

complementary, showing the effects of different pressures, on different temporal and/or spatial scales, on different aspects of ecosystem functioning. Also the level of uncertainty in the biological metrics and in the BQEs used in the assessment should not be too high and not too different between BQEs.

Further reading

Alahuhta, J., K-M., Vuori, S., Hellsten, M., Järvinen, M., Olin, M.Rask, and A., Palomäki, 2009. Defining the ecological status of small forest lakes using multiple biological quality elements and paleolimnological analysis. Fundamental and Applied Limnology, Archiv für Hydrobiology 175/3: 203-216.

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Rask, M., K.M., Vuori, H., Hämäläinen, M., Järvinen, S., Hellsten, H., Mykrä, L.,Arvola, J., Ruuhijärvi, J., Jyväsjärvi, I., Kolari, M., Olin, E., Salonen, and P., Valkeajärvi, 2011. Ecological classification of large lakes in Finland: comparison of classification approaches using multiple quality elements. Hydrobiologia, 660: 37–47.

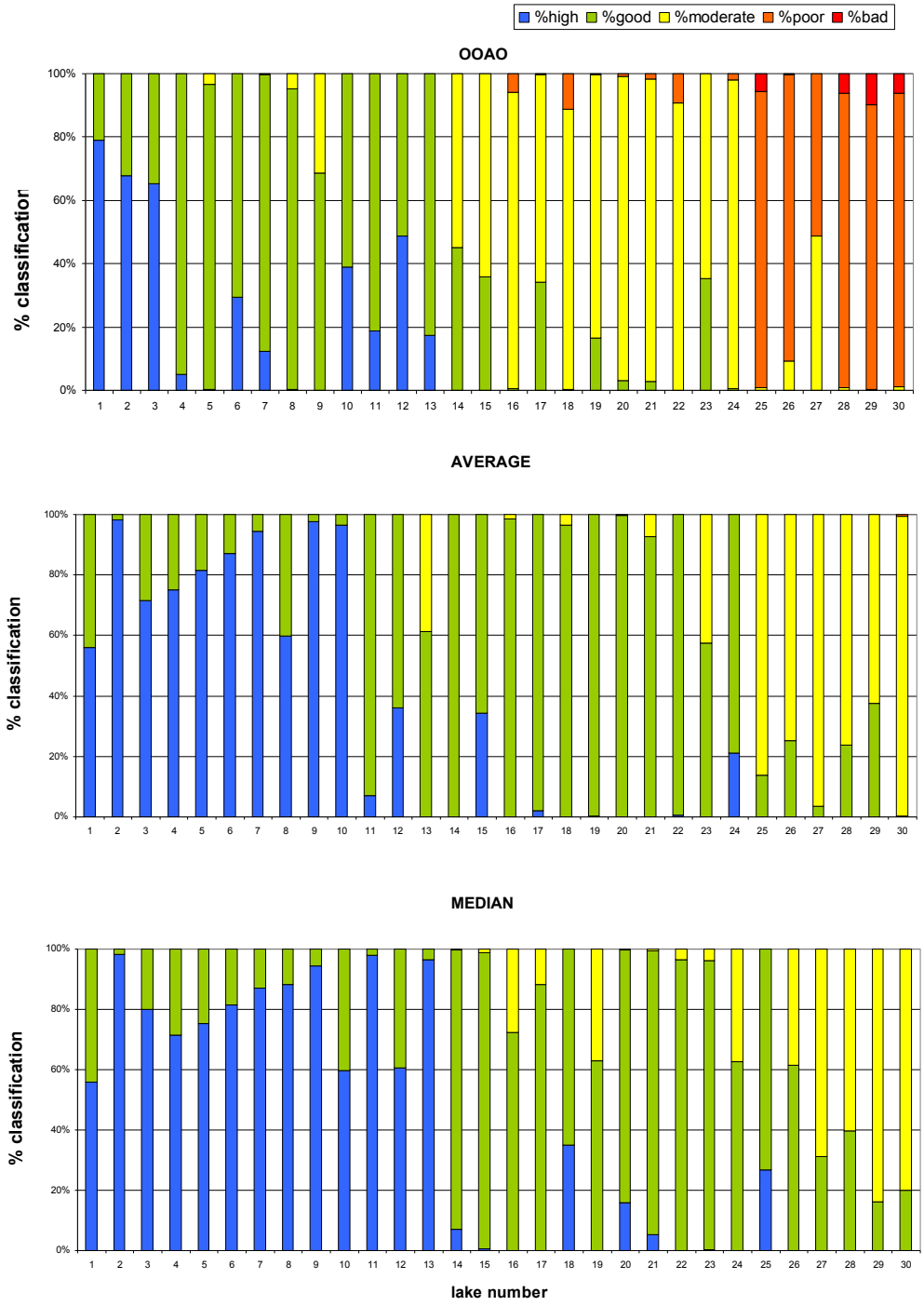

Figure 1. Example of the effect of different combination rules (OOAO, average, median) for multiple BQEs (phytoplankton, macroinvertebrates and macrophytes) on the final classification of 30 Swedish lakes. Probabilities for classifying lakes in ecological status classes were calculated using the software WISERBUGS (Clarke 2010).

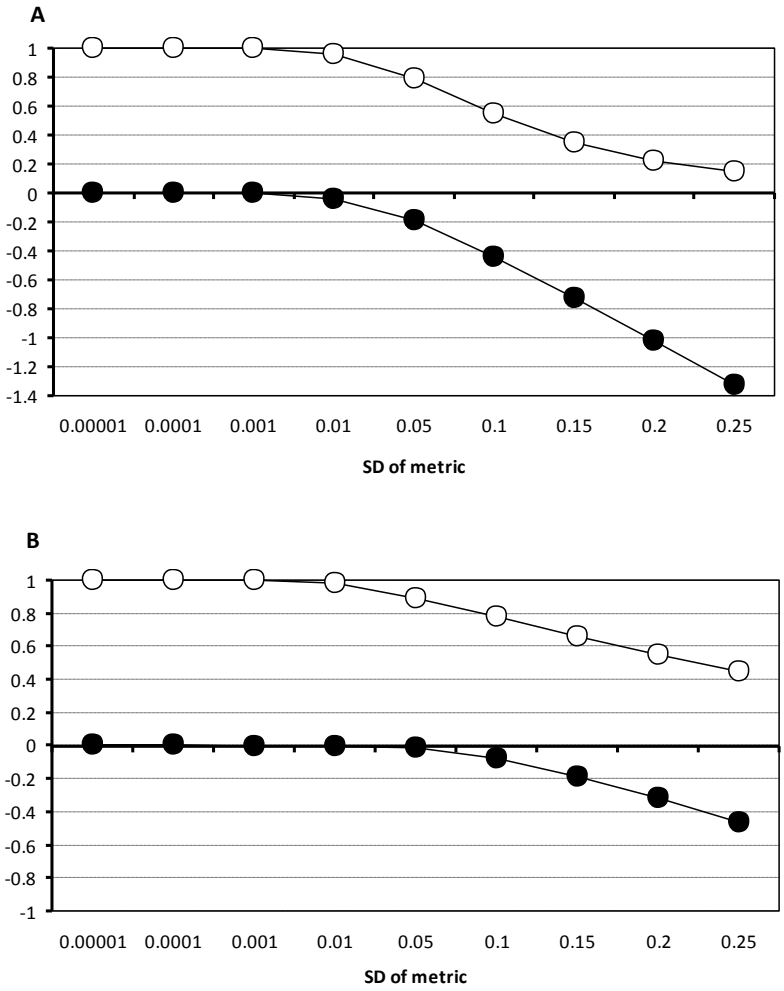

Figure 2. Combination of multiple BQEs sensitive to the same pressures or combination of pressures using one out- all out (A) or averaging (B) at different levels of metric uncertainty. Open circles indicate level of class agreement (0 = 0% agreement, 1 = 100% agreement), full circles level of class bias