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SEVENTH FRAMEWORK PROGRAMME

WISER

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

DELIVERABLE

Deliverable D6.3-1: Report from workshop on among BQEs, habitats and systems comparisons

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Dissemination Level		
PU	Public	X
PP	Restricted to other programme participants (including the Commission Services)	
RE	Restricted to a group specified by the consortium (including the Commission Services)	
CO	Confidential, only for members of the consortium (including the Commission Services)	

Content

Non-technical summary

The main aims of workpackage 6.3 are to study the responses of different *Biological Quality Elements* (BQE) in different surface water types; to determine if/how responses of different organism groups differ between ecosystems (e.g. lake vs stream) and between habitats within ecosystems (e.g. pelagic vs benthic) to stress gradients related to hydromorphological alteration and nutrient enrichment.

During the mid-term meeting in Debe, Poland, in September 2010 the workpackage participants discussed the aims and objectives of the workpackage. A roadmap was developed with particular focus on data accrual and analyses. This report summarizes the outcome and decisions agreed upon during the meeting.

Report from workshop on among BQEs, habitats and systems comparisons

WP 6.3 meeting notes from WISER mid-term meeting, Debe, Poland, 6-9 September 2010

David Angeler
Richard K. Johnson

Participants in WP 6.3.

- SLU (lead),
- UDE, ALTERRA, CSIC

The workshop was held on 7. September 2010 and assisted by:

- Richard K. Johnson and David Angeler (SLU)
- Piet Verdonschot (ALTERRA)
- Christian Feld and Daniel Hering (UDE)
- CSIC did not attend the meeting

Agenda:

- Discussion of database issues
- Discussion of analyses issues
- Discussion of complementary research questions

1. Introduction

The main aims of this workpackage are to study 1) the responses of different *Biological Quality Elements* (BQE) in different surface water types, 2) ecosystem-specific responses, and 3) habitat-specific responses within ecosystems to stress gradients related to hydromorphological alteration and nutrient enrichment. Table 1 summarizes the BQE´s and ecosystem/habitat types of interest. Selected working hypotheses on potential responses, according to the DoW, are presented in Box 1. The WISER midterm meeting in Debe (Poland) was successful for planning, defining and implementing upcoming project tasks necessary for fulfilling the requirements of the deliverables foreseen in this WP (Box 2). Several issues related to data availability, analysis approaches and complementary research questions using an integral catchment focus were discussed.

Table 1: Overview of BQEs, ecosystem types, and habitat types within ecosystems used for analysis. The letter in parentheses indicate for which ecosystem type the BQE will be analyses: L, lake; C, coastal waters; S, Stream.

BQE	Ecosystem	Habitat type
Phytoplankton (L, C)	Lakes	Profundal
Macrophytes (L, C, S)		Littoral
Benthic diatoms (S)		Pelagic
Macroinvertebrates (L, C, S)	Streams	Riffles
Fish (L, C, S)		Pools
	Coastal waters	Benthic
		Pelagic

2. Data base

The planned cross-taxon and cross-system analyses will be carried out on extensive data sets compiled and harmonized by Modules 3 and 4 and by WP 5.1. Progress of data base-related issues was highlighted during the workshop, and that still some months will be required to completely harmonize all data sets before making them available for WP 6.3. Although it was foreseen that the work on the data base will be finalised by December 2010, further delays in data collation, mainly in workpackages 3 have arisen, which have limited progress of the WP 6.3 tasks so far.

Access to a preliminary data base has been provided by WP 2.1 shortly before this deliverable was due. This preliminary data base was provided as a means to gain an overview of existing data sets, but will still require substantial effort before being ready for use in WP 6.3. There is currently still need of:

- A quality check and further data processing from WP 2.1. to standardise parameter names and units etc, and to include complete taxon lists.
- A harmonisation of waterbody codes/names, which still requires a substantial amount of work. WP 6.3. and WP 2.1. are currently working on a timely and effective solution.

During the workshop, potential limitations were identified that could arise during data analysis:

- Not enough or adequate data could be available for addressing some of the specific research questions. For example, in the case of rivers not enough data may be available to carry out meaningful comparative analysis on habitat-specific responses to the stress gradients.
- Several concerns and discussion points regarding the inclusion of coastal waters could not be addressed because of the absence of responsible partners during the meeting. The decision was made to start the analysis on stream and lake ecosystems to identify study areas of interest.
- The need for a pre-assessment of the spatial organization and occurrence of ecosystem types in the landscape was highlighted to avoid potential confounding effects in the analysis if spatial aspects are not taken explicitly into account. For example, a comparison of response gradients could be confounded if most data on lakes would be available in western Europe, while a best coverage of streams would be given in eastern Europe. We thus aim through GIS analysis to identify spatial clusters where both ecosystem types are well represented, and carry out the analyses on these clusters.

As a result, a definitive analysis strategy will be determined once these and other shortcomings have been ruled out.

3. Analysis issues

During the meeting consensus was obtained between the working partners regarding analysis protocols. These protocols will be largely based on the methodology used by Johnson and Herring (2009):

- We will contrast responses of univariate (species richness, Simpson diversity, evenness, abundance/biovolume) and multivariate metrics (e.g. DCA axis scores) of community structure. These metrics will be calculated for each BQE and then used in regression analysis.
- We will use linear and nonlinear regression analysis to identify response types and strengths of BQEs, ecosystems and habitats to single environmental variables.

- We will use Principal Component Analysis to test for responses of BQEs, ecosystems and habitats within ecosystems to abiotic (stress) gradients.

BOX 1

Working hypotheses showing expected responses of BQEs, ecosystems and habitats within ecosystems. Shown are responses ordered by increasing sensitivity

A) BQE responses

A.1) Nutrient enrichment

Lakes and coastal waters

Phytoplankton > Invertebrates >Macrophytes> Fish

Streams

Benthic diatoms > Invertebrates >Macrophytes> Fish

A.2) Hydromorphological alterations

Lakes and coastal waters

Macrophytes> benthic diatoms > Invertebrates > Fish

Streams

Macrophytes = Invertebrates > benthic diatoms > Fish

B) Ecosystem responses

Similar ecosystem responses are expected to hydromorphological alterations and nutrient enrichment

Streams > Lakes and coastal waters

C) Habitat responses within ecosystems

C.1) Nutrient enrichment

Lakes and coastal waters

Pelagic/littoral >Profundal

Streams

Riffles > Pools

C.2) Hydromorphological alterations

Lakes and coastal waters

Profundal> Pelagic

Streams

Riffles > Pools

BOX 2

Deliverables for Workpackage 6.3.

• D 6.3-1: Report from workshop on among BQEs, habitats and systems comparisons (Month 24)

• D 6.3-2: Report and manuscript on the use of BQEs, habitats and ecosystems for detecting human-induced change (Month 36)

4. Complementary research questions

In addition to studying biological responses to stress gradients related to hydro-morphological alterations and nutrient enrichment, the usefulness of an integral catchment approach was highlighted. It is well known that the connectivity of sites and the dispersal capacity of organisms mediate in local and regional community dynamics (Leibold et al. 2004). Therefore, modelling community dynamics from a metacommunity perspective could be useful for understanding integral BQE responses within and between ecosystem/habitat types from a landscape perspective.

For WP 6.3 we have developed a conceptual model (Figure 1) which emphasizes community dynamics/assembly in different aquatic ecosystem types from a landscape perspective. Briefly, the blue box in the model “sets the stage” and emphasizes environmental gradients (often those associated with one or different forms of anthropogenic stress) and spatial gradients (location of the aquatic ecosystems in the landscape), which mediates among-site connectivity. These connections can either be “direct” (e.g. hydrological connectivity) or “indirect” (biotic connectivity through migration/dispersal). Depending on how well organisms are equipped for migration/dispersal, the red box in the model shows how metacommunity dynamics (i.e. interaction of local communities across sites) may work.

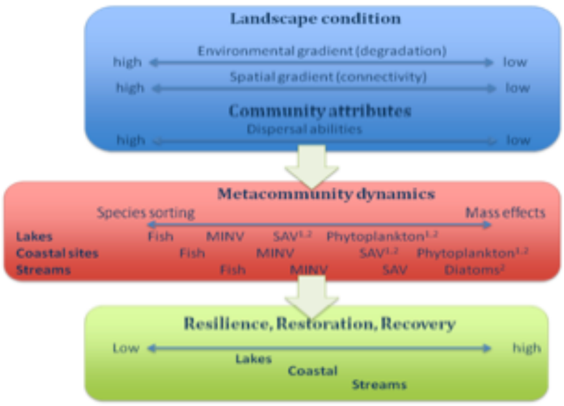
The red box emphasizes community dynamics along a gradient where on the one side combined dispersal/migration and local environmental filtering (i.e. mass effects) or only environmental filtering (species sorting) take place. The model is based on the assumption that planktonic organisms (chiefly phytoplankton as a study object in this WP) and SAV (submerged aquatic vegetation) are more readily dispersed passively (e.g. wind, floods, birds) than larger organisms which have either good flying or swimming capacity (macroinvertebrates, fish). As a result, in all three ecosystem types (lakes, streams and coastal areas), phytoplankton and SAVare expected to follow more mass-effects metacommunity models, while fish and macroinvertebrates are expected to follow the species sorting model.

As a corollary, the model also emphasizes potential consequences for ecosystem resilience (”withstanding stress(ors)”) or restoration (”responding to interventions to counteract these stress(ors)”), thereby showing links to WP. 6.4. Given that lakes are physically ”more isolated” landscape units, the model assumes that lakes, and their ecosystem services that derive from emergent community functions, may be less resilient to stress, simply because selected key organisms can not readily disperse between these ecosystems compared with hydrologically connected rivers and coastal sites.

We acknowledge the very simplistic/reductionist nature of this model, but it serves as a guide for developing a hypothesis testing framework regarding integral landscape-level responses of aquatic ecosystems and their constituent communities to environmental stressors within the WISER project. Our approach will be largely inspired by the recent paper by Soranno et al. (2010) which suggests a landscape approach to classify surface waters for multi-ecosystem management and conservation.

Their system for predictive classification modeling, grounded in the theoretical foundation of landscape limnology, creates a tractable number of ecosystem classes to which management actions may be tailored (Figure 2). Soranno et al. (2010) demonstrate their system by applying two types of predictive classification modeling approaches to develop nutrient criteria for eutrophication management in 1998 north temperate lakes. Their predictive classification system promotes the effective management of multiple ecosystems across broad geographic scales by explicitly connecting management and conservation goals to the classification modeling approach, considering multiple spatial scales as drivers of ecosystem dynamics, and acknowledging the hierarchical structure of freshwater ecosystems. Such a system is critical for adaptive management of complex mosaics of freshwater ecosystems and for balancing competing needs for ecosystem services in a changing world. Governmental entities are responsible for managing and conserving large numbers of lake, river, and wetland ecosystems that can be addressed only rarely on a case-by-case basis. Thus the integral landscape level modelling approach used within this workpackage of WISER can provide important management and conservation information, and feed back into policy (e.g. the EU Water Framework Directive).

Figure 1. Conceptual model on metacommunity dynamics of different BQEs across aquatic ecosysetm types as a function of landscape characteristics. Abbreviations: MINV, benthic macroinvertebrates; SAV (submerged aquatic vegetation); [1], colonization through emergence from seed banks; [2], colonization through inter habitat/ecosystem dispersal. For further details see text.



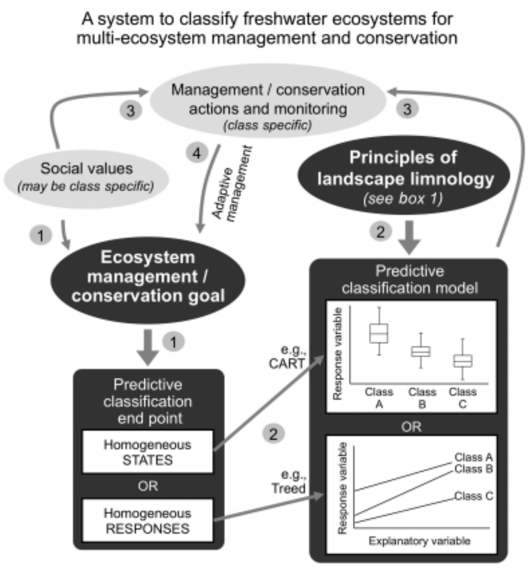


Figure 2. Overview of the system by Sorrano et al. (2010) to classify freshwater ecosystems for multi-ecosystem management and conservation. The dark gray ovals and rectangles represent the unique components of their approach that explicitly link the ecosystem management or conservation goal to the predictive classification endpoint (step 1), and that explicitly link the principles of landscape limnology with predictive classification modeling (step 2). The lighter gray ovals represent additional considerations to be included in their approach for a more integrated ecosystem management system. CART, classification and regression tree analysis

5. References

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Soranno PA, Cheruvelil KS, Webster KE, Bremigan MT, Wagner T, Stow CA (2010) Using Landscape Limnology to Classify Freshwater Ecosystems for Multi-ecosystem Management and Conservation. BioScience, 60, 440–454.