

## **Assessing linkages between river morphology and ecosystem services provided by Alpine rivers: the EU HyMoCARES project**

Evaluation des liens entre la morphologie fluviale et les services écosystémiques fournis par les rivières alpines : le projet EU HyMoCARES

Carolli M., Pusch M.\*, Beichler S., Costea G., Zolezzi G., Geneletti D., Goltara A., Boz B., Habersack H., Liebault F., Chouquet I., Gaucher R., Javornik L., Santl S., Kloetsch M., Marangoni N.

Leibniz-Institut für Gewässerökologie und Binnenfischerei (IGB)  
Müggelseedamm 301, 12587 Berlin - Germany

### **RESUME**

Les rivières alpines et les couloirs fluviaux fournissent un certain nombre de services écosystémiques importants. Ainsi, les processus et les fonctions hydro-morphologiques jouent un rôle essentiel dans la formation et le maintien des habitats fluviaux et de leurs fonctions écologiques, qui fournissent alors divers services à la société. La disponibilité de ces services a été historiquement fortement modifiée dans les vallées alpines densément peuplées par la modification des cours d'eau et de leurs plaines d'inondation, et évolue actuellement avec le changement climatique. Les nouvelles réglementations sur l'atténuation des impacts environnementaux de l'hydroélectricité sur la conservation et le soutien des services écosystémiques et le besoin apparent d'améliorer la communication entre les acteurs des corridors fluviaux de l'UE ont soulevé le besoin d'identifier des voies de gestion et des instruments de gouvernance pour mettre en œuvre ces objectifs politiques. Ainsi, le projet HyMoCARES identifie les relations qualitatives et quantitatives entre l'hydro-morphologie fluviale et la fourniture de services écosystémiques, et comment les mesures de gestion influencent les processus et les fonctions des rivières, et donc indirectement la disponibilité des services écosystémiques. Le projet montrera plusieurs exemples pratiques de l'influence de l'hydro-morphologie sur les services écosystémiques fluviaux pour plusieurs bassins fluviaux dans les Alpes qui ont fait l'objet d'une utilisation hydroélectrique, d'activités récréatives ou de projets de restauration de cours d'eau. Le projet vise à élaborer un cadre conceptuel complet reliant les mesures de gestion à l'hydro-morphologie et aux services écosystémiques, et à inclure les parties prenantes dans l'évaluation et la gestion de ces services, ce qui aidera à identifier, communiquer et finalement choisir les actions les plus efficaces.

### **ABSTRACT**

Alpine rivers and river corridors provide a number of important ecosystem services. Thereby hydromorphological processes and functions have a pivotal role in shaping and maintain river habitats and their ecological functions, which then provide various services to the society. The availability of these services has been historically greatly modified in densely populated Alpine river valleys by the modification of rivers and their floodplains, and are also currently changing with climate change. New regulations on the mitigation of environmental impacts of hydropower, on the conservation and support of ecosystem services, and the apparent need for an improved communication among stakeholders in river corridors in the EU have raised the need to identify management pathways and governance instruments to implement these policy goals. Hence, the HyMoCARES project identifies the qualitative and quantitative relationships between fluvial hydromorphology and the ecosystem service provisioning, and how management measures influence river processes and functions, and thus indirectly the availability of ecosystem services. The project will demonstrate several practical examples of the influence of hydromorphology on river ecosystem services for several river catchments in the Alps which have been subjected to hydropower use, recreational activities or river restoration projects. The project aims to elaborate a comprehensive conceptual framework relating management measures with hydromorphology and ecosystem services, and to include stakeholders into the evaluation and management of those services, which will help to identify, communicate and eventually choose the most effective actions.

### **KEYWORDS**

Alpine rivers, river ecosystem services, hydromorphology, river management

## **ASSESSING LINKAGES BETWEEN RIVER MORPHOLOGY AND ECOSYSTEM SERVICES PROVIDED BY ALPINE RIVERS: THE EU HYMOCARES PROJECT**

Alpine rivers and river corridors provide a number of important ecosystem services (ES), as defined as "direct and indirect contribution made by ecosystems to human welfare" (TEEB, 2015). Alpine valleys are often densely populated and intensely used, and most rivers have been profoundly modified e.g. for the use of their hydropower. In addition, the hydrology of many rivers is subject to profound changes due to climate change.

As hydromorphological processes and functions have a pivotal role in shaping and maintain river habitats and their ecological functions, such changes have significant impacts on the provisioning of various services to society. New regulations on the mitigation of environmental impacts of hydropower, the political request to re-develop ecosystem services, and the apparent need for an improved communication among stakeholders in river corridors in the EU have raised the need to identify management pathways and governance instruments to implement these policy goals.

Hence, the HyMoCARES project aims to identify the functional linkages between fluvial hydromorphology and the ecosystem service provisioning, and how management measures may those linkages. The project aims to elaborate a conceptual framework relating management measures on river hydromorphology with the ecosystem services concept. In addition, we include stakeholders into the evaluation those services, which will help to identify, communicate and eventually choose the most effective management actions. HyMoCARES is a project funded by the EU Interreg Alpine Space which involves thirteen partners from six different countries, with eight case studies.

Here, we present a) a newly developed a list of hydromorphological processes and functions of Alpine rivers, b) a list of important riverine ecosystem services in the Alpine region, c) a set of standard management actions; and d) a conceptual network to qualitatively link management actions and ES, which enables to predict impacts on ES probably caused by planned by management actions.

Thereby, we define processes as abiotic and biotic activities and their interactions that shape the physical component of the fluvial system. Functions represent are a subset of the interactions between ecosystem structure and processes that influence the capacity of an ecosystem to provide goods and services. In total we identified nine functions, eighteen ES for Alpine rivers and three usages of abiotic natural capital were identified. Usages of abiotic natural capital were conceptually separated from ES because they require only minor contributions from ecosystems. Finally, we identified nine typical management actions which influence processes, functions and ES.

After the elaboration of the definitions of every process, function and ES, we assigned scores to each linkage by applying a two step procedure. Firstly, we asked to a panel of experts to define if the linkage exists or not. Secondly, we followed the assessment matrix method proposed by Burkard et al. (2009). We applied this method by asking the project partners to relate – - based on their expert opinion – both management actions with functions and functions with ES using a score system between 0 (non relevant) and 5 (highly relevant).

Expert-opinion usually introduces uncertainties into such results. In order to reduce such uncertainties, Campagne et al. (2017) has proposed to use specific statistical techniques to calculate relationships scores. We choose to calculate mean and confidence interval by using bootstrapping techniques. This resulted in a matrix of expert opinion scores, which were used to produce a visualization framework for the linkages between management actions, functions and ecosystem services ( Figure 1).

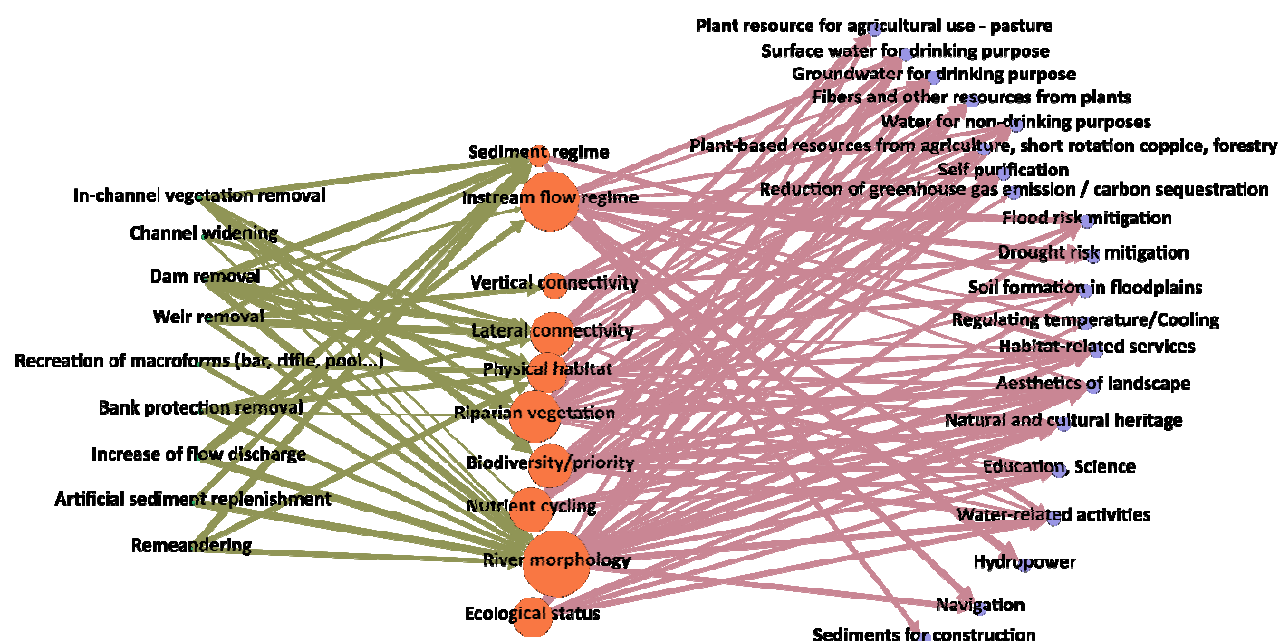


Figure 1 Network based on the analysis of the expert-opinion scores. The framework is divided in three groups: on the left we show the management actions selected in the project, in the center we show the functions and on the right we present the ecosystem services. Connections are based on the statistical analysis of expert opinions and the connection thickness depend on the mean and standard deviation of the answers.

This functional network visualization may provide an interactive tool for the use by stakeholders to identify qualitatively the consequences of a distinct management action on river ES. Alternatively, if a stakeholder is particularly interested in optimizing specific ES, the network may also be used to select the management action which may maximize specific ES.

In order to further improve this network, it will be validated by applying it to several practical examples of the influence of hydromorphology on river ecosystem services for river catchments in the Alps which have been subjected to hydropower use, recreational activities or river restoration projects. In case you should be aware of more documented case studies on linkages between processes, function and ES of river corridors, please notify us under [pusch@igb-berlin.de](mailto:pusch@igb-berlin.de) !

## LIST OF REFERENCES

- Burkhard, B., Kroll, F., Müller, F., & Windhorst, W. (2009). Landscapes' capacities to provide ecosystem services - A concept for land-cover based assessments. *Landscape Online*, 15(1), 1–22. <https://doi.org/10.3097/LO.200915>
- Campagne, C. S., Roche, P., Gosselin, F., Tschanz, L., & Tatoni, T. (2017). Expert-based ecosystem services capacity matrices: Dealing with scoring variability. *Ecological Indicators*, 79, 63–72. <https://doi.org/10.1016/j.ecolind.2017.03.043>
- Haines-young, R., Potschin, M., (2010). The links between biodiversity, ecosystem services and human well-being. In D. G. Raffaelli & C. L. J. Frid (Eds.), *Ecosystem Ecology: A New Synthesis* (pp. 110–139). Cambridge University Press, British Ecological Society.
- TEEB DE – Naturkapital Deutschland, (2015). *Naturkapital und Klimapolitik - Synergien und Konflikte*. Hrsg. Hartje, V., Wüstemann, H., Bonn, A. Berlin, Leipzig. <http://www.naturkapital-teeb.de/publikationen/projekteigene/publikationen/bericht-1.html>