Operationalizing ecosystem services for decision making with the River Ecosystem Service Index (RESI)

Opérationnalisation des services écosystémiques pour la prise de décision avec l'Indice des Services Ecosystémiques des Rivières (RESI)

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RÉSUMÉ

Les rivières et leurs plaines d'inondation sont des sites centraux de la disponibilité des services écosystémiques, mais qui sont intensément utilisés, par exemple pour l'hydroélectricité, la navigation, l'agriculture, l'approvisionnement en eau potable, ou les loisirs et le tourisme. De nos jours, ces utilisations intenses sont souvent en concurrence pour la même zone et le même plan d'eau, et produisent des compromis importants. L'indice des services écosystémiques des rivières (RESI) a été développé afin d'opérationnaliser les connaissances existantes et les évaluations non monétisées des services écosystémiques fournis par les rivières et leurs plaines d'inondation dans la gestion environnementale. Ainsi, la fourniture d'habitats pour la biodiversité représente un service écosystémique d'une importance particulière, de même que les services de régulation pertinents pour l'adaptation et l'atténuation du changement climatique. Dans notre approche, les disponibilités évaluées de tous les services écosystémiques étudiés peuvent être résumées en un indice intégratif appelé "indice de service écosystémique des rivières" (RESI) (www.resi-project.info). Le RESI peut être utilisé pour visualiser et comparer des scénarios complexes de gestion des rivières et des plaines d'inondation, et donc servir d'outil d'aide à la décision pour la communication inter- et transdisciplinaire. Le RESI a déjà été mis en pratique dans le cadre d'une procédure officielle de priorisation de la planification régionale pour une section de 80 km du Danube en Bavière (Allemagne).

ABSTRACT

Rivers and their floodplains are focal sites of ecosystem service availability but which are intensely used, e.g. for hydropower, navigation, agriculture, drinking water supply, or recreation and tourism. Nowadays, these intense uses are often competing for the same area and water body, and produce significant trade-offs. The River Ecosystem Service Index (RESI) has been developed in order to operationalize existing knowledge and non-monetized assessments of ecosystem services provided by rivers and their floodplains in environmental management. Thereby, the provision of habitats for biodiversity represents an ecosystem service of special importance, as well as regulating services relevant to adaptation and mitigation of climate change. In our approach, assessed availabilities of all studied ecosystem services may be summarized to an integrative index called the 'River Ecosystem Service Index' (RESI) (www.resi-project.info). The RESI may be used to visualize and compare complex river and floodplain management scenarios, and hence serve as a decision support tool for inter- and transdisciplinary communication. The RESI has been already been implemented in practice in the framework of an official regional planning prioritization procedure for a 80-km section of the Danube River in Bavaria (Germany).

KEYWORDS

decision support, ecosystem services, freshwater biodiversity, integrated assessment, social-ecological systems,

1 INTRODUCTION

Rivers and their floodplains are focal sites of ecosystem service availability but which are intensely used, e.g. for hydropower, navigation, agriculture, drinking water supply, or recreation and tourism (Tockner et al. 2010). Nowadays, these intense uses are often competing for the same area and water body, and produce significant trade-offs. In order to intensify some of these uses, rivers and their floodplains have been historically profoundly modified In Central Europe, most rivers have been channelized, which means that the river channel was narrowed and straightened and river banks were artificially stabilized. This facilitated navigation, the construction of hydropower plants, as well as agriculture in the floodplain areas which were then flooded less frequently or even protected by dykes. In many places this transformation has resulted in undesirable effects over time, as river incision, sagging of floodplain surface due to peat decomposition, decrease and pollution of groundwater resources, increase of flood probability, decline of fisheries, and disappearance of biodiversity.

Hence, rivers and floodplains represent sites that offer a broad array of benefits for humans but have been thoroughly modified historically in many places. The combination of high ES availability and strong human uses and modifications has made historic shifts in the availability of abiotic and biological resources especially apparent in river corridors.

Thus, recently more balanced and sustainable ways are sought to manage rivers and floodplains. Such integrative approaches should aim to serve the objectives of several important legal frameworks, as the Habitats Directive, the EU Water Framework Directive, the EU Flood Risk Management Directive, and at the same consider major economic interests, as e.g. hydropower or agriculture. Thereby, management practitioners are often faced with the challenge of harmonizing and prioritizing these various societal goals (Schindler et al. 2014).

2 THE RESI APPROACH

In order to establish a rationale for inter-sectoral decision making in complex management planning in river corridors, the River Ecosystem Service Index (RESI) has been developed in order to operationalize existing knowledge and non-monetized assessments of ecosystem services provided by rivers and their floodplains in environmental management. For the assessment, a catalogue of ecosystem services provided by rivers and floodplains has been elaborated including all three categories of ES according to CICES. All ES are assessed using spatial data which is processed in Geographical Information Systems (GIS), as e.g. the value for the provisioning services of agricultural land and pastures is calculated combining land use, soil quality and flooding frequency data. Hydromorphological data were used to calculate indicators for several ecosystem services. For river channels, hydromorphological data are relevant as well as water quality data for assessing the retention of organic carbon, phosphorus and nitrogen capacity of a river section, as retention is particularly associated with sediments. the provision of habitats for biodiversity represents an ecosystem service of special importance, as well as regulating services relevant to adaptation and mitigation of climate change.

Cultural ES were assessed e.g. based on available surface waters, experienceable parts of landscape, and the number of protection categories present. All ecosystem services included are assessed in a non-monetary way by scoring them from 1 (very low) to 5 (very high). Scores are assigned for 1-km segments of the morphological floodplain, separated into the river channel, the active and the non-active parts of the floodplain. This uniform scaling of ES availability allows the elaboration of uniform maps for various ES, and an integration of various ES through the ‘River Ecosystem Service Index’ (RESI) (www.resi-project.info). The RESI may be used to visualize and compare complex river and floodplain management scenarios, and hence serve as a decision support tool for inter- and transdisciplinary communication.

3 RESULTS FOR THE DANUBE SECTION DOWNSTREAM OF ULM

The RESI has been already been implemented in practice in the framework of an official regional planning prioritization procedure for a 80-km section of the Danube River located downstream of the city of Ulm (south Germany). For this section, as for the whole Bavarian section of the Danube, the Bavarian State Ministry of the Environment and Consumer Protection (STMUV) strives to increase the

flood retention capacity of the river section, since the 2013 century flood of the Danube has shown significant need for improvement of flood protection. Therefore, a concept to establish three regulated polder areas and up to six unmanaged flood retention areas was developed. However, such plans will always interfere with other key uses of the river and its floodplains, as hydropower, forestry or agriculture, and in this case with a planned national project of floodplain restoration and nature conservation.

In such a complex decision-making situation, the RESI concept was welcome by the regional water management agency (WWA Donauwörth) to contribute to a cross-sectoral and transparent comparison of planning options for the design and site prioritization for new flood retention areas. Hence, two different management options (scenarios) were defined and compared with each other and with the status quo. By the use of available data, 13 ecosystem services could be assessed for every floodplain segment of this 80-km section. Thereby, scenario 1 reflects an integrated planning where especially the requirements of nature conservation and of agriculture were respected: the flood retention areas, which will be flooded by an 100-yearly flooding event, cover only the land use types forest, wetlands and water bodies, but no agricultural fields; following requests of nature conservation these areas will be additionally flooded regularly, approximately 3 times per year, which is comparable to natural floodplain conditions. In contrast, scenario 2, maximizes flood protection in a larger area also including crop fields, but which will be flooded solely at extreme flooding events (> 100 years return time) without further ecological compensation. For both scenarios, ES assessments were performed for all affected 1-km segments.

Results for the individual ecosystem services in the five score levels were presented both in maps and in polar charts (Stammel et al. 2020). As a first result, the status quo of each of the 13 ES was represented so that the location of high and low value sites could be identified. Second, the effects of the two scenarios for individual ES were compared, as illustrated in Tab. 1 for three different ES in one retention area.

4 CONCLUSIONS

Our experiences show that the ecosystem service concept may establish a uniform platform for the communication and cooperation among stakeholders from various sectors. Accordingly, the newly developed River Ecosystem Service Index (RESI) may be used as a transparent cross-sectoral communication and visualization tool for the management of riverine landscapes, which enables an integrative comparison of several management scenarios, as e.g. for flood retention along a river section. The RESI summarizes data from various sources, integrating methods from different disciplines and shows effects on the whole array of ecosystem services. Based on this RESI supports the identification and decision-making for more balanced and sustainable planning and management options.

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