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Ecosystem-based management to support conservation and restoration efforts for a complex large scale socio-ecological system - the Danube River in Europe.

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The Danube River as one of the largest river-floodplain systems in Europe is a highly complex socio-ecological systems. It is a hotspot of biodiversity and ecosystem services but is also used for multiple human activities like navigation, hydropower, urban development or agriculture, making it to one of the most threatened ecosystems worldwide. Conservation and restoration of the systems biodiversity and ecosystem service provisioning is an important task but challenging because the diversity of human activities and policy targets (including WFD, Habitats and Birds Directive, Flood Risk Directive, Biodiversity Strategy or Green Infrastructure Strategy), scarcity of data compared to the complexity of the systems, heterogeneity of environmental problems and strong differences in socio-economic conditions along the Danube hampers planning. We developed and tested an integrative ecosystem-based management (EBM) approach which aims to support conservation and restoration efforts, following the principles for EBM related to the resilience of ecosystems, consideration of ecological and socio-economic concerns, inclusion of multi-disciplinary knowledge and data or operation at ecosystem scale independent from administrative or political boundaries. Therefore, our quantitative modelling approach is based on best-available data including a continuous hydro-morphological assessment for the navigable Danube River, Land cover/Land use (LCLU) data or data collected on the status of the waterway, modelling the impact on biodiversity using data on selected protected species collected for Habitats and Birds Directive and three essential ecosystem services (flood regulation, crop pollination and recreation). In a second step, we spatially prioritize river-floodplain segments for conservation and restoration based on (1) multi-functionality related to biodiversity and ecosystem services, (2) availability of remaining semi-natural areas and (3) reversibility as it relates to multiple human activities (e.g. flood protection, hydropower and navigation). A gap analysis showed that most of the sites we were prioritizing for conservation are already part of Natura 2000 sites. Some of the sites identified to have high restoration priorities are already designated as sites with high restoration potential or restoration is already ongoing (under WFD), and others were identified in areas where no sites are yet designated. Our approach is therefore a promising tool with high potential to support catchment-scale management decisions across multiple policies.