Assessment of causalities, highlighting results from the application of meta-ecosystem analysis in the case studies- Executive Summary[1]

Overview

The EU 2020 Biodiversity Strategy mid-term assessment emphasised the need to integrate the devastating economic costs for society of failing to achieve its proposed targets. It is expected that mainstreaming the values of biodiversity (BD) and ecosystem services (ES) into decision-making will help increase awareness about the implications of the further degradation and loss of natural ecosystems on human well-being. The AQUACROSS Assessment Framework (AF) offers a way of integrating complex information into a broader socio-ecological framework, which acknowledges the interdependencies of coupled human-natural systems.

This executive summary is based on AQUACROSS Deliverable 5.2, which addresses the supply-side perspective of social-ecological systems (SES), by investigating relationships and possible causal links between BD and the crucial ecosystem functions (EF) that enable the supply of ecosystem services and abiotic outputs by aquatic ecosystems and associated ecotones.

The AF supply-side approach explicitly integrates the provision of ecosystem services by aquatic systems into the socio-ecological framework, for use in Ecosystem-Based Management (EBM) contexts. To support its implementation, a linkage framework was applied to examine the complexity and the connectivity in the aquatic ecosystems and perform exploratory analysis of the socio-ecological systems. The AF allows for the categorising a problem domain along the cause-effect chain with great potential for EBM, but also as a policy-oriented tool.

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[1] *This is the executive summary of AQUACROSS Deliverable 5.2: Assessment of causalities, highlighting results from the application of meta-ecosystem analysis in the case studies. The full version of this document can be found at www.aquacross.eu in project outputs.*

1 Outcomes

Following common classifications for the specific chain elements on the AF supply-side (BD, EF, and ES), the AQUACROSS Case Studies built linkage matrices, based on expert elicitation. The information generated by the linkage framework was used in several ways:

- for unravelling the multiple relationships between the various supply-side SES components;
- for showing the relative contribution to the provision of ES across the different aquatic realms and related ecotones, from freshwaters to coastal and marine waters in Europe;
- for strengthening the importance of considering a meta-ecosystem approach to integrated management, identifying cross-ecosystem links across spatial units at different scales, in order to promote the provisioning of aquatic and related ecotone-related services;
- for establishing the risk to the supply of ecosystem services across aquatic ecosystems in Europe, establishing a causal connection to the demand-side of the SES;
- for developing the integrative AquaLinksTool, a vulnerability approach to ecosystems services provision that considers the conservation status of European aquatic systems, as classified in the recent EU Red List habitats;
- and for EBM contextualised exploratory analyses in the case studies, using from qualitative to semi-quantitative and quantitative analyses approaches of selected and relevant elements of the Biodiversity-Functions-Services chain.

2 Ecosystem services provision by aquatic realms

We have observed that aquatic realms within a domain (i.e., freshwaters, coastal or marine waters, or other non-aquatic domains), generally share more similarities regarding their ES supply patterns. However, a high turnover of ES provision across habitats was observed, with significant differences found across all realms, except for lakes and rivers. Several ES appeared to co-occur in bundles. The differences and spatial patterns of ES found across aquatic systems and associated ecotones have important implications at the time of implementing EBM plan because the loss of specific habitats may lead to:

- the loss of specific services; and
- the loss of multiple related services (bundles).

The ES Supply Score (ESS) The ES provision potential, as assessed by expert valuation, was integrated with the actual capacity to supply a service, i.e. by considering the area occupied, and with the supply condition, i.e. taking the environmental integrity and condition of the given ecosystem component, to provide a final ES Supply Score (ESS) (Figure 1).

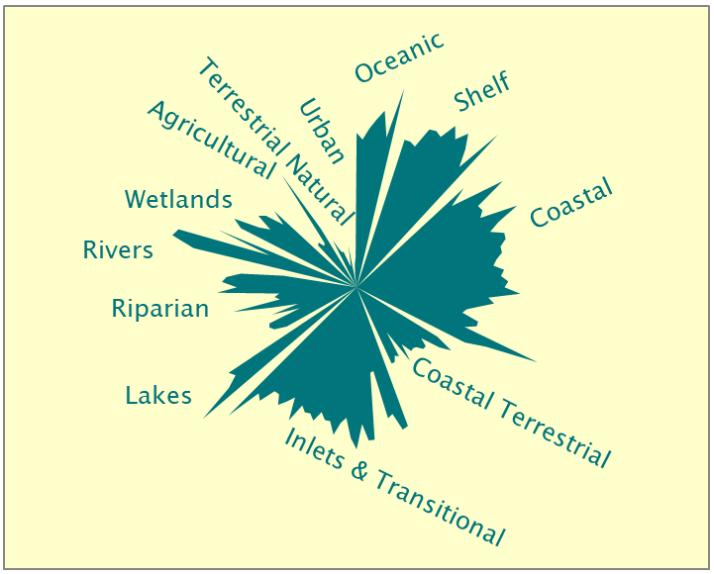

Figure 1 Ecosystem services supply score (ESS) of different habitats in each realm (range 0–1, max length observed in plot 0.8).

The highest ES Supply Score was observed in habitat 'pelagic water column' in 'shelf marine waters', while the lowest was registered in 'urbanised areas', in particular in 'constructed, industrial and other artificial habitats'. In general, habitats in non-targeted realms have lower services supply scores than aquatic and related habitats.

The Risk to Supply

The Services Supply Potential (Dimension 1 of the ESS score) is particularly important for providing a general relative value of the importance to supply of different ecosystem components. When ecosystem components are exposed to a high number of pressures, the ESS can show, for example, the associated ecosystem services that become at risk. It can also provide relevant information, for example, for scenarios testing or use within risk assessment contexts.

The ES Vulnerability

The AquaLinksTool vulnerability approach offers an alternative perspective and application to that of the ES supply score and that of the risk to services supply mentioned before. The vulnerability score considers the conservation status of European aquatic systems, as classified in the recent EU Red List habitats. By considering the status of an ecosystem component at a global scale, it offers the possibility for highlighting which ES are vulnerable due to their dependency of aquatic habitats most threatened in Europe. Because this is an EU scale classification, independent of the local conservation status, it can act as a precautionary policy support instrument at EU level.

The AquaLinksTool (Figure 2) integrates the socio-ecological systems. It allows exploring causality in a linkage chain, relating Drivers/ Activities ► Pressures ► Biodiversity Status (structural components) ► Ecosystem functions ► Ecosystem Services provision as proposed in the AQUACROSS AF.

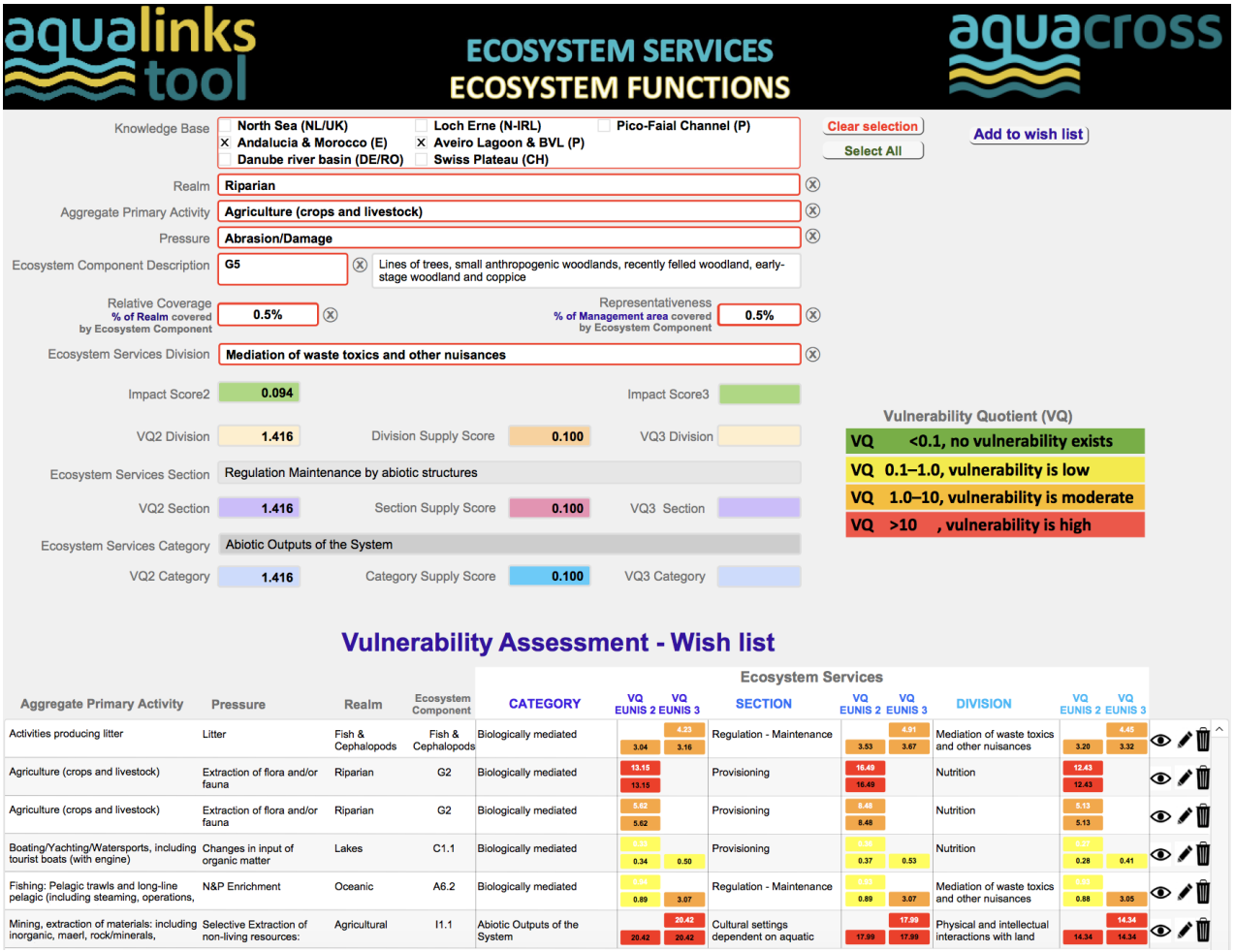

Figure 2 AquaLinksTool user interface of the AQUACROSS software application

The aim of this tool is to assess the vulnerability of ecosystem components threatening the provisioning of ES. By identifying the most vulnerable habitats regarding ES provision, the AquaLinksTool can support decision making.

3 Contextualised EBM in the case studies

Although general biodiversity conservation concerns were at the core of all case studies, each one fits a particular management and policy context. Therefore, the case studies target specific objectives set by one or several pieces of legislation or agreements: the EU Biodiversity Strategy to 2020, by EU Directives and regulations (such as the Marine Strategy, the Water Framework Directive, the Habitat and Birds Directives, the Common Fisheries Policy, and the EU Invasive Alien Species Regulation), or conservation objectives for areas under special protection (such as the Biosphere Reserves or the Natura 2000 sites). The AF supply-side characterisation was implemented by each case study and proved flexible enough for use in a wide range of EBM socio-ecological contexts, as summarised below.

- *CS1*: North Sea uses the AF to provide a holistic view where the full range of Biodiversity-Ecosystem Functioning-Ecosystem Services links is assessed and used to provide an overview of the links not directly targeted by specific management plans, while still accounting for the possible impacts of adopted measures in the ES supply balance of the entire system.
- *CS2*: Intercontinental Biosphere Reserve of the Mediterranean uses the AF to identify ES per habitat and fill gaps in indicators of ES to allow the ES spatial characterisation in support of prioritising of zones for conservation or different uses.
- *CS3*: Danube River Basin, acknowledging the multi-functionality of the systems related to biodiversity and ecosystem service, the AF was applied to identify habitats linked to the targeted ecosystem services and support a spatial prioritisation based on trade-off analysis.
- *CS4*: Lough Erne uses the supply-side of the AF to unravel relevant linkages that could highlight which ES are associated with habitats at risk by the targeted pressure for management, which is the presence of non-indigenous species in this lake.
- *CS5*: For Ria de Aveiro Natura 2000 Site, the AF was applied to integrate management at two spatial scales and inform on biodiversity and ES trade-offs at a broader scale for compensating for small-scale management options in specific areas within site.
- *CS6*: Lake Ringsjön was used to test to the AQUACROSS AF, by using the overall estimates from across aquatic systems for characterising the potential of CS6 habitats' for supplying specific ES. This information can be used, for example, for setting expectations regarding the loss/recovery of tourism-related ES in future scenarios and compare those results with those derived with the alternative sociological approach used in this case study.
- *CS7*: Swiss Plateau uses the AF to consider complex relationships between the SES components with the aim of supporting spatial and temporal prioritisation of restoration areas. The overall ecological state at the catchment scale is the main goal but alternative management scenarios are compared for ensuring the best possible sustainable equilibrium between the supply and the demanded of services by the society.
- *CS8*: By applying the AF linkages estimates in the Azores, the ES supplied by selected focal elements in the Channel Pico-Faial were identified and targeted. The aimed was to help understand this system and all of its complex interactions, including relevant stakeholders' values.

4 Conclusion

A comprehensive characterisation of the supply-side of the AQUACROSS linkage framework provides valuable information regarding the supply of ecosystem services, connecting the ecological system with the social system. While targeted ecosystem features or specific environmental and societal goals are usually the triggers of management, the AQUACROSS AF proved a useful tool for identifying potential conflicts, trade-offs and synergies, and thus support better informed decisions and management options. This information may highlight stakeholders on the consequences of their management choices, as the full range of relationships can easily be overlooked or missed when focusing on specific sectoral topics or problems. A comprehensive linkage assessment is thus a powerful instrument for decision makers.

AQUACROSS case studies demonstrated the added value of such a framework for the practical implementation of EBM. The flexibility of the AF is crucial to accommodate different spatial management contexts across very different realms and geographies or even policy and social contexts. But its flexibility is even more relevant for promoting and accompanying adaptive management within real situations and along temporal scales. Several case studies and the overall BD-ES patterns analysis clearly demonstrated that the AF linkage approach is also a powerful tool for meta-ecosystems analysis. These findings point to promising contributions in the field of EBM.

Finally, having failed 2010 targets, the EU Biodiversity Strategy mid-term assessment stressed the importance of increasing dialogue with Member States and relevant stakeholders for adoption of best practices for further integration of BD and trigger timely action towards accomplishing the 2020 targets. The lessons learnt from testing the AF in real CS scenarios provide valuable recommendations on how to move forward implementing scientific-sound EBM practices.

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