Assessing modelling approaches in selected AQUACROSS case studies – Executive Summary[1]

Overview

Despite progress in defining conservation goals to protect ecosystems and their biodiversity (e.g. the EU 2020 Biodiversity Strategy), aquatic biodiversity is declining due to strong anthropogenic activities and over-exploitation of natural goods and services. Ecosystem-based management (EBM) provides a promising approach to guide management.

EBM aims to recognize the full array of interactions within an ecosystem including humans, rather than considering single species, issues, or ecosystem services in isolation. Simulations and modelling techniques can be applied to study the complex interactions of biodiversity and drivers and pressures they are experiencing. They provide insight, allowing the modification of specific factors, e.g. conservation or management alternatives, while controlling for other factors within the simulation such as management costs and quantifying the uncertainty in the model predictions.

In the aquatic realm, these interactions are particularly challenging to quantify due to rapidly changing environmental and anthropogenic factors that can alter the habitat rather quickly. Therefore, evaluating the external conditions and the potential outcome of management scenarios remains a key challenge.

[1] *This is the executive summary of AQUACROSS Deliverable 7.3: Assessing modelling approaches in selected AQUACROSS case studies. The full version of this document can be found at www.aquacross.eu in project outputs.*

1 Outcomes

The eight AQUACROSS case studies tested key causal links between biodiversity and ecosystem services (ESS) and aimed to forecast potential future changes considering their linkages and interactions.

Trade-offs between ESS and biodiversity conservation goals were discussed for the case studies. Thus, the model results can be used to support management decisions regarding different – even potentially conflicting – policy goals (e.g. EU Biodiversity Strategy, the Water Framework Directive, the Renewable Energy Directive). The modelling outputs can facilitate decision-making processes, with identification of critical areas that potentially need to be prioritized for allocating particular management actions. The methods applied here provide maps that enable stakeholders to visualise potential outcomes of scenarios. In agreement with the EBM principles, all these features help to achieve conservation-goals and socio-economic targets, potentially leading to a win-win situation that enhances biodiversity and allows ESS use, satisfying different stakeholder demands.

2 Details on modelling approaches and scenarios

Different modelling techniques are available providing qualitative, quantitative, or spatially-explicit information and foresight (compare Deliverable 4.2 and Domisch et al. 2017, D7.1). The model choice depends on the aim of the study, the available data, time and effort required to build the model. For a quick analysis of linkage dependencies, a qualitative model is sufficient. However, it cannot be used to quantitatively assess spatial alternative management actions. The eight AQUACROSS case studies (CS) defined different research questions and showcase how to develop EBM, addressing the challenge to balance requirements for biodiversity conservation and provisioning of other ESS as crucial components to be considered in decision-making. The CS applied either quantitative spatially explicit modelling (CS2: Intercontinental Biosphere Reserve of the Mediterranean, CS3: Danube River Basin, CS5: Ria de Aveiro Natura 2000 Site and CS7: Swiss Plateau) or qualitative non-spatial approaches (CS1: North Sea, CS4: Lough Erne, CS6: Lake Ringsjön and CS8: Azores).

Despite different approaches, all CS involved experts and stakeholders to include their needs and views guiding the subsequent modelling approaches. Both – biologically mediated ESS and those reliant on purely physical aspects of the ecosystem – were considered, since both have implications for spatial planning, management and decision-making. All case studies explored the potential application of the EBM concept to support long-term planning for spatial prioritization of conservation and restoration measures.

For those CSs that applied quantitative spatially explicit modelling, three components were investigated: biodiversity models, ecosystem service models and joint prioritization. This approach allows to identify spatial patterns across the respective study areas and to specify priority areas for conservation of aquatic biodiversity and different ESS through restoration and/or management alternatives. The modelling approaches developed are suitable to be further applied in other regions.

Some examples of the case studies:

- *Case Study 2* (Andalusia-Morocco) tested management and planning of their transboundary aquatic ecosystems through green blue infrastructures (GBI) designation within natural protected areas. Via extending spatial models, a GBI designation that identifies locations in order to maximize the delivery of ecological benefits was identified.
- *Case Study 3* (Danube) modelled potential floodplain management depending on biodiversity, ESS, floodplain characteristics and status of protected areas according to Natura 2000 sites.
- As a Natura 2000 catchment, *Case Study 5* (Ria de Aveiro Natura 2000 Site) analysed potential measures across all aquatic realms i.e. freshwater, transitional, and coastal areas to set out conservation objectives for restoration balancing biodiversity and ESS.
- *Case Study 7* (Swiss plateau) identified priority sites for habitat restoration in order to counteract the impacts of hydromorphological alterations (e.g., land use change and hydropower development) on biological diversity and associated ESS. Restoration measures can be based on the evaluation of the ecological state of river ecosystem at large scales while taking into account potential costs of restoration measures and ESS trade-offs.

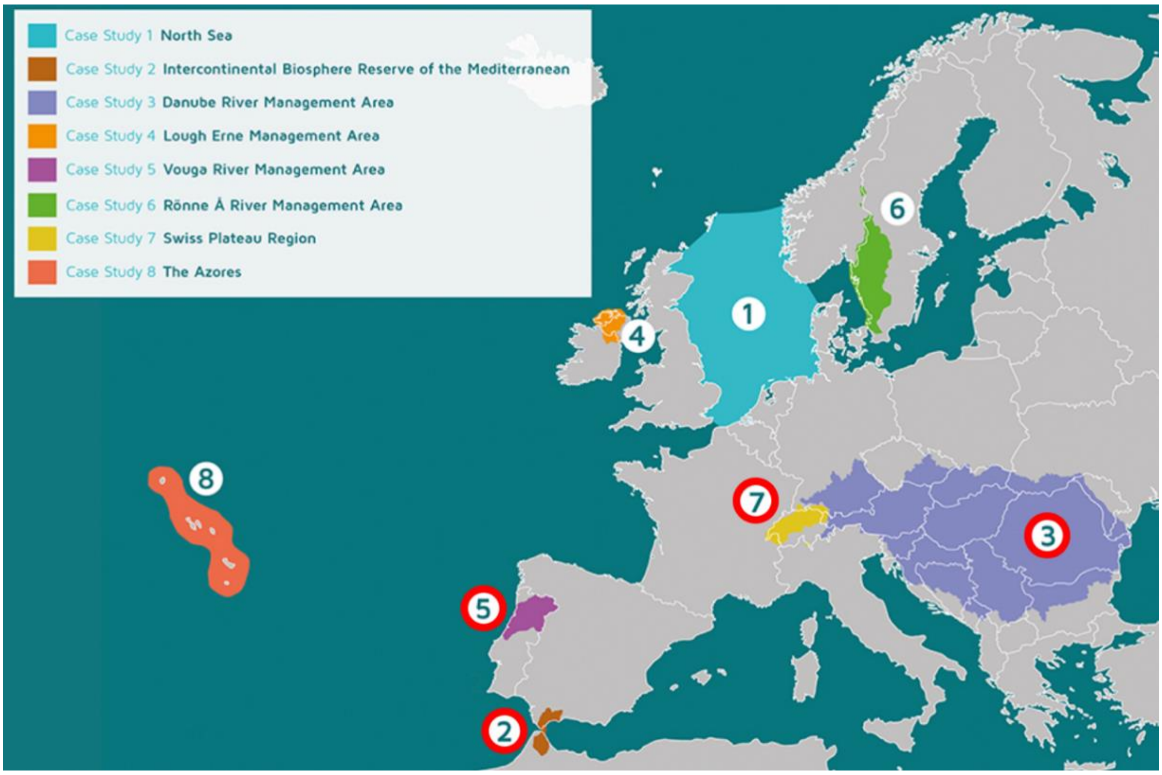

Figure 1 Location of four selected case studies in this deliverable: (CS2) Andalusia, (CS3) Danube, (CS5) Ria de Aveiro Natura 2000 Site, and (CS7) Switzerland.

3 Challenges

A number of limitations in modelling approaches have been identified by the case studies, which are related to data availability, connectivity, scenarios, socio-economic issues, and stakeholder involvement. In the case studies, scenarios were solely defined by stakeholder needs and e.g. represent alternative management scenarios, but did not consider external scenarios such as climate or land use change, omitting potentially synergistic or antagonistic effects in addition to stakeholder needs. Case studies focused on targets related to the EU Biodiversity Strategy to 2020, while other – potentially conflicting policies – were not considered despite being one of the original goals of AQUACROSS project (see Gómez et al., 2017; Deliverable 3.2). In addition, when several countries or even continents are involved (e.g., CS2: Andalusia-Morocco, CS3: Danube), further complexity is added due to (1) different demands and conservation agendas, (2) data availability and provisioning, and (3) language barriers. This led to rather large scale, higher level targets in the respective case studies (rather than detailed management actions) with less spatial resolution. However, small scales can also benefit from spatial prioritization, if fine scale data is available.

The spatial prioritisation approach requires careful consideration related to (1) the challenge of setting “adequate targets”, such as a proportion of the total population to be protected or a proportion of the delivered ESS, (2) the inability of the modelling framework to consider spill over effects and connectedness, (3) the limited number and complexity of management scenarios which can be analysed, (4) use of rudimentary cost information to analyse cost-effectiveness, and (5) involvement of stakeholders from high governance level, particularly if studies have a large study area.

Despite these open challenges, the four AQUACROSS case studies have employed well known and robust modelling approaches in a coherent framework to analyse conservation of aquatic biodiversity and different ESS. All case studies considered potential action strategies and inherent boundaries. The models used are generally able to also analyse external scenarios such as climate or land use change.

4 Outlook

From the project and in concert with the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES, 2016) future research should:

(1) consider multiple spatial and temporal scales to improve model results. Different spatial scales from local to national and regional are operated based upon different drivers of change. Dealing with multiple temporal scales might improve decision-making through providing both short- and long-term perspectives. Different phases of the policy cycle might be addressed by target-seeking multiple scenario types.

(2) engage different sectors and interactions among them. This may not only contribute to capacity-building at the science-policy interface and prevent duplication of efforts of policy makers and scientists but foremost identify the key drivers of increasing pressures on biodiversity. Agriculture or recreation activities in local areas are linked to

important or emerging economic sectors, yet these economic sectors are in conflict with environmental policy goals while promoting economic growth. This often results in little ambitious targets for biodiversity conservation in practice. Modelling could test different goals of the frameworks in order to conserve biodiversity while achieving a sustainable economic welfare.

5 Conclusion

The methods and spatial modelling approaches used in AQUACROSS case studies are robust with high flexibility and transferability potential. They can be up-scaled and are broadly applicable to all aquatic realms i.e., freshwater, coastal and marine in any region of interest. Further applications to be developed and tested include measures: (1) to compare effects of e.g. management action on different aspects of biodiversity, incl. species, genes, habitats/ecosystems, (2) to use models to prioritize policy actions, particularly in case of conflicting objectives and (3) to estimate contributions of individual actions to global biodiversity targets.

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