



Scenario Development Processes in AQUACROSS¹

Overview

Scenario development and analysis are an important component of the AQUACROSS process, particularly to enhance understanding of the sustainability and resilience of ecosystem services and biodiversity and develop ecosystem-based management strategies. Scenario analysis is a common method in environmental impact assessment, climate change impact studies, ecosystem-based management, resilience management, to name just a few. This broad application across different domains has led to a bewildering diversity of approaches and terminology. This summary and the related report reviews the current state-of-the-art in scenario development and analysis in the ecosystem services literature to develop a shared terminology and guidelines for scenario processes in the AQUACROSS case studies. The main objective of the report is to describe and explain the scenario building processes, reflecting on different information and data sources, types of stakeholder involvement and scenario uses. The document provides guidance on how to develop scenarios, i.e. possible future trajectories of the system, by combining stakeholder processes and modelling in meaningful ways. Furthermore, it supports the on-going preparation of baseline and policy scenarios (as defined in the AQUACROSS [Assessment Framework](#)).

The importance of scenario development and planning for biodiversity and ecosystem services was only recently highlighted within the methodological assessment report on scenarios and models within the Intergovernmental Panel on Biodiversity and Ecosystem Services. We follow up on this report and extend their work within AQUACROSS by linking the methods to the Assessment Framework with a special focus on measures for ecosystem-based management and the integration of resilience principles.

¹ This is the executive summary of AQUACROSS Deliverable 7.2: Scenario Development Processes in AQUACROSS. The full version of this document can be found at www.aquacross.eu in [project outputs](#).

Why is participatory scenario development important?

We focus particularly on how ecosystem-based management in aquatic ecosystems can be supported by participatory scenarios. Following up on the AQUACROSS Assessment Framework (AF), attempts are undertaken with this report to pave the way for innovative means to investigate complex, aquatic social-ecological systems. Further, the report presents an advancement of a scenario characterisation suitable for linking multiple input sources, stakeholder processes and model analysis on a case basis.

Building on an understanding of aquatic social-ecological systems as complex adaptive systems

Social-ecological systems (SES) are complex adaptive systems characterised by multiple interactions and feedbacks across spatial and temporal scales. Aquatic SES such as lakes, estuaries, catchments, or marine areas are characterised by many relationships between elements of water-related physical, biological and human systems. The complex nature of these SES can lead to unexpected behaviour or unintended responses to management, as well as abrupt changes in the state of an ecosystem and related bundles of ecosystem services. For example, lakes can abruptly shift from a clear water to a turbid state as a result of slowly changing and accumulating human pressures such as nutrient inflows. This can lead to significant changes in biodiversity, ecosystem functions and services provided. These changes are often labelled as “regime shifts” because the ecosystem and its related uses shift from one stable regime into a different one.

Another characteristic of complex adaptive aquatic SES is that they are continuously changing as the result of these complex interactions and external drivers, such as the impacts of climate change. Management of aquatic SES thus needs to be able to deal with change and adapt to unexpected developments, which could be described as ‘managing a moving target’.

Scenario development and analysis

The ultimate goal of developing and analysing scenarios is to assess and compare alternative future pathways of an aquatic SES while considering expected future biophysical and socio-economic changes. Scenario analysis processes in the context of planning and management aim to inform policy making by providing information about the possible consequences of different pathways. They can be useful to assess the implications of uncertainty about future development and develop measures that are “robust”, in other words that perform well under a range of possible futures.

The process of scenario development and analysis can vary greatly, from a science-based study to a participatory process, involving all relevant stakeholders to co-develop possible future pathways. Scenarios can be based on quantitative and qualitative data and be developed by using a variety of methods from model-based studies to narratives. In AQUACROSS, all scenario development processes involve stakeholders to some degree from informing the design of model analysis to co-developing solutions to pressing aquatic ecosystem related problems.

Scenario development and planning is increasingly popular in environmental research as well as in ecosystem service and biodiversity management where it has shown to provide multiple benefits. Among them, scenario planning fosters long-term, complex, and systemic thinking which allows for exploring the dynamics of SES.

Using scenarios as decision-support-tools, however, also faces critical tensions. On the one hand, scenarios must rely on validated data and sound scientific insights as a critical condition for their credibility. However, on the other, they must have the ambition to become a shared representation

of stakeholders about the social and ecological problems, opportunities and alternatives society is facing as well as solutions to deal with them. Even a sound scenario based on scientific methods and proven facts would only be relevant for policy action if co-developed with, or accepted by, actors involved in the decision-making process.

Fostering Policy Applications and Business Innovation

Scenarios are designed to develop or achieve realistic policy goals, to screen measures and instruments to enhance biodiversity and to support the management of ecosystem services. Particularly the development of participatory scenarios can be highly relevant because:

- ▶ The co-development with stakeholders ensures their societal relevance, given that all relevant stakeholders have an opportunity to participate in the process;
- ▶ They can help increase awareness about policy relevant issues among selected stakeholders and citizens and increase acceptability of decisions;
- ▶ They can support the evaluation of impacts under different future trajectories, by assessing different future potential outcomes associated with specific policy decisions,
- ▶ Through the co-development of scenarios, relevant business stakeholders have the opportunity to influence the design of management measures and future legislation and regulations, so that policy-goals are achieved at minimum cost for the business sector,
- ▶ By identifying possible pathways and developments, scenarios can bring more clarity to investors regarding, e.g. the future regulatory framework or future opportunities, and can thus help foster business innovation.

1 Scenario types and development approaches

Based on the AQUACROSS [Assessment Framework](#), we differentiate between baseline and policy or management scenarios. Baseline scenarios depict current trends and forecast existing management strategies into the future. Policy scenarios demonstrate alternative trajectories that result from the introduction of new policy or management strategies that go beyond current practice.

Scenarios can be classified according to multiple criteria, such as the goals, underlying moral rules, or the function that they have within a participatory process. These criteria indicate three generic approaches for developing scenarios that are of particular relevance for AQUACROSS cases. They differ in the degree to which they are explorative, normative, or descriptive.

Explorative scenarios are characterised by an emphasis on an exploration of alternative future pathways without a predetermined target (Figure 1). The objective of such an explorative process is to agree on a common target after possible pathways and their consequences have been explored. Within AQUACROSS, baseline scenarios are explorative scenarios, often in the form of narratives, to identify the issues that arise from drivers, pressures and response variables of interest in a particular case.

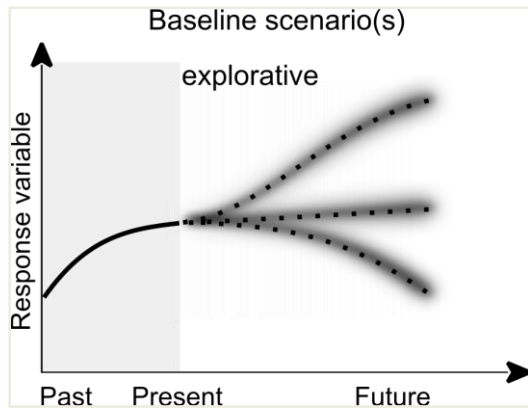


Figure 1: Baseline scenarios in AQUACROSS, showing alternative pathways of system response variables assuming the current management practice but three different external input scenarios (e.g. for socio-economic development). The grey background of alternative pathways denotes the respective uncertainty of the response variable conditional on each external input scenario.

Normative approaches to building scenarios are used when a target has been clearly defined and alternative measures to reach this target need to be assessed as part of an optimisation (Figure 2). Descriptive approaches in contrast are used to compare the effect of different implementation measures on the ecosystem or in our case the social-ecological system as part of a ‘what-happens-if’-exercise. In this regard, normative and descriptive approaches are most suitable for the development and assessment of alternative policy/management scenarios.

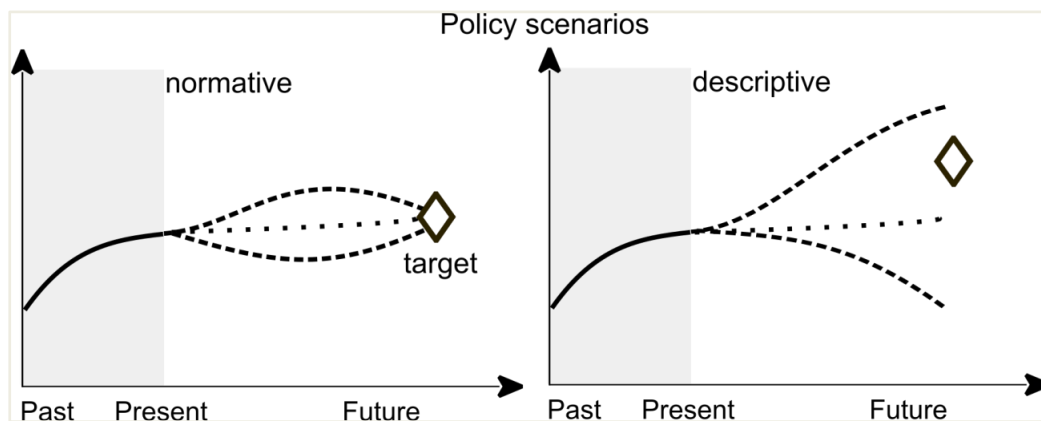


Figure 2: Alternative pathways (dashed lines) compared to the baseline scenario (dotted line). Some case study scenarios more normative (left side) in the way that the target is set first, and the question is about how to get there. Other case study scenarios are more descriptive for the purpose of policy or measure screening, where the question is about how the measures affect the system. Similar to the baseline scenario the policy scenarios may be subject to uncertainty and may show different trajectories in response to external input scenarios (not shown in this Figure for clarity).

2 Developing scenarios and analysis in AQUACROSS case studies

Within AQUACROSS, case studies integrate a broad range of stakeholder interests presented by decision makers and actors from multiple sectors (businesses, administration, civil society). Concerning ecosystem-based management, several interactions were identified as crucial: **a)** scientists with decision makers to improve salience of scientific input, **b)** decision makers with other actors in the SES to ensure legitimacy of the participatory process, and **c)** scientists with SES actors to support credibility in knowledge production. To support case studies during different stages of the scenario development process, these interactions are suggested with different emphasis in each step.

Based on the work in the Swedish case study and project work on stakeholder engagement and communication, we suggest a stepwise procedure to develop policy or management scenarios from an existing baseline scenario:

1. Choose a relevant **baseline** (agreed with stakeholders) as a reference for the assessment of the policy scenarios. (interaction a, c)
2. Identify problems, challenges, and barriers in the SES that need to be addressed in future management and formulate an objective and specific **targets** that are agreed upon based on the baseline assessment. (interaction a, c)
3. Screen available **measures** and instruments (partly suggested by stakeholders) that are considered suitable to address the problem and to be analysed with scenarios and models. (interaction c)
4. Design and construct alternative **pathways**, or indicator trajectories, i.e. response actions derived from EBM strategies, through models and/or narratives. (interaction b)
5. Build relevant **policy** scenarios and analyse **outputs** with regard to EBM. (interaction a)

Decision makers should facilitate participation from multiple actors and the broad civil society in ecosystem-based management, and in turn interact with science to support the process. Direct interaction between scientists and multiple actors, including the civil society, is advisable for improving the credibility in knowledge production or in case of doubts about sufficient participation established with decision makers.

As case study activities are at different stages and progress at different pace, the report presents a snapshot of how scenarios were developed or used so far, or which type of scenarios are foreseen in the near future. The main purpose was to clarify the role in which scenarios are connected to stakeholder involvement and model analysis (Table 1).

Table 1: Framing of targets for scenario development in AQUACROSS case studies

Case Study	Objective and target	Stakeholder involvement
1: North Sea	Conservation of seafloor habitat.	They identify issues/topics and thus shape knowledge base and phrase issues they deem most relevant.
2: Andalusia–Morocco	Decision support for policy processes to identify a suite of potential locations for a multifunctional Green and Blue Infrastructures (GBI). Target definition with stakeholders ongoing.	Stakeholders are consulted for exploring their expectations, collective goals, perceptions, social acceptance and the feasibility of measures that are proposed. This would help in defining the biodiversity, ecosystem status and ecosystem services objectives, select the conservation features and constraints.
3: Danube	Hydromorphological alterations and their effects on ecological status. Conserve a) biodiversity (birds) in Danube delta and, b) biodiversity (fish, inverts) in tributaries, c) biodiversity in protected areas along the navigable stretch of the Danube River. Targets derived from WFD and Biodiversity strategy.	They are involved by drafting (and later redefining) the scenarios and thus including their insights. The benefit is that they learn about complex problems and some trade-offs could be transformed into synergies.
4: Lough Erne, Ireland	Increase access for recreational activities and reduce invasive species in the system is the objective by stakeholders.	Stakeholder workshops that get to explore ways to reduce invasive species and improve recreation access to lake.
5: Vouga river, Portugal	Management of Natura 2000 areas from freshwater to coastal waters focused on EBM measures.	Participatory methods to co-develop scenarios, allows for inclusion of stakeholder expectations.
6: Rönne å catchment, Sweden	Implications of water governance on the co-production of ESS. Exploring ways to improve management to increase multifunctional landscapes.	Scenarios are created based on workshops and interviews, and stakeholder benefits are knowledge exchange, new contacts and improved collaboration.
7: Swiss Plateau	Improving the ecological state of rivers at the Swiss plateau while taking costs of management measures and ESS trade-offs into account and including external input scenarios for considering future changes in boundary conditions such as socio-economic development and climate change.	Stakeholders are involved to derive information about current management policies and their state of implementation, management objectives, and for discussion of the results of our analysis. They will benefit from learning from our predictions about the current state of knowledge about the effects of different management strategies under different external input scenarios.
8: Azores	Managing trade-offs among fishing, tourism (diving, whale watching) and multiple-uses: e.g. fishing, tourism, ferries and, biodiversity. No defined targets yet.	Aiming to include stakeholders in the development and assessment of scenarios. Their benefits would be identification of trade-offs (benefits & costs) that are associated with different measures.

3 Example cases for scenario processes

Chapter 4 in the report provides two example cases of scenario development processes within AQUACROSS. The first case explores Green and Blue Infrastructure (GBI) in Andalusia and Morocco with maps for optimal allocation of management zones as main output. Stakeholders are engaged iteratively in the whole research process to determine alternative combinations of conservation measures. The second case of the Rönne å catchment in Sweden investigates social-ecological co-production of aquatic ecosystem services and pathways to reach best-practice water governance. Knowledge co-development with stakeholders is a fundamental element throughout the process and results in narratives as a main output.

Providing example cases aims to give the reader an understanding of the diversity of scenario development processes within AQUACROSS. Each case describes the choice of the baseline and targets, the analysis of measures and developing pathways, and concludes with the output.

4 Outlook

Scenario development and analysis is an important tool for assessing the possible outcomes of future ecosystem-based management strategies and analysing possible trade-offs and synergies. Stakeholder engagement is critical for the success of a scenario process. However, it can take place at different steps and different degrees given the focus of the exercise, the stakeholders involved and the nature of the case study. Scenario development and analysis is a very flexible method that can easily be adapted to suit a specific case study context, policy needs, data and model availability. In the AQUACROSS case studies, scenario analysis is used to map expected consequences of existing or future policies on biodiversity and the provision of ecosystem services. Here, scenario building and analysis is particularly useful to link quantitative, often also spatial, data on biodiversity indicators and related ecosystem services with models to estimate their development under future policies. In other cases, scenarios are being used to assess outcomes that result from human interaction with aquatic systems over time, accounting for changing behaviour of ESS users and policy making under different policy options. While the uncertainty about the future is usually underrepresented in ecosystem management, scenarios as a tool to investigate forward-looking decisions help to broaden decision makers' views on the importance of nature for human wellbeing, and ultimately enable a collective effort for more socially, responsible decisions.

AQUACROSS Partners

Ecologic Institute (ECOLOGIC)—Germany

Leibniz Institute of Freshwater Ecology and Inland Fisheries (FVB-IGB)—Germany

Intergovernmental Oceanographic Commission of the United Nations Educational, Scientific and Cultural Organization (IOC-UNESCO)—France

University of Wageningen (WUR)—The Netherlands

Fundación IMDEA Agua (IMDEA)—Spain

University of Natural Resources & Life Sciences, Institute of Hydrobiology and Aquatic Ecosystem Management (BOKU)—Austria

Universidade de Aveiro (UAVER)—Portugal

ACTeon - Innovation, Policy, Environment (ACTeon)—France

University of Liverpool (ULIV)—United Kingdom

Royal Belgium Institute of Natural Sciences (RBINS)—Belgium

University College Cork, National University of Ireland (UCC)—Ireland

Stockholm University, Stockholm Resilience Centre (SU-SRC)—Sweden

Danube Delta National Institute for Research & Development (INCDDD)—Romania

Eawag - Swiss Federal Institute of Aquatic Science and Technology (EAWAG)—Switzerland

International Union for the Conservation of Nature (IUCN)—Belgium

BC3 Basque Centre for Climate Change (BC3)—Spain

Contact aquacross@ecologic.eu
Coordinator Dr Manuel Lago, Ecologic Institute
Duration 1 June 2015 to 30 November 2018

Website <http://aquacross.eu/>
Twitter @AquaBiodiv
LinkedIn www.linkedin.com/groups/AQUACROSS-8355424/about
ResearchGate www.researchgate.net/profile/Aquacross_Project2



Suggested citation: Martin, R., Hellquist, K.F., Schlüter, M., Barbosa, A. L., Iglesias-Campos, A., Torres, J. A., Barbière, J., Delacámara, G., Gómez, C. M., Arenas, M., Domisch, S., Langhans, S., Martínez-López, J., Villa, F., Balbi, S., Schuwirth, N., Rouillard, J., 2017. "Scenario Development: Deliverable 7.2 Executive Summary." Report as part of the Horizon 2020 project AQUACROSS (Knowledge, Assessment, and Management for AQUATIC Biodiversity and Ecosystem Services across EU policies).