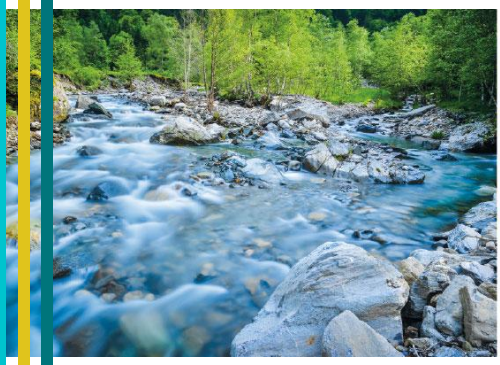

Developing the AQUACROSS Assessment Framework[1]

Overview

Aquatic ecosystems provide a full array of valuable services and abiotic components, ultimately contributing to human well-being. Many of those elements, though, are at risk due to a number of human activities and pressures. Understanding both complex adaptive natural and social systems, as well as their interlinkages, is required to provide better management responses. This ambition pervades the full strategy of the AQUACROSS project, from the definition of policy challenges and the setting of objectives to the identification of opportunities, the screening of innovative responses and the design, implementation and assessment of alternative courses of action. All these elements must be integrated into comprehensive and holistic frameworks that are able to capture all relevant interactions at stake, thus highlighting the disadvantages of limited partial approaches.

The AQUACROSS Deliverable 3.2 presents a common framework for the assessment of aquatic ecosystems that is needed for the development of integrated management concepts. This framework is in line with existing assessment initiatives and integrates ecological and socio-economic aspects in one analytical approach. Moreover, the Assessment Framework further considers relevant aspects for management of aquatic ecosystems, specifically in relation to resilience and uncertainty. In addition to the theoretical underpinnings of the analysis, the Assessment Framework also reflects a joint understanding of the key impacts on aquatic ecosystems between scientists, policy-makers and stakeholders and among ecosystem types (freshwater, coastal, and marine). Insights from a stakeholder workshop held in Berlin (March 2016) and the first AQUACROSS Forum held in Alcalá de Henares (Madrid, June 2016) greatly benefitted this process.

[1] *This is the executive summary of AQUACROSS Deliverable 3.2: Developing the AQUACROSS Assessment Framework. The full version of this document can be found at www.aquacross.eu in project outputs.*

The framework, as a living document, facilitates synergies and identifies critical linkages between the different elements of the project:

- The analysis of links between drivers of aquatic ecosystem change and relevant pressures.
- The assessment of causalities between biodiversity and ecosystem functions and services, as well as their abiotic components.
- The impact of drivers on the status and trends of biodiversity, ecosystem functions and services.
- The development of indicators to capture all relevant social-ecological-economic dimensions at the case-study level and beyond.
- The design and implementation of ecosystem-based management approaches, as innovative responses to enhance the status of aquatic ecosystems, so as to achieve meaningful policy objectives (namely the EU 2020 Biodiversity Strategy and other global biodiversity targets).

The Assessment Framework will be tested in the eight AQUACROSS case studies[2] and applied to a suite of innovative and applicable management solutions for aquatic ecosystems that serve to best enhance, through the conservation of biodiversity, the social-ecological resilience of ecosystems and their capacity to deliver services to society. The project, thus, follows an 'idea to application' approach, building on existing knowledge and generating innovative responses to policy coordination challenges by developing integrative tools and concepts with relevant stakeholders. Yet, the emphasis of Deliverable 3.2, by definition, is not on the application of the Assessment Framework itself, but rather on its design. Further work in the project will stress on the actual implementation of these analytical elements.

Since the Assessment Framework provides the foundations for applied research in the remainder of the project, the target audience of this Deliverable 3.2 is primarily internal (i.e., project partners and key stakeholders). Project partners are meant to apply it throughout the project case studies. Nevertheless, while their inputs are important, feedback from stakeholders is crucial. Stakeholders will support the deployment of the Assessment Framework and its practical application.

Moreover, scientific relevance and applications for policy and business innovation underpin the development and further review of the Assessment Framework, in line with the integrative ambition of AQUACROSS. Therefore, this document intends to use a common language to reach a wider audience in order to achieve its objectives: to develop innovative management approaches and tools focused on the restoration and protection of critical aquatic ecosystem components, as a means to sustain and enhance biological diversity and ensure the delivery of ecosystem services in the long term. The Assessment Framework brings science into the policy-making process, facilitates the analysis of response options and co-learning to change policy directions, and promotes the uptake of business opportunities associated with the sustainable management of flows (and stocks) of ecosystem services, based on new insights.

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[2] The AQUACROSS Assessment Framework will be put in practice in eight case studies and throughout different work packages.

Bridging Science

Under an ecosystem-based management approach, science is not only intended to inform and make technically sound decisions but rather as a means to build a credible knowledge base through the dialogue and interaction between scientists and stakeholders. This entails the integration of multiple kinds of knowledge, ranging from hard science to storylines.

It is important to highlight that the emphasis should be on management-driven assessment outputs. This entails the need to address upscaling issues, as well as moving from the local to the global dimensions of biodiversity targets, and from the short term to the longer term.

Moreover, integration is at the core of the AQUACROSS concept, making cooperative efforts (within the consortium; between science, policy and business; with a wide array of stakeholders; among different research and innovation actions, etc.) not a choice but rather a logical need. The outcome of these efforts is the AQUACROSS Assessment Framework, which addresses:

- The integration of relevant information for the assessment of aquatic ecosystems and their abiotic outputs across the freshwater-saltwater continuum.
- Social-ecological systems in a holistic way, as complex adaptive systems that co-evolve, thereby avoiding traditional silos and biased approaches.
- The integration across all aquatic ecosystems, mobilising expertise and knowledge from biologists, ecologists, chemists, eco-toxicologists, hydrologists, oceanographers, environmental scientists, physicists, economists, IT-experts, and other social scientists.

Significant progress has been driven by interdisciplinary research in the past (and also within the AQUACROSS consortium). This creates good conditions to better understand critical phenomena and thresholds and the emergence of macro-scale structure (i.e. at a watershed or landscape level) from micro-scale interactions. Yet, transdisciplinary research remains a major challenge. So is the analysis of non-linear dynamics and stochasticity or the understanding of tipping points or the operationalisation of resilience of social-ecological systems to external shocks.

Clear knowledge gaps apply to the understanding of the inherent trade-offs between different social-ecological strategies. This Assessment Framework will address these issues on the basis of illustrations provided by the different case studies.

Fostering Policy Applications and Business Innovation

The AQUACROSS Assessment Framework will enhance the policy relevance of scientific knowledge through the application of well-designed scenarios as communication platforms that bring science into the policy-making process. It allows making stakeholders (including business) aware of multiple relevant interactions in social-ecological systems and helping them assess current practice, screen new opportunities, and improve the design and implementation of policy responses. Policy-relevant scientific knowledge makes the value of science for policy visible and allows the alignment of research, innovation and policy priorities.

The AQUACROSS Assessment Framework will also enhance the scientific foundations of policy. Frontier (or simply new) knowledge is functional to the identification of novel courses of action. It also favours a better identification of the opportunity costs and the benefits of traditional and innovative approaches. It is, therefore, possible to anchor policy debates on empirical evidence, instead of than just on perceptions or prejudices. In the best case this leads to shared views of

sustainability challenges amongst stakeholders, and to further cooperative responses rather than competitive ones, although it is important to acknowledge uncertainty as per processes involving a significant number of variables and stakeholders.

Policy-making based on scientific knowledge supports a common ground and helps build consensus, hence focusing policy discussions on trade-offs and making choices where stakeholders' preferences and vested interests are relevant. Integration efforts in the Assessment Framework will lead, in turn, to the harmonisation and streamlining of environmental policies under the overall framework of the EU 2020 Biodiversity Strategy and other international biodiversity targets, as well as the coordination of policies in transitional and coastal waters, where different policy directives apply.

1 Introduction

Assessing is about evaluating, making (analytical) judgements or statements… It is not just about measuring, describing or informing. Hence, any assessment framework is a means to an end. Within AQUACROSS, the aim is to propose new ways of governing our relationship with nature (and not just with aquatic ecosystems, given the interrelationships with terrestrial ecosystems).

The widely used Drivers-Pressures-State-Impact-Response (DPSIR) framework, demonstrates some weaknesses previously discussed in the AQUACROSS Deliverable 3.1:[3] it does not account for feedback processes, focuses on a single pressure (thus neglecting multiple stressors), does not allow for the discussion and assessment of trade-offs in terms of natural use, conservation, and enhancement, provides limited linkages between ecosystem functions and services and human welfare, and favours reactive and remedial responses rather than proactive and pre-emptive ones. This creates the necessary conditions to highlight the multi-functionality and multiple benefits of ecosystem-based management approaches for biodiversity conservation, hence making the economic case for further investment in these approaches from the public sector, the private sector (through the identification of new business models) and civil society.

For that purpose, it is of paramount importance to understand processes and causes, rather than just describing and measuring states. The Assessment Framework is a critical toolbox to that aim, grounded on conceptual considerations included in the above-mentioned Deliverable 3.1 with the AQUACROSS concept, architecture and heuristics representing significant progress beyond the conventional DPSIR sequence.

The AQUACROSS Assessment Framework deals with at least two main issues: *what* to assess (where we are and where we could go through ecosystem-based management approaches, against baseline scenarios) and *how* to assess this. Information systems, metrics, and descriptive efforts will be relevant, but what is actually required from this Assessment Framework is a more analytical view on the basis of the best available scientific knowledge. Deliverable 3.2 provides a

[3] *Gómez et al. (2016).) The AQUACROSS Innovative Concept. Deliverable 3.1, European Union's Horizon 2020 Framework Programme for Research and Innovation grant agreement No. 642317. Available online*

comprehensive overview of these analytical approaches. It follows a logical sequence for the assessment itself, but one that clearly overcomes the traditional DPSIR framework.

Table 1: Environmental Challenges of the AQUACROSS Case Studies

AQUACROSS Case Study	Examples of Some Environmental Challenges Found in Case Studies
Case Study 1: Trade-offs in ecosystem-based fisheries management in the North Sea aimed at achieving Biodiversity Strategy targets	Pressures from Fishing (extraction of species)
Case Study 2: Analysis of transboundary water ecosystems and green/blue infrastructures in the Intercontinental Biosphere Reserve of the Mediterranean Andalusia (Spain) - Morocco	Organic pollution (Nutrients) and water abstraction
Case Study 3: Danube River Basin - harmonising inland, coastal and marine ecosystem management to achieve aquatic biodiversity targets	Morphological alterations to river and coastal habitats
Case Study 4: Management and impact of Invasive Alien Species (IAS) in Lough Erne in Ireland	Invasive Alien Species
Case Study 5: Improving integrated management of Natura 2000 sites in the Vouga River, from catchment to coast, Portugal	Various sources of micro and macro pollutants, invasive Alien Species, alterations to river and coastal habitats
Case Study 6: Understanding eutrophication processes and restoring good water quality in Lake Ringsjön - Rönne å Catchment in Kattegat, Sweden	Organic pollution (Nutrients)
Case Study 7: Biodiversity management for rivers of the Swiss Plateau	Various sources of micro and macro pollutants, habitat alteration
Case Study 8: Ecosystem-based solutions to solve sectoral conflicts on the path to sustainable development in Azores	Pressures from Fishing (extraction of species)

2 The AQUACROSS Project and D3.2

The AQUACROSS project, funded under the EU's Horizon 2020 Research and Innovation Programme, seeks to improve the management of aquatic ecosystems, thereby supporting the achievement of the EU 2020 Biodiversity Strategy and the Strategic Plan for Biodiversity 2011-2020.

As part of the project work, the AQUACROSS Assessment Framework (current Deliverable 3.2) has been developed as part of Task 3.2 of the project, an ambitious cooperative effort built on Task 3.1 that led to Deliverable 3.1. The overall aim of Task 3.2 is to design the AQUACROSS Assessment Framework by defining concepts and proposing potential methods and tools to be included into specific work-package research, where the framework will be tested in the different case studies (Table 1). Task 3.2 deals with the following objectives: (i) applicability: e.g. linking policy/science in the three aquatic realms; (ii) building from existing knowledge: e.g. enhancing ecosystem-based management with Mapping and Assessment of Ecosystems and their Services (MAES) - while

improving MAES, e.g. regarding resilience thinking, etc.; (iii) and relevance: e.g. making ecosystem-based management operational.

Focusing initially on the DPSIR framework, the AQUACROSS Assessment Framework provides the elements to assess:

- The links between drivers of aquatic ecosystem change and multiple pressures.
- The link between pressures and changes in the state (impacts).
- The link between impacts and biodiversity loss.
- The link between biodiversity level and ecosystem services delivery.
- The role that ecosystem-based management is to play as an innovative response to biodiversity loss.

By further refining the concept and proposing potential methods and tools to be included into specific work-package research, the AQUACROSS Assessment Framework provides the foundations for applied research throughout the project. Yet, Deliverable 3.2, as a living document, will be tested in the different case studies and further developed as other work packages evolve, leading to the final Assessment Framework: Deliverable 3.3.

3 The Assessment Framework as a cooperative effort

The AQUACROSS Assessment Framework is the combination of scientific analyses that stem from different disciplines of knowledge and integrative efforts. This framework should enable analytical advice for the practical application of ecosystem-based management approaches in aquatic ecosystems through relevant models and guidance protocols, while using adequate sets of data and indicators.

Despite the vast number of research initiatives promoting a range of concepts, methods and models that aim to support decision-making and the achievement of EU and other international biodiversity targets, the establishment of an operational framework that links the assessment of efforts towards the conservation of biodiversity and ecosystem functions and services and their integration in public and private decision-making remains challenging.

Therefore, co-building scenarios between stakeholders and researchers is required to facilitate a comprehensive representation of the overall social-ecological system and turn business-as-usual into new policy responses. This exercise may result in the demand of precise and well-focused scientific answers to relevant problems (such as whether reductions in fish biomass landings are due to previous overfishing or to the degradation of the supporting ecosystem, including regulating services). Such an exercise may also provide the basis to build a shared perception of the problem and its driving factors, which is a critical requirement for cooperation and collective action.

4 What is to be assessed

Complex adaptive natural systems are featured by emergent patterns, such as food-web structure and nutrient cycling. Two fundamental and intertwined challenges are to be understood: the

relationships amongst phenomena at different scales (time, space, organisational complexity) and resolving market failures (i.e., public goods, common-pool resource conflicts, externalities) that emerge. In other words, complex dynamics in social-ecological systems and management challenges, where individual behaviour does not necessarily lead to rational and sustainable outcomes for society as a whole or a set of individuals.

Hence, mobilising and integrating knowledge is required to understand **how social and ecological systems are linked at multiple levels and across different scales**, how these linkages give rise to the dynamics we see at the system level, and what the role of mutual adaptation/co-evolution is (data availability permitting). All this should be functional to a more specific objective on practical grounds, consisting of providing the ends and the means to deliver a better political response to current sustainability challenges in all relevant policy domains linked to water and biodiversity. Comprehensive scenarios, able to inform decision-making instead of bounded models, therefore, are critical given the emphasis on showing the advantages of holistic over partial approaches. This means full scenarios in order to evaluate the pros and cons of taking remedial actions, solving trade-offs, comparing alternative courses of action, improving policy design and implementation, etc. Needless to say, that this ambition will go through a reality check as part of the applied work in the different case studies.

AQUACROSS' **baseline scenarios** are, therefore, to be built to provide a comprehensive representation of the overall social-ecological system, focusing on the relevant interactions and identifying environmental and policy challenges. This effort combines scientific knowledge and data on stakeholders' perceptions. Therefore, building a baseline scenario is not just a scientific endeavour but also the result of matching this knowledge with expert judgements and stakeholders' beliefs and perceptions.

The AQUACROSS approach consists in **co-building these scenarios through a meaningful science-policy dialogue** in which, for instance, first impressions by stakeholders on the factors driving ecosystems' degradation are challenged with empirical evidence and scientific explanations. Scenarios are double-edged decision support systems. On one side, they must rely on validated data and sound scientific insights as a critical condition for their credibility. On the other side, they must have the ambition to become a collective representation both of social and ecological problems and opportunities and alternatives to deal with them. Actually, even a sound scenario based on scientific methods and proven facts would only be relevant for policy action if co-developed or, at worst, assumed by stakeholders (e.g. social agents).

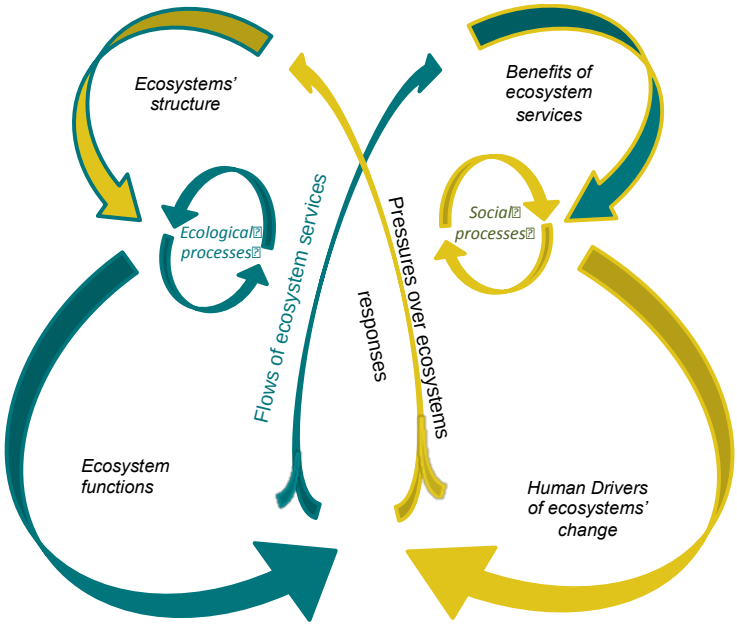
5 How to assess it

In order to **design baseline scenarios** that represent, to a possible extent, the whole social-ecological system, there is a need to set the decision context, framing ecological (geographical areas, ecological processes, etc.) and institutional (stakeholders, regulations in place, development trends, etc.) boundaries. Identifying suitable system boundaries that integrate not only the main interacting components but also the leverage points for management to induce a desired change to improving biodiversity levels and ecosystem services delivery is crucial for creating the baseline.

The AQUACROSS Architecture (Figure 1) considers two interrelated sets of linkages between the ecological and the socio-economic parts of the system. The supply-side perspective describes and analyses the capacity of the ecological system to fulfil social demands of ecosystem services, thus

contributing to human welfare. The demand-side perspective, in turn, describes and analyses how the effective demand of all kinds of ecosystem services and abiotic outputs by the socio-economic system affects the ecological system, its structure, and functioning. The supply side influences the demand-side perspective in terms of how the ecosystem benefits society, but it is also influenced in turn by the demand side through drivers, pressures and resulting changes in the state of the ecosystem.

Figure 1: System relationships: combining socio-economic and ecological systems



The link between society and ecosystems is analysed through the identification of all relevant social, policy and economic processes that may result in a pressure (or a combination of them) over the ecosystem or, in other words, of the drivers of human pressures over ecosystems. From the AQUACROSS perspective, significant pressures are those that result in a change in ecosystem state and lead to a change in the functioning of the ecosystem, thus potentially impacting both biodiversity and human welfare at once.

The construction process for baseline scenarios is supported by **resilience thinking principles**, particularly by those principles related to complex adaptive systems and slow variable and feedbacks. Deliverable 3.2 illustrates the application of resilience-related principles to the assessment.

Modelling tools help build baselines. In addition, **data flows** are definitely necessary in a stepwise assessment. Deliverable 3.2 describes in detail a full workflow that covers species occurrence and environmental variables monitoring data collection, defining objectives from policies and stakeholders, and the evaluation of action strategies and optimisation of management measures.

The **definition and structuring of objectives**, essential for the assessment, builds upon the baseline analysis, where the main challenge and the policy context is to be set along with policy priorities for the local level. The precise definition of objectives should provide a standpoint for screening, assessing, designing and implementing management alternatives to reach these objectives. Furthermore, the analysis entails the assessment of current status of policy implementation, identifying **gaps between baseline and target status (deficits)**.

Comparison between objectives and baseline allows the identification of deficits that must be bridged and provides an operational definition of the objectives. This can subsequently be used to assess the effectiveness and facilitate the choice of management measures, which will be suited to achieve policy objectives, and hence reduces deficits. Deliverable 3.2 contains examples of this analysis on aquatic ecosystems.

However, objectives are by no means **assessment criteria**, which aim to judge the system and the alternative means that may be used to reach those goals. Within the AQUACROSS approach, any policy objective is defined in terms of a desired or target condition of the involved aquatic ecosystem, including its biodiversity level. Thus, the analysis of any other ambition related to the social system (such as mobilising sufficient financial resources, gaining political acceptance, improving social fairness, etc.) is considered within criteria to assess the alternative ways to reach the primary environmental targets, then to assess the institutional capabilities to meet what is actually required for sustainability.

Two types of criteria are provided within the AQUACROSS Assessment Framework: those designed for assessing the whole system (or *system* criteria) and those designed for assessing the outcomes of alternative courses of action (*output* criteria). The exercise entails choosing the most informative ones when judging baseline, policy scenarios or decision-making processes (see Section 4 above).

- **Baseline scenarios**: Assessment of baselines is essential to identify sustainability problems, representing ongoing processes, supporting the definition of current sustainability challenges, and helping define policy targets at the scale of any study site. Assessment of baselines is also of paramount importance to single out opportunities and barriers to overcome sustainability challenges and, therefore, to support the definition of management strategies. *Resilience*, *adaptability* and *transformability* are criteria to assess the sustainability of ecological and social systems within the AQUACROSS framework.
- **New policy scenarios (EBM)**: Counterfactual scenarios result from the implementation of ecosystem-based management approaches and should be judged, in general, on the basis of their contribution to sustainability and, in particular, for their intended and realised contribution to reach policy targets (*effectiveness*) and for their contribution to human well-being (*efficiency*, *equity*).
- **Decision making processes**: These processes refer to the potential of current institutional policy set-ups to properly address sustainability challenges within prevailing governance structures. It involves criteria for judging the capacity to overcome institutional inertia, technology lock-ins, as well as conventional analytical approaches in order to progress towards better policy coordination, and innovative technological approaches based upon integrative management strategies (i.e., ecosystem-based management). Criteria under this category will support reform efforts as an integral part of ecosystem-based management.

The assessment focuses on human actions and processes in the socio-economic system that drive pressures on aquatic ecosystems, and how changes can be characterised to understand and define the relevant links between society and aquatic ecosystems. This implies assessing **drivers, pressures** and **multiple stressors**, to better understand the sensitivity and dynamics of ecosystem services to environmental change (and specifically biodiversity loss), as well as the environmental limits of ecosystems (i.e., threshold analysis).

Managing responses should go beyond the direct regulation of single activities (such as fishing) or related pressures (such as sea floor abrasion) to encompass broader management alternatives such

as managing food chains, aquaculture, marine protected areas, incentives, pricing regulations, research, development and innovation, etc. Therefore, having the best understanding of what determines the drivers, as the result of deliberate human decisions, is at least as important as describing the drivers themselves. Understanding drivers is equivalent to ascertaining the individual and collective decisions that result in a certain demand of services provided by biophysical ecosystems (including ecosystems services mediated by biotic processes and abiotic goods and services), at the adequate spatial and temporal scales and at different levels (individual and institutional decisions taken at local, regional and international levels).

Pressures, in turn, are mechanisms (either single or multiple, with cumulative consequences) through which a driver has an effect on the environment. From AQUACROSS' standpoint, significant pressures are those that result in a change in the **ecosystem state,** which leads to a change in the functioning of that ecosystem, and thus might impact both biodiversity and human welfare.

Identifying clearcut and consistent relationships between social processes, drivers, pressures and ecosystem state, facilitates the identification and selection of indicators and the focus of management options in a coherent way that can be further used to analyse causal links between biodiversity, ecosystem functions and services. Qualitative and quantitative approaches can be used to link drivers with pressures and ecosystem structures.

The **analysis and understanding of causalities between biodiversity, ecosystem functions and services dimensions** will also build on the Assessment Framework, focusing on required elements for the quantification of the features of biodiversity (from population to communities, habitat types, landscapes and seascapes) required for delivering ecosystem services (i.e., from ecosystem state to human well-being). Information assessed at this stage provides insights on how biodiversity-related causal links are affected during disturbance and recovery through a suit of metrics, indicators and analytical methods that contribute to the development of management options in aquatic ecosystems.

The assessment of ecosystem services can be approached from the supply side—the potential or capacity of the ecosystem to supply services, whether or not they are used—or the demand side—the services people require from ecosystems whether they are actually provided or not. One may say, therefore, that a 'supply side' assessment based on ecosystem capacity considers how the state of the ecosystem would affect the generation of the actually used services and the potential to provide more and better services for present and future generations.

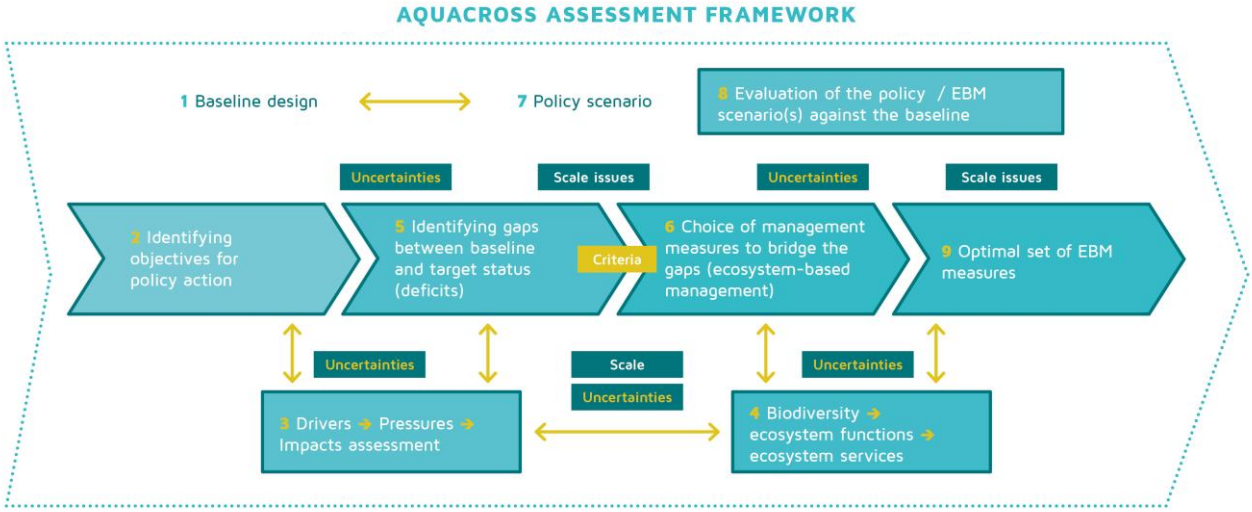
While the capacity of the ecosystem to supply services is tightly contingent on the state of that ecosystem (biodiversity and ecosystem processes and functions), the demand and actual use of services can be decoupled from the state of the ecosystem, as they are a clear outcome of social processes. Deliverable 3.2 includes a wide literature review and illustrations assessing the relationships between aquatic ecosystem state, functions and services.

Yet, the assessment **continues ascertaining impacts and responses** to enhance the meaningfulness of some economic variables (value, price, cost estimates) in co-decision processes; to assess the added value of ecosystem-based approaches able to recognise the role of multifunctional land management and landscape and seascape patterns on the delivery of aquatic ecosystem services, and to develop options to enhance biodiversity levels and to maintain ecosystem integrity beyond protected areas; as well as to promote the uptake of business opportunities associated with the sustainable management of flows (and stocks) of ecosystem services.

However, while the AQUACROSS architecture provides a conceptual basis for broadly understanding the causal relationships between different components of the system, quantifying the interrelationships between different components requires specific disciplinary inputs, and may involve consideration of tipping points and non-linearities, as well as uncertainties inherent to environmental and social processes (i.e. cross-cutting issues):

- **Resilience thinking,** critical in the definition of scenarios, but also in the design and implementation of responses to deal with uncertainty and to respond to unexpected changes (as these systems are characterised by non-linear dynamics, complex interactions across scale, self-organisation, etc.), through enhancing diversity and redundancy (not only ecological but also in the social system) and diversity of knowledge and response options and to provide opportunities for learning (e.g., in stakeholder processes) and changing policy directions based on new insights.
- **Uncertainty,** linked to the assessment of information/data, and methods and tools required for creating scenarios of trends in drivers and pressures, causal links between biodiversity and ecosystem services delivery, trade-offs between competing objectives, valuations, etc. Particularly, individual and collective decisions are main sources of uncertainties: regarding societal preferences, the estimated effects of management alternatives (which, in turn, entail uncertainties about future socio-economic development, environmental factors that might change or responses of ecological and economic attributes) and the implementation of the chosen management options. Examples are given in Deliverable 3.2.
- Dealing with **varying spatial and temporal scales** related to ecosystem function, services and human benefits, to progress towards adaptive responses. Combining the analytical tools summarised in Deliverable 3.2 and testing them in the application of AQUACROSS case studies will facilitate and enable a standardised approach to consideration of scale issues within the project.
- **Data and metrics**, reinforcing ongoing processes such as the reporting on SEBI indicators and those used to track Aichi Biodiversity Targets, in order to monitor the progress towards the EU Biodiversity Strategy and other global targets, as well as ensuring coherence with other relevant policy processes. Deliverable 3.2 details data and information flows for analytical purposes required to complete the assessment exercise.

Figure 2: AQUACROSS Assessment Framework sequence



6 The Way Forward

Unlike other projects, AQUACROSS aims to continuously review and refine this Assessment Framework towards Deliverable 3.3 (Final Assessment Framework). For that purpose, the development of the AQUACROSS Assessment Framework and, therefore, the investigation into the specific elements for assessment, is (i) mindful of the practical challenges to be faced in terms of applicability (e.g., linking policy and science in the three aquatic realms); (ii) makes the most out of existing knowledge to enhance current EBM practice; and (iii) ensures relevance.

The practical application of the Assessment Framework should shed light on a number of questions and issues, such as:

- What are the most relevant drivers affecting aquatic ecosystems? How can the demand for ecosystem services be compared against the ability of aquatic ecosystems to deliver services in a sustainable way?
- Are there alternative definitions of drivers and pressures depending on whether the anchorage is on science or policy?
- Given the abundance of information to fill into the different data layers but the relative scarcity of information to understand links between drivers and pressures, a challenge to be addressed is how to move from descriptive to more analytical approaches.
- To what extent can knowledge on biodiversity loss, drivers and indicators be adapted, downscaled and made useful for specific applied assessments (i.e., case studies)?
- What is the connection between the analysis of drivers and pressures, and the ecological assessment of links between ecosystem functions, services and biodiversity through the assessment of changes in the state of aquatic ecosystems?
- How to go beyond the emphasis on indicators (and the constraints of modelling efforts) to analyse causal links between biodiversity and ecosystem services delivery?
- May a convincing storyline about those links be built with weak to no evidence about those links? Should not this approach be caveated?

- How could the application of the Assessment Framework shed light on the critical differences between causality and correlation, prediction and forecasting, statistical analysis and scientific knowledge? How can we move from predictive models towards decision-support tools but also analysing and not just measuring uncertainty?
- Could the outcomes of the analysis of the above-mentioned causal links be used to actually assess the effectiveness of policy options regarding biodiversity?
- How do existing models address ecosystem-based management?

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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 (UAVR)—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

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