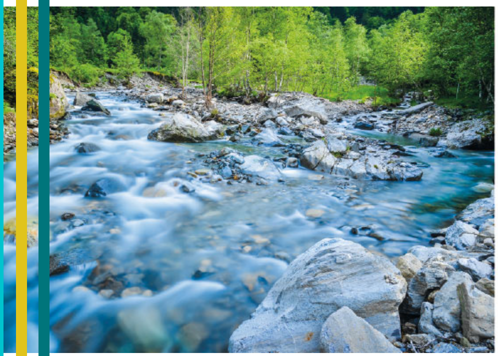

The AQUACROSS Innovative Concept– Executive Summary[1]

Overview

Biodiversity is declining worldwide, despite major political efforts to halt this process. This negative trend not only impacts the habitats of these species but also the humans who depend on them for benefits, such as food, shelter, medicine, etc. International agreements and European policies, including the EU 2020 Biodiversity Strategy, set goals to halt this increasing trend in biodiversity loss, but have so far failed to reach their targets.

Some of this failure can be attributed to disjointed or narrowly applied environmental policies. Aquatic habitats, in particular, are subject to separate governance, split between freshwater, coastal and marine areas, despite being intimately connected through the flow of water from mountains to sea. This poses a challenge as problems faced in one area often lead to issues in another, potentially threatening aquatic biodiversity and the benefits they provide in the process.

Recognising this challenge, AQUACROSS aims to promote better management of these aquatic systems to ensure both the protection of aquatic biodiversity and the sustainable provision of benefits humans depend upon. To do so, management of these ecosystems should take into consideration all the various factors that affect them. This requires looking at the system as a whole rather than its individual parts, accounting for both internal and external interactions and managing them to achieve targeted goals. This integrated management approach is largely known as **ecosystem-based management (EBM)**. By managing an ecosystem as a whole and its interactions with other systems, including social systems, human needs can be balanced with environmental needs, affording better protection to aquatic biodiversity and ecosystem health. This balance not only encourages sustainable use of environmental

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[1] This is the executive summary of AQUACROSS Deliverable 3.1: The AQUACROSS Innovative Concept. The full version of this document can be found at www.aquacross.eu in project outputs.

resources but also supports the achievement of EU policy objectives and other international biodiversity targets.

The first step towards managing a system as a whole and practicing EBM is through understanding the various linkages and interactions between environmental and societal systems. Through analysing this overarching relationship between these two systems, a conceptual framework can be established to identify and assess major factors impacting these systems. This conceptual framework must not only take into account interactions between environmental and societal systems, but must also consider that unpredictable events will always occur and that ecosystems will change to accommodate disturbances, provided they are healthy. Therefore, the challenge lies in creating a framework that is flexible enough to allow for the inherent uncertainty of these systems and the ability of ecosystems to recover and adapt to changes. Practically applied, this framework could, for example, help uncover factors negatively influencing an ecosystem, which will help in identifying possible EBM solutions to address or manage these negative factors.

Within this context, AQUACROSS seeks to further knowledge of EBM for aquatic ecosystems, spanning freshwater, coastal and marine environments. This deliverable takes the first steps in understanding how aquatic ecosystems and societal systems interact. It reviews relevant, scientific concepts and approaches to understanding these systems and identifies their respective strengths and weaknesses. This work will support the development of the AQUACROSS Assessment Framework to help identify and analyse the factors influencing aquatic biodiversity loss, how these factors interact, and what are the management options available to ensure robust and healthy aquatic ecosystems. Ultimately, the AQUACROSS Assessment Framework will be practically applied in the project's eight case studies located throughout Europe and its Outermost Regions and Overseas Countries and Territories.

Building on Science

To support political decision-making and the practical implementation of EBM, it is necessary to build upon sound science. In the case of AQUACROSS, which aims to provide consistent analysis across all aquatic realms (i.e. freshwater, coastal and marine), a new science and advanced understanding of how ecological and socio-economic systems interact is necessary. This document broadens the understanding of the complex interactions between these two systems, taking an interdisciplinary approach to integrate multiple scientific concepts, such as resilience, uncertainty and ecosystem services. By considering each concept's strengths and weaknesses, this work pushes the boundaries of existing knowledge to lay the foundation for an assessment framework applicable to multiple aquatic habitats and systems.

Applications for Policy

As the final purpose of the AQUACROSS Assessment Framework is to support EBM as a management approach to aquatic ecosystems, its conceptual foundations must not only build upon state-of-the-art science but also be grounded in the political dimension. The work undertaken in this document identifies and analyses traditional management approaches for ecosystems and how they differ from EBM. Successful EBM of aquatic systems requires strong and enabling institutional frameworks, yet existing institutional setups and processes often ignore EBM in favour of more traditional management options, despite the multiple benefits of EBM as a governance approach. Thus, effective implementation of EBM requires the adaptation of prevailing institutions and policy-making processes. In other words, it requires doing different things in different ways. Through understanding the inherent tradeoffs and the institutional structures needed to properly manage aquatic ecosystems, this work can better equip policy-makers to make EBM approaches happen; promoting the transition to a more sustainable EU.

Fostering Innovation

Sustainable management of aquatic ecosystems and their resources not only requires coordination and cooperation from the political realm, but also the involvement of the private sector and the civil society. Socio-economic systems play a large role in influencing ecological systems, which provide valuable commodities and services human well-being depends upon. As such, business and industry often act as drivers of environmental change. This document specifically addresses the role of businesses within the overarching socio-economic system, taking into consideration the ways in which businesses interact and impact the larger system as a whole. The integration of businesses within the conceptual foundation of the assessment framework provides opportunities for innovative business solutions to support the practical implementation of EBM for aquatic ecosystems.

1 Introduction

There has been significant political progress to protect ecosystems and their biodiversity, both internationally and within the EU. The international Convention on Biological Diversity (CBD) and the Strategic Plan for Biodiversity 2011-2020, amongst other agreements and conventions, take steps on a global scale to address the sustainable use and protection of biodiversity. Europe, too, has passed and implemented multiple environmental policies to safeguard these resources, including the EU 2020 Biodiversity Strategy, the Birds and Habitats Directives, the Water Framework Directive (WFD), and the Marine Strategy Framework Directive (MSFD).

Despite the steps taken thus far, there remains a disturbing trend of biodiversity loss, especially within aquatic ecosystems. This trend is reflected both globally and in the EU, where the current rate of policy implementation is not foreseen as enough to effectively combat the degradation of ecosystems and biodiversity loss. Reasons for these shortcomings include the weak level of policy implementation and enforcement by Member States, the need for better integration between policies, and the need for setting coherent priorities underpinned with adequate funding.

Within this gap, the AQUACROSS project aims to support the achievement of global and EU biodiversity targets and promote the implementation of EBM within aquatic ecosystems, spanning freshwater, coastal and marine environments.

2 The AQUACROSS Project

- About the project and the purpose of this Concept Note

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, deliverable 3.1 AQUACROSS innovative concept aims to provide a solid foundation for the initial scientific consensus within the project consortium. This work includes (1) reviewing available and state-of-the-art concepts and approaches relevant to the project's objectives; (2) identifying knowledge gaps aimed at improving aquatic ecosystem management spanning the water continuum (freshwater-coastal-marine systems); (3) developing a glossary of terms to foster common understanding and agreement and ensure the consistent use of these terms; and (4) specifying key research questions. Ultimately, this work will build the basic structure of the AQUACROSS Assessment Framework, a collectively-built knowledge base that will be the conceptual and operational backbone of the project.

3 The AQUACROSS Concept

AQUACROSS takes a unique, integrative approach to address the challenges stated above. In practical terms, the AQUACROSS Concept is fundamentally based upon three central concepts: **ecosystem-based management (EBM)**, **resilience**, and **complex adaptive systems**. These concepts lay the groundwork upon which to build the AQUACROSS Assessment Framework and the work to be carried out in the rest of the project. Understanding what these concepts are, how they are connected, and what their benefits are sheds light on the structuring of the project's work and explains how and why certain elements are pieced together in specific ways.

3.1 Ecosystem-based Management

- Differing definitions of EBM highlight the need for a consolidated definition
- Why EBM is important and represents the cornerstone of AQUACROSS

EBM is generally understood as any management or policy options intended to restore, enhance and/or protect the ability of an ecosystem to remain in good health. The purpose of this approach can be explained by highlighting the fundamental connection between humans and nature, whereby humans depend upon the benefits that ecosystems provide (i.e. food, shelter, medicine, etc.). Thus, ensuring the health of an ecosystem also ensures the continued provision of the benefits human well-being depends upon.

While there are many definitions of EBM used throughout academic literature and policies, they all contain some form of this theme: connecting nature to humans. However, these definitions differ significantly in their view to connecting these elements and the role or purpose of EBM.

These differences highlight the need for a consolidated, practical definition that addresses the different dimensions in the interpretation of EBM.

A consolidated definition is important to promote EBM over more traditional management approaches, which tend to be narrow in scope and run the risk of ignoring interactions within an ecosystem that contribute to its healthy functioning. EBM provides an alternative approach towards ecosystem management that balances the needs of an ecosystem with the practical demands of society. As such, EBM represents the cornerstone of AQUACROSS which seeks to strike this balance for aquatic ecosystems: protecting aquatic biodiversity and sustainably meeting the targets of EU and global policies.

3.2 Resilience

- What is resilience and why is it important?
- How resilience is incorporated into EBM and AQUACROSS

Broadly explained, resilience is a general characteristic of a system that results from its ability to respond to change and transform when necessary. Supporting the resilience of an ecosystem will allow for the continued use of its resources without drastically altering its component parts or threatening its functioning or health. Consequently, disregarding an ecosystem's resilience to human disturbances can lead to bad management practices, such as deteriorating ecosystem conditions or the critical endangerment of biologically significant species.

Incorporating the concept of resilience into policies and management practices requires a different method to planning processes. AQUACROSS initiates this change by integrating 'resilience thinking' into its conceptual foundation. Resilience thinking is a framework approach to sustainability that emphasises, like EBM, the interdependency of nature and humans across multiple scales, including time and space. As such, EBM can include resilience thinking within its management options through restoring, enhancing and/or protecting the resilience of an ecosystem.

3.3 Complex Adaptive Systems

- What are Complex Adaptive Systems and how do they apply to ecosystems and socio-economic systems?
- How complex adaptive systems is connected to EBM and resilience

The last central concept of AQUACROSS is Complex Adaptive Systems. These are systems composed of many individuals making choices and responding to signals and events both within and outside the system. They are self-organised, with the structure, function and dynamics of the system emerging naturally through the multitude of small interactions between individuals and with other complex systems, rather than through any form of central control.

The idea of complex adaptive systems can actually be applied to ecosystems and socio-economic systems. Both systems can be viewed as networks formed by many individuals or units acting at the same time and responding to signals or events from their surrounding environment. The lack of central control does not entail chaos, and the system still shows order. Like schools of fish swimming or flocks of birds flying together, even humans walking down the street, all act as individuals and respond to the movements and actions within the crowd to adapt their behaviour to accommodate changes. In such a way, ecosystems and socio-economic systems are autonomous, self-organised, complex adaptive systems.

Accepting that these systems are both complex adaptive systems establishes a foundation to view the dynamics of natural and human systems. Combining this concept with the notions of EBM and resilience creates a structure from which AQUACROSS activities and research can build on. Like chess, the movements of the pieces are explained through 'complex adaptive systems', which the players want to influence within sustainable boundaries (i.e. resilience) to achieve checkmate (i.e. EBM).

3.3.1 Ecological Systems

What are ecological systems and why do humans depend on them?

As explained above, ecosystems are complex adaptive systems of the natural world. In natural systems, actions are taken by individual units both living and non-living, such as animals, plants, insects, water, energy and nutrients. Each unit behaves according to simple rules of thumb – for example, following the herd for migratory species or finding the fastest way downhill in the case of water runoff. Most individual units, either actively or passively, adapt to changes in their environment and to others' adaptive changes by changing behaviour, migrating, dying, mutating, etc. Consequently, the system is characterised by the continuous change induced by actions and reactions of its constituent elements.

Humans depend on ecosystems in various ways, for example, to supply materials for basic survival (e.g. food, medicine, energy, shelter, etc.) or to provide settings for recreational activities or places of worship. Over time, this dependence of humans on natural systems has influenced all parts of the globe, in many different ways, leaving no place 'undisturbed'.

3.3.2 Socio-economic Systems

What are socio-economic systems and how do humans contribute to them?

As mentioned above, socio-economic systems are also complex adaptive systems of the human domain. Decisions are made by individual units in the different markets. These units make decisions much like those described in ecological systems – for example, following a route to a destination, making a choice to buy something or not, or deciding to talk with a person close by. Most individuals, either actively or passively, also adapt to changes in their environment and to others' adaptive changes. This comes from taking cues from others changing behaviour or hearing news about the benefits of a certain product or vacation destination.

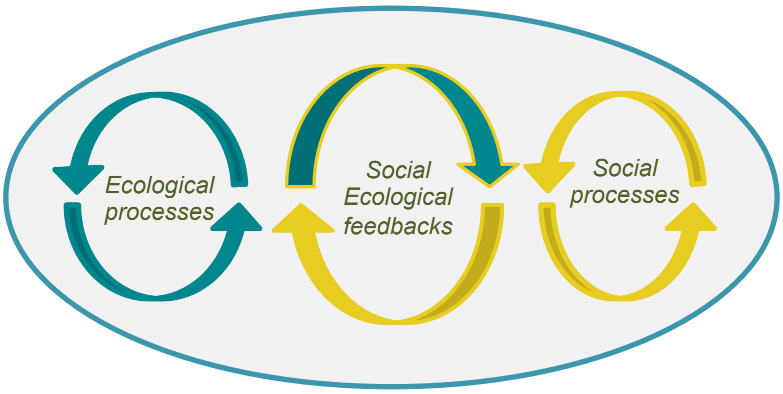
Though actions occur at an individual level, patterns and outcomes can be seen at a group level. For example, the rise in interest in eating a certain food changes the amount of product in grocery stores and outlets, changing quantities ordered by sellers and farmers increasing their prices. Businesses start to invest in niche markets to open restaurants catering to people eating this food. As such, the system undergoes continuous change induced by the actions and reactions of its elemental components.

3.3.3 System Interlinkages

- The two systems as separate complex adaptive systems but also intertwined

Over the past century, socio-economic and ecological systems have become increasingly interconnected, revealing the reliance of society and the economy on the environmental benefits provided by ecosystems and their ability to shape production and consumption patterns at local and global scales. Conversely, nature is dependent upon humans to regulate themselves, to ensure protection and proper management of environmental resources. The increasing interdependence of nature and society highlights the idea that these systems are interacting components of a larger socio-ecological system (SES) (see Figure 1).

Figure 1: Socio-economic and ecological systems as two interconnected complex adaptive systems



Source: Own elaboration based on Biggs et al. (2015), p.8

3.3.4 Policy Implications

- What the three main concepts of AQUACROSS imply for future policies

Acknowledging SES as dynamic and adaptive should lead to a redefinition of realistic and forward-looking management targets based on EBM. Rather than focusing on a static view towards ecosystem performance, management strategies should focus on the ability of the SES to stay within critical thresholds and remain resilient, in order to provide essential functions.

Holistic management and policy approaches call for a shift towards a more dynamic and organic way of thinking in which unexpected change and uncertainty are intrinsic characteristics of the system. While operationalising this approach is still in progress, the idea of socio-economic and ecological systems as complex adaptive systems already sheds light on the limitations of traditional approaches to governance and policy-making, let alone on the risk of continuing these approaches as responses to new environmental and social challenges.

4 From Concept to Practice: the AQUACROSS Design

The AQUACROSS design is the first step in the research project strategy designed to develop the AQUACROSS Assessment Framework[2]. It stands for the methodological approach to operationalise the aims highlighted within the AQUACROSS concept. The design must (1) integrate and synthesise scientific knowledge in a fashion that is familiar to stakeholders and managers and (2) inform EBM approaches to manage complex socio-ecological systems (SES). The AQUACROSS design should, therefore, provide a base to put the diverse and scattered pieces of scientific knowledge together to inform policy decisions, through enhancing resilience and long-term sustainability of SES.

4.1 Starting with an Adapted DPSIR

- What is DPSIR and its existing limitations
- How it is adapted and used in AQUACROSS

DPSIR is a framework used to describe interactions between society and the environment. The individual components of DPSIR (**D**riving forces, **P**ressures, **S**tates, **I**mpacts, **R**esponses) arrange a chain of interactions that lead to certain outcomes seen in either society or within an environment. The inherent use of this framework for evaluation is that it directly connects ecological systems with socio-economic systems; thus, bridging science and policy to inform better decision-making within governments and institutions.

However, the DPSIR framework is limited in scope to only looking at one pressure in an ecosystem, without taking into account other feedback processes. It also fails to properly include impacts on ecosystem functions and services (i.e. benefits from nature) and their subsequent effects to human well-being. Considering this, AQUACROSS adapted the DPSIR framework to include ecosystem functions and services, human well-being, and both social and ecological processes.

4.2 System Relationships

As described previously, the relationship between social and ecological systems can be seen within an overarching SES system. In more detail, the two systems represent two sets of links: the first refers to how ecosystems are linked to human welfare; the second to how social systems shape and change ecosystems. These links are connected through the complex adaptive processes within both systems. From a societal perspective, the 'providing-side' (i.e. ecosystems to society) and the 'using-side' (i.e. society to ecosystems) act as complementary frames to analyse ecosystem services.

[2] The AQUACROSS Assessment Framework (Deliverable 3.2) will make the project concept operational by mobilising existing data, analytical models and assessment tools and by bridging identified knowledge gaps, according to the concepts, the structure and the roadmap provided in AQUACROSS Deliverable 3.1.

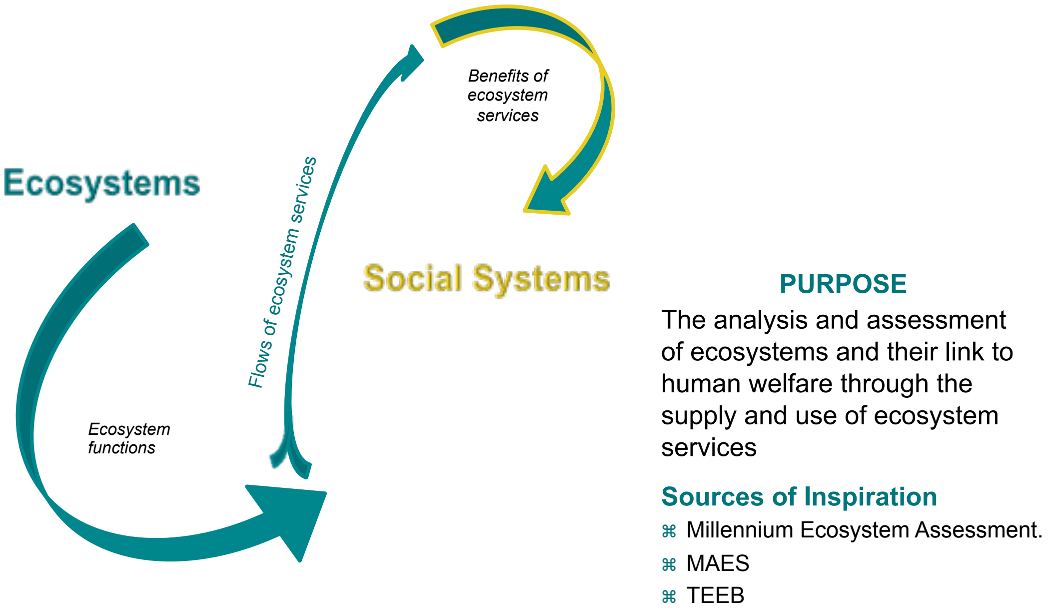
4.2.1 Provision of Ecosystem Services

How ecosystems influence human well-being

The *providing-side relationship* goes from the ecological to the social system (see Figure 2). It represents the potential of ecosystems to provide and deliver ecosystem services to society. It includes the capacity of the social system to transform those services into benefits for people and society. The provision of these services and benefits all rely on the biophysical processes occurring within the ecosystem.

Ecosystem services are the outcome of complex ecosystems processes and their benefits can go far beyond their individual use, spreading out over socio-economic and ecological systems. Some benefits of ecosystem services to human well-being are indirect, for example, generating economic growth and employment from businesses or sectors dependent on the provision of ecosystems services (e.g. commercial fisheries, offshore and onshore aquaculture or irrigated agriculture).

Figure 2: System relationships: provision of ecosystem services to society



Source: Own elaboration

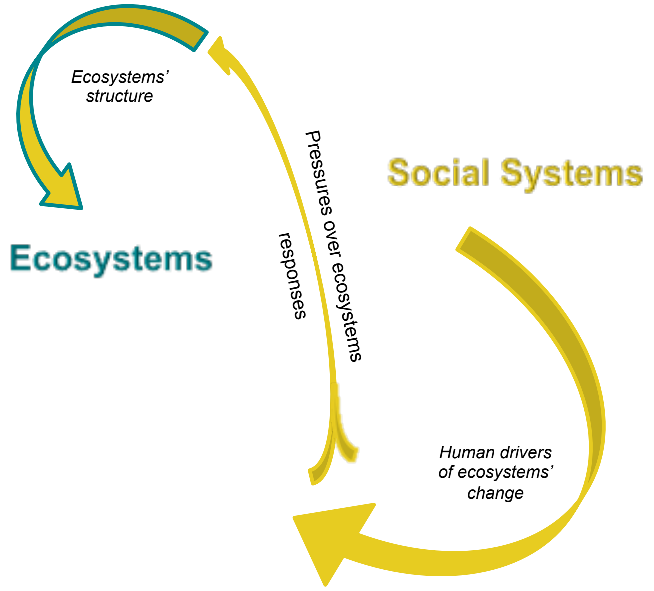
4.2.2 Ecosystem Services Use

How social systems influence ecosystem conditions

The *using-side relationship* goes from the social to the ecological system (see Figure 3). It represents and explains the demand and use of ecosystem services and the pressures these create on ecosystems. The demand for ecosystem services depends on income, tastes, technology, institutions, and other social and economic factors. Beyond pressures on ecosystems, this using-side relationship also considers social and individual decisions towards protecting and restoring ecosystems to preserve their benefits.

Social demand for ecosystem services and benefits manifest as 'drivers' of ecosystem change. These drivers then create pressures within ecosystems, by changing an ecosystem's condition or structure. Usually, drivers are detrimental to an ecosystem, causing harm and degradation. However, actions to address negative environmental conditions (e.g. pollution in water sources) can also drive ecosystem change. These actions are termed 'responses', and can come from local individuals up to national governments and international policies.

Figure 3: System relationships: use of ecosystem services by society



PURPOSE

The analysis of the multiple pathways in which society shapes ecosystems through the way the demand of ecosystem services are satisfied and the way ecosystems are governed

Sources of Inspiration

- Impact pathway analysis.
- DPSIR

Source: Own elaboration

4.2.3 A Combined View

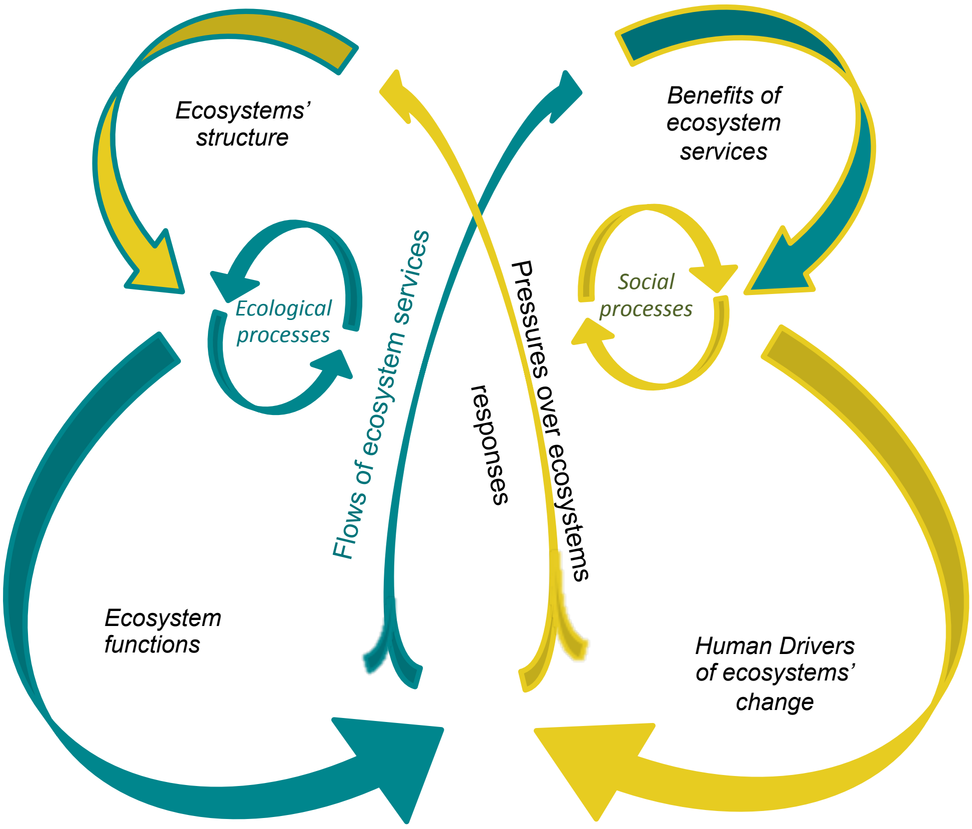
AQUACROSS Design and the overall picture, combining both system links

The AQUACROSS design as a whole is formed by two pathways linking the two complex adaptive systems (see Figure 4). The provisioning-side explains how ecosystems services (the main outcome of ecological systems) are connected to human well-being. The using-side explains how the drivers of ecosystems change and the responses to ecosystem challenges (the main outcomes of social systems) are linked to ecosystem structures and conditions.

Operating in parallel, one complex system, the ecological one, reacts to human-driven impacts (drivers and responses) by transforming into a new system with a different ability to provide ecosystem services; the other complex system, the social one, reacts to the changes in provision of ecosystem services by generating new social drivers and responses. In such a way, both systems feed into each other and react to changes in the other by changing and adapting itself.

This combined view of both systems challenges traditional policy and management approaches, which tend to assume a rigid view towards ecosystems and their connection to society. Rather, this approach highlights the fluid dynamics characterising the interaction between both systems, shedding light on areas where improved understanding is necessary to ensure the sustainability and resilience of both systems.

Figure 4: System relationships: combining socio-economic and ecological systems



Source: Own elaboration

5 AQUACROSS Strategy

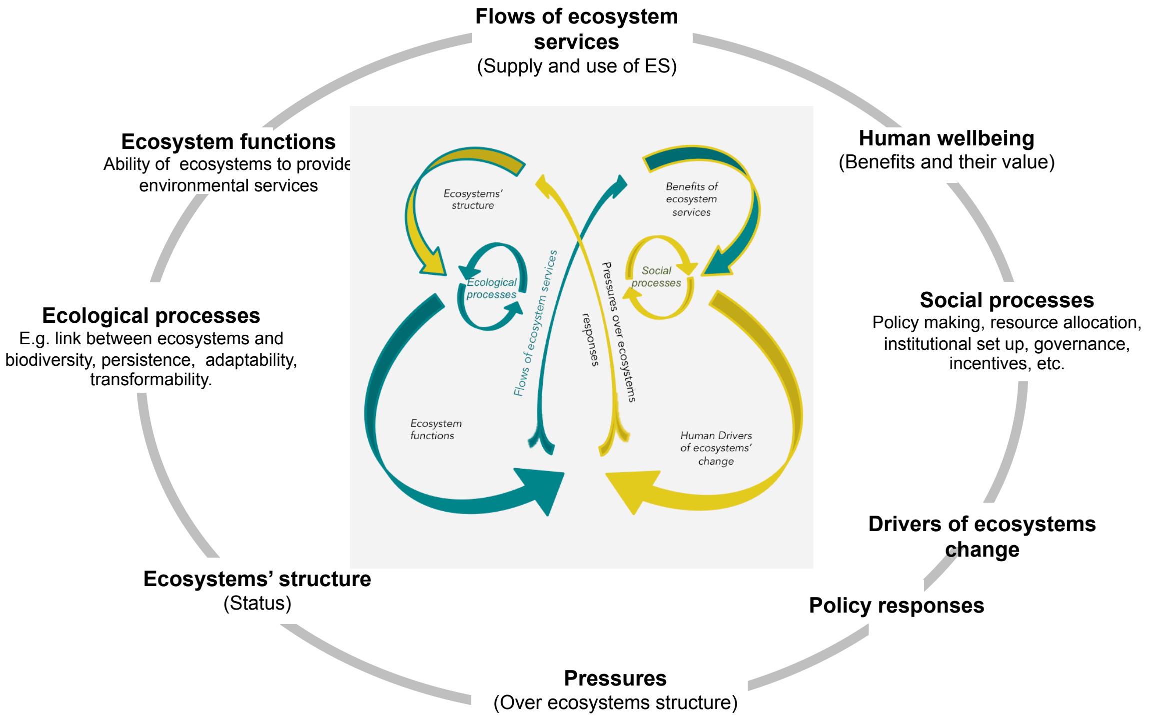
Building upon the AQUACROSS Design pictured in Figure 4 above, the AQUACROSS Strategy extracts the key points of the overall socio-economic system (SES) and pairs these points with models and tools that can possibly be used to analyse them. This two-step process of (1) identifying the key points and their available information and (2) pairing them with scientific models and tools for analysis, aims to clarify how the different key points link to each other within the overall design. In so doing, the strategy helps to make the AQUACROSS concept and design more operational and better able to inform the AQUACROSS Assessment Framework. This heuristic method, or approach to problem solving, allows flexibility and room for adjustment as the project develops.

5.1 Key Points of the AQUACROSS Design

Utilising the adapted DPSIR framework previously described in section 4.1, the first step of the AQUACROSS Strategy extracts the key points of scientific and policy interest from the interaction between the socio-economic and ecological systems. Nine points were identified as key areas of interest, depicted in the grey circle surrounding the linked systems in Figure 5.

Reading the circle in a clockwise fashion reveals a chain of interactions that continuously occur between the systems, further explaining their interconnected nature within the overall SES.

Figure 5: Key points identified within the overall socio-ecological system



Source: Own elaboration

The nine points of the SES each represent bundles of information belonging to various scientific and academic fields. Like puzzle pieces, they contain a small portion of the overall picture within their defined shapes. Individually, they remain important, bringing knowledge of a certain topic within the SES to the fore. These nine points include:

- **Flows of ecosystem services** which map the flows of ecosystem services provided by particular ecosystems. They include services that maintain ecosystems and that flow to the socio-economic system through the provision of goods and services.
- **Human well-being** which maps the benefits of ecosystem services for human well-being and the way they are used by society. This point may include information about the value of these benefits in monetary terms.
- **Social processes** gather relevant concepts and methods to understand the demand of ecosystem services as well as the governance institutions in place. This point also includes the social impacts and responses to environmental challenges (e.g. climate change) and the analysis of adaptive responses to these changes.
- **Drivers of ecosystem change** refer to the decisions to utilise and transform ecosystem services within the market economy and the overall socio-economic system. These drivers are mediated by policy institutions, technology and social values.
- **Policy responses** map primary changes in an ecosystem resulting from policy and management options intended to generate a positive impact on an ecosystem.

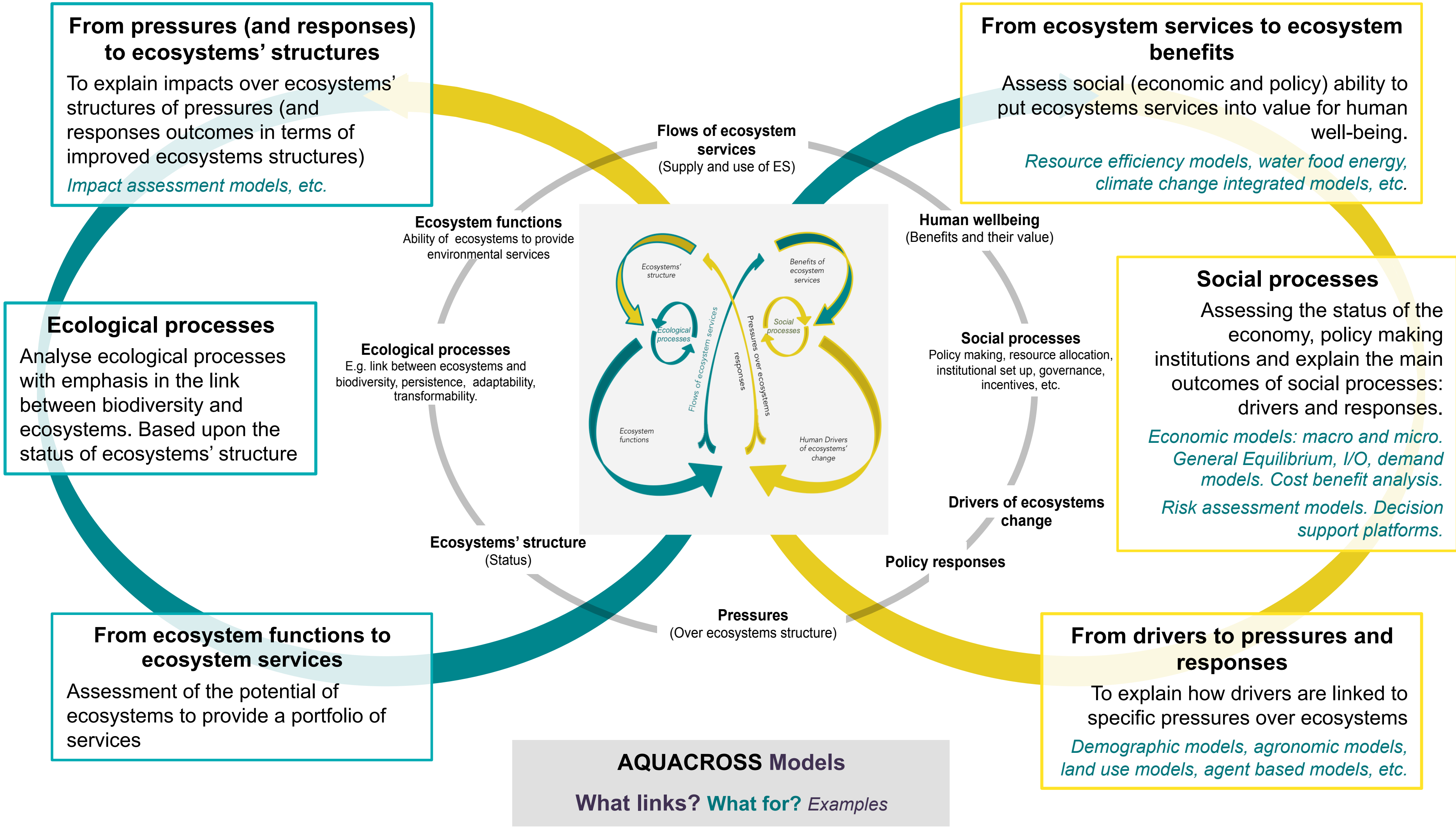
- **Pressures** map the relevant qualitative and quantitative information about how the socio-economic system affects and directly transforms the ecological one.
- **Ecosystems' structure** maps information representing the ecological status of an ecosystem through indicators measuring quantity, quality, morphology, biodiversity, etc.
- **Ecological processes** map the natural transformations resulting from complex interactions between living and non-living (e.g. nutrients) components of ecosystems through the universal driving forces of matter and energy. Special attention is given to the links between ecosystems and biodiversity, as well as to the link between biodiversity, the delivery of ecosystems services, and ecosystem resilience.
- **Ecosystem functions** map the potential of ecosystems to provide flows of ecosystem services, depending on the structure and ecological processes within the ecosystem.

5.2 Utilising Available Models and Tools for Analysis

The key points described in the previous section, though useful individually, only offer insight on portions of the overall flow between ecosystems and socio-economic systems. The second step in the two-step process of the AQUACROSS Strategy is to pair these key points with scientific models and tools currently available, since the aim is not to describe but rather to explain. The purpose of this step is to analyse how the key points can be connected to better understand the links between them. As such, this step takes each puzzle piece and puts them together in an attempt to scientifically build a comprehensive picture of SES. To do so, models and tools are required to create scenarios, storylines and assessments to explain their interactions. Broadly grouped, there are six links that require analytical models to piece together the nine key points. These six links and the models required to explain them are depicted in Figure 6, include:

1. **From ecosystem services to ecosystem benefits** requires economic models that explain how ecosystem services are transformed into benefits.
2. **Social processes** require analytical models that explain the drivers of ecosystem change as outcomes of economic and social processes.
3. **From drivers to pressures and responses** requires analytical models that explain the pressures resulting from the drivers of ecosystem change.
4. **From ecosystem functions to ecosystem services** requires analytical models that explain how ecosystem components are impacted by pressures.
5. **Ecological processes** require ecological models that explain the adaptive processes taking place in the ecological system.
6. **From pressures (and responses) to ecosystem' structures** requires ecosystem models that assess the functions performed by ecosystems.

Figure 6: Available models and tools to analyse links between key points of the socio-ecological system



Source: Own elaboration

6 The Way Forward

This document lays forth the foundations of the AQUACROSS project and the scientific and collaborative work to be carried out throughout its duration. It explains the steps and key ideas to build the AQUACROSS concept, develop its design, and propose a strategy. This work will be used as the foundation for the practical development of the AQUACROSS Assessment Framework, building upon the key concepts of AQUACROSS: ecosystem-based management (EBM) as the cornerstone concept of the project, due to its policy and management applications; resilience thinking as the backbone to build up sustainability; and complex adaptive systems as self-organising entities (such as socio-economic systems or an ecological system).

As per the way forward, this work identified some critical issues:

- There is no need to promote radical institutional change, in the sense that transitional approaches are more realistic (i.e. making the best out of available knowledge and management practices). Therefore, the scope of the project's concept and Assessment Framework will also be down-to-earth;
- AQUACROSS will build on scientific work previously conducted and widely accepted, for policy relevance, but also recognises the constraints of these processes;
- AQUACROSS will bear in mind the difference between datasets, data flows, and information layers on one side, and information that is actually needed for analytical or assessment purposes on the other side. This stems from the belief that even in the presence of data, sometimes there is lack of understanding;
- There are clear opportunities to add value from AQUACROSS, as part of this conceptual exercise: shedding additional light on DPSIR (and moving beyond); contributing to the discussion of links among ecosystem components (i.e. structure, processes, functions, functioning, and services) to ascertain relationships between biodiversity and ecosystem services, etc.;
- The challenge may be not so much to yield new indicators or metrics, but rather to use insightful ones that are not part of common practice; and,
- Further attention is needed for trade-offs, uncertainties, and critical thresholds.

Annex 1 – Glossary (abridged version)

Term	Definition (as in the Concept note)
Adaptability	A defining component of resilience. It refers to the capacity of a social-ecological system (SES) to adjust its responses to changing external drivers and internal processes and thereby allow for development within the current stability domain and/or along the current trajectory.
Adaptation	It is the "adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities" (IPCC, 2007). According to Lukasiewicz et al. (2015), in terms of land and water management, adaptation actions involve reducing non-climate threats that increase the resilience of populations to a changing environment in situ as well as enabling the species concerned to migrate to a more suitable habitat under a changing climate (CBD, 2010).
Complex adaptive system	Complex adaptive systems (such as an economy or an ecological system) consist of many local or micro-level adaptive agents The structure, the functions and the dynamics of the system at the macro-level are not planned by a central control but emerge from the interaction and interconnectedness of their constituent parts and of the system with other complex adaptive systems. Complex adaptive systems are self-organising entities.
Driver	The main outcome of social and economic interactions and are mediated by policy institutions, technology, and social values.
Ecosystem based management (EBM) approach	EBM "is an interdisciplinary approach that balances ecological, social and governance principles at appropriate temporal and spatial scales in a distinct geographical area to achieve sustainable resource use. Scientific knowledge and effective monitoring are used to acknowledge the connections, integrity and biodiversity within an ecosystem along with its dynamic nature and associated uncertainties. EBM recognises coupled SES with stakeholders involved in an integrated and adaptive management process where decisions reflect societal choice" (Long et al., 2015 p. 59).
Ecological process	They are the natural transformations resulting from the complex interactions between biotic (living organisms) and abiotic (chemical and physical) components of ecosystems through the universal driving forces of matter and energy.
Ecosystem service	Those benefits humans get from ecosystems.
Ecosystem structure	Components and their layout within the ecosystem. It includes the biotic (living organisms) and the abiotic components.
Persistence	Persistence is the tendency of a SES subject to change to remain within a stability domain, continually changing and adapting yet remaining within critical thresholds.
Pressure	Direct and indirect transformation over the ecosystems structure. It

	includes, for instance, water abstractions, diversion, impoundment, pollution, land use, soil transformation, alterations of nutrient and sediment balances.
Resilience (ecological /social /economic/ socio-ecological)	A general characteristic of a system that results from its ability to respond to change, perturbations and perturbation regimes (adaptability), and transform when necessary. It is closely connected with the diversity of ecosystems and species (heterogeneity), the capacity of a system to contain or spread a perturbation along its constituent parts (which depends on the system modularity), and the capacity of a particular part or population to recover after a shock has taken place (which is linked to the system connectivity). **Adaptability** – a component of resilience defined as the capacity of a SES to adjust its responses to changing external drivers and internal processes and thereby allow for development within the current stability domain, along the current trajectory. **Transformability** – a component or resilience reflecting the capacity of a SES to create new stability domains for development, a new stability landscape, and cross thresholds into a new development trajectory.
Resilience thinking	It is a framework approach to sustainability that emphasises that humans and ecosystems are interdependent, that SES are complex adaptive systems and that cross-scale dynamics matter to support the deliberate transformation of SES. Resilience thinking aims at: 1) assessing firstly the relative merits of the current versus alternative, potentially more favourable stability domains, and, 2) fostering resilience of the new development trajectory, the new basin of attraction. It focuses on the three aspects of SES: resilience as persistence, adaptability and transformability (Folke et al., 2010).
Transformability	The capacity to create new stability domains for development and a new stability landscape, and to cross thresholds into a new development trajectory.

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