DRAFT REPORT

HOW COMMUNITY EMPOWERMENT TOOLS AND NATURE-BASED SOLUTIONS (NBS) CAN CONTRIBUTE TO ADDRESSING COASTAL CHALLENGES AND BUILDING RESILIENT COMMUNITIES?

Requested by:

Project EmpowerUs
“Socio-economic Empowerment of Coastal communities”

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Eklipse Expert Working Group

A draft report of the Eklipse Expert Working Group on "Building resilient coastal communities through Nature-Based Solutions and Empowerment Tools".

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GLOSSARY

Term	Definition	Key References
Biodiversity	The variability among living organisms from all sources including, inter alia, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part; this includes diversity within species, between species and of ecosystems.	Convention on Biological Diversity (1992)
Blue economy	A marine-based economic development that leads to improved human well-being and social equity, while significantly reducing environmental risks and ecological scarcities.	Everest-Phillips (2014)
Circular economy	An economy based on a spiral loop, i.e., a system that minimises matter, energy flow and environmental deterioration without limiting economic growth or social and technical advancement.	Geng et al. (2009)
Co-creation	A collaborative approach to engagement that allows stakeholders to collectively design and build more inclusive and sustainable mechanisms for change.	EmpowerUs Grant Agreement (p. 102)

(Community) Empowerment	An intentional ongoing process centred in the local community, involving mutual respect, critical reflection, caring, and group participation, through which people lacking an equal share of valued resources gain greater access, decision authority and power over those resources and on their lives. Although empowerment is considered both a process and an outcome, is most consistently viewed in the literature as a process in the form of a dynamic continuum, involving: (i) personal/psychological empowerment; (ii) the development of small mutual groups; (iii) community organisations; (iv) partnerships; and (v) social and political action.	Adapted from: Cornell Empowerment Group (1989) in Perkins & Zimmerman (1995) & Labonte (1994) in Laverack & Wallerstein (2001)
Community engagement	The active, voluntary involvement of individuals and groups in changing problematic conditions in communities and influencing the policies and programs that affect the quality of their lives and the lives of other residents	Ohmer (2007)
Ecosystem services	The benefits people obtain from ecosystems. These include provisioning, regulating, and cultural services that directly affect people and supporting services needed to maintain the other services.	Millennium Ecosystem Assessment (2005)
Empowerment Tools (ETs)	Encompass a diverse set of strategies, resources, or mechanisms tailored to augment the self-efficacy, autonomy, and active participation of individuals or communities in decision-making processes. They should be differentiated from participatory tools, which promote the involvement and contribution of people to a programme, which in turn may build their capacities, skills and competencies; yet do not necessarily assist communities to gain or seize more power through collective social and political action.	Adapted from: Laverack & Wallerstein (2001)

Living Labs	Open innovation ecosystems in real-life environments using iterative feedback processes throughout a lifecycle approach of an innovation to create sustainable impact within a given geographical context. Living Labs act as intermediaries/orchestrators among citizens, research organisations, companies and government agencies/levels, integrating research and innovations with public-private-citizen partnerships.	Adapted from: Enoll (2019), Tiwari et al. (2022)
Nature-based solutions (NbSs)	Actions to protect, sustainably manage and restore natural and modified ecosystems in waysthat address societal challenges effectively and adaptively, to provide both human well-being and biodiversity benefits. Ecosystem-based adaptation (EbA), presents a nature-based solution that harnesses biodiversity and ecosystem services to reduce vulnerability and build resilience to climate change.	IUCN (2016)
Participatory processes	Specific methods employed to achieve active participation by all members of a group in a decision-making process.	Chatty et al. (2003)
Resilience	The capacity of a social-ecological system to sustain desired outcomes in the face of disturbance and change, by either buffering or withstanding a shock, or by adapting or transforming in response to change.	Adapted from: Chandler (2014), Turner et al. (2022), and Folke (2006)
Sustainability	The persistence over an apparently indefinite future of certain necessary and desired characteristics of both the ecosystem and the human subsystem within.	Hodge (1997)

ABBREVIATIONS

Abbreviation	Description
CBPR	Community-based Participatory Research
DoW	Document of Work
EbA	Ecosystem-based Adaptation
EbM	Ecosystem-based Management
EC-KCBD	EU Knowledge Centre for Biodiversity
EMB	Eklipse Management Body
ET	Empowerment Tool
EWG	Expert Working Group
IUCN	International Union for Conservation of Nature
LL	Living Lab
MEG	Methods Expert Group
NbS	Nature-based Solution
PRISMA	Preferred Reporting Items for Systematic Reviews and Meta-Analysis
REA	Rapid Evidence Assessment
SDG	Sustainable Development Goal
SEL	Social-Ecological Landscape
TCL	Transition Coastal Lab
TEP	Tailored Empowerment Program
WoS	Web of Science

1. EXECUTIVE SUMMARY

Coming soon

2. INTRODUCTION

2.1. Background

All people on Earth depend directly or indirectly on the oceans, seas and inland waters. Without healthy seas and waters, there is no life on Earth. This is why knowing, protecting and restoring our natural ecosystems is one of the defining endeavours of our time (UNESCO-IOC, 2022). Healthy and resilient societies depend on giving nature the space it needs (European Commission, 2019). The intensification of major challenges such as ecological degradation, extreme weather events, sea-level rise, pollution and coastal erosion must urgently be addressed by European Coastal Regions (Moraes et al., 2022). The realisation of the EU's Mission: Restore our Ocean and Waters and the UN's Sustainable Development Goals (SDGs) implies a transformation that reverses the environmental, societal, and financial crises coastal communities are facing. The aspirational priorities identified by the EU Green Deal and associated policies have the potential to catalyse transformation and resilience towards sustainable, balanced and inclusive coastal development, through e blue and circular economy principles (European Commission, 2020). However, the preconditions, barriers and success factors for such change and necessary innovations are not yet adequately understood at local, regional, national or European levels (Malhi et al., 2020; Seddon et al., 2020). Community empowerment tools (ETs) and Nature-based Solutions (NbSs) represent an opportunity to align socio-environmental and resilience goals, at a time of strained budgets in a global context and when short-term needs may run counter to long-term goals (Moraes et al., 2021).

Nature-based Solutions (NbSs) can be understood as "actions to protect, sustainably manage and restore natural and modified ecosystems in ways that address societal challenges effectively and adaptively, to provide both human well-being and biodiversity benefits" (IUCN, 2016). Especially in urban contexts, NbSs can contribute to improving air quality, reducing flood risk (Loos et al., 2016) and heat island effects, provisioning of open green space or improving public health and wellbeing (Croeser et al., 2021). For the effective implementation of such ecosystemic solutions, the engagement of the community is crucial (Vignola et al., 2009; Sieber et al., 2018) and still requires testing at varying community levels (Tiwari et al., 2022). Coastal communities can be seen as 'Living Labs' to design, implement, test, and validate NbSs by demonstrating demand for transformative actions towards sustainability. NbSs may be used as critical elements in transforming current coastal development models towards addressing the climate, biodiversity and pollution crises, including the need for sustainable and equitable social and economic development (UNEP, 2020; Gerritsen et al., 2021).

Communities cannot only be seen as passive beneficiaries or end-users of nature's benefits, but need both interest and power to influence what happens (Reed et al., 2009). Empowered key actors and agents who can proactively decide, plan, protect, manage or restore ecosystems as a purposeful and significant contribution to affect change, enhance resilience and economic development (Vignola et al., 2009). Empowering coastal communities is the development pathway for producing an effective change in practices and lifestyles, shortcutting the gaps between scientific development and sustainable societal applications; for instance, through the applications of NbSs. To accomplish this, the use of ETs combining both bottom-up (community scope) and top-down (political scope) interventions is essential to drive positive societal transformations. For instance, in the case of climate-related urban challenges,

community tools and interventions to promote early actions on urban governance and climate change should be supported by integrated policies and participatory processes from multiple stakeholders to improve resilience through an empowerment process (Salvador Costa et al., 2022; Chatty et al.,2003). It is crucial to pay special attention to the design of participatory processes, in order to provide better-informed and sustainable environmental decisions and beneficial social outcomes in a range of decision-making contexts, where stakeholders are engaged (de Vente et al., 2016).

This report aims to explore **"How community empowerment tools and nature-based solutions can contribute to addressing coastal challenges and building resilient communities".** This request has been put forward by the EmpowerUS Project (see Chapter 2.2). Based on a Rapid Evidence Assessment, the evidence of NbSs, as well as the evidence on the application of empowerment tools in coastal communities across Europe and other high-income countries and territories will be presented in Chapter X and Y. Building upon this, a catalogue and classification scheme of ETs is developed (Chatpter X). The report synthesizes of the joint application of NbSs and ETs for enhanced coastal resilience building, presenting policy recommendations in Chapter X.

2. 2 Knowledge need in the EmpowerUs project

The current request is put forward by the EmpowerUs[1] project. Funded under the European Union's Horizon Europe program, the EmpowerUs project aims to bring socio-economic empowerment of coastal communities as users of the sea to ensure more resilient, inclusive and sustainable coastal development. The project is led by the Nordland Research Institute in Norway and encompasses 16 partners in 9 countries. Methodologically, the three-year project experiments with Living Labs (LLs) (Figure 1).

The Living Lab framework (see box 1) has been adapted and contextualised for the EmpowerUS project, introducing the so called Transition Coastal Labs (TCLs), which aim to empower communities in coastal European regions by addressing socio-economic and ecological challenges. By facilitating approaches to multi-actor collaboration, different types of solutions will be chosen to build Tailored Empowerment Programs (TEPs) adapted to each TCL. The TCLs will then choose the most appropriate option to be developed in a pilot phase (i.e., implementation of a pilot study). This approach will locally empower coastal communities to tackle their societal challenges, and to co-create solutions for sustainable, resilient and inclusive coastal regions.

The EmpowerUs project selected six LLs situated across Europe: 1. Connemara, Ireland; 2. Traena, Lofoten, Norway; 3. Aland Islands, Finland; 4. Burgas, Bulgaria; 5. East Limassol, Cyprus; and 6. Cap de Creus, Spain (Figure 1).

[1] "Socio-economic empowerment of coastal communities as users of the sea to ensure sustainable coastal development"

Figure 1. The EmpowerUS EU project facts (left) and locations of the six Transition Coastal Labs (TCLs) in the project (right).

Box 1. The Living Lab approach and its importance to anchor NbSs

Living Labs (LLs) are "open innovation ecosystems in **real-life environments** using **iterative feedback processes** throughout **a lifecycle approach** of an innovation to create **sustainable impact.** They focus on **co-creation, rapid prototyping & testing** and **scaling-up** innovations & businesses, providing (different types of) **joint-value** to the involved stakeholders" (ENOLL, 2024). In this context, LLs serve as intermediaries, facilitating collaboration among citizens, research organisations, companies, and government agencies. While various LL share common traits such as co-creation, real-life settings, multi-stakeholder participation, and diverse methodologies, they also exhibit different implementations of these characteristics, emphasising user involvement and effective orchestration (Kumer et al., 2022).

Implementing NbSs in LL settings has been proven to play a key role for capacity-building, political and community actions, and city planning, in order to build resilience in coastal European cities (Kumer et al., 2022; Aniche et al., 2024; Bradley and Mahmoud, 2024; reviewed by Tiwari et al., 2023). EU projects such as VITALISE, coordinated by the European Network of Living Labs (ENOLL), SCORE[2], URBANET[3] or UNALAB[4] have found positive results linked to enhanced coastal resilience, increased public health, and empowerment (see e.g. Bernaerts et al., 2022).

This review found a research gap on the exact relationship between empowerment and LLs compared to the well-studied relationship between NbSs and LLs (partially due to the scattered nature of empowerment/community actions). Yet, theoretically, the principles on which the LLs are based (i.e. stakeholder engagement, collaboration, social inclusivity, decision-support, etc) seem to be synergetic to the ones from Empowerment Tools (ETs) (i.e., community actions, political actions, economy-based actions, etc). Therefore, our research assumes the importance of implementing NbS-ET actions in the context of LLs.

2.3. Eklipse process

Eklipse (https://eklipse.eu/) is a knowledge brokering mechanism created in 2016 to help governments, institutions, businesses, and NGOs make better-informed decisions. Eklipse is recognised by the European Commission as a key actor in developing the scientific pillar of the Knowledge Centre for Biodiversity (EC-KCBD), the Science Service for Biodiversity. Since 2022, Eklipse has been a self-sustaining mechanism, managed by the non-profit organisation Alternet (https://alterneteurope.eu/). Eklipse answers requests related to biodiversity and ecosystem services. The different steps of the Eklipse process are shown in Figure 2.

[2] https://score-eu-project.eu/

[3] https://www.urbanet.info/nature-based-solutions-in-european-coastal-cities/

[4] https://unalab.eu/en

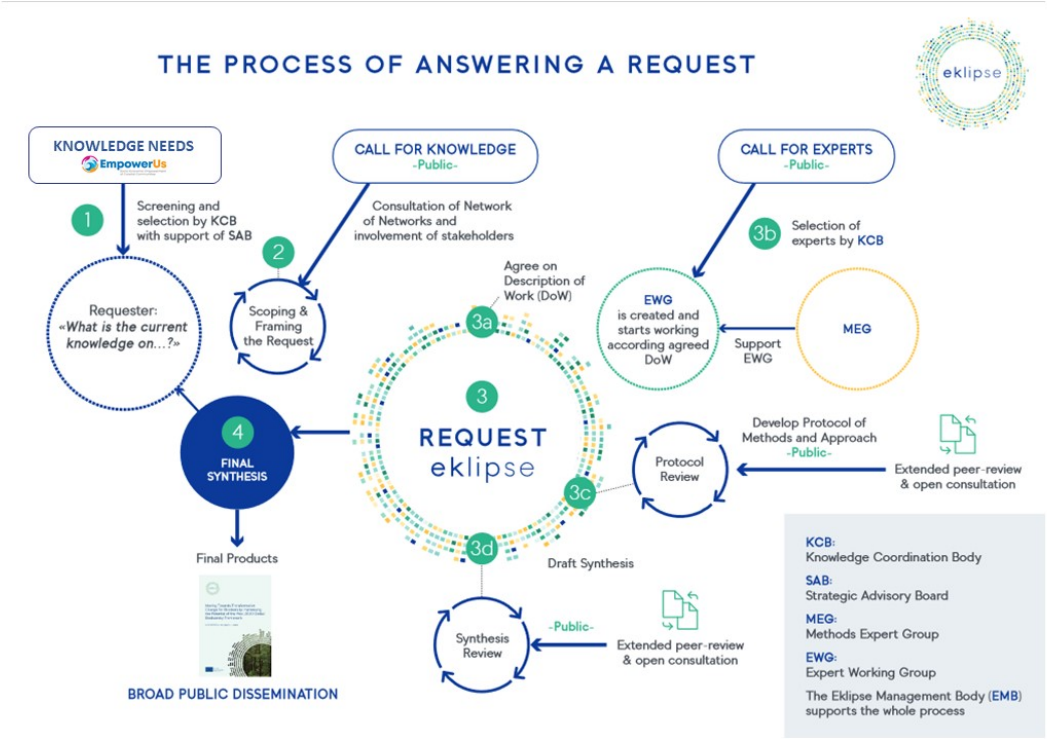


Figure 2. Eklipse process to answer the request.

Each step supports the next:

- **Scoping phase**

A scoping group is put in place composed of at least a Knowledge Coordination Body (KCB) focal point, a Deputy, a Methods Expert Group (MEG) representative and an Eklipse Management Body (EMB) contact point. The scoping group liaises with the requester during the scoping phase in order to refine the question and identify how Eklipse could provide an added value. The MEG supports the scoping group, advising on methods and approaches for answering the request. This scoping phase usually also involves looking for knowledge and expertise on the refined question. Once the KCB and the requester agree on the reformulation, the request can move forward and the answering process can start.

In order to better understand the needs of the EmpowerUs project and especially of the Living Labs/TCLs, a survey was developed by the Work Package 4 of the project to identify their main societal and environmental challenges and which of those were common to the six TCLs (see the survey in Annex 1 and the results in Annex 2). Those results showed that the Living Labs collectively represent a broad spectrum of coastal and marine ecosystems as well as socio-economic conditions and challenges typical for Europe, and that the specific societal challenges identified in these Living Labs can be considered representative of the general challenges faced by other Living Labs situated in this continent. After a meeting between the EmpowerUs project (especially the official requester´s representatives: Coordinator and Work package 2 lead) and the Eklipse scoping group, it was agreed that the request

should be reformulated to better address their needs. As a result of the revision, the following request was agreed: **"How community empowerment tools and nature-based solutions can contribute to addressing coastal challenges and building resilient communities".**

Moreover, Eklipse organised another meeting with a representative of the European Environment Agency (EEA) which supported the fact that the outputs of the request would be useful for other coastal communities in Europe.

- **Answering phase**

Based on the work during the Scoping Phase, a Document of Work (DoW) was developed under the supervision of the scoping group in close collaboration with the requester (see 3a in Figure 2). The DoW provides the background, aims, time frame and relevance of the request, describing in particular: why the request has been put forward, what the requester wants from the process, the European policy relevance of the request, the resources, and the potential methods identified to answer the request. Depending on the type of request and the advised method(s), different types of approaches can be considered.

To answer this request, Eklipse sent out a Call for Expertise (CfE), from which 7 experts were selected in April 2023. In order to complete the EWG, a second targeted call for experts (CfE n. 13/2023) took place in July 2023, from which 3 new members joined the EWG (Figure 3). These experts cover a broad range of transdisciplinary expertise in natural & social sciences, policy & planning, coastal resilience, governance & participation; and also geographical representation (10 countries) to form the Eklipse Expert Working Group (EWG). As of March 2024, for the preparation of this final evidence report, only six experts remain actively involved in the answering process for this request.

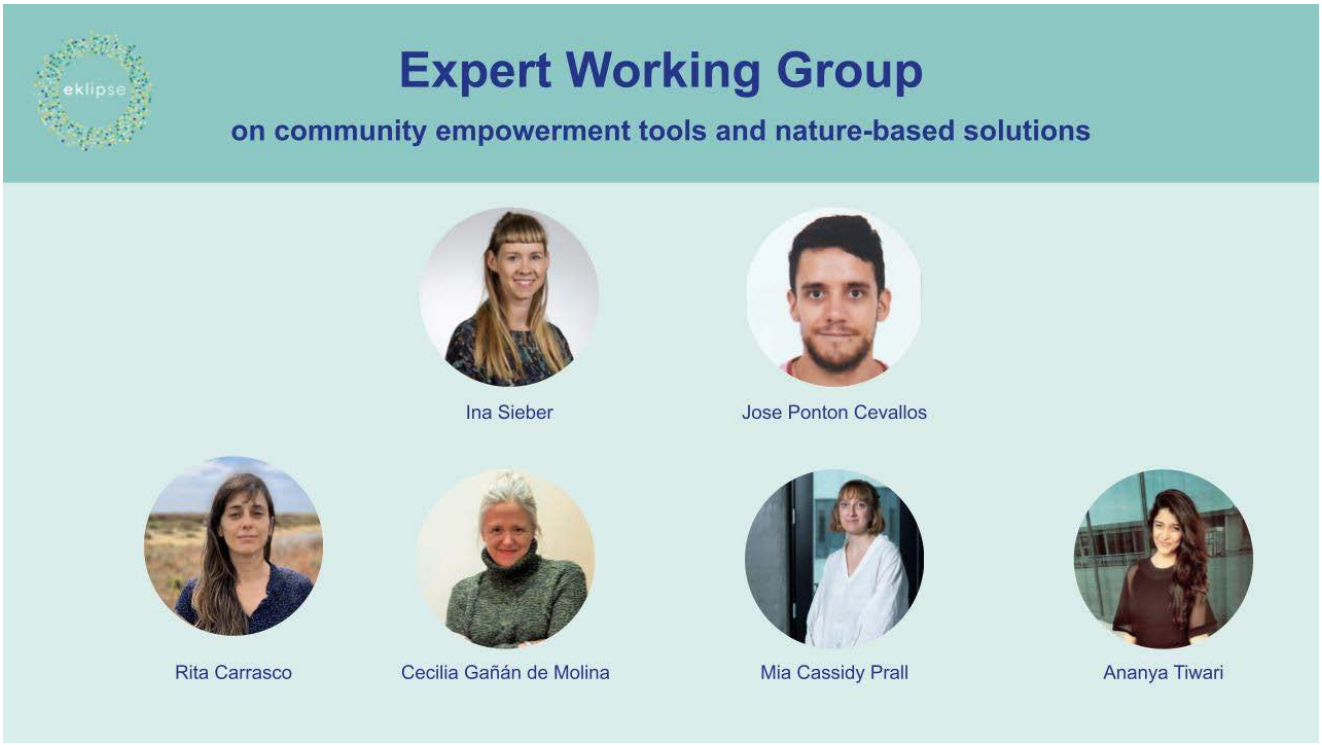


Figure 3. Schematic representation of the EWG on NbSs and community empowerments.

3. OBJECTIVES

After considering the request, the EWG and the Eklipse team interacted iteratively during virtual meetings and agreed that the process of responding to the request will include a general objective and three specific objectives:

General Objective. Rapidly review and summarise the current state of the existing evidence concerning the role of Nature-based Solutions (NbS) and community Empowerment Tools (ETs) in addressing coastal challenges across Europe, as well as critically assess the impact/outcomes of these interventions in fostering empowerment and therefore resilience within these communities.

- Specific Objective 1. Rapidly review and summarise the volumes, characteristics and contributions of the existing evidence on the application of NbSs for coastal resilience building in Europe and other high-income countries and territories.
- Specific Objective 2. Rapidly review and summarise the volumes, characteristics and contributions of the existing evidence on the application of ETs for coastal resilience building in Europe and other high-income countries and territories, and develop a catalogue and classification scheme of ETs for this context.
- Specific Objective 3: Synthesise the scope and characteristics of the joint application of NbSs and ETs for coastal resilience building in Europe and other high-income countries and territories, and critically assess the outcomes/impacts of such interventions in fostering empowerment.

Originally, two general objectives were foreseen to answer this request; with the second objective aiming to “provide inclusive and participative decision-support tools and community engagement scenarios to facilitate the co-creation process of empowerment programs tailored for each TCL”. However, following a meeting in September 2023 in Belfast (Northern Ireland, UK) with the EmpowerUs project consortium, it was decided that only one general objective would be needed.

4. METHODOLOGY

This section describes the methodology proposed by the EWG in a two-step approach. In the first step – the methodological framework – we describe the methods in general, in relation to the objectives. The second section will describe the methods proposed in more detail.

4.1. Methodological framework

4.1.1. Method selection workshop

The EWG met online with the Eklipse MEG in June 2023 to select a set of Knowledge Synthesis Methods and outline steps towards delivering the report on Empowerment Tools (ETs) and Nature-Based Solutions (NbSs). Using the MAGICKS1 toolbox provided on the Eklipse Website and based on the 21 potential Knowledge Synthesis Methods, two distinct, complementary methods were selected based on the needs of the contracting EmpowerUS project. However, considering the time required for the development of two methods in parallel, after the meeting in Belfast, it was decided to proceed with the most expedient method, which will be explained below.

4.2.2. Initial methodological framework

In pursuit of the overarching and specific objectives outlined previously, we collectively determined that employing a Rapid Evidence Assessment (REA) would serve as an effective literature-based method to swiftly review, synthesise, and evaluate the existing body of evidence concerning NbSs and ETs pertinent to the enhancement of coastal resilience. A comprehensive understanding of the current state of evidence in this domain will furnish the EmpowerUs project with well-informed conclusions and recommendations to install solid interventions in their TCLs. A more detailed connection between objectives and the implementation of the method can be found in the Table 1 and in Figure 4 below.

Table 1. Relationships between the request objectives and proposed implementation of the knowledge synthesis method.

Specific Objectives tackled	Implementation of Rapid Evidence Assessment (REA)
Nexus between NbSs and coastal challenges and resilience *(Specific Objective 1)*	*Exploratory focus* Synthesis of volumes and characteristics of evidence about coastal/marine NbS interventions in Europe and other high-income countries and territories in relation to different descriptors, such as methodological approach, geographic scale, global and coastal societal challenges addressed, NbS approaches applied, direction of governance process and community engagement level addressed, project cycle phase, etc.
Nexus between ETs and coastal challenges and resilience *(Specific Objective 2)*	*Exploratory focus* Synthesis of volumes and characteristics of evidence about ETs (both related and unrelated to NbS) in coastal/marine areas of Europe and other high-income countries and territories in relation to different descriptors : scopes of action, global and coastal challenges, level of stakeholder engagement
	Analytical focus Catalogue of ETs found in the literature and proposed classification scheme.
Nexus between NbSs and ETs and impact on empowerment (as dimension of resilience) *(Specific Objective 3)*	*Exploratory focus* Synthesis of volumes and characteristics of evidence about the joint application of NbSs+ETs in Europe and other high-income countries and territories, including joint approaches applied, co-creation and empowerment processes addressed, etc.
	Evaluation focus Critical assessment of the evidence about impacts/outcomes of NbSs + ETs application in fostering empowerment, including the methods and indicators applied to monitor these outcomes (performance).

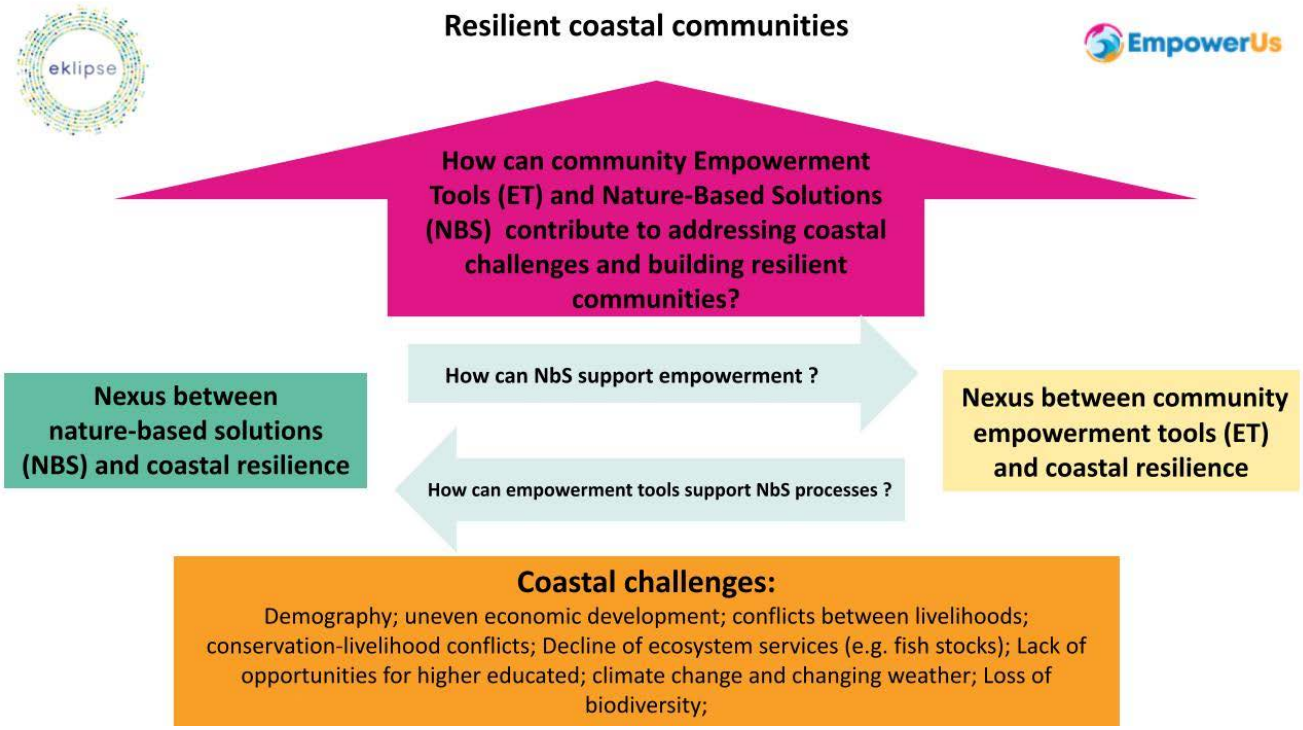


Figure 4. Conceptual framework linking Nature-based Solutions (NbS) and Empowerment Tools (ETs) in the context of coastal resilience.

4.2. Literature-based Method: RAPID EVIDENCE ASSESSMENT

4.2.1. Description of the method

A Rapid Evidence Assessment (REA) is a type of evidence review that describes the volume and characteristics of an evidence base, provides a synthesis of what that evidence indicates and critically assess such evidence. Whilst being less resource and time intensive compared to a full systematic review, REAs (as well as other methods like Quick Scoping Reviews) are designed to be transparent and to minimise bias and are typically used to understand the impact either of a 'pressure' or a policy intervention (Waterson & Randall, 2013; Collins et al., 2015).

Our REA was conducted in four phases. The first phase was a structured search of the academic, international peer-reviewed literature ('scientific') and the 'grey' literature (*sensu* Adams et al., 2016) produced by organisations outside of the traditional commercial or academic publishing companies. The search was based on keywords, titles and/or abstracts of these records to assess their relevance. For the case of the scientific literature, we used the two academic databases, Web of Science (WoS) and Scopus; while for the grey literature, we used a mix of search engines (Google) and specific repositories (World Bank, TIM-Joint Research Center & Nature Network). Duplications were removed at this stage. Based on the identification of potential publications, a first screening (second phase) was conducted, checking abstracts for suitability, reducing the number of publications. In a third phase, retrieved records were assessed by conducting a full content analysis for further removing irrelevant articles, and extracting evidence of the records. The final fourth phase consisted of a synthesis and evaluation of the selected literature, as well as a provision of derived conclusions and recommendations for the requester. The PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analysis) technique (see Liberati et al., 2009) was used to report the results obtained in each of the phases of the REA process for both scientific and grey literature (see Figure 6 in the Results).

4.2.2. Advantages and Limitations of REAs

REAs provide relevant syntheses of evidence, carried out in a short period of time (3-6 months), so they are quicker to complete than an equivalent systematic review. They allow an overview of the evidence on a particular issue able to support programming decisions on key topics. Methods are documented transparently and shortcuts are clear to see.

With regard to limitations, in order to be "rapid", REAs are not as exhaustive and comprehensive as a systematic review, and therefore they make concessions in relation to the breadth, depth and comprehensiveness of the search. For that reason, it is not usually suitable for very broad topics, including for related policy decisions (Grannan et al., 2010). Risk of bias is variable.

Errors associated with the development of the REA include misinterpretations related to individuals (i.e., subjectivity), misinterpretations linked to term analysis (i.e., content analysis), and misinterpretations drived by the content of the publication and external to the individual (i.e., external errors). These biases

can be avoided through consistency checking and validation, e.g. through a second screening. This exercise was made in our research as explained below (see Data synthesis, visualisation and approach to organise knowledge/data)

4.2.3. The REA process: methodology

4.2.3.1. Search and screening strategy

An initial scoping search was first performed to test for specificity and sensitivity using the online academic databases WoS and Scopus. Search queries were constructed by connecting individual keywords with boolean operators to analyse the relationship between nature-based solutions, empowerment tools, resilience and coastal/marine environments, as follows:

(NbS **OR** empowerment tools) **AND** resilience **AND** coastal

Additionally, in the case of WoS, Scopus and Google, other keywords relating to the main terms (e.g., synonyms, elements of terms) were added to the search query (connected by OR to the main term) to increase the breadth of the evidence (see Table 2). The final selection and number of keywords was chosen to ensure records remain relevant and manageable to analyse in the timeframe provided by the requester.

Table 2. List of keywords used for structured searches in the two academic databases (Web of Science and Scopus) and Google.

Nature-based solutions	Empowerment tools	Resilience	Coastal
"nature-based solution*" OR "nature based solution*" OR "nature-based approach*" OR "nature-based intervention*" OR "ecosystem-based solution*" OR "ecosystem-based adaptation" OR "ecosystem-based mitigation" OR "ecological restoration" OR "ecosystem-based management" OR "green infrastructure*" OR "blue infrastructure*"	"community empowerment" OR "empowerment" OR "social empowerment" OR "social innovation*" OR "community action*" OR "empowering" OR "empowerment tool*"	"resilience" OR "coastal resilience" OR "coastal adaptation" OR "community resilience" OR "social-ecological resilience"	coast* OR marine

Although the term “nature-based solutions” was only coined in 2016 by the International Union for Conservation of Nature (IUCN), the focus of the search were studies documenting the application of

different types of ecosystem-based approaches (e.g., EbA) under the umbrella term of NbS, in which the concepts of ecosystem services and social-ecological systems are operationalized into practice. Thus, to increase the breadth of the evidence, all articles published after the year 2012 were included. This was the first year after the completion of the UK National Ecosystem Assessment (NEA), one of the most complete NEAs in Europe (Schröter et al., 2016), and the first year of full economic recovery among major economies (UN, 2012). For the scientific literature, articles, reviews, book chapters and conference proceedings were considered for searches. For the grey literature, the search included reports, briefs, white papers, dissertations, guidelines and other documents from government/intergovernmental organisations, NGOs, research institutions, etc. All records were checked to avoid double counting and minimise bias, and then assessed for relevance following a PICO (population, intervention, comparison, outcome)/topic statement (see Liberati et al., 2009):

- **Population:** studies conducted in Europe, including overseas territories; though other high-income countries (i.e., OECD countries) were also included due to their similarity in socio-economic conditions. The addition of non-EU countries allowed for the incorporation of a richer set of experiences among advanced economies, including disputed seas (Alexander & Graziano, 2017).
- **Intervention:** studies addressing NbS or Empowerment interventions for coastal resilience building throughout the project cycle phase (design, implementation, or evaluation).
- **Comparator:** if possible, studies documenting social-ecological status of the system before and after the interventions.
- **Outcome:** if possible, studies reporting impacts/outcomes of empowerment processes and resilience building through the application of NbS + Empowerment interventions, by either quantitative or qualitative indicators (e.g., narratives about creation of placeness), and the methods to assess these impacts/outcomes.
- **Types of study:** 1) biophysical/ecological studies employing quantitative methods like observational/measurement, experimental or modelling approaches; 2) socio-economic studies using quantitative methods (e.g., surveys, cost-benefit analysis); 3) socio-cultural studies using qualitative methods (e.g., interviews, expert elicitation); 4) review studies, 5) conceptual studies, 6) other documents with a non-research focus (i.e., grey literature documents like reports, policy briefs, guidelines, institutional websites or fact sheets about NbS/Empowerment approaches).
- **Language:** English

4.2.3.2. Data extraction and classification

First, all eligible records from the scientific and grey literature were organised for data extraction, using the following classification scheme (when applicable):

- General descriptors: countr(ies) of intervention, year of publication
- Type of study: see above
- Ecosystem: e.g., urban, coastal, marine, wetland, grassland, forest, cropland
- Scale: local, regional (i.e., sub-national), national, supranational, others (e.g., global, unspecific)
- Global societal challenges addressed (after IUCN, 2016)[5]: climate change mitigation/adaptation, social and economic development, disaster risk reduction, human health, food and water

[5] The IUCN has identified several of the most urgent global challenges that NbSs hold promise to tackle.

security, biodiversity loss and ecosystem degradation. Socio-environmental justice was also added as a category due to relevance in community settings.

- Intervention typologies:
  - *NbS approaches* (after IUCN, 2016): infrastructure/hybrid (i.e., natural/green/blue infrastructure), management (i.e., ecosystem-based management), restoration (i.e., ecological restoration, forest landscape restoration, ecological engineering), issue-specific (i.e., ecosystem-based adaptation, ecosystem-based mitigation, ecosystem-based disaster risk reduction, climate adaptation services), others (such as ecosystem protection approaches like Marine Protected Areas and other area-based conservation measures).
  - *Empowerment scopes of action* (after Salvador Costa et al., 2022)[6]: political scope, community scope, public and environmental health, resource management, science and research, economy-based, funding-related, others.
- Project cycle phase of intervention: design (or planning), implementation, evaluation (and/or monitoring)
- Direction of governance process: top-down, bottom-up, both
- Level of stakeholder engagement: inform, consult, involve, collaborate, empower (following the IAP2's public participation spectrum by Bobbio (2019) (Figure 5)
- Evidence of co-creation process: (yes/no)
- Definition of resilience: (yes/no) and qualitative description
- Policy recommendations: qualitative description
- Relation to European coastal challenges: contribution of studies/interventions in tackling specific coastal/marine challenges identified for European coastlines and grouped in 'socio-economic', 'ecological/ecosystemic', 'legal/regulatory', and 'knowledge/well-being/socio-cultural' domains.

Following, selected records from the scientific literature and grey literature that included a **comparator** and/or **outcome** were further analysed using the following scheme:

- Main outcomes/impacts of empowerment process: qualitative description
- Evidence of empowerment processes leading to coastal resilience building: (yes/no)
- Methods/indicators used to report empowerment impacts/outcomes: qualitative description
- Main challenges in achieving empowerment: qualitative description

[6]Categories for community actions that contribute to empowering communities are based on their governance process direction and/or the sector or purpose they address. Originally conceived as measures to combat climate change, these categories have been adapted here to address various global societal challenges. Political actions, whether at the local, regional, national, European, or global level, are primarily characterised as top-down interventions. Conversely, community actions predominantly embody a bottom-up approach. Public health and environmental, science and research, resource management, economy-related, and funding-based actions generally represent a hybrid approach of community interventions. It's important to note that these categories are usually not mutually exclusive, as actions usually comprise one of the first two related to direction of governance (political vs. community), plus other categories.

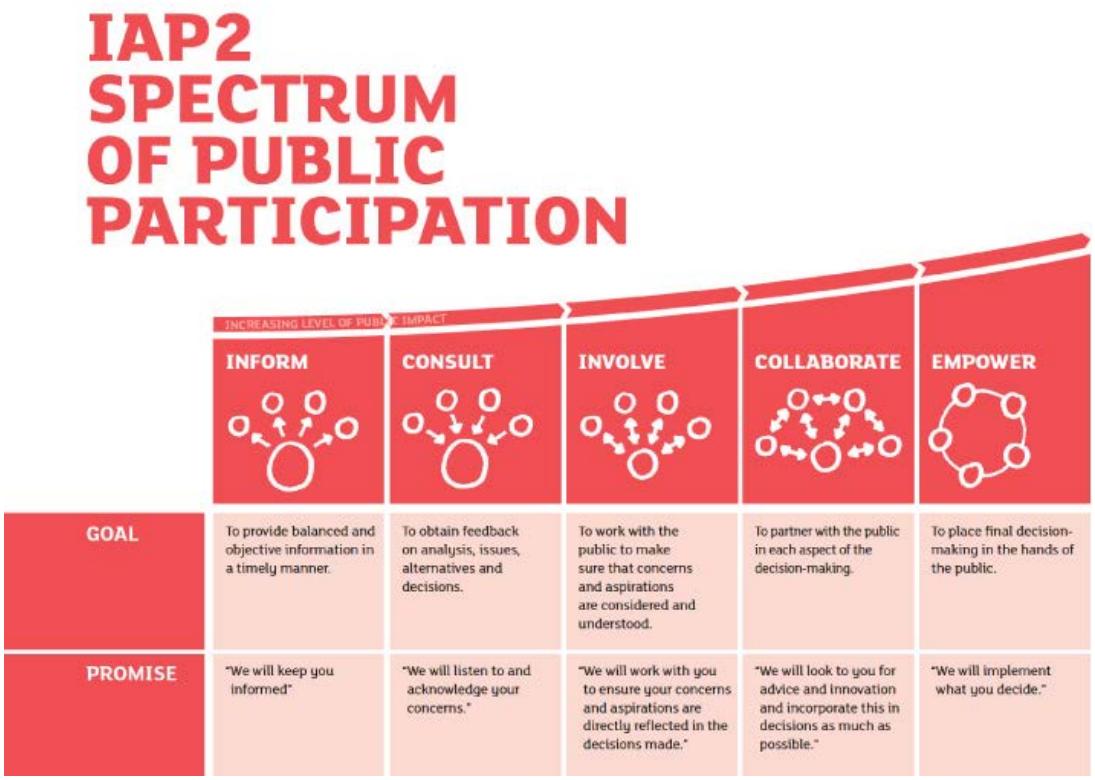


Figure 5. International Association for Public Participation (IAP2)'s public participation spectrum (Bobbio, 2019) used to assign different levels of stakeholder/community engagement to the interventions found in publications screened during this literature review (Source: Place Speak).

4.2.3.3. Consistency checking and validation

Literature reviews, such as REAs, inherently entail a degree of subjectivity in their analysis, much like other forms of literature review conducted by diverse individuals. To ensure robustness, a consistency checking was performed whereby three MEG/KCB members examined a minimum of three papers from the original database of records. They then compared the classification of these papers with that determined by the EWG. The analysis evaluated the percentage of "similarities" (% TRUE) and "dissimilarities" (% FALSE) between the two classifications. If the percentage of dissimilarities exceeded 50%, the classifications were deemed ambiguous, prompting a thorough review of the publications to understand the reasons behind such ambiguities. However, following this cross-check analysis, none of the papers examined exhibited dissimilarities surpassing 50%. This outcome validates the initial classifications derived during the screening of publications, thereby bolstering confidence in the integrity of our results.

4.2.3.4. Data synthesis, visualisation and approach to organise knowledge/data

First, a PRISMA flow diagram was used to document the REA process and volumes of records at distinct stages. Prevalences (i.e., percentage of records reporting a response level within a variable or combination of levels across multiple variables) were calculated to quantitatively contrast the literature

based on attributes/descriptors (e.g., scale, direction of governance process), and contributions were summarised in charts (mainly bar and pie charts). These practices were in line with existing approaches for describing outputs from bibliometric analyses and critical literature reviews (see e.g. Secinaro et al., 2020; Minghui Gui & McGill, 2018). Other attributes/descriptors from studies were qualitatively contrasted and summarised in tables (e.g., definitions of resilience, methods to report empowerment outcomes). All relevant records were organised in an Excel sheet with their attributes and classifications (e.g., 1/0 binary responses) to facilitate their exploration.

4.2.3.5. Classification of the Empowerment Tools (ETs) and compilation of a catalogue

From the literature review it was obtained information on the level of participation/engagement observed in the different publications, the classification of community actions based on scope and the links between, or the empowerment related to coastal community resilience. To cluster the literature and to distinguish various ETs for the Catalogue, the literature volumes were qualitatively assessed based on full text reads. Content analysis on the different participatory approaches/methods employed or acknowledged during these community interventions were retrieved. These were clustered according to aims and targets, and level of stakeholder involvement. Grouping this information allowed to cluster 6 distinct groups of ETs which proved to be successful for enhancing socio-ecological resilience. Following the principle of "categories *a posteriori*," this review presents a synthesis of results, showcasing final categories derived from interpreted findings regarding community actions that contribute to community empowerment.

4.2.3.6. Outcomes of the request

Following the methodology explained under the previous chapters, the obtained products of this knowledge-synthesis request and their formats were:

- OUTCOME 1: Rapid evidence assessment of contributions of NbSs and Empowerment literatures in addressing coastal challenges in Europe and other high-income countries, and their impact in empowerment processes and resilience of coastal communities, including a list of challenges and opportunities to integrate these approaches for coastal resilience building in Europe. *Format*: Final evidence report and Executive summary of evidence report for the wider public.
- OUTCOME 2: Catalogue of ETs obtained from evidence base to support the EmpowerUs requesters' objectives. *Format*: Database with list of ETs and descriptors for classification, including indications and examples of how to use the database.

5. RESULTS

5.1. Literature volumes and characteristics

5.1.1. Literature volumes

In the first phase of our REA, structured searches for the scientific literature yielded 459 records in WoS and 374 in Scopus, which were then consolidated into 554 records following duplicate removal. Similarly, searches for grey literature across Google and specific repositories (i.e., World Bank, TIM-Joint Research Center & Nature Network) generated 240 records, leading to 228 unique records post-duplicate removal.

During the second phase, 336 scientific records were screened out based on abstract relevance, with an additional 16 records excluded for other various reasons in the third phase (e.g., lack of full document accessibility), resulting in 202 studies selected for data extraction and synthesis in the fourth phase. In contrast, due to the absence of abstracts in many grey literature documents, a full-text screening was directly undertaken (third phase), culminating in the inclusion of 16 records in the final dataset comprising a total of **218 items** for analysis.

The PRISMA flow diagram presented below (Figure 6) provides a concise overview of the REA process encompassing both scientific and grey literature:

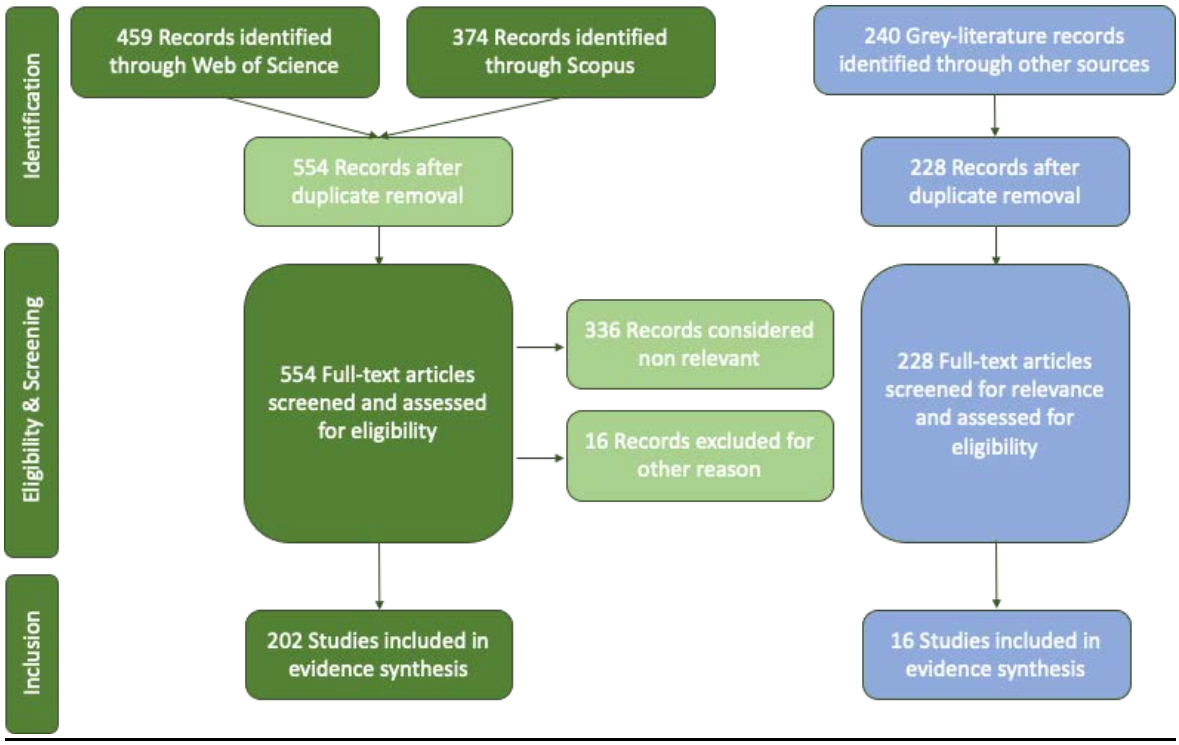


Figure 6. Overview of the screening process (from 6/2023 - 12/2023) of the literature, following the PRISMA scheme (Liberati et al., 2009).

5.1.2. Year of publication

Since 2012, 218 relevant studies have been published on these topics. Notably, there was a significant surge in publications on the topic observed in 2017. Despite a slight dip in 2020, the peak occurred in 2022, with 41 studies addressing NbSs and Empowerments. The decline in 2023 can be attributed to the timing of the literature search conducted in June 2023, as numerous annual publications may not have been released at that point (Figure 7).

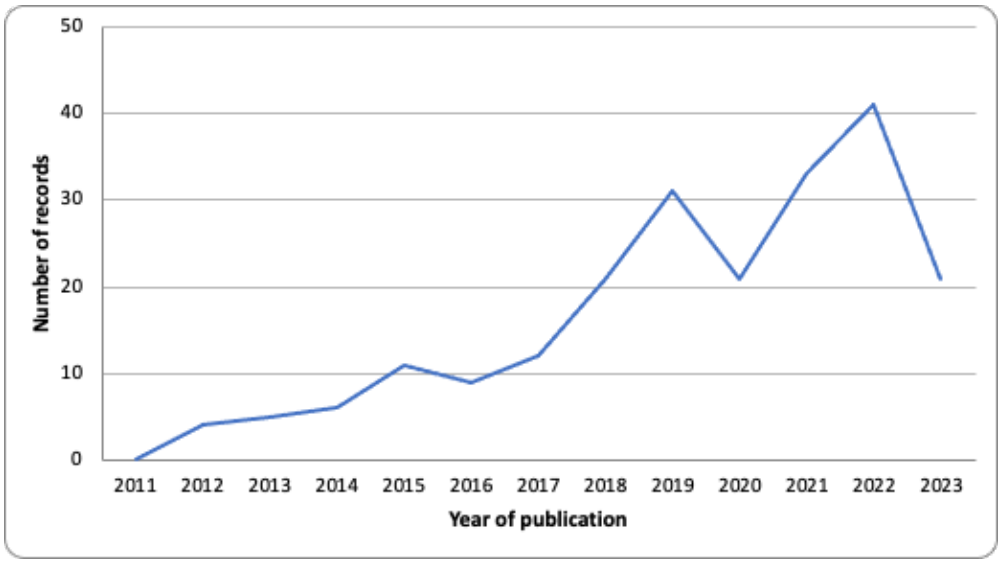


Figure 7. Evolution of publication numbers linked to NbSs and Empowerment in coastal communities from 2011.

5.1.3. Types of studies/methodological approaches

All examined studies underwent analysis based on their study type and methodological approaches. The majority of records (82%) comprised empirical research (178 publications in total). Within this category, 59 studies (27%) presented case studies devoid of statistical methods, while 39 publications (18%) from the social sciences utilised interviews, ethnography, or other socio-cultural approaches. Additionally, 36 studies (17%) included measurements/observations, typically for biophysical and/or economic variables, whereas 22 studies (10%) developed and applied modelling techniques. A smaller subset, comprising 14 studies (6%), adopted an experiential setting. Surveys, primarily for economic analysis, were the least common among the empirical studies, with 8 applications (4%) (Figure 8). Moreover, 63 studies (29%) employed extensive literature review approaches, whereas conceptual studies were the least prevalent, amounting to 32 studies (15%) (Figure 8). It's worth noting that many publications combined multiple study types, averaging 1.4 approaches per publication.

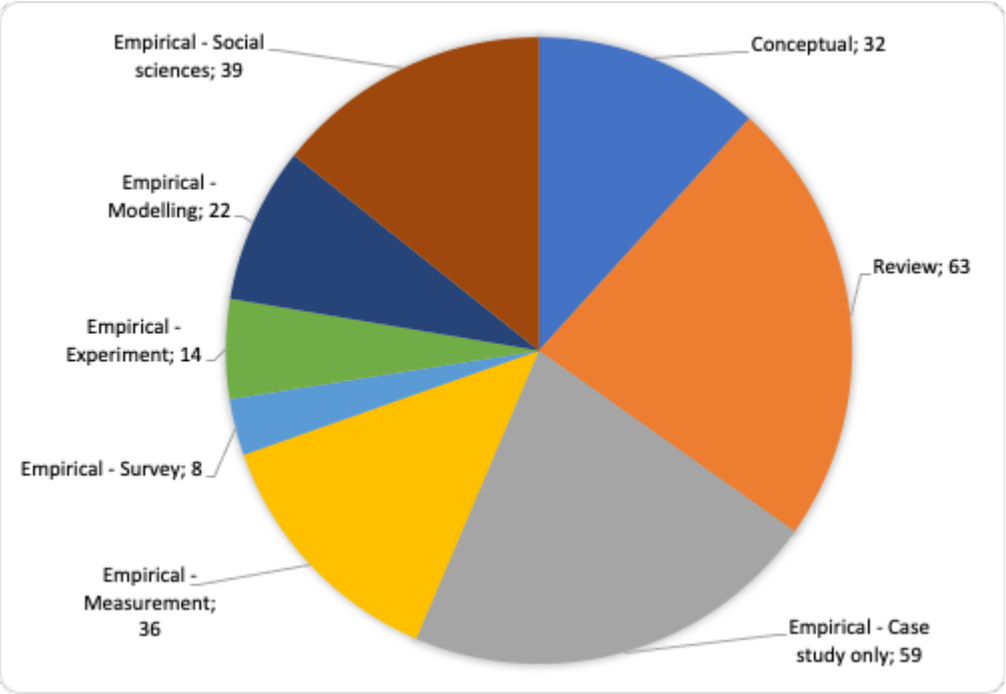


Figure 8. Overview of the study types/methodological approaches used in publications related to NbSs and Empowerment for coastal resilience.

5.1.4. Topics of publications

The distribution of topics covered by the records reveals that 132 studies (60%) delve into the interface between NbSs and Empowerment. Specifically, 67 publications (31%) concentrate solely on NbSs, while 19 publications (9%) exclusively address ETs (Figure 9). Out of these 218 studies, 199 studies (91%) focus on NbSs and 151 studies (69%) relate to empowerment.

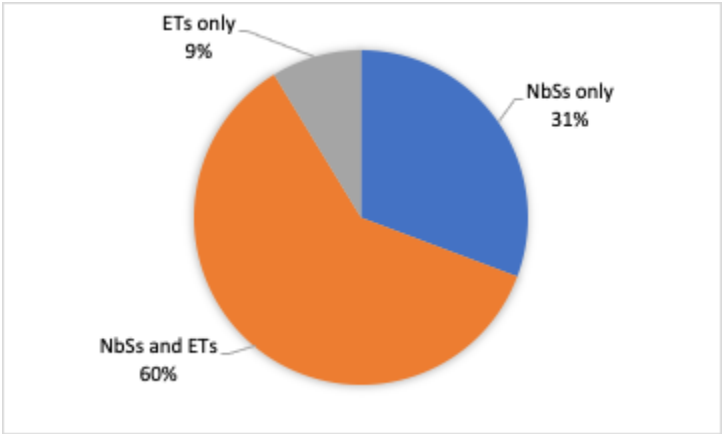


Figure 9. Distribution of studies assessed (N=218) in relation to topics covered: NbSs only, ETs only or NbSs+ETs.

5.1.5. Topics based on title analysis

To gain an initial insight into trends and patterns within the evaluated literature, a word cloud analysis based on titles proves invaluable. This analysis highlights enduring themes present in the literature, notably centred around coastal resilience, adaptation, nature, and ecosystem-based approaches. Notably, restoration, depicted prominently in the upper left corner of the cloud (Figure 10), occupies a significant space within the word cloud.

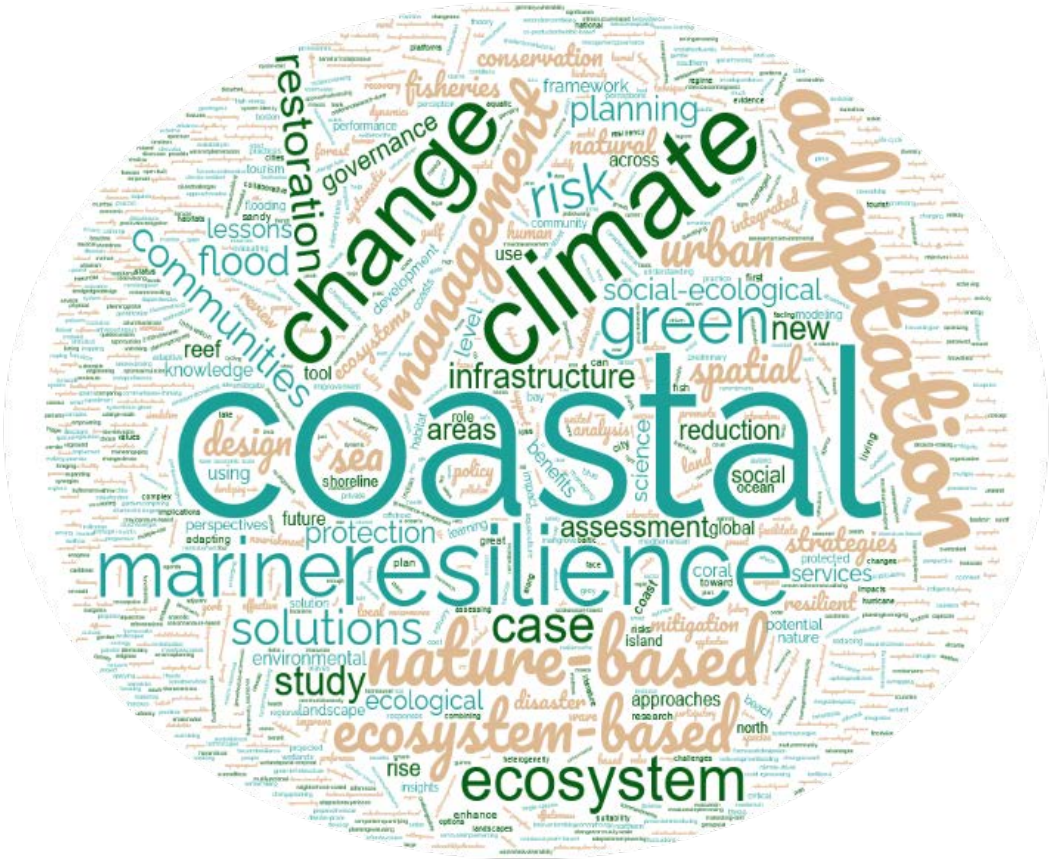


Figure 10. Word cloud analysis of publication titles assessed for this study.

5.1.6. Ecosystem types

Coastal ecosystems (69%; N=150) were dominantly represented in studies, followed by marine ecosystems (37%; N=80), urban ecosystems' (30%; N=66), and wetlands (13%; N=29; Figure 11). The most frequent combination of ecosystems were coastal and marine ecosystems (N=62), coastal and urban ecosystems (N=44), and coastal and wetland ecosystems (N=24). Other ecosystem types (9%; N= 20; Figure 11) found in the literature comprised rivers, or aquatic ecosystems, multiple ecosystems, or all ecosystems without distinction. Studies focusing only on Empowerment (without NbS co-implementation) addressed only coastal, urban, marine, wetland, lakes, and other ecosystem types (Figure 11).

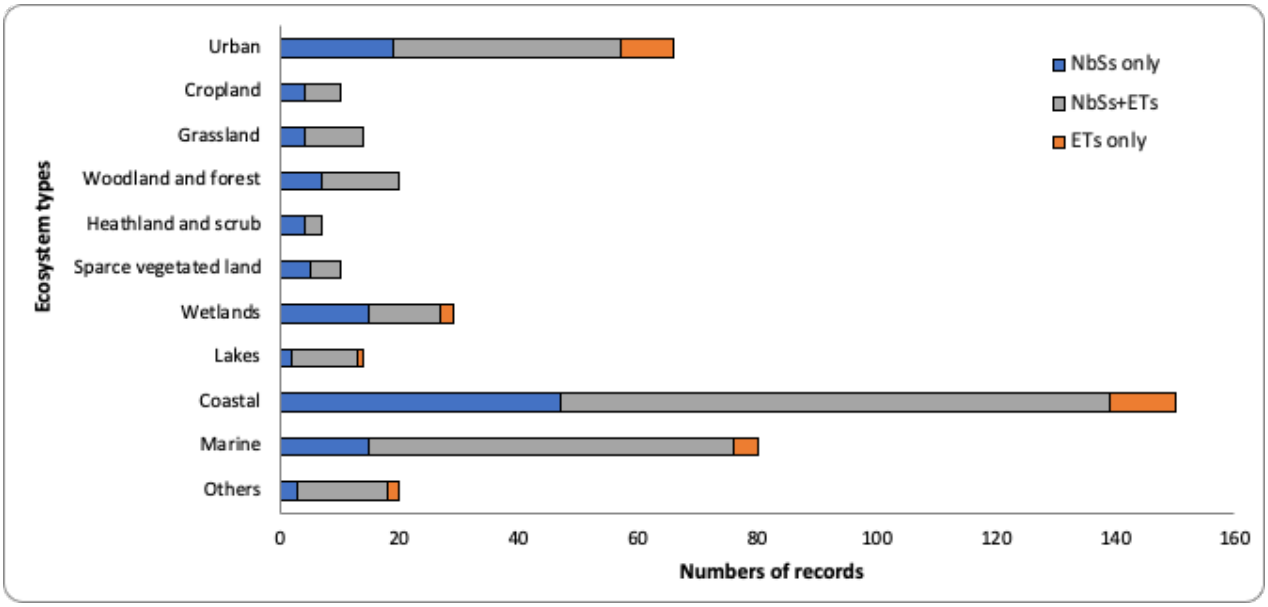


Figure 11. Overview of the ecosystem types addressed in NbS and Empowerment studies for coastal resilience.

5.1.7. Spatial scales and countries of interventions

The majority of the reviewed studies primarily operated at the local scale (45%; N=80; Figure 12)), succeeded by regional (32%; N=65), supranational (22%; N=44), and national levels (16%; N=32). Regional studies encompasses analyses across multiple regions within a country, extending beyond several kilometres, while supranational studies entail transboundary analyses involving multiple countries, like in the Baltic Sea or European coastal areas.

Additionally, other scales (26%; N=53) were observed, including conceptual, landscape, multiscale, and global dimensions, which were also significant in our findings (Figure 12).

Studies exclusively addressing NbSs predominantly occurred at the supranational scale (8%; N=18) rather than the local scale (5%; N=11). Conversely, studies focusing solely on Empowerment exhibited an opposite trend (Figure 12).

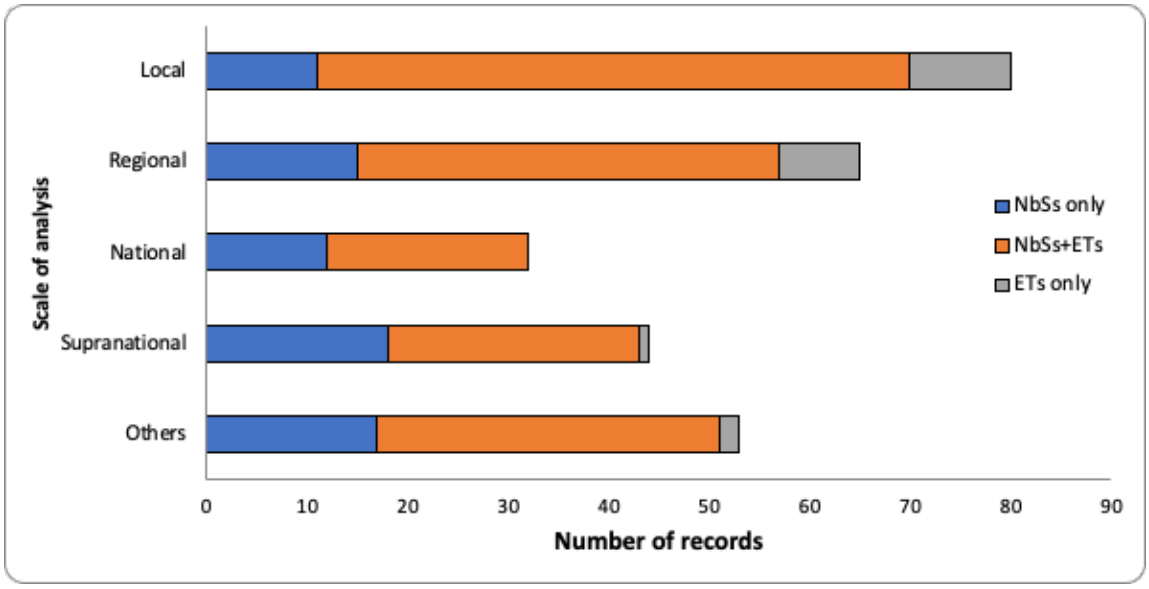


Figure 12. Overview of the scale of assessments related to NbSs and Empowerment for coastal resilience.

A geographic overview shows distribution of studies based on countries. With 57 studies, the USA is the best represented in terms of NbS and Empowerment studies, followed by the UK (N=10), Australia (N=10), Canada (N=9) and the Netherlands (N=7). Studies covering multiple countries/scales (N=14), Europe (N=10) and global assessments (N=8) were also representative (Figure 13).

Figure 13. Overview of the countries of interventions related to NbSs and Empowerment for coastal resilience. Circle size is relative to the number of records found for that specific country. Other studies representing supranational scales (e.g., multiple countries, Europe, Baltic Sea, Mediterranean Sea, global) are not depicted here.

5.2 Definitions of Resilience

According to our research, the definition of "resilience" is mostly missing in the reviewed papers, with only 11% of the papers including it (24 papers out of 218) (Figure 14). In those papers including a definition, some papers recognized the ambiguity of the resilience concept itself, "with multiple, potentially incommensurable definitions having been advanced in scholarship and policy" (Bone et al., 2016).

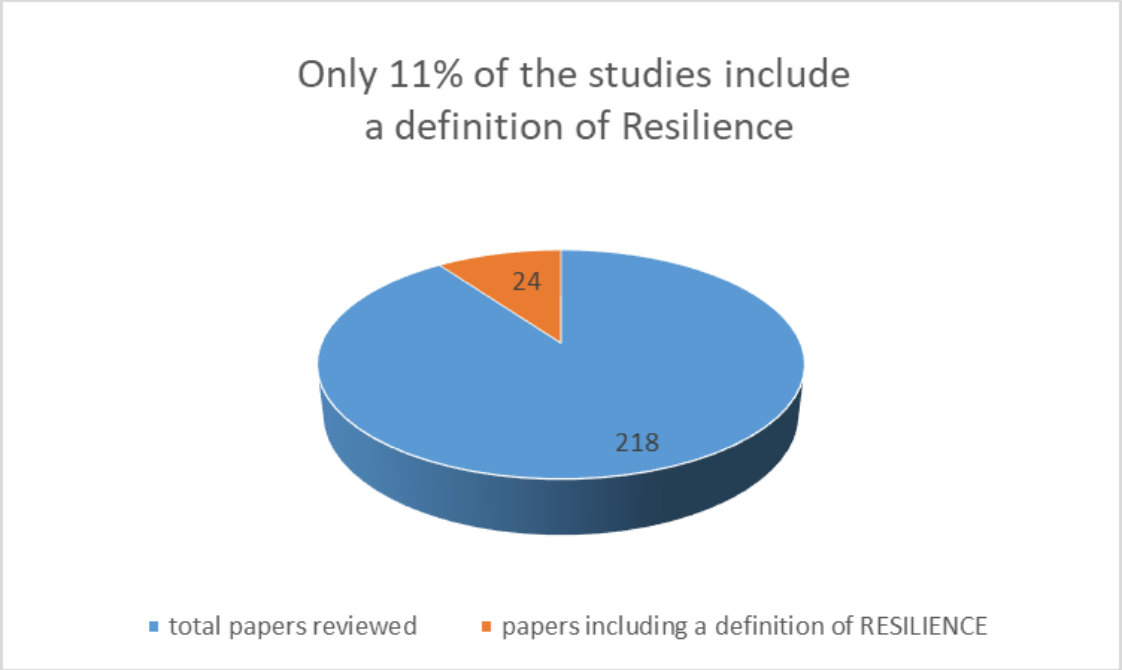


Figure 14. Representation of resilience concepts in the studies addressed.

From these 24 studies defining resilience, 66% do it according to a socio-ecological perspective, confirming this a trend to a holistic consideration of this concept when applied to specific communities such as the coastal ones (Figure 15).

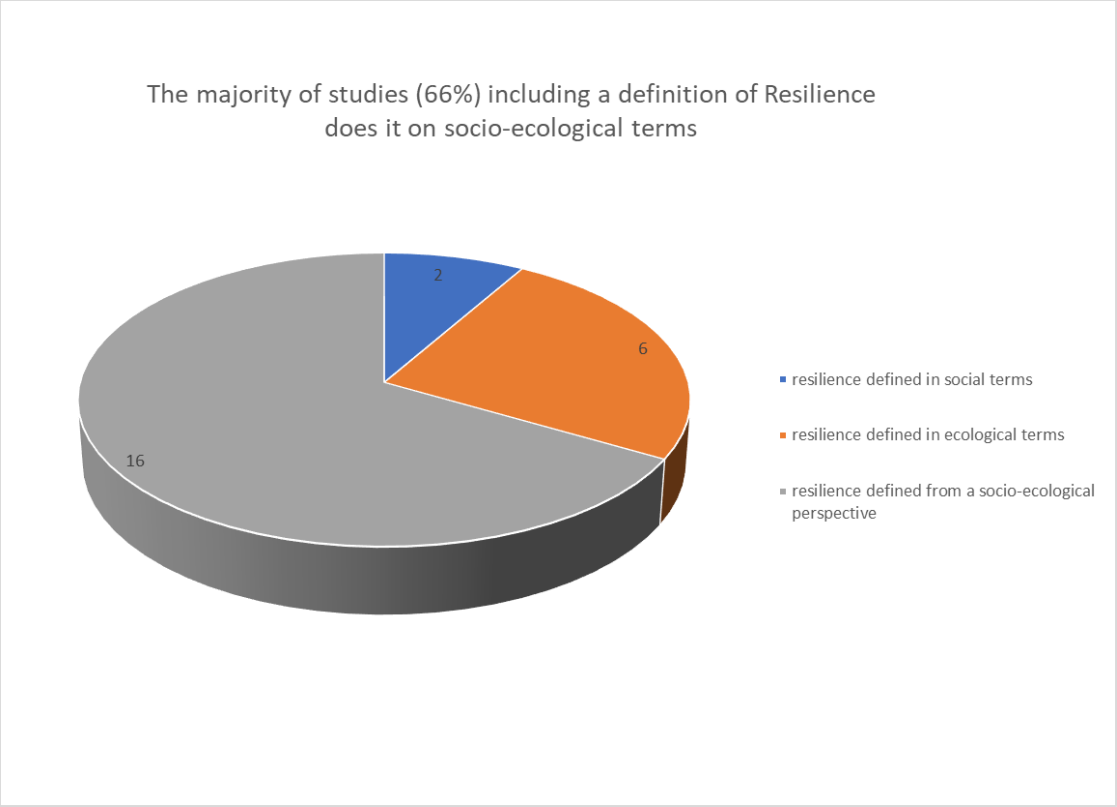


Figure 15. Distribution of studies according to the type of addressed resilience.

The approaches to define resilience on socio-ecological terms tend to follow common patterns and take on board a variety of terms such as disturbance, systems, function, ability, capacity, or change (Figure 16).

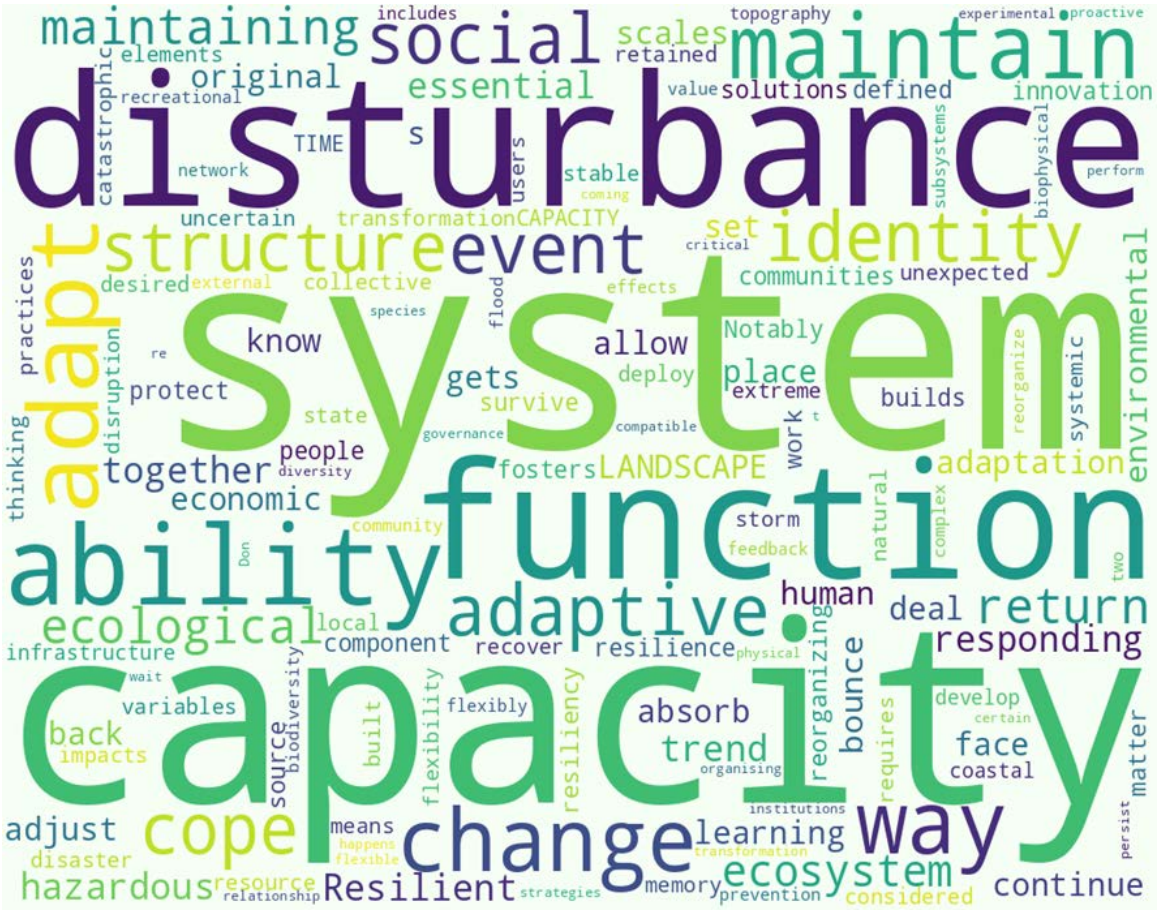


Figure 16. Common terms referred to in the studies addressing resilience based on document titles.

In general terms, “resilience” has been classified into three categories: local-communities’ resilience, economic resilience, and ecological resilience (Kim et al., 2017). All of them are interlinked in socio-ecological approaches such as, for example, sustainable land-use planning. In a significant number of the studies “resilience” is considered the “capacity of a socio-ecological system to absorb or withstand perturbations and other stressors such that the system remains within the same regime, essentially maintaining its structure and functions”. This concept is attributed to C.S. Holling in his 1973 paper titled "*Resilience and stability of ecological systems*" (Holling, 1973), although it has been further developed and refined by other researchers describing to which extent the system is capable of self-organisation, learning and evolution (Holling, 1973; Gunderson & Holling (2002).

Specific nuances are found though among the different approaches of socio-ecological “resilience”. One of them in Kuwae & Crooks (2021) highlights systemic thinking as a core requirement for resilience communities, in order to consider the built and natural elements of the landscape together as an infrastructure. This collective attribute in the communities (linked to a concrete systemic mindset) is complemented by Miller-Hesed et al. (2020) who link “resilience” with proactiveness of a certain social system in the face of a crisis/disturbance. In addition, other authors incorporate in the definition the individual capacity of managers to “be flexible, adaptive, and experimental at scales compatible with the scales of critical ecosystem functions” (Holling, 1996).

Interestingly, some authors like Chapin et al. (2009) and Berkes (2011) consider that the socio-ecological system can be used as a unit of analysis, with the assumption that the delineation between social and ecological systems is artificial and arbitrary.

As indicated above, according to our results, there is a majority agreement about the need to consider coastal resilience as an integrated concept including both human and natural systems, in a combined way. As a matter of fact, from all the literary references reviewed that include a definition of resilience, the few studies (4 out of 24) that refer to the highest level of stakeholder involvement, which is empowerment, consider resilience from a socio-ecological point of view.

In the Annex 3, an overview and summary of the definitions included in the literature review can be found, classified in the three perspectives upon which resilience is considered: ecological, social and socio-ecological.

5.3. (Objective 1) Nexus between NbSs and coastal challenges and resilience

5.3.1. Nature-based Solution approaches

The prevailing NbS approaches in NbS studies (N=199) encompass 'ecosystem-based adaptation' (EbA) (36%; N=72), followed by 'ecosystem-based management' (EbM) (27%; N=53) and ‘ecological restoration’ (23% = 45) (Figure 17A). Other types of NbS approaches were also prominent (24%; N=52; Figure 17A), and often co-occurred in combination with the preceding more typical approaches. These include marine protected area management (e.g., Roberts et al., 2017) and wetland restoration (e.g., Bousquin & Hychka, 2019) categorised under 'conservation' approaches (26%; N=14); nature-positive design (e.g., Thomson et al., 2022), sustainable land-use planning (e.g., Kim et al., 2017), and planned retreat (e.g., Rocle & Salles, 2018) grouped as 'planning' approaches (6%; N=12); green stormwater infrastructure (e.g., Beery, 2018) identified within 'infrastructure' approaches (7%; N=14); ecosystem-based climate policy (e.g., Wustemann et al., 2017) classified within 'decision-making/policy' approaches (5%; N=10); and finally, combined (multi-approach) strategies (2%; N=3; Figure 17B).

Approaches like EbM (46 from 53 studies) and ‘climate adaptation services’ (24 from 27 studies) were relatively more addressed in the literature encompassing both NbSs and empowerment (N=132) (Figure 17A).

Figure 17. (A)

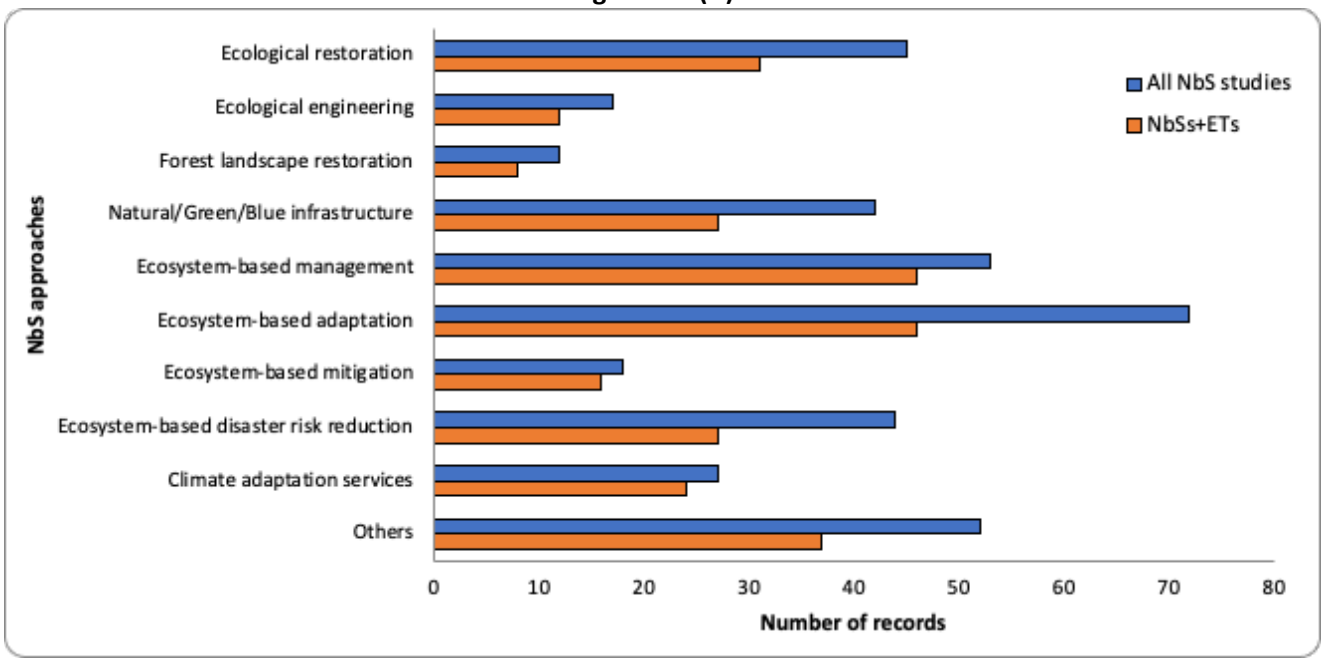


Figure 17. (B)

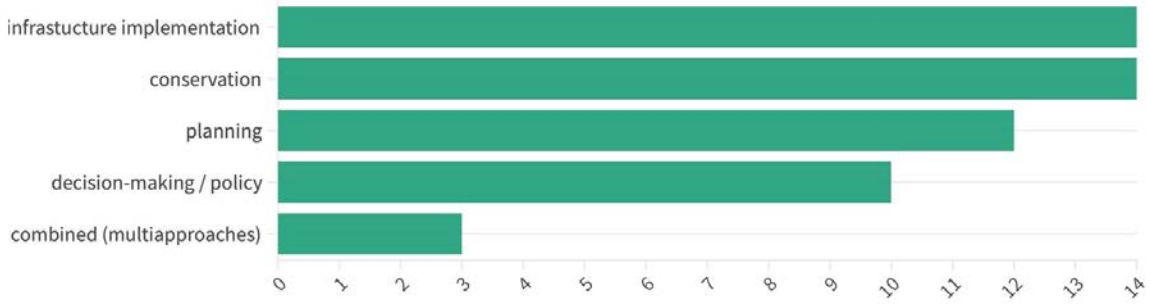


Figure 17. (A) Number of studies reporting different NbS approaches for the NbS literature (N=199) and for NbS+empowerment literature (N=132). **(B)** Other categories included as NbS approaches.

Box 3. Sustainable Land-Use Planning to Improve the Coastal Resilience of the Social-Ecological Landscape (SEL) (Kim et al., 2017)

"Development activities in coastal regions (e.g., urbanisation and tourism development) can lead to dramatic land-use changes, which can accelerate the decrease in coastal resilience and ultimately destroy a coastal social-ecological landscape (SEL) (Klein et al., 1998). For example, most coastal forests were artificially created to protect social landscapes from sandstorms, including residential and agricultural areas; in other words, the use of coastal forests can negatively affect the size of coastal dunes and coastal grasslands (Leet et al., 2010). If coastal dunes increase extremely high wind stress, the coastal forest will be destroyed, decreasing its area (Navarro-Ponts et al., 2016). However, the coastal dunes in Korea are gradually decreasing in area, and they must be protected (Seok et al., 2015) (…). Moreover, coastal dunes not only create a SEL but also protect a unique social landscape(…). As the prevalence of land-use changes, frequent conflicts can arise among residents, local governments, and associated governmental departments over the protection of the ecological landscape (Stepanova, 2015). To alleviate these conflicts, the use of coastal dunes, coastal forests, and coastal grasslands has been progressively managed and planned as components of the ecological landscape, because a decision maker cannot mediate differences among stakeholders regarding the best approach to land-use in coastal regions. Such a phenomenon can lead to imbalances in the coastal SEL, thus integrated planning and management are necessary to protect and stabilise the ecological landscape. This approach can be achieved by Sustainable Land-Use Planning and play an important role in improving coastal resilience" (Kim et al., 2017).

5.3.2. Societal challenges addressed by NbSs

The identified NbS studies (N=199) addressed the following global societal challenges (after IUCN, 2016) more often: 'climate change adaptation/mitigation' (65%; N=129; Figure 18).), followed by 'disaster risk reduction', 'environmental degradation and biodiversity loss' (49%; N=98 each), and 'economic and social development' (32%; N=64; Figure 18). Social and human-related challenges were more predominantly tackled by a using a combination of NbSs and ETs (N=132), such as in the case of socio-environmental justice (29 out of 30 papers), human health (22 out of 24) and economic and social development (57 out of 64) (Figure 18). This indicates that more studies are currently monitoring the impact of NbSs on under-researched topics that contribute hugely to the quality of life in society. For instance, Pinkerton et al (2019) argue that an EbM approach can contribute to increasing social justice by empowering indigenous communities through more effective fisheries management. Spalding et al (2014) find that EbA approaches (such as wetland restoration) can protect vulnerable communities from increasing coastal climate risks.

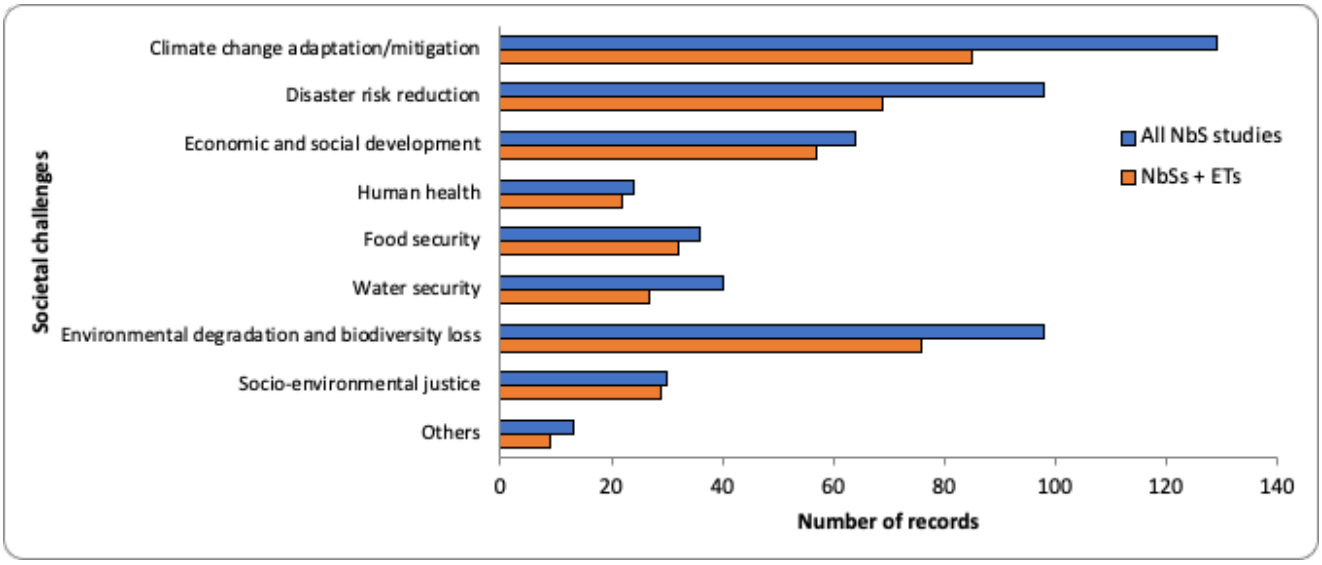


Figure 18. Prevailing global societal challenges addressed in the reviewed NbS (N=199) and NbS+Empowerment studies (N=132).

5.3.3. Level of stakeholder engagement achieved by NbSs and direction of governance process

More than half of the reviewed NbS studies (54%; N=107) provided no evidence of engagement processes initiated with communities and/or stakeholders. In the smaller fraction of case studies referring the application of engagement methods or reporting evidence of these processes, the majority only achieved the lowest levels of stakeholder engagement, which are 'inform' (26%; N=51; Figure 19), 'consult' (26%; N=51) and/or 'involve' (24%; N=48; Figure 19) people. For example, Rendon et al. (2020) found that citizens in Wales, UK were involved in decisions about EbA measures for coastal protection.

On the other hand, fewer studies reported people being engaged to 'collaborate' (19%; N=37), while even less reported evidence of the 'empower' level (12%; N=24, Figure 19). In addition, almost all NbS studies providing evidence of engagement processes, applied participatory or empowering approaches in conjunction; particularly those reaching the highest two levels ('collaborate' and 'empower'), as well as 'inform' level (Figure 19).

In addition, evidence of co-creation was revealed in only 41 NbS studies (21%), from which 40 co-demonstrated the application of ETs. Robinson et al. (2020) demonstrated the effectiveness of Structured Decision Making in facilitating EbM for range extending species like the long-spined sea urchin (*Centrostephanus rodgersii*) in Australia. This co-creation approach involved engaging stakeholders at all levels, including the empowerment level, guiding them through each step towards implementing management strategies, and fostering collective learning.

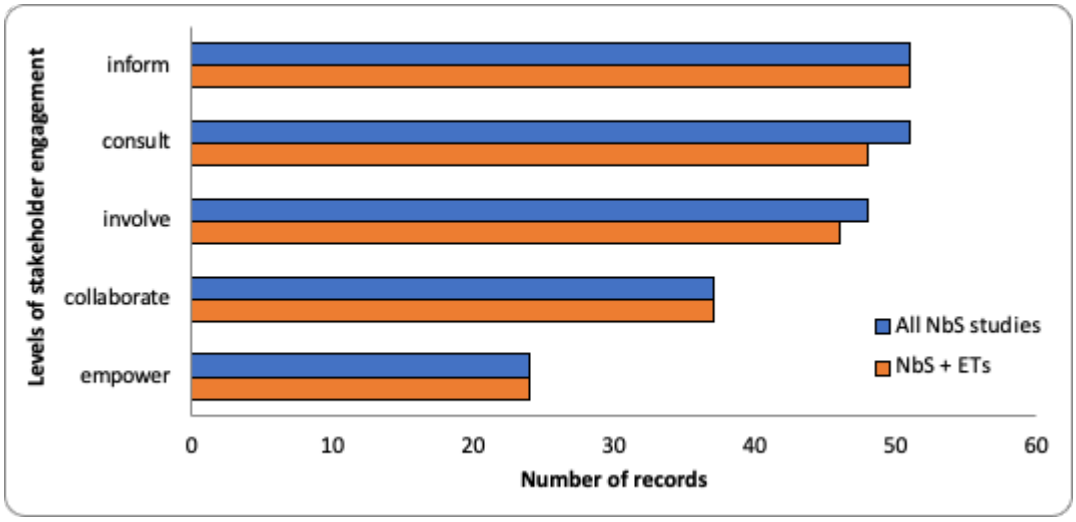


Figure 19. Levels of stakeholder engagement achieved in the reviewed NbS (N=199) and NbS+Empowerment literature (N=132).

In regard to the directions of the governance process addressed in the reviewed NbSs records, many studies provided no evidence or no information on the directional governance mechanisms at place (34%; N=67; Figure 20). Among those studies reporting governance processes (66%; N=132), most utilised a top-down direction (35%; N=70); while both directions (top-down and bottom-up) (23%; n=46) and a bottom-up direction (8%; N=16) were less prevalent amongst records (Figure 20). Ramalho et al. (2022) studied the relevance of NbSs in local climate adaptation strategies by surveying all municipalities across Portugal, and found evidence that NbSs are increasingly implemented through top-down approaches. Conversely, Mollmann et al. (2014) adopted a bottom-up approach in their study, in which expert knowledge was leveraged and stakeholders participated in the design of ecosystem-based fisheries management strategies, aiming to transition from single-species to integrated ecosystem assessments, ultimately providing valuable advice for managing Baltic Sea fish stocks.

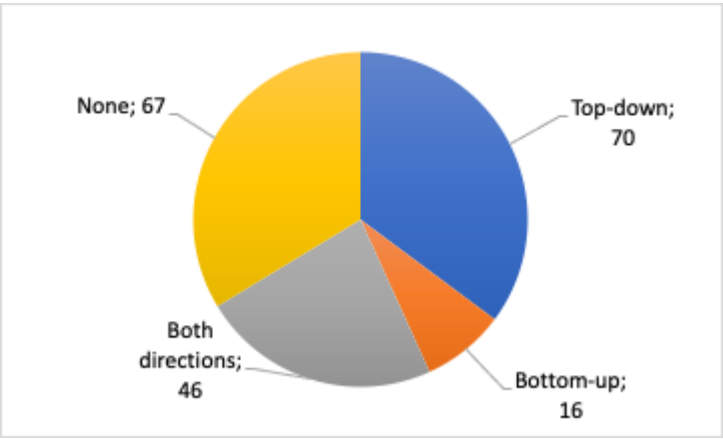


Figure 20. Proportion of papers focusing on NbS studies (N=199) in relation to the directions of governance processes addressed in the NbS process.

5.3.4. NbS project cycle stages' focus

Most reviewed studies focusing on NbSs reported evidence of the project cycle stages in which the NbSs process was occurring (68%; N=136). Most studies focused on the design/planning stage of the NbSs project cycle (33%; N=65), followed by the evaluation stage (25%; N=50; Figure 21). Only few records reported to NbSs implementation (4%; N=8; Figure 21). For example, Kiddle et al. (2021) reviewed how urban design agendas linked ecosystem services, NbSs, traditional ecological knowledge and wellbeing for more effective designing of NbS projects in New Zealand and other Pacific islands.

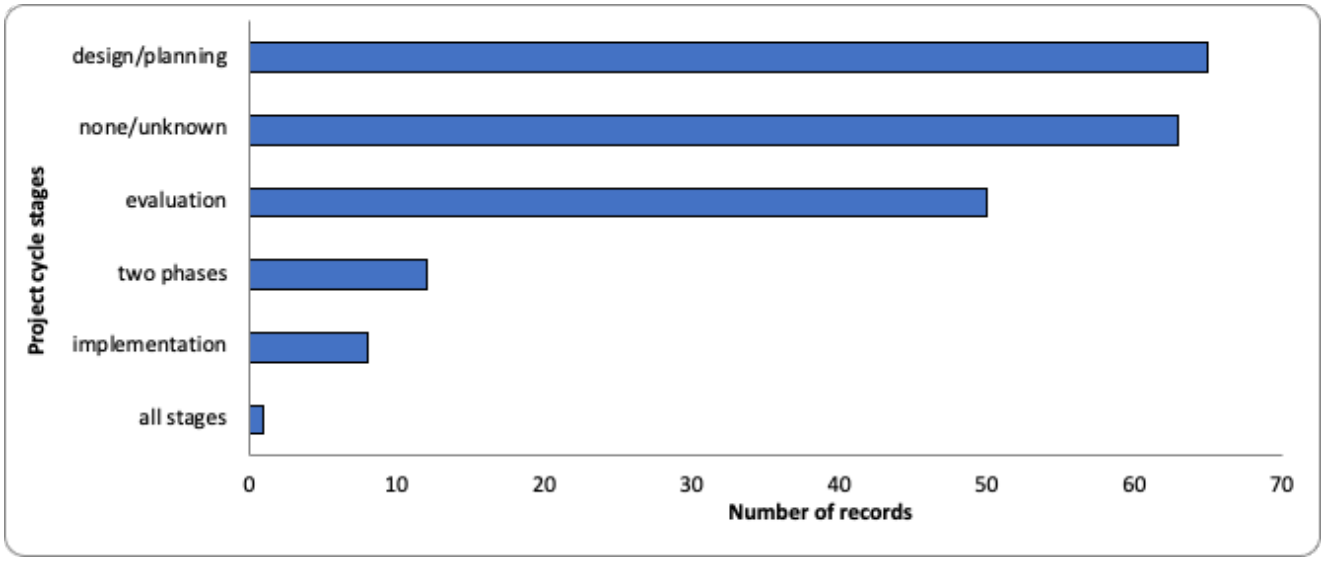


Figure 21. Stages of the project cycle addressed by NbS reviewed studies (N=199).

5.3.5. From scientific knowledge to praxis: coastal challenges addressed through NbSs

In the endeavour to bridge scientific knowledge with practical application, we analysed how the examined NbS case studies and their distinctive approaches might offer insights into addressing coastal challenges, expanding the challenges faced within EmpowerUs' Living Labs or TCLs (Refer to Section 2.1. Background, and Figure 1) to broader challenges faced by coastal communities. This aims to provide stakeholders with best practices and potential interventions to enhance resilience.

On average, among the 199 papers focused on NbSs, authors addressed on average 6.9 distinct coastal challenges. Notably, ecological and ecosystemic challenges took precedence, being the subject of discussion in the vast majority of papers (82%; N=164). Following closely behind were legal and regulatory challenges, identified in 126 studies (63%). Subsequently, issues pertaining to knowledge, well-being, and socio-cultural aspects were noted in 109 studies (55%). Lastly, socio-economic challenges were less frequently examined, appearing in only 84 records (42%) (Figure 21).

Regarding environmental/ecosystemic challenges, climate change (56%; N=112) and natural hazards (48%; N=95; Figure 21) emerged as the most prominent categories, with a predominant focus of NbS studies on bolstering resilience to climate change. Furthermore, challenges like habitat degradation (38%;

N=75), conservation (37%; N=73), and biodiversity loss (32%; N=63) garnered significant attention within NbS literature, while pollution (15%; N=30) and food production/security (15%; N=29; Figure 21) were the least explored.

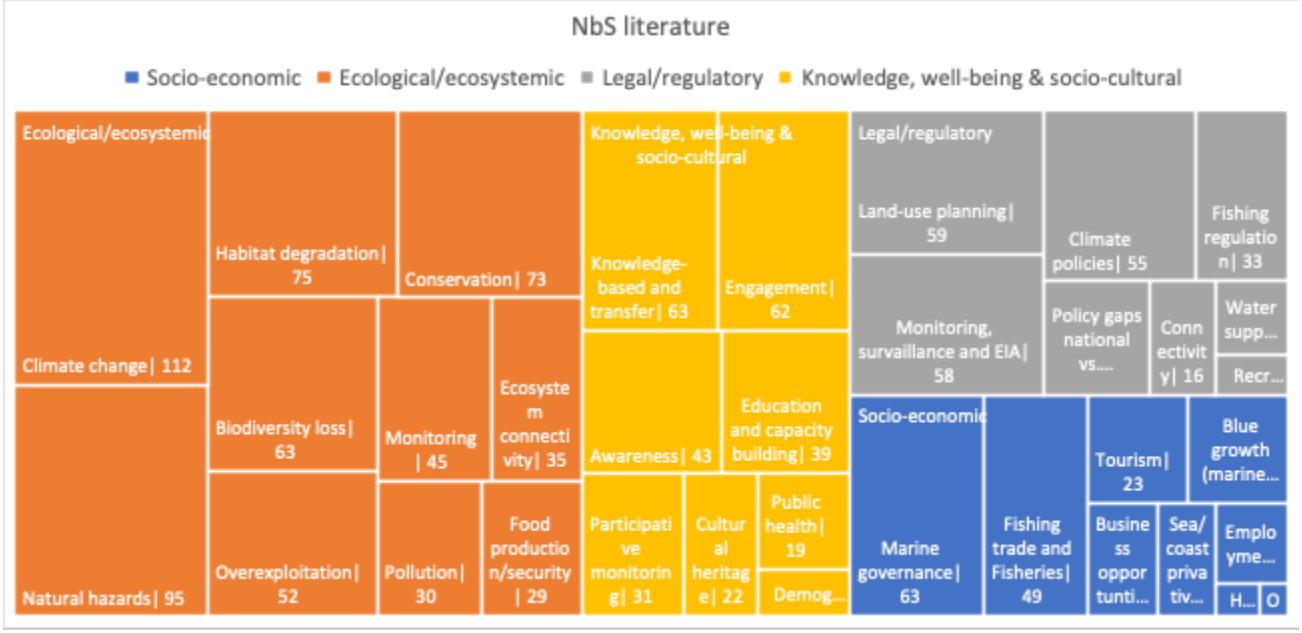


Figure 21. Relative contribution of NbS studies (N=199) focusing on coastal challenges relevant to coastal communities in Europe grouped in different domains.

In terms of socioeconomic challenges, our literature review revealed a predominant focus on marine governance (32%; N=63), fisheries and fishing trade (25%; N=49), tourism (12%; N=23), and blue growth/economy (12%; N=23; Figure 21). However, limited NbS studies addressed challenges like the housing crisis (2%; N=3) and outmigration (1%; N=2; Figure 21).

Furthermore, NbS studies delved into challenges within the 'knowledge, well-being, and culture' domain, including knowledge-transfer (32%; N=63), community engagement (31%; N=62), awareness raising (22%; N=43), and education and capacity building (20%; N=39; Figure 21). Conversely, topics like public health (10%; N=19) and demographics (5%; N=9) ranked lower (Figure 21). While some topics overlapped in studies (e.g., engagement and awareness raising were often addressed together), many articles had unique focuses (e.g., public health).

Upon examining the impact of NbS interventions on legal and regulatory challenges within coastal areas, it was observed that most studies pertained to land use planning (30%; N=59), monitoring, surveillance, or environmental impact assessment (EIA) (29%; N=58), and climate policies (28%; N=55; Figure 21). Conversely, regulatory challenges such as water supply (6%; N=11) and recreational boat (3%; N=6; Figure 21) policies received less attention.

5.3.6. How does NbSs contribute to resilience ?

The recognition of NbSs' role in contributing to socioeconomic, political, and environmental, and spatial resilience has been growing increasingly recently. However, the different dimensions and ways in which NbSs contribute to building resilience are not entirely understood. Our research finds examples that illustrate the different categories of resilience that NbSs contribute to:

1) Political Resilience: Political resilience refers to the capacity of a political system to endure and adapt to internal and external pressures while maintaining stability and functionality. A study by Cumming et al. (2016) found that the NbS coral reef restoration contributes to increased spatial resilience, encourages multi-level or polycentric governance approaches in the region, and supports community wellbeing. Political scientists argued that this is a window into larger scale change, triggered by changes in leadership encouraged through decentralised governance. France (2016) interviewed stakeholders on different types of NbSs, including rangeland restoration in Iceland, wetland restoration in the USA, forest and agricultural land restoration in Canada, and rainforest restoration in Australia. They found that hybrid governance models and effective stakeholder engagement were key to the successful implementation of these projects, thus also showcasing NbSs' role in decentralising authority by encouraging more bottom-up approaches.

2) Environmental Resilience: Environmental resilience refers to the ability of ecosystems to withstand and recover from disturbances, maintaining their essential functions and biodiversity. Examples from the literare are presented by Pryboutok et al. (2021) who found that NbSs offer protection to vulnerable communities against flooding along the Texas coast. Song et al. (2023) also share evidence of the role of nature-based restoration for reduction of flood risk in South Korea, as grey-engineering based solutions proved to be ineffective in the face of cyclones and typhoons. Mitchel and Bilkovic (2019) argued that dynamic shorelines (with marshes) support local biodiversity and make coastal regions resilient. Johnston et al. (2023) found evidence that dune restoration led to reduction in coastal erosion in the UK.

3) Spatial Resilience: Spatial resilience refers to the ability of a geographic area or system to absorb and recover from disturbances while maintaining its structure, function, and capacity for adaptation. A study by Tasopolou and Pozokidou (2021) based in western Greece found that blue-and-green infrastructure has contributed to increasing spatial resilience by encouraging multiple ecosystem services within the case-study territory, including connectivity, multifunctionality, planning, and networking. They argued NbSs can often enhance local decision-making processes, as well. Whelchel et al. (2018) found in their literature review that NbSs such as sustainable urban drainage systems (SUDS), bioswales, and green infrastructure support spatial dynamics in urban regions, making them more biodiverse, spongy, and carbon neutral.

4) Socioeconomic Resilience: Socio-economic resilience refers to the capacity of communities or societies to withstand and recover from socio-economic shocks or stresses, while maintaining or enhancing their well-being and adaptive capacities. Dutch researchers argue that EbA strategies can reduce vulnerability and encourage social innovation, thus supporting community wellbeing (Lebbe et al., 2021). Silva et al. (2017) found that green infrastructure in modern cities of Latin America reduced coastal risk, offered recreational and economic opportunities to local populations, thus increasing socioeconomic resilience. Soanes et al. argue that NbSs such as mangrove restoration protected vulnerable communities in the Caribbean from hurricanes and offered socioeconomic opportunities.

5.4 (Objective 2) Nexus between Empowerment and coastal challenges and resilience

Out of all 218 papers, 151 papers link to empowerment(69%). Out of these papers, 19 publications (9%) solely focus on empowerment without NbSs.

5.4.1. Coastal challenges addressed by the empowerment literature

The literature on empowerment intricately outlines the coastal challenges it tackles. On average, each study grapples with approximately 8.01 challenges. Notably, ecological and ecosystemic challenges emerge as dominant themes, featuring in a significant portion of studies (85%; N=128), garnering a total of 498 mentions (Figure 22). Challenges concerning knowledge, well-being, and culture—termed socio-cultural challenges—are prevalent in 68% of the studies (N=103), tallying 290 mentions (Figure 22). Following closely, legal and regulatory hurdles manifest in 65% of the records (N=98), with 221 mentions (Figure 22). Conversely, socio-economic challenges receive comparatively less attention, appearing in only half of the empowerment literature (N=76), with a total of 200 mentions (Figure 22).

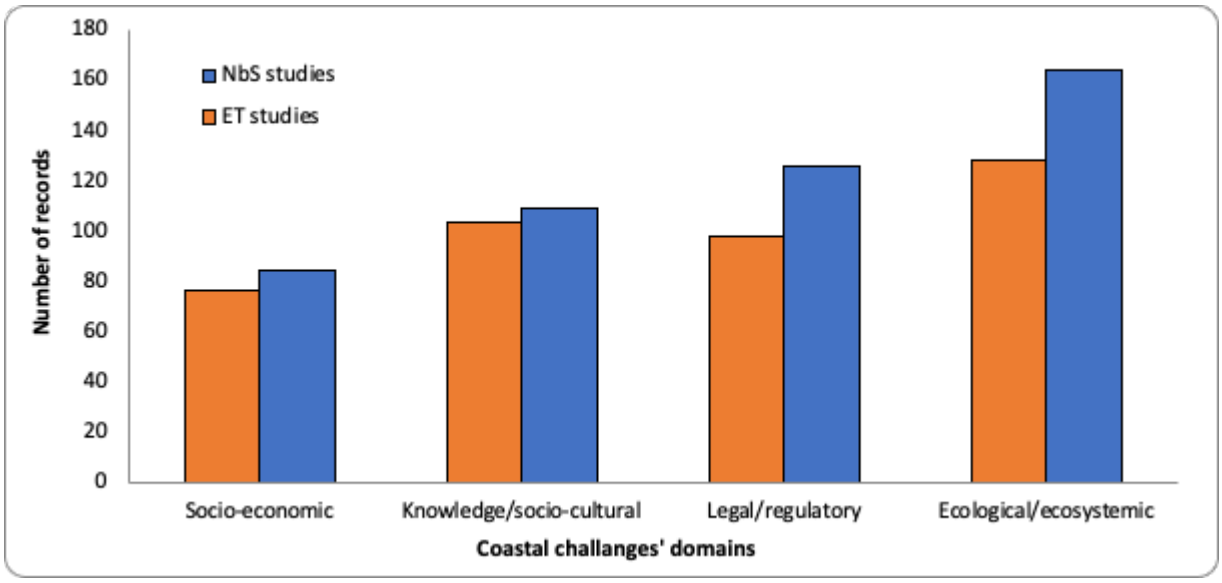


Figure 22. Numbers of studies related to NbSs (N=199) and Empowerment literature (N=151) addressing distinct coastal challenges grouped in different domains.

When comparing the coastal challenges addressed in the NbS literature to those in the empowerment literature, a distinct pattern emerges: the empowerment literature places a relatively stronger emphasis on interventions targeting socio-economic and socio-cultural challenges (as highlighted in Figure 23 above). For example, socio-cultural challenges such as engagement and awareness were notably more prevalent in the empowerment literature compared to NbS studies (Figure 23). Furthermore, it's noteworthy that nearly all NbS papers concentrating on marine governance and fisheries (both socio-economic challenges) also incorporated empowering approaches.

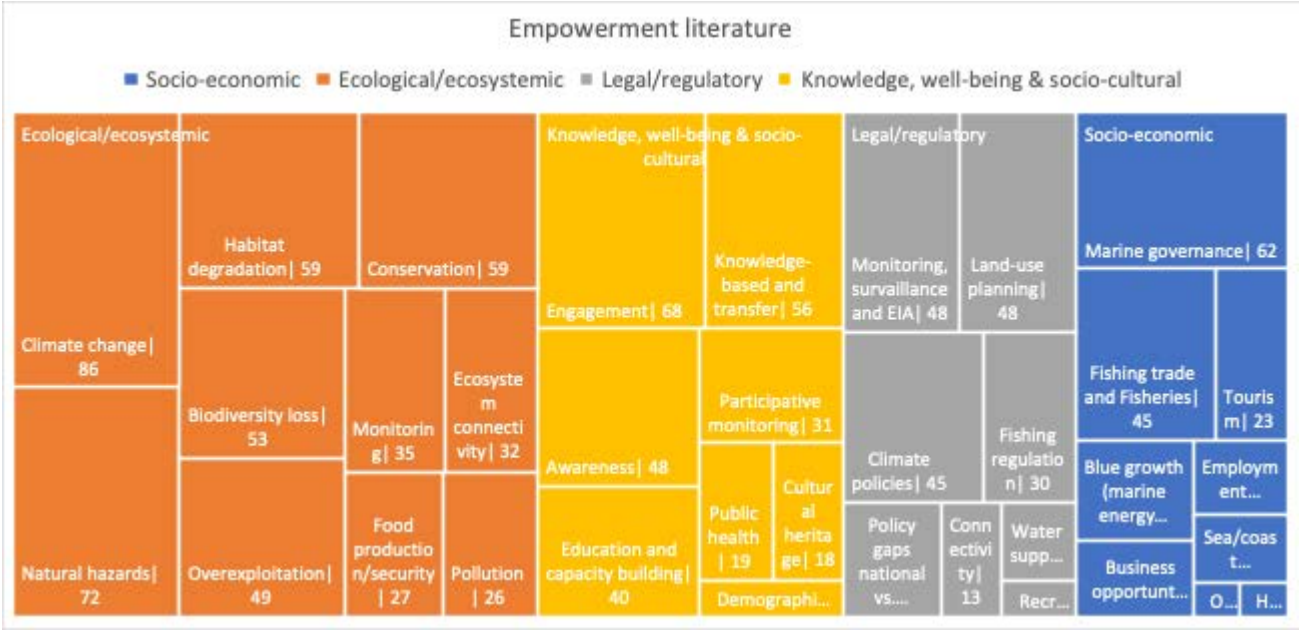


Figure 23. Relative contribution of empowerment studies (N=151) focusing on coastal challenges relevant to coastal communities in Europe categorised by domain (socio-economic, ecological, legal and knowledge, well-being and culture).

5.4.2. Scopes of action of empowerment tools

How are these challenges addressed in the Empowerment literature? The scopes of action give information on the nature of approaches taken in the literature relating to Empowerment (N=151). The majority of studies (57%; N=86) applied actions within the community scope, encompassing preference assessments and the implementation of local NbS interventions (Figure 24). Following closely were actions based on science and research, with 68 publications (45%), and actions rooted in the political sphere, with 58 publications (38%) (Figure 24). The latter category includes studies targeting policy impact, enhanced governance, or democratisation. Subsequently, actions based on resource management ranked fourth (31%; N=47), followed by actions focusing on socio-environmental justice (18%; N=27), economy-based actions (14%; N=21), actions geared toward public and/or environmental health (10%; N=15), and funding-related actions (7%; N=11) (Figure 24).

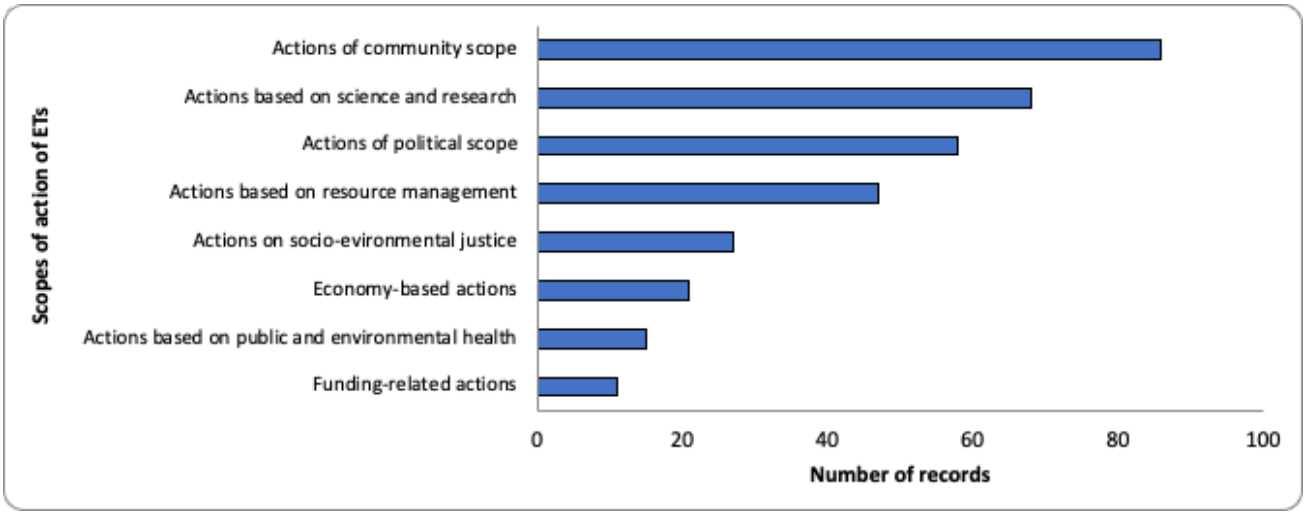


Figure 24. Number of studies related to Empowerment (N=151) reporting different scopes of action.

5.4.3. Level of stakeholder engagement addressed in the empowerment literature: relation to scopes of action

Engagement of stakeholders was analysed in all studies related to empowerment. Notably, all Empowerment literature scopes of action addressed the five levels of stakeholder engagement. Following the IAP2 classification (Bobbio, 2019), the majority of empowerment literature studies inform stakeholders (38%; N=58), thus providing them with relevant and balanced information to understand the research process, or consult them (38%; N=57), collecting stakeholder feedback and preferences on the process (Figure 25). With 36% (N=55), stakeholder involvement took place, meaning that researchers worked together with stakeholders to consider concerns and aspirations on the research process (Figure 25). Collaboration is taking place in only 25% (N=38) of all studies, reflecting little partnering with the public in each aspect of the decision-making, including the development of alternatives and the identification of preferred solutions (Figure 25). Empowerment, as from this literature review, the predominantly scientific efforts to build equal partnerships with stakeholders for undertaking the research designed for stakeholders and community needs, took place in 17% (N=26) of the analysed studies (Figure 25).

Notably, due to the recency of the concept of co-creation, not many studies were classified as applying a co-creation perspective (32%; N=47), whilst the term was not actively mentioned in the publication itself. Co-creation processes were predominantly evidenced in papers addressing funding-related actions (7 out of 11 studies), followed by actions of political scope (31 out of 58) and actions of community scope (42 out of 86).

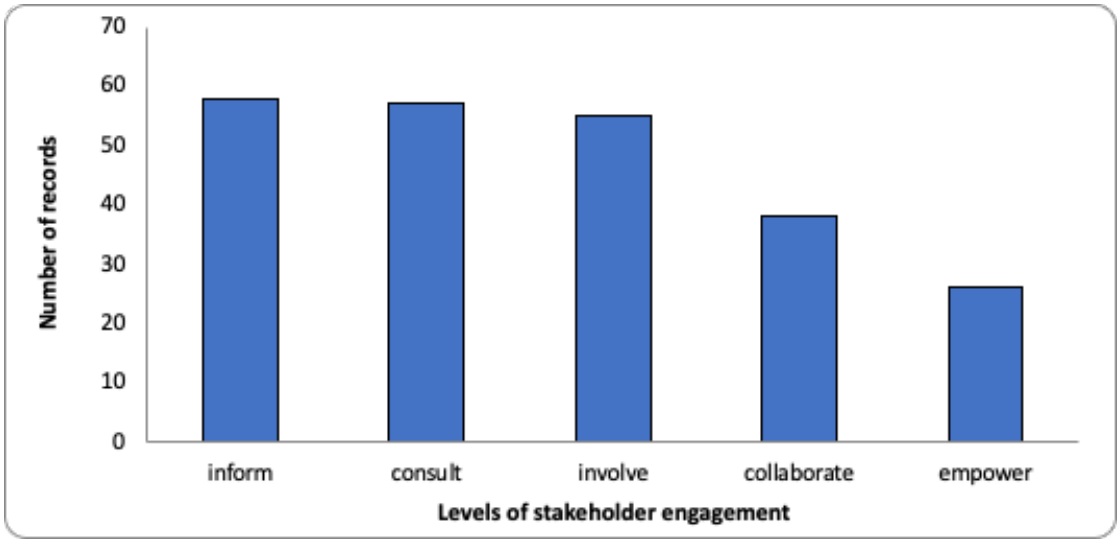


Figure 25. Levels of stakeholder engagement achieved in the reviewed empowerment literature (N=151).

5.4.3 Proposed classification of Empowerment Tools

Empowerment tools (ETs) encompass a diverse range of solutions, instruments, instructional sets, strategies, resources, or mechanisms crafted to enhance the self-efficacy, autonomy, and proactive engagement of individuals or communities in decision-making processes (Laverack & Wallerstein, 2001). It is important to distinguish ETs from participatory tools, which foster people's involvement and contribution to programs, potentially enhancing their capacities, skills, and competencies, but may not directly facilitate communities in acquiring more power through collective social and political action. Empowerment tools are designed to assist communities in undertaking specific actions to facilitate socio-ecological transitions and bolster resilience (Laverack & Wallerstein, 2001).

Based on the literature on empowerment, 6 distinct groups of ETs were clustered, which proved to be successful for enhancing socio-ecological resilience (Table 3; Figure 32 in Discussion).

a. **Education and awareness-raising tools** encompass methods and approaches to educate communities and raise general awareness on environmental, socio-ecological and socio-economic issues, allowing citizens to make informed decisions, informing communities in a timely manner matters.

- Actions to create awareness and information
- Actions to communicate science
- Actions to equip citizens with basic understanding needed to make decisions

Education and awareness-raising tools provide information on, for example, NbSs, projects and efforts to preserve nature (Jones et al., 2013; Bousquin & Hychka, 2019; De Klerck & Hoskins, 2019; Moraes et al. 2022). Education tools can enhance social learning, though for example engaging faith-based communities for rural coastal resilience in the US (Miller et al., 2020). Awareness raising approaches on the importance of healthy ecosystems and important ES supplied by nature also fall in this category. Here,

the example of Jones et al. (2013) showcases how the use of communication, education and awareness-raising to promote appreciation of marine ecosystems and benefits of MPAs throughout Europe.

b. **Knowledge tools** encompass methods and approaches directed at knowledge production to answer community or societal questions and needs, including stakeholder involvement and consultation in knowledge production processes in a timely manner.

    - Actions to create knowledge
    - Tools to answer specific questions and needs
    - Participative approaches and modes of knowledge production

    Knowledge tools were plentiful in the literature (Jones et al., 2013; Chchun et al., 2015; Hendricks et al., 2018; Lago et al., 2019; Charles et al., 2020; Molino et al., 2020; Queirós et al., 2021; Riera-Spiegelhalder et al., 2023; Robinson et al., 2023) and serve to enhance social learning, though for example engaging faith-based communities for rural coastal resilience in the US (Miller et al. 2020). Further, knowledge tools help to identify knowledge needs and research gaps for informed decision-making. Here, examples show how stakeholder defined scientific needs can help address coastal resilience decisions in the US (Molino et al., 2020). Similarly, preference assessments can identify needs and tradeoffs for different stakeholders, such as in the context for EbM (Chchun et al., 2015), conservation and blue growth (Queriós et al., 2021). Social learning through, for example stakeholder engagement, can help build the capacity of actors to mobilise knowledge and resources for action and encourage changing actors' relationships, understanding, values and norms (Lago et al., 2019). Their study shows how the application of knowledge tools for EbM was able to promote participation of society in policy design and research activities throughout the EU (Lago et al., 2019). Charles et al. (2020) present a typology of community sciences.

c. **Platform/Dialogue tools** encompass methods and approaches to foster new or strengthen existing modes of communication and networks, bringing together strategic alliances for enhanced community decision-making. Community participation often ranges from consultation to collaboration.

    - Actions to generate new modes of communication and interaction
    - Networking and group formation

    Platform/Dialogue tools can bring together stakeholders from different disciplines, e.g. through nature-based approaches with co-benefits for local microclimate like community gardens (Lin et al., 2018). Participatory approaches, such as participatory mapping or participant interviews can become tools to consider societal perceptions and values in NbS implementation whilst simultaneously engaging local communities in decisions about protecting natural and built-environment systems, as an example from northern Sweden shows (van Well et al., 2023). On a larger scale, Carcamo et al. (2014) show how collaboration and knowledge networks in coastal resource management can work towards multiple-use marine protected area implementation.

d. **Governance tools** encompass methods and approaches supporting new and transformative governance structures that ensure community empowerment through collaboration for just, equitable and democratic policy and decision-making, fostering bottom-up approaches and stakeholder and community collaboration and co-design.

- Actions to support a new governance structure that enables community empowerment
- Actions for equity, democratisation, environmental justice and policy targets
- Actions encouraging grassroot organisations, bottom-up approaches and new organisational structures including polycentric governance

Governance tools (Vasseur et al., 2022; deLorme et al., 2022; Gargiulo & Zucaro, 2023; Vuik et al., 2019) found many examples in the empowerment literature and proved to foster environmental justice and inclusion of Social and Gender Dimensions linked to coastal adaptation (Prakash et al. 2022), if used properly. Myers et al. (2012) highlight how stewardship can lead to enhanced adaptive capacity in the USA (Myers et al. 2012). Democratisation and public inclusion of EbA and planning (Vasseur et al. 2022) can improve acceptance of novel ecosystem-based planning measures. Community-based spatial mapping for the selection of Green Infrastructure Locations for enhanced flood resilience was applied in the US (Reckner & Tien, 2023).

e. **Co-Creation tools** encompass methods and approaches to create novel, transformative modes of collaboration and decision-making, creating new arenas for co-designed research and collaboration amongst stakeholders, communities, enterprises and science.

- Actions to create novel, transformative modes of collaboration and decision-making
- New, integrative forms of research support guiding community based interests

Co-creation tools are growing in the scientific literature, yet, few concise examples can be found. Tiwari et al. (2022) show how implementing LLs in urban coastal cities can build climate resilience, encompassing different participatory approaches. They combine education and awareness raising tools with building networks amongst urban planners about NbSs throughout Europe to integrate these into local policies and planning and including socio-economic well-being in climate adaptation policies (Tiwari et al., 2022).

f. **Community-led nature-based tools**, in the lens of empowerment tools, encompass environmental and nature-based actions that enhance resilience, whilst simultaneously fostering community collaboration and co-design, creating co-benefits from local to regional scale.

- Environmental actions for enhanced resilience with co-benefits for communities
- Actions of changing or preserving aspects of physical environment that increase community resilience and benefits for the environment

Community-led nature-based tools often imply enhancing community empowerment indirectly. In many studies, the co-benefits resulting from NbSs are rarely assessed, yet there is growing evidence on the social and economic outcomes of coastal NbS implementation (see Raymond et al., 2017; Roe et al., 2021; Paxton et al., 2023). Successful examples from the literature review draw upon community-led urban gardens (Lin et al., 2018) or community-led habitat restoration for iconic species (Thomson et al., 2022). Existing NbS Toolboxes, such as the URBiNat NbS Catalogue[7] argue that "*by combining physical and infrastructural solutions with social and economic practices the aim is to build collective awareness on commonalities, both material and immaterial, and contribute to a better understanding of human and non-human dimensions of our urban environments*" (URBiNat, 2024). Their catalogue of NbSs target co-

[7] https://urbinat.eu/nbs-catalogue/

design and co-creation perspectives for EbM, inspired by nature and with positive impact on human well-being. If embedded properly into governance structures, community-led nature-based approaches can be co-produced and co-designed (Hölscher et al., 2024). Additional instances of compendiums detailing nature-based intervention typologies and case studies, accompanied by demonstrated developmental benefits for indigenous communities including employment opportunities, food security, and empowerment, are available in Roe et al. (2021)[8] (see an example below in Table 3). This resource serves as a valuable reference for decision-makers seeking insights into potential investment avenues in nature-based initiatives with an empowerment focus.

Concise examples for the application of different ETs can be found on different levels and scales of implementation. It has to be noted that the level of stakeholder involvement in Table 3 are mere recommendations. Depending on the degree of participation within each approach, the actual involvement can vary.

[8] https://www.iied.org/sites/default/files/pdfs/2021-06/20206iied_4.pdf

Table 3. Empowerment Tools classified from the literature review on "Building coastal community resilience through NbSs and empowerment tools" based on their aims, methods, level of stakeholder engagement, and respective sources.

Empowerment Tool category	Method	Description	Level of stakeholder engagement	Sources
Education and awareness raising tools	Printed information	Provision of informative materials such as fact sheets, brochures, newsletters, media advertisements, letters, position papers, and press releases. The aim is to educate, stimulate interest, and elicit a response. This communication can be distributed via direct mail or electronically through e-newsletters, emails, or SMS.	inform	Bank of I.D.E.A.S (2020)
Education and awareness raising tools	Media Initiatives	Utilises media channels for either paid advertising or editorial content, facilitating information dissemination and feedback collection through methods such as clip-out coupons. Securing free media involves distributing news releases or obtaining interview opportunities across print, radio, or television platforms.	inform	Bank of I.D.E.A.S (2020)
Education and awareness raising tools	Displays	A community action to share project details and increase awareness of specific issues. Interactive displays can enhance commitment and can accompany forums, workshops, exhibitions, conferences, or similar gatherings. Static displays can be set up in various locations like parks, hiking areas, urban centres, council offices, libraries, community centres, etc.	inform	Bank of I.D.E.A.S (2020)
Education and awareness raising tools	Science Cafe/ World Café	Aims to establish a secure and inclusive setting where various ideas and viewpoints on a topic can be deliberately interlinked through multiple rounds of small-group discussions. The World Café method proves beneficial when seeking to explore a topic comprehensively from diverse angles, ensuring active participation from all individuals present, and fostering the formation of new connections among participants. Additionally, it can serve as an effective tool for gathering insights from community-level grantees and beneficiaries.	consult/ involve	https://www.fsg.org/wp-content/uploads/2021/08/World-Cafe-Method_0.pdf
Education and awareness raising tools	Open Days/ Information Sessions	This entails setting up displays, providing printed materials, and having project team members available at a central location to address questions or engage in discussions in a relaxed	inform/ consult	Bank of I.D.E.A.S (2020)

		setting. It offers a casual opportunity for the public to stop by at their convenience, gather information, and engage in conversation.		
Knowledge tools	Interviews	Entail discussions with stakeholders on various themes, such as homes, workplaces, or community venues, to gather insights on project or community-related issues. For instance, door-to-door visits to businesses along a street can gather personal or expert opinions.	consult	Bank of I.D.E.A.S (2020)
Knowledge tools	(Semi) Structured Interviews	Entails crafting a questionnaire to initiate dialogue with interviewees, thereby prompting detailed information and facilitating elaboration on their responses with open or closed questions.	consult/ involve	
Knowledge tools	Narrative assessment	Involve the qualitative evaluation of individuals' stories, life narratives, or personal accounts to gain insights into their experiences, beliefs, and perspectives. This method often involves analysing the structure, themes, and language used in narratives to uncover underlying meanings and patterns. Narrative assessments are commonly employed in fields such as psychology, sociology, and education to understand identity formation, emotional experiences, and cultural contexts. By examining narratives, researchers and practitioners can gain a deeper understanding of individuals' lives and experiences, which can inform interventions, cultural dimensions etc.	consult	Neimeyer & Levitt (2003) available on http://www.pcp-net.org/encyclopaedia/assess-narr.html
Knowledge tools	Preference Assessments	Involve evaluating the choices, priorities, and preferences of individuals or groups regarding various options, often related to goods, services, or policies. In the context of environmental sciences, preference assessments are used to understand stakeholder preferences for ecosystem services, land-use practices, conservation strategies, or environmental policies. These assessments can employ various methods such as surveys, interviews, workshops, or experimental designs to elicit and analyse preferences. The results help inform decision-making processes by identifying preferred options and understanding trade-offs among different choices.	consult	https://oppla.eu/sites/default/files/uploads/methodfactsheetpreference-assessment.pdf
Knowledge tools	Stakeholder- based Problem Analysis	Approach used to identify, analyse, and understand complex issues or challenges by actively involving stakeholders who are affected by or have knowledge about the problem. This method encourages collaboration, dialogue, and the exchange of perspectives to gain a comprehensive understanding of the problem from various viewpoints. Participatory problem	involve/ consult	Van Rooien et al. (2021)

		analysis aims to involve stakeholders, promote transparency, and facilitate the development of effective solutions that address the root causes of the problem while taking into account diverse interests and concerns.		
Knowledge tools	Surveys / Questionnaires	Method of collecting data, wherein participants are invited to share their experiences or opinions via structured questionnaires. These questionnaires can be administered through mail, face-to-face interviews, telephone interviews, or increasingly, online platforms. Online surveys may take the form of open communities, facilitating discussions on web pages. Surveying methods can include blanket, random, or targeted distribution. Questionnaires ensure consistency by presenting identical questions to each respondent, enhancing the reliability of the gathered results	involve/ consult	Bank of I.D.E.A.S (2020)
Knowledge tools	(Online) Participatory Mapping	Participatory mapping refers to the collaborative development of maps based on local knowledge and perception. This method can integrate modern cartography tools combined with participatory techniques to map complex spatial phenomena. For example, individuals are invited to identify or mark locations t on a provided map in order to improve capabilities of communities and people to use this knowledge.	engage	
Knowledge tools	Behavioural Mapping/ Mobility Map	Method for gaining an understanding of movement patterns for an individual, a group, or a community. A mobility map provides insights into where people go, for what reason, how frequent, how far the travel is. When developing such a map, gender awareness and sensitivity can be improved by identifying the differences in mobility patterns between the sexes. A good grasp of mobility patterns enhances project planning efforts, as the impact of interventions are more easily anticipated and evaluated	consult/ involve	Flanagan, 2015 https://www.echocommunity.org/resources/53f99bb6-f532-4606-8229-0327c16dbd3c; https://urbinat.eu/nbs/behavioural-mapping/
Knowledge tools	Citizen/ Community Sciences	At the heart of the scientific process, it can be more narrowly understood as people, who are not professional scientists, taking part in research, i.e. co-producing scientific knowledge. This involves collaborations between the public and researchers/institutes but also engages governments and funding agencies. Participation can range from the short-term collection of data to the intensive use of leisure time to delve deeper into a research topic together with	engage	OECD (2017); *Green Paper Citizen Science Strategy 2020 for Germany* (2016)

		scientists and/or other volunteers, to ask questions, and to get involved in some or all phases of the research process.		
Knowledge tools	Workshop	"A period of discussion and practical work on a particular subject, in which a group of people share their knowledge and experience", intended to foster collaboration towards a collective outcome, such as compiling lists of issues, exploring various options, or establishing a consensus on a plan of action. Workshops effectively bring together stakeholders with diverse values, proving most beneficial when addressing specific issues and seeking solutions. The outputs of workshops may include jointly developed reports, opinions, suggestions, or plans endorsed by all participants regarding a given issue or proposal.	involve/ engage	Oxford Dictionary (2024)
Knowledge tools	Social Learning	Refers to the process by which individuals, communities, and organisations acquire knowledge, values, and skills related to environmental issues through interactions with others and their environment. It involves collaborative efforts, shared experiences, and dialogue among stakeholders to understand complex environmental problems, develop solutions, and adapt to change. Social learning emphasises the importance of communication, cooperation, and collective action in addressing environmental challenges effectively.	collaborate	Bandura (1977)
Knowledge tools	Socio-ecological Timeline	Participatory method that maps the social and ecological history of a specific area, focusing on significant events and tipping points identified by local stakeholders. Approach to document perceived changes in sense of place, tracing events and adaptation measures from a given past to the present. These timelines serve as empowerment tools, combining local knowledge with scientific insights to support adaptive capacity and self-governance in coastal communities.	engage/ collaborate	Brattland et al. (2019)
Knowledge tools	Public Hearings	Open gatherings designed to involve a broad audience in sharing information and fostering dialogue. They serve to raise awareness about specific issues or proposals and can serve as initial or ongoing platforms for public engagement. Typically, these meetings feature presentations followed by discussions and opportunities for questions.	involve	Bank of I.D.E.A.S (2020)
Platform/ Dialogue tools	Participatory Stakeholder Analysis	Participatory stakeholder analysis may begin with secondary data examination (desk study); however, to effectively discern interests and strategize for subsequent engagement, direct collaboration with key stakeholder groups is essential. Utilising workshop-based or field-based approaches, primary data can be gathered, facilitating brainstorming sessions with	involve	African Development Bank (2001)

		stakeholders to identify their interests and expectations while jointly planning participation strategies throughout the project lifecycle.		
Platform/ Dialogue tools	Focus Groups	Describes an organised group discussion format, where focus groups are utilised to gather insights on specific topics or issues. Led by a facilitator, this 'group interview' engages a small group of individuals (5-12 persons) to capture a wide range of perspectives. These sessions aim to elicit opinions, generate ideas, and typically begin with broad discussions before narrowing down to specific questions or points of interest.	involve/ engage	Bank of I.D.E.A.S (2020)
Platform/ Dialogue tools	Participatory Mapping	Participatory mapping refers to the collaborative development of maps based on local knowledge and perception. This method can integrate modern cartography tools combined with participatory techniques to map complex spatial phenomena. For example, individuals are invited to identify or mark locations t on a provided map in order to improve capabilities of communities and people to use this knowledge.	involve/ engage	
Platform/ Dialogue tools	PGIS	Participatory mapping refers to the collaborative development of maps based on local knowledge and perception. PGIS integrates modern geospatial information systems (GIS) with participatory techniques to map complex spatial phenomena. For example, individuals are invited to identify or mark locations t on a provided map in order to improve capabilities of communities and people to use this knowledge.	involve/ engage	Schuurman (2009)
Platform/ Dialogue tools	PPGIS	Participatory mapping refers to the collaborative development of maps based on local knowledge and perception. Public PGIS integrates modern geospatial information systems (GIS) with participatory techniques but emphasises the local level to promote knowledge production by local and nongovernmental groups.	involve/ engage	
Platform/ Dialogue tools	Joint Fact Finding	Specialised consultative public engagement strategy utilised by decision makers to address contentious factual disputes surrounding environmental, energy, public health, and social policy issues. JFF establishes a secure environment for technical discussions among stakeholders, facilitating a deeper understanding of the substantive issues while minimising unnecessary friction and contention. By jointly developing findings, JFF produces outcomes that are more credible, useful, and enduring. If applied for policy and decision-making, it could become a governance tool.	involve/ collaborate	Adler (2017) available on https://mediate.com/a-users-guide-to-joint-fact-finding-jff/

Governance tools	Citizen Panels	This entails establishing a local reference group composed of community members chosen for their expertise or keen interest in a particular topic. These groups are typically created with a defined purpose and mandate to offer comprehensive input and advice, often over an extended period, in contrast to focus groups. Ideally, these groups should consist of fewer than 12 members	collaborate	Bank of I.D.E.A.S (2020)
Governance tools	Participatory spatial planning	An approach to spatial planning that actively involves stakeholders, including community members, in the decision-making process regarding the organisation and management of land use and development within a specific geographic area. This method emphasises collaboration, dialogue, and the incorporation of local knowledge and perspectives to ensure that planning decisions reflect the needs, aspirations, and values of the communities affected. Participatory spatial planning aims to promote transparency, equity, and social inclusion in the planning process, ultimately leading to more sustainable and effective spatial arrangements.	engage/ collaborate	Nadin et al. (2021)
Governance tools	Stewardship building	Stewardship refers to the values and actions of individuals, communities, corporations, and government organisations aimed at promoting collective rather than individualistic interests. It encompasses efforts to reduce vulnerability to anticipated changes, enhance resilience in the face of disturbances and uncertainties, and transition from undesirable trajectories when opportunities arise. In the context of sustainability, stewardship involves identifying practical strategies, enhanced education and strong leadership to maximise social benefits, mitigate social-ecological sensitivities to climate change impacts, and enhance stewardship potential.	collaborate/ co-design	Myers et al. (2019)
Governance tools	Polycentric governance	A flexible framework for analysing decision-making structures across various contexts, without being confined to federal, market, or network-based systems. This approach enables an in-depth examination of Germany's diverse decision-making landscape, which varies significantly among federal states in terms of levels, types, and multiplicity of actors and decision-making authority, as well as approaches to public participation. Within polycentric governance systems, where participatory processes are embedded, a multitude of participatory approaches are expected to emerge, reflecting the autonomy of decision-making centres and the diverse visions of stakeholders. While participation may not be tightly regulated, the decentralised nature of decision-making allows actors to actively shape processes according to their preferences. Nonetheless, organisers are anticipated to provide opportunities for	co-design	Blomquist & Schröder (2019); Journal Schröder & Watson (2024).

		participant involvement in decision-making, with the potential for these processes to culminate in joint decision-making outcomes.		
Governance tools	Participatory scenario planning	Collaborative approach to decision-making that involves stakeholders in crafting and evaluating potential future scenarios. It aims to raise awareness, guide policy, and aid decision-making under uncertainty by tailoring scenarios to specific needs through inclusive engagement. This method ensures relevant, credible outcomes through a process that involves discussing methods, tailoring approaches, organising workshops, and evaluating results in collaboration with stakeholders. Depending on the level of Stakeholder involvement, higher levels of empowerment can be achieved.	involve/ engage	https://oppla.eu/product/17608
Co-Creation tools	Living Labs	Open innovation ecosystems in real-life environments using iterative feedback processes throughout a lifecycle approach of an innovation to create sustainable impact. Living Labs act as intermediaries/orchestrators among citizens, research organisations, companies and government agencies/levels.	co-design	EnoLL (2019)
Co-Creation tools	Ownership building	Ownership in participatory approaches refers to the state or right of possessing something, which can enhance creativity, practice, and knowledge production by fostering a sense of belonging among co-creators. It is not limited to tangible outcomes but extends to intangible aspects such as the development of ideas or applications. Recognized as a crucial yet often overlooked aspect of co-creation, ownership can be facilitated by branding the group of co-creators and affirming equal standing among them, fostering empowerment and perceived control throughout the process	co-design	Oxford Dictionary (2010); Leask et al. (2019)
Co-Creation tools	Participatory Study Design	involves collaborative research designs, methods, and frameworks conducted directly with those affected by the studied issue to drive action or change. It engages individuals or groups who may lack formal research training but represent the interests of the research focus. Participatory study design emphasises participatory, democratic methods, valuing genuine involvement in the research process.	co-design	Vaughn & Jacquez (2020)

Co-Creation tools	Community-based participatory research (CBPR)	An orientation to research often focused on health-related issues that equitably involves all partners, including researchers and community members, in all phases of the research process, from study design to dissemination.	co-design	https://jprm.scholasticahq.com/article/13244-participatory-research-methods-choice-points-in-the-research-process?attachment_id=36974
Community-led Nature-based approaches	Community Gardens	"Open spaces which are managed and operated by members of the local community in which food or flowers are cultivated" (Guitart et al., 2012, p. 364). Community gardens can be understood as a land-based ongoing practice, which is a bridging process among teaching, learning, and policy-makers in the field of Socio-ecological environments. Community gardening not only fosters outcomes for individuals, but also for the larger social-ecological system, with co-benefits such as urban cooling, enhanced air quality, pollination or food production.	co-design	Guitart et al. (2012); Datta (2016)
Community-led Nature-based approaches	Community-led Habitat Restoration	Community-based habitat restoration entails collaborative endeavours within local communities to rehabilitate degraded ecosystems. By engaging residents, it not only aims to address environmental degradation but also promotes social cohesion, empowerment, and a sense of stewardship among community members. A participatory approach fosters a deeper connection between people and their natural surroundings, leading to more sustainable and resilient ecosystems.	co-design	IUCN (2021); Thomson et al. (2023)
Community-led Nature-based approaches	Adaptive coastal design	Involves integrating green infrastructure (GI), best management practices (BMP) and low-impact development (LID) strategies within urban flood-adaptive design, such as green spaces, permeable surfaces, and vegetation, to mitigate climate-related impacts of sea level rise and flooding. The approach emphasises engaging and empowering local communities throughout the planning and design process to ensure that projects reflect the needs and preferences of residents.	co-design	Huber et al. (2017)
Community-led Nature-based approaches	Nature-based food production	Harnessing nature in nature-based food production systems, such as ecosystem-based seaweed harvesting, often enhances food security; though sometimes food production exceeds subsistence needs, generating surpluses for sale and thus benefiting local economies.	co-design	Roe et al. (2021)

		Investments in harnessing nature also often report benefits for rights, equality and empowerment. Such interventions may revive traditional knowledge, or involve capacity building, acquiring new skills and building knowledge-sharing platforms.		

5.5 (Objective 3) Links between NbSs and Empowerment literature and empowerment outcomes

The studies considering both NbSs and ETs in coastal communities are quite representative, reaching a total of 61% of the papers reviewed (132 out of 218).

5.5.1. Combinations of NbS approaches and empowerment scopes of action employed

All combinations of NbS approaches and Empowerment literature scopes of action were utilised in studies focusing on both NbS and empowerment literature, except for 'ecological engineering' and 'forest landscape restoration', which did not incorporate economy-based actions. Moreover, 'ecological engineering' also omitted actions based on public and environmental health (Figure 26).

More prevalent combinations were observed between actions based on science and research and EbM (21%; N=28), EbA (19%; N=25), and ecological restoration (14%; N=18) (Figure 26). Similarly, frequent pairings included actions based on resource management and EbA (20%; N=26), EbM (16%; N=21), and ecological restoration (14%; N=19), as well as actions of community scope and EbA (19%; N=25), EbM (16%; N=21), and ecological restoration (14%; N=19). Actions of political scope predominantly aligned with EbA approaches (14%; N=19) (Figure 26).

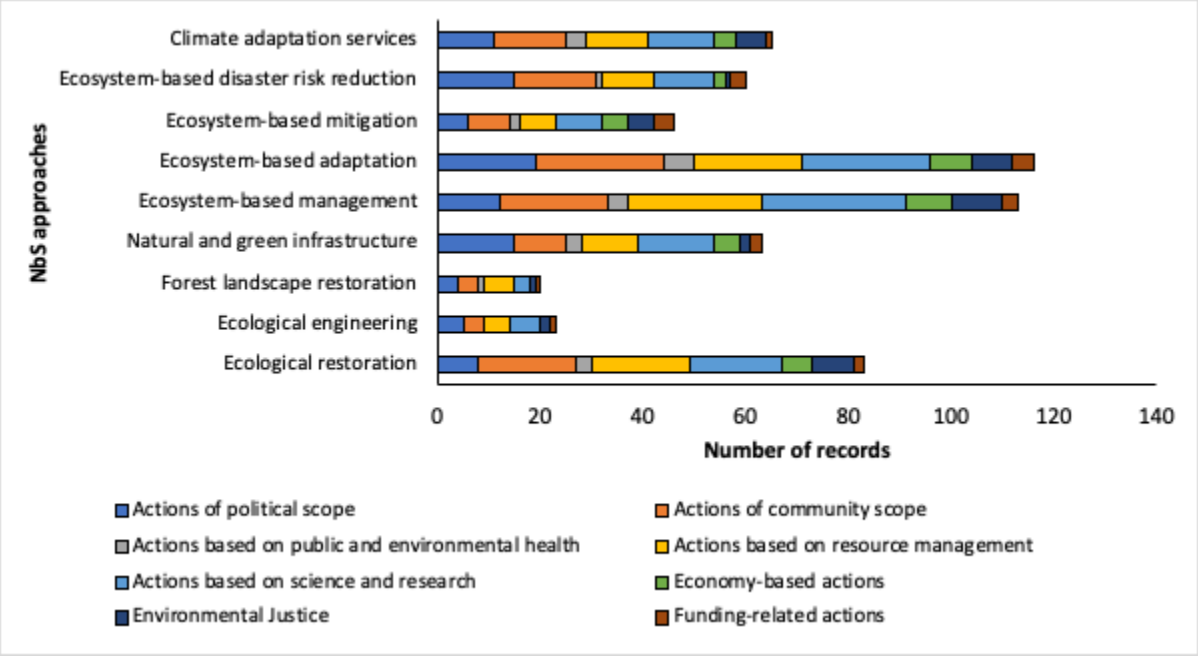


Figure 26. Combinations of NbS approaches and empowerment scopes of actions employed in NbS+Empowerment studies (N=132).

Only approximately one third of NbS+Empowerment studies revealed co-creation approaches (30%; N=40), with EbA focus often co-occurring with actions of community scope (11%; N=14), political scope (8%; N=11), and actions based on science and research (8%; N=11) (Figure 27). However, most studies reporting actions based on resource management in any combination of NbS approaches did not adhere to a co-creation perspective. For example, only 2 out of 26 studies (8%) utilised this type of action in conjunction with EbM; whereas only 1 study out of 7 did this in conjunction with 'ecosystem-based mitigation' (Figure 27).

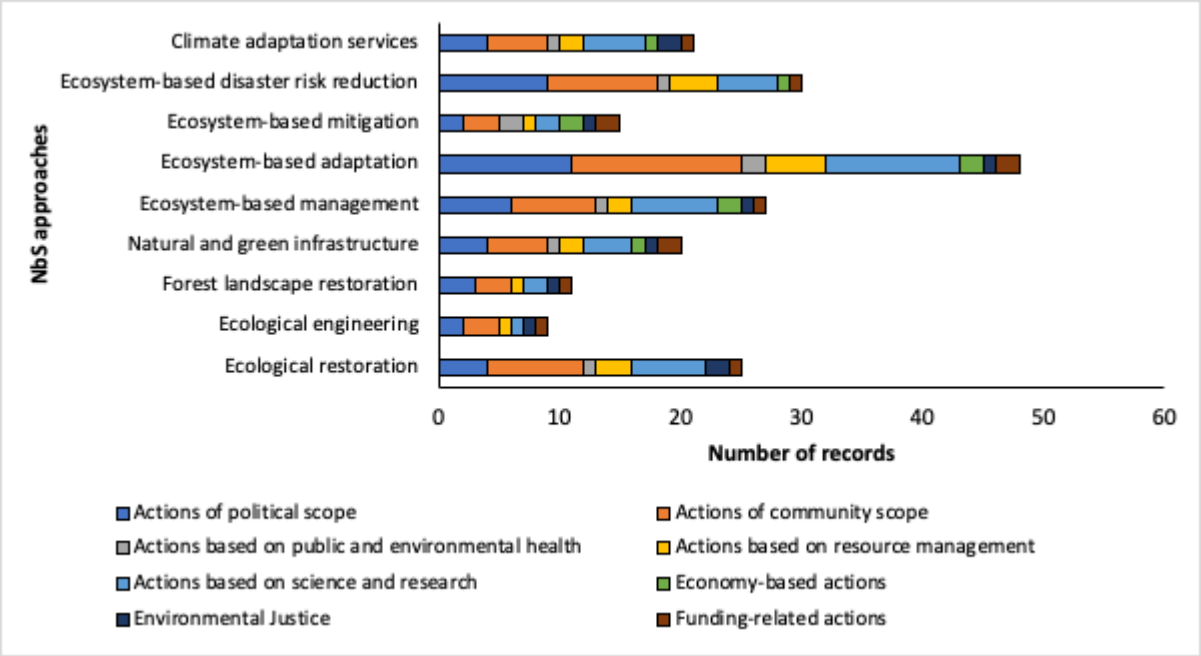


Figure 27. Combinations of NbS approaches and Empowerment literature scopes of actions employed in NbS+Empowerment studies (N=132), in which co-creation perspectives were evidenced (N=40).

5.5.2. Combination of NbS and Empowerment studies reporting the 'empowerment' level of stakeholder engagement

From these 132 studies that consider both Empowerment and NbSs, 24 (18%) were related to the maximum level of stakeholder engagement, which is 'empowerment' (Figure 28).

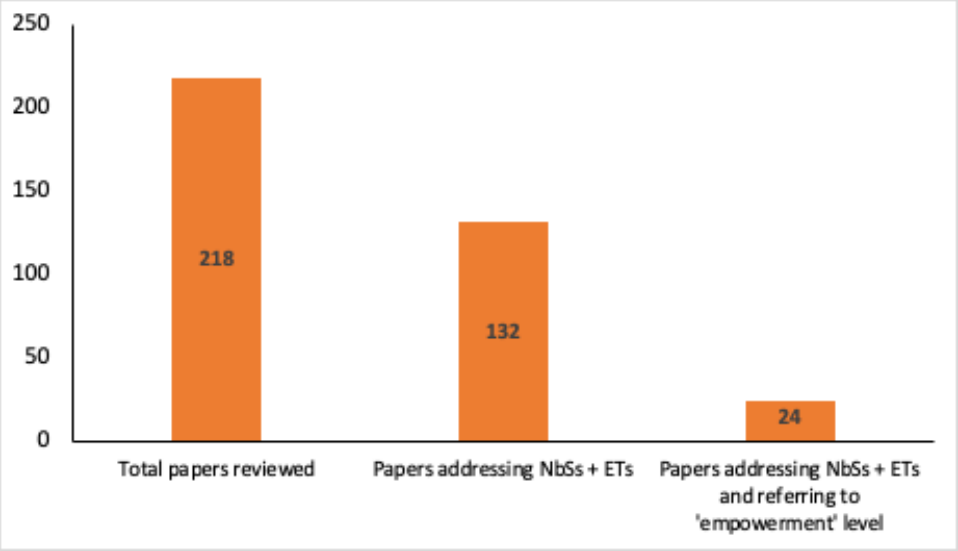


Figure 28. Distribution of papers reviewed, addressing NbSs+Empowerment and referring to the 'empowerment level' of stakeholder engagement.

Among the 24 studies with evidence of empowerment, our investigation delved into the role of various governance directions employed. It emerged that in the majority of cases (83%; N=20), a mixed top-down and bottom-up governance approach was utilised (Figure 29).

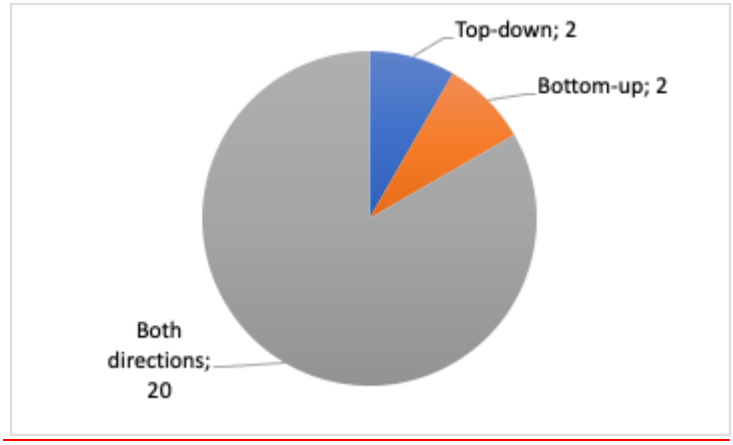


Figure 29. Proportion of papers focusing on NbS+Empowerment integration with evidence of empowerment (N=24) in relation to the directions of governance processes addressed.

5.5.3. Examples of empowerment outcomes/impacts and methods employed to report them

Empowerment, the highest level of stakeholder engagement, is reported in 26 publications out of a total of 218 studies considered in this review, from which 21 were chosen for full content analysis to investigate outcomes of empowerment processes and overall impact on coastal resilience. These publications report diverse empowerment outcomes, often as a result of such co-creation processes. For

example, Tiwari et al. (2022) find in their review that LLs can be an appropriate approach for empowering communities when working with NbSs and disaster risk reduction. LLs require collaborative governance which builds trust and enables prolonged engagement of diverse stakeholders. Pinkerton et al. (2019) find that EbM approaches that explicitly consider social justice can lead to empowerment that benefits both humans and nature. Their study explores reinstating traditional indigenous environmental governance practices as a means of empowering communities and restoring ecosystems.

Several articles point to the importance of values when engaging in empowerment work. For example, Robinson et al. (2023) find that structured decision-making (SDM) stands out as a promising approach for integrating diverse values into decision-making and can therefore be a promising empowerment tool. Herbst et al. (2020) similarly argue for a values-based approach to ecosystem services valuation, as a focus on values can lead to empowerment.

Narratives and stories appear to be another mechanism through which to realise empowerment outcomes. Vanderlinden et al. (2020) find that narratives and sense making approaches offer a promising way of addressing issues of knowledge and power, and thus realising empowerment (see Box 3).

Box 3. Stories, narratives, and sense making to empower communities

When faced with unprecedented changes, communities make sense of these changes by constructing narratives based on their existing knowledge, experiences, and beliefs. This process is known as sense making (Vanderlinden et al., 2020).

Sense-making processes are closely tied to empowerment and have the ability to give communities agency and power when approached with care. Sense making may offer a way of representing diverse stories and narratives of change to work towards just plural futures. When navigating narratives and sense making with diverse stakeholders, it is critical to be aware of the following points:

- *Accuracy vs. plausibility of narratives:* Plausible stories may offer more meaningful interpretations of changes than accurate ones.
- *Narratives and power:* The adoption of certain narratives may reflect conscious or subconscious attempts to shift local power relations.
- *Stories as a coping mechanism:* Stories are crucial for making sense of and coping with changes. Science and local knowledge can interact to influence knowledge and agency to make sense of a changing world through stories.

In summary, “a focus on narratives and sense making may help in respecting the interplay between plausibility, accuracy and ambiguity in situations of multiple interpretations. It may facilitate dealing with issues of knowledge and power which are central to transdisciplinary climate change adaptation research” (Vanderlinden et al, 2020).

Brattland et al. (2019) similarly use socio-ecological timelines as a co-production method and find that co-produced socio-ecological histories can lead to empowerment (see Box 4).

Box 4. Socio-ecological timelines as an empowerment tool

What is a socio-ecological timeline?
A socio-ecological timeline (SET) traces the social and ecological history of a specific place. SETs place emphasis on participatory identification of significant events and tipping points based on thresholds of concern that are meaningful to local stakeholders.

A socio-ecological timeline for the Porsanger Fjord
Brattland et al. (2019) construct a socio-ecological timeline of the Porsanger Fjord. This timeline is developed based on perceptions of change in the local environment by fishers. The resulting socio-ecological timeline traces socio-ecological events and adaptation measures taken in the Porsanger Fjord from 1945 until present day. The timeline illustrates the relationship between the local ecosystem state, governance and management structures, and the consequent ability of local fishers to adapt throughout time.

Socio-ecological timelines as an empowerment tool
Socio-ecological timelines offer an approach that combines local observation and scientific study to guide adaptation action. Such a process can bring stakeholders together and support the development of adaptive capacity and self-governance in coastal communities (Brattland et al., 2019).

Finally, practices of care such as theories of 'caring with', can support empowerment in climate change adaptation decision-making processes due to the ability of a care lens to dismantle structural relationships and rethink power dynamics (Bond & Barth, 2020).

While these publications engage stakeholders in order to carry out research that directly responds to community needs, none of these publications present a specific approach or method for measuring or assessing the outcomes of the empowerment processes that they engage in.

While the scientific publications surveyed did not report methods for measuring empowerment, two grey literature publications offer approaches to measuring empowerment outcomes. World Bank (2023) suggests comparing NbS project outcomes with the World Bank Gender Tag Portal to assess empowerment outcomes related to gender. While this approach may be helpful for measuring gender-related empowerment outcomes, it does not offer a comprehensive approach to tracking empowerment outcomes for all community groups.

Gann et al. (2019) propose a more comprehensive five-star system to evaluate progress of restoration projects towards social goals and a social wheel to assist in this tracking process. Box 5 presents this approach in detail.

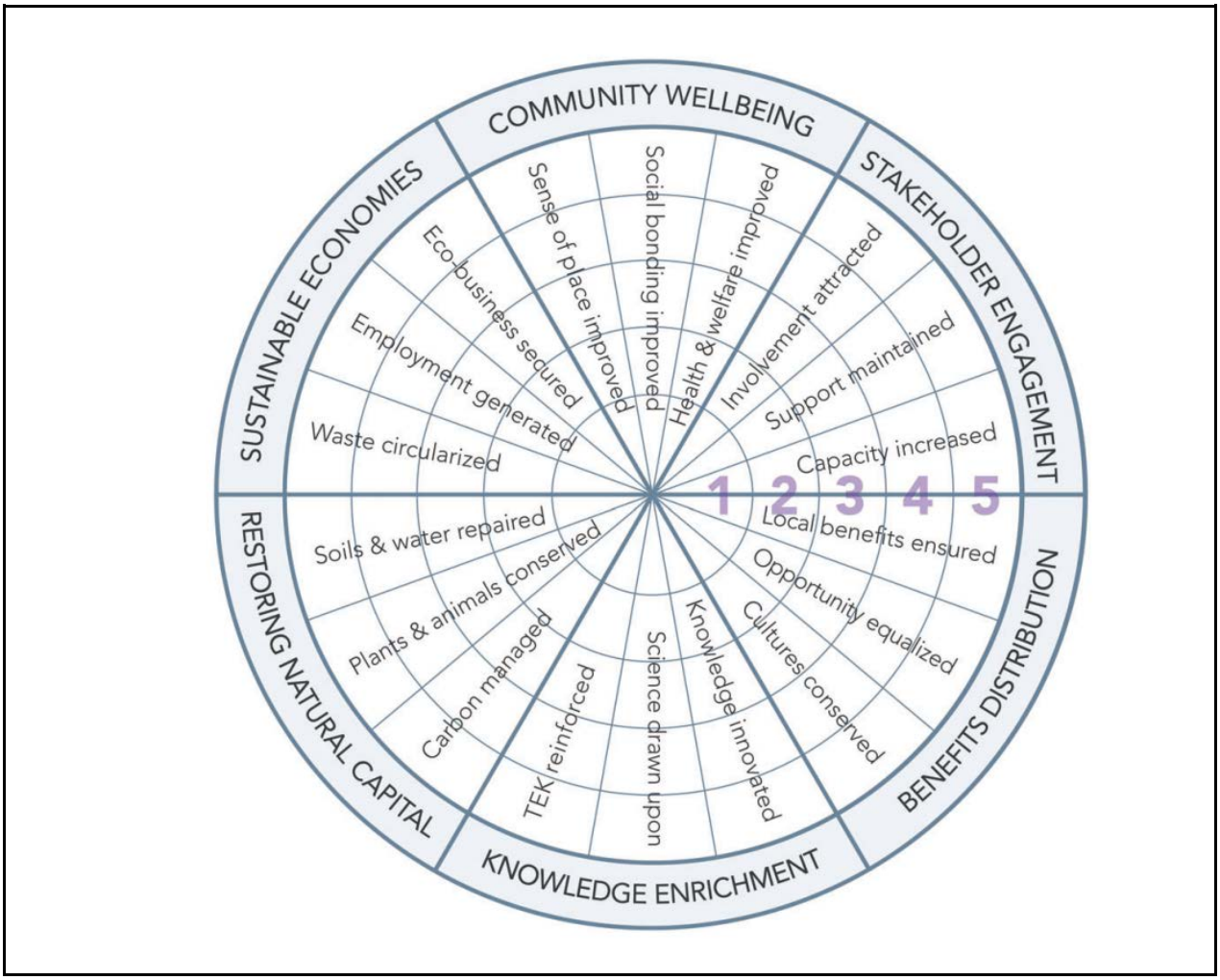
Box 5. A method for measuring empowerment outcomes in NbS projects

The Social Benefits Wheel and associated social five-star system (Gann et al., 2019) provides an approach for measuring progress towards social goals in NbS projects. The example below shows possible social goals, but it is important to note that these goals may vary depending on the project. However, the structure of the tracking procedure is flexible and can be applied in a variety of contexts. As a first step, categories of social goals should be defined and sub-divided into more specific social goals. A five-star rating system should then be developed for each goal, with 5 representing the optimal social outcome.

For example, in the image below Gann et al. (2019) have identified 18 social goals falling into 6 categories. Following the identification of these social goals, they have developed indicators of success for each goal. An example of the indicators developed for community wellbeing is explained below:

Community well-being

1) Core participants identifying as stewards and likely improving social bonding and sense of place
2) All participants identifying and likely benefiting from improved social bonding and sense of place
3) Many stakeholders likely benefiting from improved social bonding, sense of place, and return of ecosystem services including recreation
4) Most stakeholders likely benefiting from increased social bonding, sense of place, and return of ecosystem services including recreation
5) Public identification of the site as having wellbeing benefits from local participation and return of ecosystem services including recreation


COMMUNITY WELLBEING
STAKEHOLDER ENGAGEMENT
BENEFITS DISTRIBUTION
KNOWLEDGE ENRICHMENT
RESTORING NATURAL CAPITAL
SUSTAINABLE ECONOMIES
Sense of place improved
Social bonding improved
Health & welfare improved
Involvement attracted
Support maintained
Capacity increased
Local benefits ensured
Opportunity equalized
Cultures conserved
Knowledge innovated
Science drawn upon
TEK reinforced
Carbon managed
Plants & animals conserved
Soils & water repaired
Waste circularized
Employment generated
Eco-business secured
1 2 3 4 5

6. DISCUSSION AND RECOMMENDATIONS

6.1. General introduction/findings

The literature reviewed comprises various types of publications. Out of the total 218 studies, 178 (82%) were classified as empirical research articles, 63 (29%) were literature reviews, and 16 documents (7.3%) belonged to grey literature. Additionally, 23 publications (11%) included conference proceedings, book chapters, or other contributions. Each of these studies underwent thorough analysis based on their study type and methodological approaches.

Among the empirical articles, 59 studies (27%) presented case studies without statistical methods. Predominantly, the focus of NbS papers was on ecological/ecosystemic challenges, followed by legal/regulatory aspects, knowledge, well-being, and socio-cultural challenges, and lastly, socio-economic challenges.

6.1.1. How diverse was our dataset

This groundbreaking study represents the first comprehensive exploration in the literature assessing the significance of NbSs and Empowerments when applied to coastal systems. Our research involved the evaluation of literature spanning from 2012 to 2023. The utilisation of a REA method and information classifiers, were established as robust tools for extracting trends from both types of literature. Moreover, the scientific screening process underwent successful validation for consistency.

The volume of information collected was notably substantial for Europe and OECD countries. Particularly, the United States of America received considerable coverage in publications on coastal NbSs, likely influenced by policies stemming from the implementation of interventions such as those outlined in the National Preparedness Goals (FEMA, 2015), which were established in response to the devastating hurricane season, notably Hurricane Sandy in 2012. Specifically, 31% of the analysed studies solely focused on NbSs (N=67), while 9% exclusively addressed Empowerment (N=19). Despite mentions of empowerment in passing, studies presenting concise tools and methods for addressing community empowerment remained scarce.

Coastal ecosystems held the dominant presence in NbS studies, followed by marine ecosystems, urban ecosystems, and wetlands. The prevailing NbS approaches included Ecosystem-based Adaptation (EbA), followed by Ecosystem-based Management (EbM). The identified NbS studies primarily aimed at addressing societal challenges related to climate change adaptation/mitigation, disaster risk reduction, environmental degradation, biodiversity loss, and economic and social development. Social and human-related issues, encompassing socio-environmental justice, human health, and economic and social development, were predominantly addressed using a combination of NbSs and ETs.

While the majority of the reviewed studies operated at the local scale, the governance processes predominantly favoured a top-down approach. This could potentially lead to deviations in the implementation of NbSs or empowerment actions due to limited familiarity with local constraints. To enhance the effectiveness of local approaches, the adoption of bottom-up governance models is recommended.

Empowerment emerged as a significant aspect, with 151 studies assessing or including it as a participatory research methodology. The majority of these studies (87%; N=132) addressed both NbSs and Empowerment, highlighting the interdependence of these approaches in promoting sustainable coastal management practices.

6.2. Specific Objective 1: Rapidly review and summarise the volumes, characteristics and contributions of the existing evidence on the application of NbSs for coastal resilience building in Europe and other high-income countries and territories.

The European Union (EU) has established itself as a global leader in championing and implementing Nature-based Solutions (NbSs) (Calliari et al., 2022). While NbSs are widely recognized for their role in addressing environmental challenges such as carbon capture, biodiversity conservation, and climate adaptation, their contributions to social and economic objectives such as recreational opportunities, tourism promotion, job creation, and social cohesion have often been overlooked. Historically, monitoring of NbSs has been insufficient, resulting in limited data on their effectiveness in addressing societal challenges. However, with increased funding for climate adaptation, researchers are increasingly exploring the role of NbSs in achieving climate adaptation goals, such as using mangroves for flood risk reduction, tree planting to mitigate heat waves, and cultivating drought-resistant crops.

Consequently, studies conducting cost-benefit analyses of NbSs are gaining popularity. Nonetheless, only a small fraction of these analyses quantifies the social and economic co-benefits associated with NbSs. This lack of comprehensive assessment has contributed to the limited adoption of NbSs, particularly among policymakers and engineers who tend to favour conventional grey-engineering solutions such as flood defences over nature-based approaches like sand dune management for flood risk reduction. Herein lies the importance of studies that emphasise the societal co-benefits of NbSs, shedding light on the multitude of advantages these ecosystem-based interventions offer, including recreational opportunities, job creation, and social cohesion, in addition to disaster risk reduction.

The NbS approaches identified in the literature analysed addressed a wide array of societal challenges, encompassing climate adaptation/mitigation, disaster risk reduction, environmental degradation, biodiversity loss, and economic and social development. While more than half of the reviewed studies assessed or proposed technical or environmental assessments of NbSs, there was a noticeable absence of direct engagement or empowerment processes initiated with communities and stakeholders during NbS framework implementation. Among the studies that did utilise engagement methods or reported evidence of these processes, the majority only achieved the lowest levels of stakeholder engagement (i.e., inform or consult). Moreover, when examining differences in stakeholder engagement levels across types

of NbS approaches, a decreasing pattern in the number of records was observed as the engagement level increased.

Our extensive screening of NbS case studies across the EU and OECD countries has allowed us to highlight several challenges to consider in current NbS socio-ecological frameworks:

1) The diversity of studies concerning the implementation of NbSs extends beyond the climate change narrative, indicating significant potential for research and technological development in deploying ecosystem-based solutions to address a broader spectrum of challenges. Nonetheless, there remains a notable dearth of knowledge regarding operational capacity for implementation.
2) Most of the studies reviewed primarily focused on the design or planning stages of the NbS project cycles, with a conspicuous absence of literature describing the implementation, post-implementation and evaluation phases. This suggests that we are still in the nascent stages of assessing NbS progress, or it could imply a scarcity of scientific literature supporting detailed local case studies.
3) Recognizing the increasing importance of monitoring the effectiveness of NbSs, it becomes imperative to conduct rigorous monitoring of NbS projects to ascertain their long-term socioeconomic impact. This will aid in quantifying the co-benefits and trade-offs, thus enabling the calculation of the true value of these projects. However, there remains a glaring lack of monitoring and evaluation performance indicators for NbSs in the scientific literature.
4) Challenges abound in applying global NbS frameworks to local contexts, navigating interactions among stakeholders at multiple levels, and aligning various land management policies across different spatial scales. The integration and widespread adoption of NbSs within national governance frameworks must proceed cautiously, considering potential discrepancies in alignment models and participation levels. Our screening indicates that the implementation of NbSs is highly context-specific, varying across time, space, and local socio-ecological conditions, as well as different planning, financing, and regulatory frameworks.
5) Furthermore, challenges emerge from the difficulty of establishing resilient communities solely through NbSs while ensuring the resilience of NbS initiatives themselves. The continued adequacy of an NbS requires continuous adjustment to flexible objectives and suitability, as these may frequently shift over time due to emerging socio-economic challenges or natural constraints, which are often beyond control. For example, numerous NbS initiatives implemented in coastal areas may encounter challenges in long-term adaptation due to the impacts of climate change.

Acknowledging these challenges as a starting point, we propose global recommendations on the role of knowledge, investments, application, governance, and community engagement (Figure 30). The implementation of NbSs may not always offer a win-win solution if it fails to adequately benefit local communities and marginalised or vulnerable groups, such as women and immigrants. There is an urgent need to incorporate emerging research and implementation insights throughout the NbS lifecycle to ensure its effectiveness and sustainability.

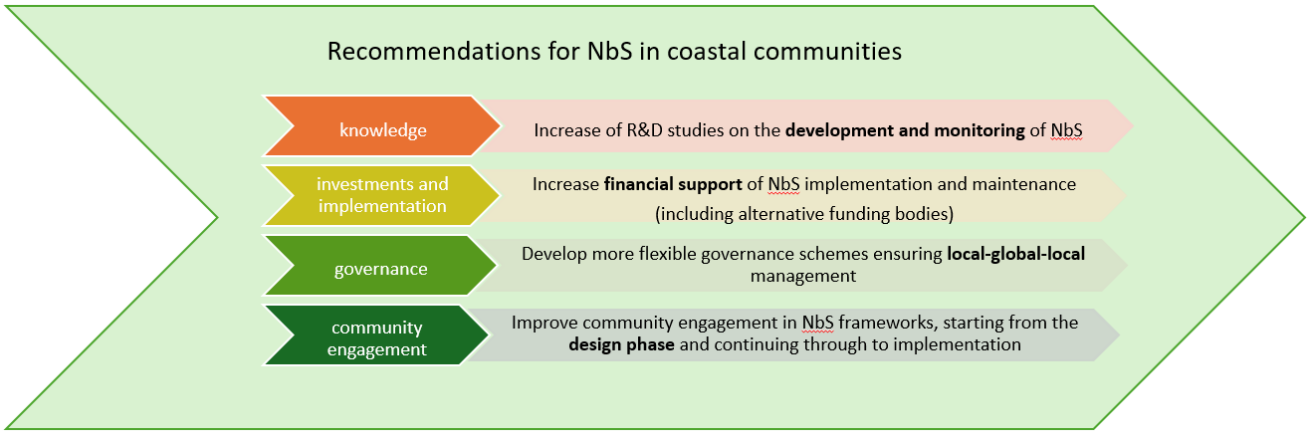


Figure 30. Recommendations on increasing NbS impact on coastal areas.

6.3. Specific Objective 2: Rapidly review and summarise the volumes, characteristics and contributions of the existing evidence on the application of ETs for coastal resilience building in Europe and other high-income countries and territories, and develop a catalogue and classification scheme of ETs for this context.

The quest for Empowerment Tools led into an exploration where empowerment, although a widely used term in NbS literature and beyond, lacked a succinct definition within the broader literature. In the context of this study, empowerment aligns with the interpretation put forth by Laverack & Wallenstein (2001), who define it as "an intentional ongoing process rooted in the local community, characterised by mutual respect, critical reflection, caring, and group participation. Through this process, individuals lacking an equitable share of valued resources gain greater access, decision authority, and power over their lives." This definition, adapted from the work of the Cornell Empowerment Group (1989) as cited in Perkins & Zimmerman (1995) and Labonte (1994) , underscores the essence of empowerment within our study framework '(Laverack & Wallenstein 2001).

Empowerment tools, hence the methods and approaches employed to achieve empowerment, encompass a diverse array of strategies, resources, or mechanisms tailored to enhance the self-efficacy, autonomy, and active participation of individuals or communities in decision-making processes. Following Laverack & Wallenstein (2001), the distinction between participatory and empowering approaches hinges on their respective agendas and objectives. Empowerment approaches are explicitly designed to catalyse social and political transformations, embodying ideals of liberation, advocacy, and community activism. In such approaches, participants acquire power by assuming control over decision-making processes within their interpersonal relationships, facilitated through problem identification, solution generation, and action implementation.

In contrast, participatory approaches may not necessarily aim for emancipation or empowerment. Instead, they often foster the involvement and contribution of individuals, citizens, or stakeholders to a program, which may, in turn, enhance their capacities, skills, and competencies. However, these approaches may not necessarily empower communities to seize more power through collective social and political action (Laverack & Wallerstein, 2001).

Empowerment can thus be perceived as an ideal, while participatory approaches may be based on relatively lower levels of citizen engagement (see Arnstein, 1969). Consequently, ETs serve as vehicles for progress towards this ideal.

When compiling the list of ETs, three difficulties were faced: 1) a lacking definition of empowerment in the literature, 2) a need for interpretation of the data, and 3) lacking schemes to measure empowerment / lacking evidence on concrete empowerment outcomes.

1) Despite being a prevalent keyword in publications, empowerment often remained on the periphery of focus. The majority of screened literature centred around nature-based approaches (N=199), primarily identifying, calculating, or implementing suitable NbSs for coastal areas, often utilising participatory methods (N=92) but without a primary emphasis on empowerment. Few studies delved into social sciences and humanities, exploring empowering approaches (N=26), and also only few focused on co-creation (N=49) or deliberative design intended to empower people. This made it challenging to categorise methods and approaches into distinct categories of empowerment or participation.
2) Interpretation is essential for categorising the empowerment tools. While it's feasible to classify the different approaches themselves based on scopes of action and levels of stakeholder involvement, much of the literature necessitates interpretation. Often, the reviewed literature presents participatory and empowerment approaches in concise applications and case studies, requiring abstraction and broadening the scope of the tool from specific case studies to broader applicability. This demands familiarity with participatory and empowerment approaches beyond the realm of NbS topics. It involves classifications "*a posteriori*," where analysis of a sample is undertaken to distil shared traits, commonalities, and differences.
3) While empowerment, inclusion, and participation are frequently mentioned in many of the reviewed articles, few studies actually report empowerment outcomes from such processes. Additionally, there's scant attention given to measuring empowerment within the surveyed literature. None of the scientific articles surveyed provided a methodology for measuring empowerment outcomes, with only two grey literature publications mentioning specific approaches for measuring empowerment. This gap may reflect a broader challenge in measuring feelings of empowerment, and could be related to a wider tendency among researchers to favour quantifiable and easily measurable outcomes. Consequently, while empowerment may indeed be occurring, there's limited focus on understanding how. This underscores an urgent need to

prioritise monitoring and evaluation to gain deeper insights into how to deliberately engage in empowerment processes.

6.3.1. Creating a Catalogue of Empowerment Tools

The reviewed literature unveils numerous examples of nature-based approaches and participatory methods aimed at empowering coastal communities. While participation and empowerment are not necessarily causally linked, empowering or participatory methods, alongside knowledge co-production, can directly contribute to community empowerment (Laverack & Wallenstein, 2001). According to these authors, empowerment can be understood as both a process and an outcome, or a dynamic continuum.

The review yielded 151 studies related to empowerment processes and/or tools. A thorough analysis revealed six distinct categories of Empowerment Tools (ETs): Education and Awareness-raising tools, Knowledge tools, Platform/Dialogue tools, Governance tools, Co-creation tools, and Community-led nature-based approaches. It's worth noting that the latter category encompasses only those nature-based approaches that allow for co-design and ownership, such as community gardens (Lin et al., 2018) or community-led habitat restoration initiatives (Thomson et al., 2022) (Table 4).

Within each tool category, varying levels of participation and stakeholder involvement are possible, ranging from mere informing and providing balanced and objective information in a timely manner, to consultation, involvement, collaboration, and ultimately, co-design, placing the final decision-making in the hands of the public (see IAP2 classification in Bobbio et al., 2019).

Among the empowerment literature, 47 (32%) reported instances of co-creation, often in the form of a transdisciplinary and joint approach to problem definition and/or potential solutions.

Table 4. List of selected tools and related actions.

Tools/ approaches	Description
Education tools	● Actions to create awareness and information ● Actions to communicate science to diverse audiences ● Actions to equip citizens with basic understanding needed to make decisions
Knowledge tools	● Actions to cocreate knowledge ● Tools to answer specific questions and needs ● Participatory approaches and modes of knowledge production

Platform/Dialogue tools	● Actions to generate new platforms and modes of communication and interaction ● Networking and group formation
Governance tools	● Actions to support a new governance structure that enables community empowerment ● Actions for enhancing democracy, environmental justice and targeted policy decisions ● Actions encouraging grassroot initiatives , bottom-up approaches and new organisational structures including polycentric governance.
Co-Creation tools	● Actions to create novel, transformative modes of collaboration and decision-making ● New, integrative forms of research support guiding community based interests
Community-led Nature-based approaches	● Environmental actions for enhanced resilience with co-benefits for communities ● Actions changing or preserving aspects of physical environment that increase community resilience and benefits for environment

Each of these Empowerment Tools (ETs), if utilised effectively, aims to enhance community resilience and empowerment (Figure 32). However, the level of empowerment achieved can vary depending on the tool. While educational tools often provide information, knowledge tools typically involve consultation and active involvement. Governance tools have been shown to facilitate collaboration with stakeholders. Co-creation, as the ultimate form of transdisciplinarity, demonstrates collaboration and co-production of knowledge in the literature reviewed.

Empowerment can be viewed as linked to social capital and social networks that are fostered through knowledge co-creation and co-production but also in the development of "a theory of change" that incorporates perspectives on hazards, risk management, community resilience, and nature's contribution to adaptation (Vasseur et al. 2022).

While individual approaches can be effective, combining different tools and adopting multi-tiered approaches involving various stakeholders at different levels of empowerment can be beneficial (Figure 32; Table 4). Utilising participatory tools can foster active engagement by all members of a group in decision-making processes (Chatty et al., 2003). Co-design and co-production of research and implementation can promote ownership among urban communities. Through the implementation of communication strategies, including educational empowerment tools, general awareness of the importance of coastal ecosystems can be raised, as demonstrated in various studies (Jones et al., 2013; Bousquin et al., 2019; Miller et al., 2020) and through the EmpowerUs project. The application of Living

Labs (LLs) related to NbSs can ensure broad acceptance of EbM and EbA by the coastal population, with high levels of participation, as well as the creation of sustainable and transformative governance structures . However, only one study applying NbSs in LLs was found in the literature review (reviewed by Tiwari et al., 2022).

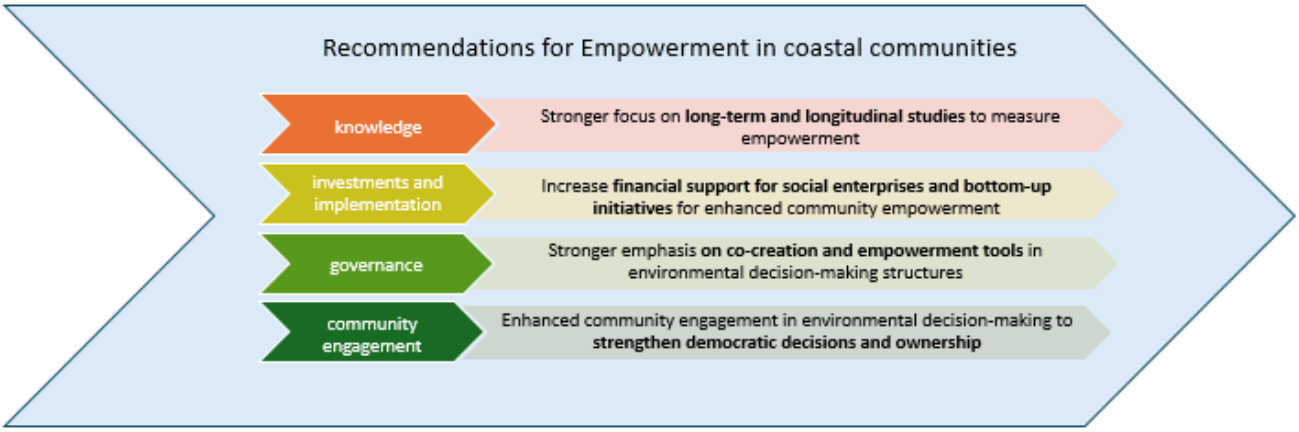


Figure 31. Recommendations for Empowerment in Coastal communities

6.4. Specific Objective 3: Synthesise the scope and characteristics of the joint application of NbSs and Empowerments for coastal resilience building in Europe and other high-income countries and territories, and critically assess the outcomes/impacts of such interventions in fostering empowerment.

6.4.1. What insights have emerged from the coupling of NbSs + Empowerments?

Bringing together NbS and insights from the empowerment literature yields valuable perspectives. There is compelling evidence indicating that the success of environmental conservation and NbS initiatives hinges on the level of participation facilitated through diverse methods, such as citizen science, leading to improved integration and site-specific outcomes (Sterling et al., 2017; Wolff et al., 2022). Moreover, NbS projects frequently yield co-benefits, including cultural and societal advantages, as highlighted in numerous studies (Raymon et al., 2017; González-García et al., 2023). The practice of co-creation and co-production for NbSs has gained traction in recent years, emerging as an integral process in the planning and execution of these interventions (Hölscher et al., 2024). By integrating participatory approaches and ETs at various stages and levels within NbS projects, we can effectively foster empowerment (see Figure 32).

Figure 32. Different tools and approaches can add to community empowerment

Each of these ETs holds potential for empowering stakeholders through research, but their effectiveness relies on specific conditions (Bergold & Thomas, 2012):

1) Participatory research approaches require a well-functioning democracy to thrive.
2) Participatory research necessitates a 'safe space,' where participants feel comfortable sharing their personal perspectives, opinions, and experiences regarding the situation at hand.
3) A clear definition of 'stakeholders' and 'communities' and the extent of participation are crucial. Co-researchers often represent the immediately affected individuals, often marginalised segments of the community with limited time and resources. Active stakeholder and community involvement can prevent the creation of hegemonic knowledge.

In this context, it is imperative to recognize that NbS projects must be implemented with careful consideration of participation, inclusion, and empowerment to ensure the realisation of social co-benefits. Failure to address social complexities in NbS implementation can result in maladaptation and increased marginalisation of vulnerable groups. For instance, nature-based climate change adaptation projects may encounter stagnation due to impasses in the adaptation process (Sieber et al., 2018), reinforce existing power dynamics, or contribute to green gentrification or climate gentrification (Anguelovski et al., 2019). In the worst-case scenarios, this could involve the displacement of vulnerable communities and exacerbation of inequalities (Hobbie et al., 2020). As highlighted by Pinkerton et al. (2019), "navigating the trade-offs among protected species, ecosystem conservation, and social justice issues such as food security and poverty alleviation presents one of the greatest challenges of our time (...). Tackling the question of hunting a once-endangered, charismatic predator brought back from the

brink of extinction on the basis of social justice places EbM scientists and managers in uncomfortable territory. It forces us to democratise the concept of EbM by addressing the issues of social justice head-on" (Salomon et al., 2018). Therefore, it is crucial to carefully consider the trade-offs between environmental sustainability and social justice when implementing NbSs.

6.4.2. How do NbSs + ETs define a pathway for socio-ecological resilience?

Answering the question of how NbSs and ETs can lead to socio-ecological resilience is not as straightforward as it may seem. Only 11% of the reviewed literature provides a definition of resilience. However, many of these papers do not aim to assess the contribution of NbSs to resilience but rather focus on method development, testing, and implementation. Among the studies that do focus on empowerment, represented in the highest level of stakeholder involvement according to Bobbio (2019), and include a definition of "resilience" (N=24), resilience is mainly considered from a socio-ecological perspective (16%; N=4).

It is noteworthy that some authors identified specific attributes necessary for coastal communities to be socio-ecologically resilient, such as a systemic-thinking mindset capable of considering the built and natural elements of a territory in a holistic way. Some authors even argue that the distinction between social and ecological systems is artificial and arbitrary, advocating for the use of socio-ecological systems as a unit of analysis (Berkes, 2011). Additionally, the role of diversity, both in the natural context (number of species) and in the social sphere (number of institutions and governance arrangements), is considered crucial for building resilience in communities (Jones et al., 2013).

Furthermore, a set of individual and collective attributes is linked to resilient communities in the literature, such as a proactive attitude in the face of crisis or the ability of managers to be flexible and experimental. These social traits suggest that the pathway to socio-ecological resilience requires a commitment within communities to forward-thinking and transformative/disruptive visions.

Our results indicate that NbSs and ETs share some common features that have the potential to act as catalysts for resilience in coastal communities (Table 5).

Table 5. Key features of NbSs and ETs that can act as catalyzers for resilience.

Key features	Catalyzers for resilience
A systemic approach	The literature emphasises that resilience-oriented policies, while crucial, are not enough on their own. They must be complemented by an integrated vision for the territory rooted in principles of social justice and planetary/social well-being. This entails ensuring that: (i) the social-ecological system is treated as a unified entity for analysis, including a definition of a social-ecological landscape (SEL) (see Box 1), thus avoiding artificial divisions between social and ecological systems; (ii) all institutional levels, policies, and actors are interconnected, fostering collaboration and coherence; and (iii) a territorial approach that transcends boundaries is adopted to promote regional synergies and enhance ecological coherence.
A shared vision and an involved community	A long-term scenario vision is crafted in collaboration with the neighbourhood, ensuring stakeholder involvement at all levels. Within this framework of a "social acceptance" democratic process, the identification of key actors as legitimate intermediaries is crucial for fostering trust within the network. Additionally, the community has taken steps to provide tools for altering the structural relations and policy responses that perpetuate inequalities, such as the disparity where "the rich get seawalls and the poor get moved" (Bond and Barth, 2020).
An integrated and multi-level governance	A comprehensive array of support mechanisms, encompassing political, financial, technical, and relational aspects, is established to uphold an integrated multi-level framework for the coastal community. Strong local ties with regional and national levels mitigate the adverse effects of political discontinuity on environmental and social initiatives aimed at bolstering resilience. It is only by fostering connections between these communities and various hierarchical levels and external entities that robust mechanisms can be developed to sustain strategic actions. As noted by Abrams et al. (2021), "A key lesson for environmental management agencies globally is that institutional design may help set a supportive context for resilience-informed management, but the potential can only be realised through the intentional actions of managers at multiple hierarchical levels as well as their external partners."
Managing both a social process and an ecological exercise	Effectively managing resilience necessitates a holistic approach that integrates ecological processes with the active engagement of social actors in all decisions, actions, or strategies pertaining to resilience. Such management initiatives must be underpinned by political decisions that provide adequate incentives, resources, and guidance to address this wide array of interconnected objectives and challenges. As articulated by McVittie et al. (2018), "... mainstreaming climate change adaptation and disaster risk reduction objectives through ecosystem approaches in policies and funds, engaging local and regional actors, and filling the knowledge gaps are essential components for nature-based solutions contributing to climate action."
Diversity	As stated by Jones et al. (2013), "...in the face of strong driving forces, rather than relying solely on specific types of incentives and institutions, it is crucial to acknowledge that the cornerstone of resilience lies in diversity—both in terms of species within ecosystems and institutions within governance systems." Thus, the dedication to fostering a broad spectrum of governance structures and entities within communities is equally vital as the preservation and promotion of biodiversity within these regions.

6.4.3. There is an urgent need for measuring NbS + Empowerment + resilience across scales

The Rapid Evidence Assessment showed that very few studies dealt with the measurement of "empowerment". Often, publications referred to empowerment as a goal, rather than means. Often, studies discuss empowerment without clearly defining the concept or providing a specific methodology to measure empowerment outcomes. It therefore remains unclear the extent to which different approaches support empowerment outcomes. Despite the broad body of scholarly literature on measuring empowerment (Lavenack & Wallenstein, 2001; Salvador Costa et al., 2022; Maiorano et al., 2021); and the evaluation of NbS including empowerment (van der Jagd et al. 2023), our review obtained little direct evidence of empowerment outcomes/impacts directly linked to coastal resilience building. One potential explanation for this can be, as sought in the focus of publications: most reviewed publications either focussed on research and implementation of NbS, including EbA and different framings such as EbM or alike (202 publications). In these studies, 104 studies relate to empowerment and participation related to NbS, often as an accompanying process, but not as an object of study. Whilst NbS implementation is often a relatively quick process of selecting and building respective structures, the effects of empowerment and resilience building are often to be observed within longer time frames. Such limited focus on empowerment outcomes can be explained by the slow uptake and change of morals, norms and values amongst individuals, communities and societies. Such processes are much more difficult to measure and assess, as they often fall outside of current funding schemes, project structures and timeframes. Often, correlations between NbS and empowerment arise, yet causality is difficult to prove scientifically due to the complexity of socio-ecological systems.

Monitoring empowerment along research project trajectories (at varying temporal and spatial scales) would require a transformation - in research as well as funding schemes. Longitudinal studies and long-term assessments are needed to increase the impact of the approaches applied. There is a dearth of evidence studying the connection between NbS and socioeconomic empowerment or resilience, studies such as Munang et al (2013) and Sheng et al (2019), have discovered that NbS can support marginalised groups more than grey-engineering based infrastructure due to its ability to provide socio-economic co-benefits such as supporting livelihoods. NbS can also provide numerous social advantages by being an inclusive and participatory approach which accounts for regional sensitivities. However, such studies often represent a snapshot, a moment in time. Rarely, the empowerment and changes in community resilience are assessed *ad postum*. Here, a transformation in funding and funding schemes would be required, with much stronger focus on the changes in values and norms caused by NbS or empowerment projects.

6.5. Recommendations for research and policy making

- Decentralised governance mechanisms that allow for citizen engagement and stakeholder collaboration are important for implementation of NbS-Empowerment initiatives, and for building resilience.

- Effective monitoring and technical evaluations of the impact of NbS and Empowerment initiatives in a clear and concise manner are necessary. The lessons learned from these initiatives should be recorded and used for future projects as well as shar6.5
- ed with other municipal governments.
- Greater funding provisions for community-based and smaller scale NbS and Empowerment interventions could be important in fostering proactive action from not only academics/researchers but also the community at large.
- Stronger emphasis on community-led small-scale and bottom up approaches using NbS for climate change adaptation
- Increased collaboration amongst different sections of society- such as academia, civil society/citizens, industry, public sector, and media- is important in order to foster real change and encourage implementation of more NbS-Empowerment initiatives. Co-creation processes and mechanisms such as living labs can support this.
- Implementing solutions that are contextualised in local needs and requirements, based on citizen surveys etc, are important to ensure the effectiveness of NbS-ET solutions. These solutions can often be scalable/replicable in other regions of the country/Europe, so it's important to emphasise this component to support knowledge exchange.
- To ensure the long-term impact of NbS-ET initiatives, it is important to consider factors such as climate change as well as future socioeconomic changes to make decision-making processes robust and the impacts of interventions longer-lasting. For example, implementation of new NbS initiatives while considering 1-2 metre of sea-level rise expected by the end of 2100, could ensure long-term resilience as opposed to considering NBS initiatives only as part of five-year plans.
- Important to spread awareness about NbS-ET initiatives through conversations and programmes at local government levels, including sharing data on their efficacy and impacts, in order to encourage their uptake.
- Longitudinal studies on NbS and Empowerment, as well as on the application of ET needed.

7. CONCLUSION

The aim of this report was to provide **the first evidence-based knowledge on the contribution that NbS and empowerment tools can make to the resilience of coastal communities.** In the first place, we found out that "**Resilience" is a concept mainly described according to socio-ecological term**s, entailing at the same time natural and social processes. From this perspective, we confirmed that understanding the resilience-related dynamics requires the implementation of systemic-thinking frameworks that jointly consider social sciences and natural sciences.

There is clear evidence on the role that the use of NbS and ET can have in promoting coastal communities' resilience. In relation with NbS, specifically, we concluded that **community-led nature-based approaches can be considered an ET if they are properly designed and implemented,** by contemplating participatory and engagement processes, namely co-creation and/or co-production of knowledge. However, we did not find much evidence of analyses that qualify or quantify the social and economic co-benefits of NbS and nature-based community-led approaches for coastal communities. Among the studies on NbS utilising engagement methods or reporting evidence of these processes, the majority only achieved the lowest levels of stakeholder engagement (information) and focused mainly in the design/planning or evaluation stages of the NbS project cycles. This indicates a gap in the scientific and grey literature supporting the description of NbS implementation that needs to be addressed in the future.

Regarding "Empowerment", whilst it has become a common term in NbS-related studies and beyond, a **concise definition of "Empowerment Tools" was difficult to find in the broader literature.** "Empowerment" within the context of this study follows the interpretation of Laverack & Wallenstein (2021) as "an intentional ongoing process centred in the local community, involving mutual respect, critical reflection, caring, and group participation, through which people lacking an equal share of valued resources gain greater access, decision authority and power over those resources and on their lives''. As a result, "Empowerment" can be understood both as a process and as an outcome. In this sense, our findings indicate that **co-creation**, as ultimate form of transdisciplinarity, supports not only collaborative frameworks and co-production of knowledge schemes, but allows for the **emergence of a theory of change** that can contribute in a relevant manner both to community resilience and to facilitate nature's contribution to adaptation (Vasseur et al., 2022). In this sense**, Living Labs** have been identified as suitable mechanisms to ensure broad acceptance of NbS and co-creation approaches in coastal communities due to the high degree of participation applied and to the transformative governance promoted. Unfortunately, beyond some particular scientific papers in this regard, out of the screened literature, **only a few studies address co-creation approaches** or deliberative design intended to empower people. Furthermore, studies presenting concise tools and methods to address (and assess) community empowerment and community resilience are still few. This makes it difficult to distinguish the methods and approaches used into categories of empowerment or participation. In our study, through the use of interpretation that has been needed to categorise the empowerment tools found, we were able to provide a **Catalogue of Empowerment tools** that is transferable and replicable from one context to

another. The Catalogue encloses Empowerment tools/actions for socio-ecological resilience classified according to methods of application, level of stakeholder engagement, and respective sources. Six distinct groups of ETs were clustered, including Education tools, Knowledge tools, Platform/ Dialogue tools, Governance tools and Community-led nature-based tools. We recommend that the information produced is made accessible to a broad set of stakeholders to ensure a wide reach of knowledge.

As per the **measurement of empowerment**, none of the reviewed studies provided a methodology for measuring empowerment outcomes. It therefore remains unclear the extent to which different approaches support empowerment outcomes linked to coastal resilience. This gap may reflect a general challenge with measuring the complex aspects involved in the concept of "empowerment". Whilst general concepts to measure empowerment exist, there are only few assessments related to NbS in a coastal context. This could relate to a wider tendency of researchers to favour quantifiable, timely and easily measurable outcomes. The effects of empowerment and resilience are often visible within longer time frames. A transformation in research and a new rationale for funding schemes addressing empowerment is needed to assess the effects of such NbS approaches on the empowerment of coastal communities.

Finally, in relation with Resilience, we identified some common features that NbS and ET share and have the potential to act as catalysts for Resilience: a systemic approach and a systemic mindset; an involved community around a shared vision for the territory; an integrated and multi-level governance including bottom-up and top-down approaches; an integrated approach for environmental management in a holistic manner; and an effective consideration of socio-cultural and socio-environmental diversity as a driver to improve resilience both in the natural systems (number of species) and in the social ones (number of actors, entities, governance arrangements, etc).

We concluded that the pathway for coastal communities' socio-ecological resilience goes beyond the implementation of specific Nbs or ETs and requires, additionally, a commitment within communities with forward-thinking and transformative/disruptive visions towards sustainability. What remains to be done is a proliferation of research and innovation studies, financial investment, and changes in current governance models to achieve a transformation. There is also a lack of recommendation policies, at the EU level, to create common strategies (and legislation frameworks) for the design, implementation, assessment and maximisation of joint NbS and ET approaches.

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9. ANNEXES

ANNEX 1a. Survey sent to the TCLs during the scoping phase

Eklipse Survey for EmpowerUs requests

Dear EmpowerUs TCLs Teams,

We kindly invite you all to participate in a first short EmpowerUs survey, in order to support Eklipse having a better understanding of the Transition Coastal Labs (TCLs) challenges before starting the evidence synthesis processes of the two initial questions proposed in the EmpowerUs proposal (Task 4.1). The aim of this survey is mainly to support the Eklipse Scoping Phase during which the initial questions will be discussed, refined and reformulated to meet the evidence needs of the requesters by 1) defining who should be the requesters for the EmpowerUs requests (see section 1) and 2) defining the main challenges to be addressed in your TCLs (see section 2.).

Completing this survey should take approximately 10-15 minutes and is open **until January 6th 2022**.

Many thanks in advance for your input to the Survey for the Eklipse requests. If you have any question, please contact us at: candice.pouget@ufz.de

***Eklipse was created in 2016 to help governments, institutions, businesses, and NGOs make better-informed decisions when it comes to biodiversity and ecosystem services in Europe**. Eklipse is a science-policy mechanism of the public interest. The lawful basis for processing your personal data under the EU's General Data Protection Regulation (GDPR) will be a public task. Our privacy policy (http://eklipse.eu/privacy-policy/) contains further information on the purpose and lawful basis for processing your personal data.*

* Required

1. Last name, First name *

2. Name of the Transition Coastal Lab (TCL), Country *

3. Role in EmpowerUs *

4. Are you living in the TCL community? *

Check all that apply.

- [ ] Yes
- [ ] No
- [ ] Other: _____

5. Which of the following group(s) of stakeholders are you working closely with in your TCLs? *

Check all that apply.

- [ ] Public authority (e.g. municipality, agency, ministry)
- [ ] Political entity (e.g. city or regional parliament)
- [ ] Civil Society Organisation (e.g. non-governmental organisation)
- [ ] Private sectors (e.g. company, small and medium-sized enterprise, consultant)
- [ ] Academia/Research (e.g. university, research institute)
- [ ] International or transnational organisation (e.g. EU, UN, River basin management)
- [ ] Local organisation (e.g. local associations, initiatives)
- [ ] Land owners
- [ ] Other: _____

6. Please specify your above answers *

_____

_____

_____

_____

_____

Section 1: Definition of the requesters for the EmpowerUs knowledge synthesis needs

7. Who should be part of the requester consortium? *

Mark only one oval.

- ◯ EmpowerUs coordinator + an appointed deputy
- ◯ EmpowerUs coordinator + appointed deputy + two appointed TCL representatives
- ◯ EmpowerUs coordinator + appointed deputy + two appointed TCL representatives + external relevant stakeholders and interest groups at the EU level (e.g. EC DG MARE, EC-KCBD, EC DG REGIO, etc...)
- ◯ EmpowerUs coordinator + an appointed deputy + external relevant stakeholders and interest groups at the EU level (e.g. EC DG MARE, EC-KCBD, EC DG REGIO, etc...)
- ◯ Only external relevant stakeholders and interest groups at the EU level (e.g. EC DG MARE, EC-KCBD, EC DG REGIO, etc...)
- ◯ Other: _____

8. If you choose "Other", please specify

_____

9. Would you be interested in being appointed to represent the TCLs in the requester consortium? *

Mark only one oval.

- ◯ Yes
- ◯ No
- ◯ Maybe

Section 2: Main challenges to be addressed in your TCLs

10. A) What are the main challenges your coastal community is facing today? *

Please, weight each of them using the following scale:
a. Not relevant at all for the community
b. Relevant to some extent for part of the community
c. Relevant to some extent for the whole community
d. Very relevant for part of the community
e. Very relevant for the whole community
f. Extremely relevant: Priority number one to tackle by the community
g. I don't know

(If you don't see all the columns a - g, please scroll right.)

Mark only one oval per row.

	a. Not relevant at all for the whole community	b. Relevant to some extent for part of the community	c. Relevant to some extent for the whole community	d. Very relevant for part of the community	e. Very relevant for the whole community	f. Extrem releva Priori numb one t tackle the commu
A.1. Coastal / Beach erosion (e.g. Is it safe to build here, or will erosion increase?)						
A.2. Marine pollution (e.g. Is it safe to swim here, or is the water too polluted? Is it safe to eat fish caught here, or do they contain too many contaminants? Do you see a lot of plastic and other garbage floating)						

A.3. Fishing stocks decline (e.g. Are small-scale fisheries and fishing industry suffering from declining fishing stocks? Can leisure fishermen catch as much fish (and fish species) as the former generation? Are fishing stocks being overharvested or have coastal communities still the possibility to have fishing activities?)						
A.4. Weather patterns (e.g. Have you noticed that storminess, flooding due to sea level rise, flash floods, etc. increased?)						
A.5. Land degradation & deteriorating ecosystems (e.g. Is it wise to invest in tourism development or other projects here, or will the area lose its attractiveness due to other						

land use / developments?)						
A.6. Population growth in coastal areas (e.g. Have you noticed that the effects of booming population growth and economic and technological development are occurring here?)						
A.7. Economic development and competing demands (e.g. Do you observe unprecedented pressure on the economic development of their resources?)						
A.8. Loss of coastal biodiversity (e.g. Are the unique coastal ecosystems and their functions threatened due to habitat conversion, land cover change, pollutant loads, and introduction of invasive species, etc?)						

A.9. Water quality (e.g. Is pollution from industry, agriculture, and urban areas degrading the quality of much water?)	○	○	○	○	○	○
A.10. Conflicts with predators (e.g. predator-human conflicts, or predator-farm animal/fish conflicts.)	○	○	○	○	○	○
A.11. Conflicts between different users of the sea / with land users.	○	○	○	○	○	○

11. Please elaborate or comment on your answers to question A) in the box below.

12. B) What types of other societal challenges are at play in your TCL? *

Please, weight each of them using the following scale:
a. Not relevant at all for the whole community
b. Relevant to some extent for part of the community
c. Relevant to some extent for the whole community
d. Very relevant for part of the community
e. Very relevant for the whole community
f. Extremely relevant: Priority number one to tackle by the community
g. I don´t know

(If you don't see all the columns a - g, please scroll right.)

Mark only one oval per row.

	a. Not relevant at all for the whole community	b. Relevant to some extent for part of the community	c. Relevant to some extent for the whole community	d. Very relevant for part of the community	e. Very relevant for the whole community	E n l r t co
B.1. Gender segregated labour force						
B.2. Ethnically segregated labour force						
B.3. Outmigration of young people						
B.4. Lack of higher educational opportunities						
B.5. Lack of career opportunities for professionals/higher educated						
B.6. Poor connectivity/mobility						

/transport networks					
B.7. Seasonal influx of people/heightened holiday home demands	○	○	○	○	○
B.8. Lack of investment in local area	○	○	○	○	○
B.9. Skewed gender ratios in population	○	○	○	○	○
B.10. Challenges adding and capturing value locally to raw materials/resources (e.g., fish processing for higher-value products)	○	○	○	○	○
B.11. Generational labour change (e.g. 'greying of the fleet' in fisheries)	○	○	○	○	○
B.12. Over-use/over-tourism	○	○	○	○	○

13. In question B), how are any of the challenges rated d, e or f related to the fact that you are living near the sea? Please elaborate or comment on your answers in the box below.

Section 3: Next steps of the Eklipse process

Many thanks for your input to the Eklipse initial scoping on:
Request n°1: Nexus between Nature-Based Solutions (NBS), Ecosystem Services (ES) and Coastal Challenges (CC) in the paradigm of sustainable development.

Request n°2: "Development of an empowerment framework tailored to coastal resilience (including a review of existing empowerment tools).

The series of steps within the scoping phase go as follow:

- EmpowerUs and Eklipse to decide on composition of requester consortium
- Eklipse analyses the answers to the survey
- Eklipse starts a process of dialogue with the requesters and other relevant stakeholders
- Through the dialogue and the pre-screening on existing reviews/assessments and national reports and potentially a Call for Knowledge, the requests will be refined and reformulated.
- A document of work (DoW) that collates the results of the survey, the literature screening as well as a summary of requester expectations, methodological options, timeline and potential outcomes will be produced.
- If both requesters and Eklipse Knowledge Coordination Body (KCB) agree on the DoW, it will be shared publicly and available on the Eklipse website (Answers to the survey will be anonymised).
- Eklipse develops and launches a Call for Experts and sets up an independent Expert Working Group (EWG),selected by Eklipse Knowledge Coordination Body (KCB). The EWG will be responsible of the answering process of the requests in the agreed timeline
- Following Eklipse ethical infrastructure, Requesters are not allowed to be part of the Expert Working Group and are not part of the selection committee. During the dialogue phase and depending on requester expectations and Eklipse guidelines, it should be decided on whether TCL experts would be eligible to apply to the Call for Experts.

14. Any additional comment?

15. *

By answering the following survey, I agree to the collection, storage and use by Eklipse team of the information provided by me. I retain the right to ask Eklipse to delete all my personal data at any moment. For further information: http://eklipse.eu/privacy-policy/

Mark only one oval.

- Yes
- No

Please don´t forget to finalize the survey by clicking on the button "submit" in the next page.

ANNEX 1b. Answers to the survey sent to the TCLs during the scoping phase

ANSWERS OF THE EKLIPSE SURVEY

EMPOWERUS REQUESTS

BACKGROUND INFORMATION FOR PARTICIPANTS

Dear EmpowerUs TCLs Teams,

We kindly invite you all to participate in a first short EmpowerUs survey, in order to support Eklipse having a better understanding of the Transition Coastal Labs (TCLs) challenges before starting the evidence synthesis processes of the two initial questions proposed in the EmpowerUs proposal (Task 4.1). The aim of this survey is mainly to support the Eklipse Scoping Phase during which the initial questions will be discussed, refined and reformulated to meet the evidence needs of the requesters by 1) defining who should be the requesters for the EmpowerUs requests (see section 1) and 2) defining the main challenges to be addressed in your TCLs (see section 2.).

Completing this survey should take approximately 10-15 minutes and is open **until January 6th, 2022**

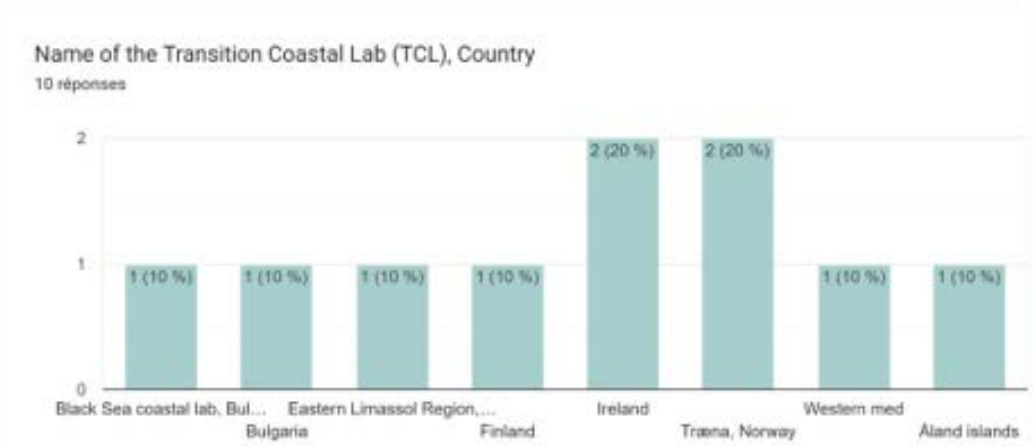
Many thanks in advance for your input to the Survey for the Eklipse requests. If you have any question, please contact us at: candice.pouget@ufz.de

Eklipse was created in 2016 to help governments, institutions, businesses, and NGOs make better-informed decisions when it comes to biodiversity and ecosystem services in Europe. *Eklipse is a science-policy mechanism of the public interest. The lawful basis for processing your personal data under the EU's General Data Protection Regulation (GDPR) will be a public task. Our privacy policy (http://eklipse.eu/privacy-policy/) contains further information on the purpose and lawful basis for processing your personal data.*

SUMMARY OF THE ANSWERS FROM THE PARTICIPANTS

(ANONYMISED, FROM THE FORM)

1. NAME OF THE TRANSITION COASTAL LAB (TCL), COUNTRY



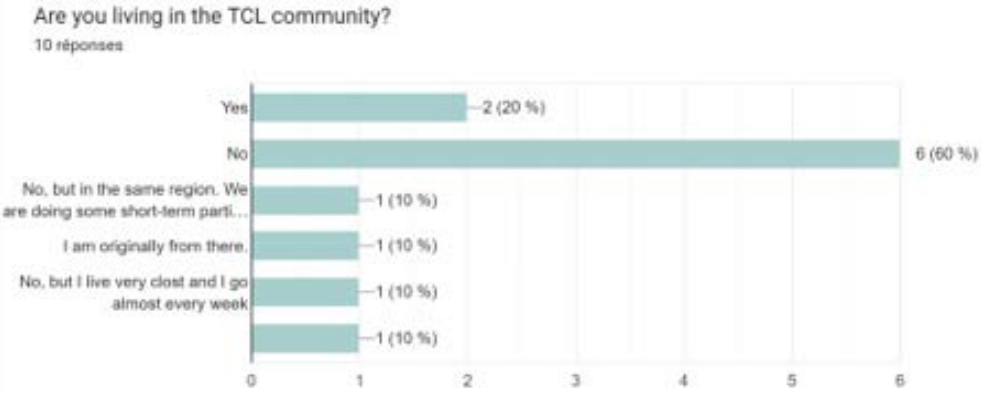
2. ROLE IN EMPOWERUS

Role in EmpowerUs

9 responses

- Academic leads
- Academic host
- Transition Coastal Lab
- Academic Lead
- Academic
- TCL Academic Lead
- WP lead
- IP OF CASE STUDY
- TCL Host

3. ARE YOU LIVING IN A TCL COMMUNITY?



4. WHICH OF THE FOLLOWING GROUP(S) OF STAKEHOLDERS ARE YOU WORKING CLOSELY WITHIN YOUR TCLS?

SECTION 1: DEFINITION OF THE REQUESTERS FOR THE EMPOWERUS KNOWLEDGE SYNTHESIS NEEDS

WHO SHOULD BE PART OF THE REQUESTER CONSORTIUM?

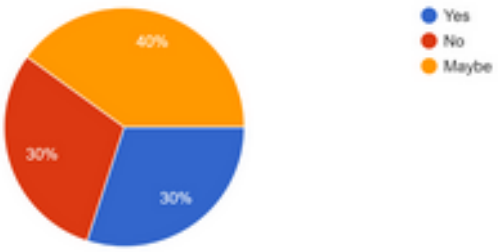
Who should be part of the requester consortium?
10 réponses

If you choose "Other", please specify
1 response

Civil Society in order to ensure real bottom-up processes

WOULD YOU BE INTERESTED IN BEING APPOINTED TO REPRESENT THE TCLS IN THE REQUESTER CONSORTIUM?

Would you be interested in being appointed to represent the TCLs in the requester consortium?
10 réponses



SECTION 2: MAIN CHALLENGES TO BE ADDRESSED IN YOUR TCLS

7. A) WHAT ARE THE MAIN CHALLENGES YOUR COASTAL COMMUNITY IS FACING TODAY?

GENERAL ANSWERS (please find the answer per item below.)

Please, weight each of them using the following scale:

a. Not relevant at all for the community

b. Relevant to some extent for part of the community

c. Relevant to some extent for the whole community

d. Very relevant for part of the community

e. Very relevant for the whole community

f. Extremely relevant: Priority number one to tackle by the community

g. I don't know

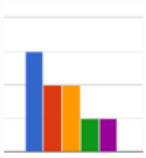
Please elaborate or comment on your answers to question A) in the box below.

RESPONSE 1: Some of these answers are uncertain and must be further investigated in the lab. There are several relatively large projects ongoing/in the starting phase, so we do not yet know the consequences and potential conflicts that may arise from these. In our TCL, the issue is quite the opposite to that of A.6. There are few childbirths and young people are leaving, so there are some concerns regarding the domino effect of this on the population/demographics. Interestingly, there is a housing shortage (due to amongst other things, homes being kept as holiday houses by those outmigrating). Future economic development relies on available housing for employees, and conflicts surrounding who's responsibility it is to provide this is an issue.

RESPONSE 2: Some responses such as for example the issue of extreme storm events are a guess as we are yet to conduct interviews with the communities there to see how they have seen things change.

RESPONSE 3: SOME QUESTIONS ARE NOT SUITABLE FOR OUR CONTEXT. ARE NOT WELL FORMULATED. AN EXAMPLE: THE QUALITY OF WATER WILL BE MEASURED DIFFERENTLY ACCORDING TO THE CONTEXT. IN OUR TCL THE QUALITY OF WATER IS "EXCELLENT". IF YOU GO YOU WILL SEE TRANSPARENT WATERS FOR SWIMMING, BEAUTIFUL CAVES ("CALAS")... NEVERTHELESS, THERE ARE PLASTICS AND MICROPLASTICS, AND FISHERS COMPLAIN ABOUT THIS. THEY COMPLAIN THEY FISH PLASTICS. THERE ARE ALSO CAMPAIGNS FOR CLEANING BEACHES AND CAVES ("CALAS") ORGANIZED BY FISHERS AND CIVIL SOCIETY TOGETHER. THIS IS ONLY AN EXAMPLE, THERE ARE OTHER QUESTIONS NOT WELL FORMULATED...A.5, A.6, A.7, not suitable. A.11 IS NOT UNDERSTANDABLE.....THERE ARE TENSIONS OR COMPETITION (NOT CONFLICTS...WHAT DO YOU UNDERSTAND BY CONFLICTS? PROBLEMS REPORTED TO POLICE?...THIS IS NOT VERY WELL FORMULATED AND MAY PRODUCE SOME CONFUSION)...QUESTION A.5 IS NOT RELEVANT TO OUR TCL. WE HAVE TOURISM DEVELOPMENT SINCE THE 50s IN THE XXth century. AND NOW IS ONE OF THE MAJOR PROBLEMS...IT IS EXPECTED MAY THERE BE NEW THREATS TO BIODIVERSITY, FOR EX. MEGA PROJECTS IN FRONT OF THE MPA IN SPECIALLY VULNERABLE AREAS

ANSWERS FOR EACH ITEM

A.1. COASTAL / BEACH EROSION (E.G. IS IT SAFE TO BUILD HERE, OR WILL EROSION INCREASE?) Please, weight each of them using the following scale: a. Not relevant at all for the community b. Relevant to some extent for part of the community c. Relevant to some extent for the whole community d. Very relevant for part of the community e. Very relevant for the whole community f. Extremely relevant. Priority number one to tackle by the community g. I don't know	
A.2. MARINE POLLUTION (E.G. IS IT SAFE TO SWIM HERE, OR IS THE WATER TOO POLLUTED? IS IT SAFE TO EAT FISH CAUGHT HERE, OR DO THEY CONTAIN TOO MANY CONTAMINANTS? DO YOU SEE A LOT OF PLASTIC AND OTHER GARBAGE FLOATING) Please, weight each of them using the following scale: a. Not relevant at all for the community b. Relevant to some extent for part of the community c. Relevant to some extent for the whole community d. Very relevant for part of the community e. Very relevant for the whole community f. Extremely relevant. Priority number one to tackle by the community g. I don't know	
A.3. FISHING STOCKS DECLINE (E.G. ARE SMALL-SCALE FISHERIES AND FISHING INDUSTRY SUFFERING FROM DECLINING FISHING STOCKS? CAN LEISURE FISHERMEN CATCH AS MUCH FISH (AND FISH SPECIES) AS THE FORMER GENERATION? ARE FISHING STOCKS BEING OVERHARVESTED OR HAVE COASTAL COMMUNITIES STILL THE POSSIBILITY TO HAVE FISHING ACTIVITIES?) Please, weight each of them using the following scale: a. Not relevant at all for the community b. Relevant to some extent for part of the community c. Relevant to some extent for the whole community d. Very relevant for part of the community e. Very relevant for the whole community f. Extremely relevant. Priority number one to tackle by the community g. I don't know	

A.4. WEATHER PATTERNS (E.G. HAVE YOU NOTICED THAT STORMINESS, FLOODING DUE TO SEA LEVEL RISE, FLASH FLOODS, ETC. INCREASED?)

Please, weight each of them using the following scale:

a. Not relevant at all for the community
b. Relevant to some extent for part of the community
c. Relevant to some extent for the whole community
d. Very relevant for part of the community
e. Very relevant for the whole community
f. Extremely relevant: Priority number one to tackle by the community
g. I don't know

A.5. LAND DEGRADATION & DETERIORATING ECOSYSTEMS (E.G. IS IT WISE TO INVEST IN TOURISM DEVELOPMENT OR OTHER PROJECTS HERE, OR WILL THE AREA LOSE ITS ATTRACTIVENESS DUE TO OTHER LAND USE / DEVELOPMENTS?)

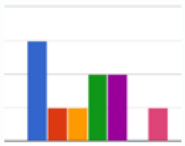
Please, weight each of them using the following scale:

a. Not relevant at all for the community
b. Relevant to some extent for part of the community
c. Relevant to some extent for the whole community
d. Very relevant for part of the community
e. Very relevant for the whole community
f. Extremely relevant: Priority number one to tackle by the community
g. I don't know

A.6. POPULATION GROWTH IN COASTAL AREAS (E.G. HAVE YOU NOTICED THAT THE EFFECTS OF BOOMING POPULATION GROWTH AND ECONOMIC AND TECHNOLOGICAL DEVELOPMENT ARE OCCURRING HERE?)

ase, weight each of them using the following scale:

a. Not relevant at all for the community
b. Relevant to some extent for part of the community
c. Relevant to some extent for the whole community
d. Very relevant for part of the community
e. Very relevant for the whole community
f. Extremely relevant: Priority number one to tackle by the community
g. I don't know



A.7. ECONOMIC DEVELOPMENT AND COMPETING DEMANDS (E.G. DO YOU OBSERVE UNPRECEDENTED PRESSURE ON THE ECONOMIC DEVELOPMENT OF THEIR RESOURCES?)

Please, weight each of them using the following scale:

a. Not relevant at all for the community
b. Relevant to some extent for part of the community
c. Relevant to some extent for the whole community
d. Very relevant for part of the community
e. Very relevant for the whole community
f. Extremely relevant: Priority number one to tackle by the community
g. I don't know

A.8. LOSS OF COASTAL BIODIVERSITY (E.G. ARE THE UNIQUE COASTAL ECOSYSTEMS AND THEIR FUNCTIONS THREATENED DUE TO HABITAT CONVERSION, LAND COVER CHANGE, POLLUTANT LOADS, AND INTRODUCTION OF INVASIVE SPECIES, ETC?)

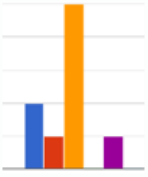
Please, weight each of them using the following scale:

a. Not relevant at all for the community
b. Relevant to some extent for part of the community
c. Relevant to some extent for the whole community
d. Very relevant for part of the community
e. Very relevant for the whole community
f. Extremely relevant: Priority number one to tackle by the community
g. I don't know

A.9. WATER QUALITY (E.G. IS POLLUTION FROM INDUSTRY, AGRICULTURE, AND URBAN AREAS DEGRADING THE QUALITY OF MUCH WATER?)

Please, weight each of them using the following scale:

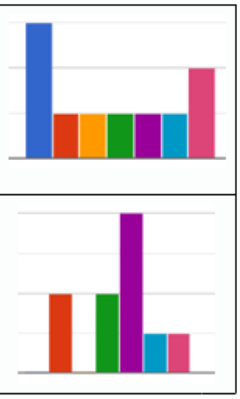
a. Not relevant at all for the community
b. Relevant to some extent for part of the community
c. Relevant to some extent for the whole community
d. Very relevant for part of the community
e. Very relevant for the whole community
f. Extremely relevant: Priority number one to tackle by the community
g. I don't know



A.10. CONFLICTS WITH PREDATORS (E.G. PREDATOR-HUMAN CONFLICTS, OR PREDATOR-FARM ANIMAL/FISH CONFLICTS.)

Please, weight each of them using the following scale:

a. Not relevant at all for the community
b. Relevant to some extent for part of the community
c. Relevant to some extent for the whole community
d. Very relevant for part of the community
e. Very relevant for the whole community
f. Extremely relevant: Priority number one to tackle by the community
g. I don't know



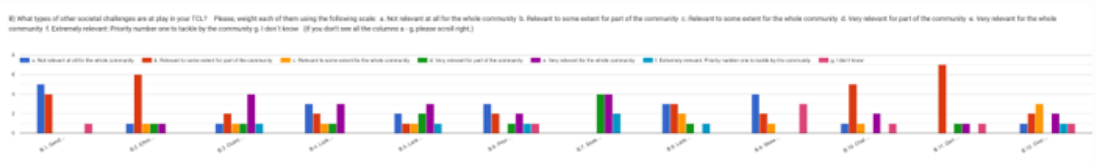
A.11. CONFLICTS BETWEEN DIFFERENT USERS OF THE SEA / WITH LAND USERS.

Please, weight each of them using the following scale:

a. Not relevant at all for the community
b. Relevant to some extent for part of the community
c. Relevant to some extent for the whole community
d. Very relevant for part of the community
e. Very relevant for the whole community
f. Extremely relevant: Priority number one to tackle by the community
g. I don't know

9. B) WHAT TYPES OF OTHER SOCIETAL CHALLENGES ARE AT PLAY IN YOUR TCL?

GENERAL ANSWERS (please find the answer per item below.)



Please, weight each of them using the following scale:

a. Not relevant at all for the community
b. Relevant to some extent for part of the community
c. Relevant to some extent for the whole community
d. Very relevant for part of the community
e. Very relevant for the whole community
f. Extremely relevant: Priority number one to tackle by the community
g. I don't know

In question B), how are any of the challenges rated d, e or f related to the fact that you are living near the sea? Please elaborate or comment on your answers in the box below.

RESPONSE 1: A majority of them are indirectly linked to the fact that the lab is on an island out in the sea, but mostly due to the long distance to the mainland and other cities. An ethnically segregated labour force is quite common in rural coastal communities of Norway where the fish industry and tourism are a major economic activities. However, it is also common in other lower-paid sectors of the economy, such as construction work, all over Norway. In both the fish and construction industries, a large part of the seasonal workers is from Eastern Europe. B.3., B.4. and B.5.: The outmigration of young people is common in rural areas all over Norway, and especially in northern Norway. It doesn't help that the youth have to go other places from grade 11 and onwards, in addition to having few employment options to come back to after having finished higher education. With such few people and few pupils, it does not make sense to have higher education opportunities on the island, however, a more diverse job market could potentially attract the youth enough to return after finishing their studies. B.6. There have been many demonstrations and "fights" with the county government for a better transportation, both between the islands within the municipality and between the islands and the mainland. The county government can only provide so many routes and has to plan for many coastal towns. Many still complain a lot about the lack of connectivity with other transportation methods once

they arrive to the mainland. B.7. During the summertime there is a large influx of tourists, especially during the Tregna music festival. Additionally, several cruise ships arrive with large amounts of people, that want something to do and something to see. Some of the actors we have talked to say there are too few amenities and activities for the cruise tourists. For those who do not come in cruises and do not own holiday homes, there is a limited accommodation offer. A new hotel is currently in the making and might tackle some of these challenges. There are also heightened influx of people from abroad during the high fishing season.

RESPONSE 2: Season: affects summer season as attractor for tourists and expats. Archipelago living = rural living. Same challanges with generational shifts, outmigration and jobs/education.

RESPONSE 3: It does not have to do with the sea but with the governmental policies for specific development in the area. It is also important to say here that there is not a very long distance between the communities at hand and the bigger cities of Limassol and Larnaca. Commuting is therefore not an issue for higher educated professionals.

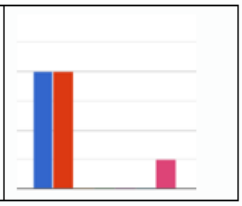
RESPONSE 4: Tourism is a major pressure linked to coastal resorts and the Wild Atlantic Way tourism initiative.

RESPONSE 5: The sea and the coast, specially the spanish one, have been for decades a touristic attraction.

ANSWERS FOR EACH ITEM

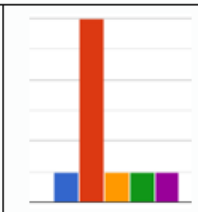
GENDER SEGREGATED LABOUR FORCE

se, weight each of them using the following scale:



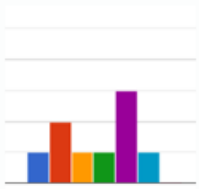
ETHNICALLY SEGREGATED LABOUR FORCE

se, weight each of them using the following scale:



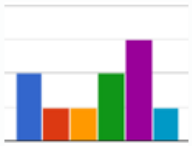
OUTMIGRATION OF YOUNG PEOPLE

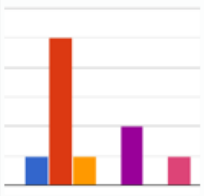
se, weight each of them using the following scale:



LACK OF HIGHER EDUCATIONAL OPPORTUNITIES

se, weight each of them using the following scale:

LACK OF CAREER OPPORTUNITIES FOR PROFESSIONALS/HIGHER EDUCATED ase, weight each of them using the following scale: a. Not relevant at all for the community b. Relevant to some extent for part of the community c. Relevant to some extent for the whole community d. Very relevant for part of the community e. Very relevant for the whole community f. Extremely relevant: Priority number one to tackle by the community g. I don't know	
POOR CONNECTIVITY/MOBILITY/TRANSPORT NETWORKS ase, weight each of them using the following scale: a. Not relevant at all for the community b. Relevant to some extent for part of the community c. Relevant to some extent for the whole community d. Very relevant for part of the community e. Very relevant for the whole community f. Extremely relevant: Priority number one to tackle by the community g. I don't know	
SEASONAL INFLUX OF PEOPLE/HEIGHTENED HOLIDAY HOME DEMANDS ase, weight each of them using the following scale: a. Not relevant at all for the community b. Relevant to some extent for part of the community c. Relevant to some extent for the whole community d. Very relevant for part of the community e. Very relevant for the whole community f. Extremely relevant: Priority number one to tackle by the community g. I don't know	

LACK OF INVESTMENT IN LOCAL AREA ase, weight each of them using the following scale: a. Not relevant at all for the community b. Relevant to some extent for part of the community c. Relevant to some extent for the whole community d. Very relevant for part of the community e. Very relevant for the whole community f. Extremely relevant: Priority number one to tackle by the community g. I don't know	
SKEWED GENDER RATIOS IN POPULATION ase, weight each of them using the following scale: a. Not relevant at all for the community b. Relevant to some extent for part of the community c. Relevant to some extent for the whole community d. Very relevant for part of the community e. Very relevant for the whole community f. Extremely relevant: Priority number one to tackle by the community g. I don't know	
0. CHALLENGES ADDING AND CAPTURING VALUE LOCALLY TO RAW MATERIALS/RESOURCES (E.G., FISH PROCESSING FOR HIGHER-VALUE PRODUCTS) ase, weight each of them using the following scale: a. Not relevant at all for the community b. Relevant to some extent for part of the community c. Relevant to some extent for the whole community d. Very relevant for part of the community e. Very relevant for the whole community f. Extremely relevant: Priority number one to tackle by the community g. I don't know	

1. GENERATIONAL LABOUR CHANGE (E.G. 'GREYING OF THE FLEET' IN FISHERIES) ase, weight each of them using the following scale: a. Not relevant at all for the community b. Relevant to some extent for part of the community c. Relevant to some extent for the whole community d. Very relevant for part of the community e. Very relevant for the whole community f. Extremely relevant: Priority number one to tackle by the community g. I don't know	
2. OVER-USE/OVER-TOURISM ase, weight each of them using the following scale: a. Not relevant at all for the community b. Relevant to some extent for part of the community c. Relevant to some extent for the whole community d. Very relevant for part of the community e. Very relevant for the whole community f. Extremely relevant: Priority number one to tackle by the community g. I don't know	

ANNEX 2a. References screened literature - Scientific literature

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ANNEX 3. Table of definitions for the "resilience" concept.

ECOLOGICAL DEFINITIONS		
Title of the study	**Citation**	**Definition**
Simulation modelling for a resilience improvement plan for natural disasters in a coastal area	Song, K. et al.2018 "Simulation modelling for a resilience improvement plan for natural disasters in a coastal area". Environmental Pollution, Volume 242, Part B, 2018. Pages 1970-1980, ISSN 0269-7491, https://doi.org/10.1016/j.envpol.2018.07.057	"Resilience means the ability of a set of variables to absorb changes from an unexpected catastrophic disaster and return to the original stable state"
Green infrastructure in comprehensive plans in coastal Texas	Woodruff, S. et al. 2021. "Green infrastructure in comprehensive plans in coastal Texas", Journal of Environmental Planning and Management, 64:9, 1578-1598, https://doi.org/10.1080/09640568.2020.1835618	"Urban resilience emphasises the ability to maintain or return to desired functions in the face of disturbance and ability to adapt to change.
Experience of localised flooding predicts urban flood risk perception and perceived safety of nature-based solutions	Li J, Nassauer JI, Webster NJ, Preston SD and Mason LR 2022. "Experience of localised flooding predicts urban flood risk perception and perceived safety of 2 nature-based Solutions". Front. Water 4:1075790. doi: 10.3389/frwa.2022.1075790	"The capacity to absorb, recover from, and adapt to extreme storm events and their uncertain impacts (Liao, 2012; Disse et al., 2020; Mcclymont et al., 2020)".
Re-thinking the Territory of Concepcion, Chile: A Resilient and Strategic Planning for a Vulnerable Urban Coastal System	Rey Hernández, C., Tillie, N. (2020). Re-thinking the Territory of Concepción, Chile: A Resilient and Strategic Planning for a Vulnerable Urban Coastal System. In: Moore, J., Attia, S., Abdel-Kader, A.,	The concept of resilience can be defined as a "Mechanism to manage risk and vulnerability and the capacity to absorb shocks, uncertainty and change through renewal-organisation-adaptation" (Laboy and Fannon 2016). In that sense, resilience is about the capacity of a system to preserve and restore the physical environment's normal function in the face of shocks and disturbances of limited duration.

	Narasimhan, A. (eds) Ecocities Now. Springer, Cham. https://doi.org/10.1007/978-3-030-58399-6_4	
The ecological imperative for environmental design and planning	Steinet et al. 2013. "The ecological imperative for environmental design and planning". Frontiers in Ecology and the Environment. https://doi.org/10.1890/130052	According to the ecologist Lance Gunderson and his colleagues, "Resilience has been defined in two different ways in the ecological literature, each reflecting different aspects of stability" (…).
Planning coastal Mediterranean stone pine (Pinus pinea L.) reforestations as a green infrastructure: combining GIS techniques and statistical analysis to identify management options	Portoghesi et al. 2022. "Planning coastal Mediterranean stone pine (Pinus pinea L.) reforestations as a green infrastructure: combining GIS techniques and statistical analysis to identify management options". Annals of Forest Research. VOL. 65 NO. 1 (2022) / Research article. DOI: https://doi.org/10.15287/afr.2022.2176	"Capacity of a landscape to adapt over time".
SOCIAL DEFINITIONS		
Title of the study	**Citation**	**Definition**
Assessing social innovation across offshore sectors in the Dutch North Sea	Soma, K. et al., 2019. "Assessing social innovation across offshore sectors in the Dutch North Sea". Ocean & Coastal Management, Volume 167, 2019, Pages 42-51, ISSN 0964-5691, https://doi.org/10.1016/j.ocecoaman.2018.10.003.	"As such, adaptive capacity can be defined as a source or component of the resilience of a system. Notably, social innovation builds resiliency and fosters resilient solutions to adapt and survive".

Advancing disaster risk reduction through the integration of science, design, and policy into eco-engineering and several global resource management processes	Whelchel, A.W. et al. 2018. "Advancing disaster risk reduction through the integration of science, design, and policy into eco-engineering and several global resource management processes". International Journal of Disaster Risk Reduction, Volume 32, 2018, Pages 29-41, ISSN 2212-4209, https://doi.org/10.1016/j.ijdrr.2018.02.030.	"Resilience, as considered in this paper is defined as "the capacity of (…) systems to cope with a hazardous event or trend or disturbance, responding or reorganising in ways that maintain their essential function, identity and structure, while also maintaining the capacity for adaptation, learning and transformation".
SOCIO-ECOLOGICAL DEFINITIONS		
Title of the study	**Citation**	**Definition**
Empowering hope-based climate change communication techniques for the Gulf of Maine	Steiner, F. 2013. "Empowering hope-based climate change communication techniques for the Gulf of Maine". Front Ecol Environ 2013; 11(7): 355–361, doi:10.1890/130052	"Resilient communities work together to protect the people and places that matter to them."
Building Resilience through Collaborative Management of Coastal Protection and Restoration Planning in Plaquemines Parish, Louisiana, USA	Hemmerling, S.A.; DeMyers, C.A.; Carruthers, T.J.B. Building Resilience through Collaborative Management of Coastal Protection and Restoration Planning in Plaquemines Parish, Louisiana, USA. Sustainability 2022, 14, 2974. https://doi.org/10.3390/su14052974	(…) resilience, which consists of a set of practices that these same local resource users deploy to cope with environmental disturbances and that are retained in their collective memory.
Linking climate change mitigation and adaptation through coastal green–gray infrastructure: a perspective	Tomohiro Kuwae & Stephen Crooks .2021. Linking climate change mitigation and adaptation through coastal green–grey infrastructure: a perspective, Coastal Engineering Journal, 63:3, 188-199, DOI:	"Resilience, at the core, requires systemic thinking, where the built and natural elements of the landscape are considered together as infrastructure".

	10.1080/21664250.2021.1935581	
Exploring the Role of Outdoor Recreation to Contribute to Urban Climate Resilience	Beery, T. 2019. "Exploring the Role of Outdoor Recreation to Contribute to Urban Climate Resilience". Sustainability 2019, 11, 6268. https://doi.org/10.3390/su11226268	"The Stockholm Resilience Center defines resilience as the capacity of a system, be it an individual, a forest, a city or an economy, to deal with change and continue to develop. Drawing on these ideas, a useful way to describe socio-ecological resilience is the flexibility that allows for systems to adjust to disruption".
Sustainable Land-Use Planning to Improve the Coastal Resilience of the Social-Ecological Landscape	Kim, M.; You, S.; Chon, J.; Lee, J. 2017. "Sustainable Land-Use Planning to Improve the Coastal Resilience of the Social-Ecological Landscape". Sustainability 2017, 9, 1086. https://doi.org/10.3390/su9071086	Resilience has been classified into the following three categories: "geological resilience", which is the ability to return to the original coastal topography of the area; "ecological resilience", which is the ability to maintain biodiversity and the structure and function of the ecological network; and "social economic resilience", which includes economic effects such as flood prevention and recreational value]. By conducting a comprehensive analysis, some researchers have derived optimal land-use plans and classified resilience into three categories (local-communities' resilience, economic resilience, and ecological resilience).
Engaging the Private Homeowner: Linking Climate Change and Green Stormwater Infrastructure	Beery, T. 2018. "Engaging the Private Homeowner: Linking Climate Change and Green Stormwater Infrastructure". Sustainability 2018, 10, 4791. https://doi.org/10.3390/su10124791	"Resilience refers to the capacity of a system to adapt to disturbance in ways that allow the system to reorganise, while maintaining function and identity".
Living shorelines enhanced the resilience of saltmarshes to Hurricane Matthew	Smith, C.S. et al. 2018. "iving shorelines enhanced the resilience of saltmarshes to Hurricane Matthew /2016). Ecological applications. Volume28, Issue4. June 2018. Pages 871-877	"Resilience has been defined as the ability of an ecosystem or community to "bounce back" from or adjust flexibly to an external disturbance".(Timmerman 1981).

	https://doi.org/10.1002/eap.1722	
Implementing ecosystem-based management: evolution or revolution?	Berkes, F. 2011. "Implementing ecosystem-based management: evolution or revolution? Fish and Fisheries. Volume13, Issue4 December 2012. Pages 465-476 https://doi.org/10.1111/j.1467-2979.2011.00452.x	"Resilience theory uses the term social-ecological system, the complex adaptive system that includes social (human) and ecological (biophysical) subsystems in a two-way feedback relationship (Chapin et al. 2009; Berkes 2011). The social-ecological system can be used as the unit of analysis, with the assumption that the delineation between social and ecological systems is artificial and arbitrary".
Stakeholder-defined scientific needs for coastal resilience decisions in the Northeast U.S.	Grace D. Molino, Melissa A. Kenney, Ariana E. Sutton-Grier. 2020. "Stakeholder-defined scientific needs for coastal resilience decisions in the Northeast U.S". Marine Policy, Volume 118, 2020, 103987, ISSN 0308-597X https://doi.org/10.1016/j.marpol.2020.103987	This study uses the definition provided by the 3rd NCA, "an ecological, human, or physical system's ability to persist in the face of disturbance or change and continue to perform certain functions". Issues impacting coastal resilience were considered anything which would affect the natural, built, social, and economic functions of communities within the coastal Northeast.
Engaging faith-based communities for rural coastal resilience: lessons from collaborative learning on the Chesapeake Bay	Miller Hesed, C.D., Van Dolah, E.R. & Paolisso, M. 2020. "Engaging faith-based communities for rural coastal resilience: lessons from collaborative learning on the Chesapeake Bay". Climatic Change 159, 37–57 (2020). https://doi.org/10.1007/s10584-019-02638-9	"Resilience to me means being proactive. Don't wait until it happens. Be there and have strategies in place to deal with it before it gets there, so when it gets there, you know it's coming but you know how to bounce back from it".

Can Forest Managers Plan for Resilient Landscapes? Lessons from the United States National Forest Plan Revision Process	Abrams, J., Greiner, M., Schultz, C. et al. 2021. "Can Forest Managers Plan for Resilient Landscapes? Lessons from the United States National Forest Plan Revision Process". Environmental Management 67, 574–588 (2021). https://doi.org/10.1007/s00267-021-01451-4	"(…) system resilience requires managers to be flexible, adaptive, and experimental at scales "compatible with the scales of critical ecosystem functions" (Holling 1996, p. 32, emphasis removed).
Blue Infrastructure Finance: A new approach, integrating Nature-based Solutions for coastal resilience.	Thiele, T., Alleng, G., Biermann, A., Corwin, E., Crooks, S., Fieldhouse, P., Herr, D., Matthews, N., Roth, N., Shrivastava, A., von Unger, M. and Zeitlberger, J. 2020." Blue Infrastructure Finance: A new approach, integrating Nature-based Solutions for coastal resilience". IUCN, Gland, Switzerland. https://bluenaturalcapital.org/wp2018/wp-content/uploads/2020/03/Blue-Infrastructure-Finance.pd	"Resilience: the capacity of social, economic and environmental systems to cope with a hazardous event or trend or disturbance, responding or re-organising in ways that maintain their essential function, identity and structure, while also maintaining the capacity for adaptation, learning and transformation". (Definition IPCC).
Governing marine protected areas: Social–ecological resilience through institutional diversity	P.J.S. Jones, W. Qiu, E.M. De Santo. 2013. "Governing marine protected areas: Social–ecological resilience through institutional diversity". Marine Policy, Volume 41, 2013, Pages 5-13, ISSN 0308-597X, https://doi.org/10.1016/j.marpol.2012.12.026.	This paper argues that, regardless of the MPA (Marine Protected Areas) governance approach adopted (i.e., government-led, decentralised, private or community-led), resilience in MPA governance systems derives from employing a diversity of inter-connected incentives. The significance of institutional diversity to governance systems parallels that of species diversity to ecosystems, conferring resilience to the overall socio– ecological system. The paper concludes that, in the face of strong driving forces, rather than relying on particular types of incentives and institutions, it is important to recognise that the key to resilience is diversity, both of species in ecosystems and of institutions in governance systems.

Introducing the H2020 AQUACROSS project: Knowledge, Assessment, And Management for AQUAticBiodiversity and Ecosystem Services Across EU Policies.	Lago et al. 2019. "Introducing the H2020 AQUACROSS project: Knowledge, Assessment, and Management for AQUAtic Biodiversity and Ecosystem Services aCROSS EU policies, Science of The Total Environment, Volume 652, 2019, Pages 320-329, ISSN 0048-9697, https://doi.org/10.1016/j.scitotenv.2018.10.076.	Resilience is defined as the "ability to cope with alterations induced by the presence of multiple stressors with unpredictable or no directional environmental change" (Rockströmetal.,2014). "A system is resilient when it retains or returns to its essential features and functions after its elements, processes and structures are subjected to pressure. In AQUACROSS, resilience was not only considered on conceptual grounds but also from a practical perspective to facilitate the integration of knowledge on eco- system functions and services with values, needs and preferences of stakeholders to develop sustainable solutions".
International principles and standards for the practice of ecological restoration. Second edition	Gann, George D.; McDonald, Tein; Walder, Bethanie; Aronson, James; Nelson, Cara R.; Jonson, Justin; Hallett, James G.; Eisenberg, Cristina; Guariguata, Manuel R.; Liu, Junguo; Hua, Fangyuan; Echeverria, Cristian; Gonzales, Emily; Shaw, Nancy; Decleer, Kris; Dixon, Kingsley W. 2019. International principles and standards for the practice of ecological restoration. Restoration Ecology. 27(S1): S1-S46.	**Ecosystem resilience**: "The degree, manner and pace of recovery of ecosystem properties after natural or human disturbance. In plant and animal communities this property is highly dependent on adaptations by individual species to disturbances or stresses experienced during the species' evolution". **Social-ecological resilience**: "The capacity of a complex social–ecological system to absorb disturbance and reorganise while undergoing change such that it retains similar function, structure, identity, and feedback. It is a measure of the extent to which a complex social–ecological system can adapt and persist in the face of threats and stresses".
Salty Urbanism: Towards an Adaptive Coastal Design Framework to Address Sea Level Rise	Huber et al. 2017. "Salty Urbanism: Towards an Adaptive Coastal Design Framework to Address Sea Level Rise". The Plan Journal 2 (2): 389-414, 2017 - doi: 10.15274/tpj.2017.02.02.06	"By adopting ecological terms, architecture and urban design can achieve greater resilience and retool itself with the ability to adapt to changing conditions".

ANNEX 4. Complementary analyses about the contribution of distinct NbS approaches to coastal challenges and resilience

Societal challenges addressed by NbSs

Nearly all challenges were addressed by the implemented types of NbSs approaches. For instance, the predominant ecosystem-based mitigation strategy tackled challenges like climate adaptation, disaster reduction, and water security. These very challenges are also taken into account in the less common practice of forest landscape restoration (Figure A4.1.).

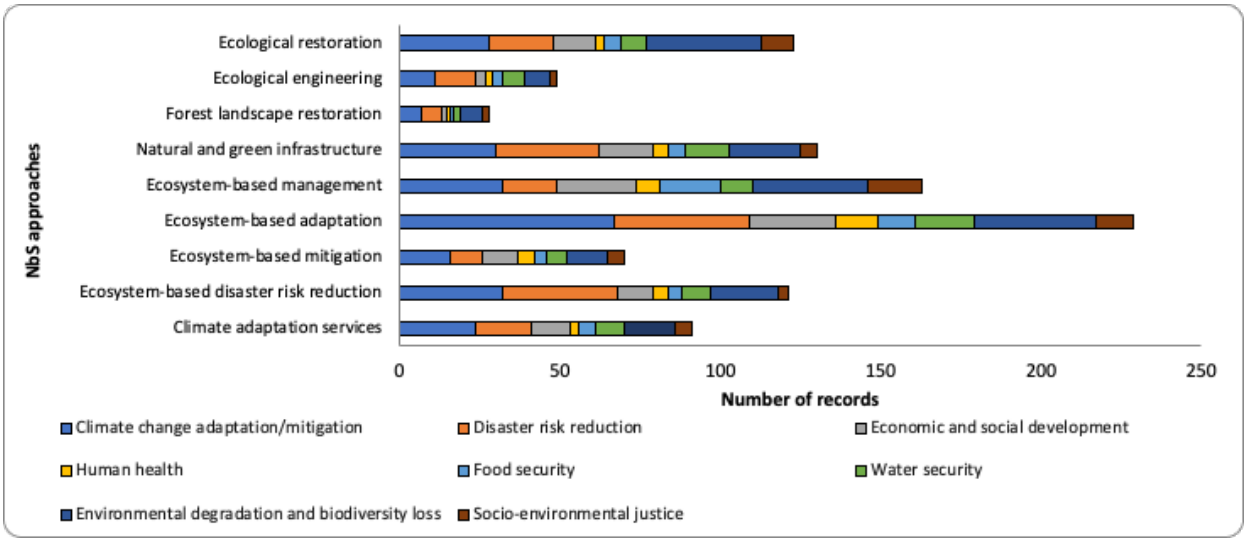

Figure A4.1. Distribution of global societal challenges tackled by distinct NbSs approaches in NbS studies (N=199).

Level of stakeholder engagement achieved by NbSs and direction of governance process

Based on the number of applied approaches, the 'ecosystem-based adaptation', 'ecosystem-based management' and 'ecological restoration' were the approaches providing evidence of the highest two levels of community engagement (Figure A4.2.). Co-creation perspectives were more prominent in studies addressing an 'ecosystem-based adaptation' (N=18) or 'ecosystem-based disaster risk reduction' (N=12) approaches.

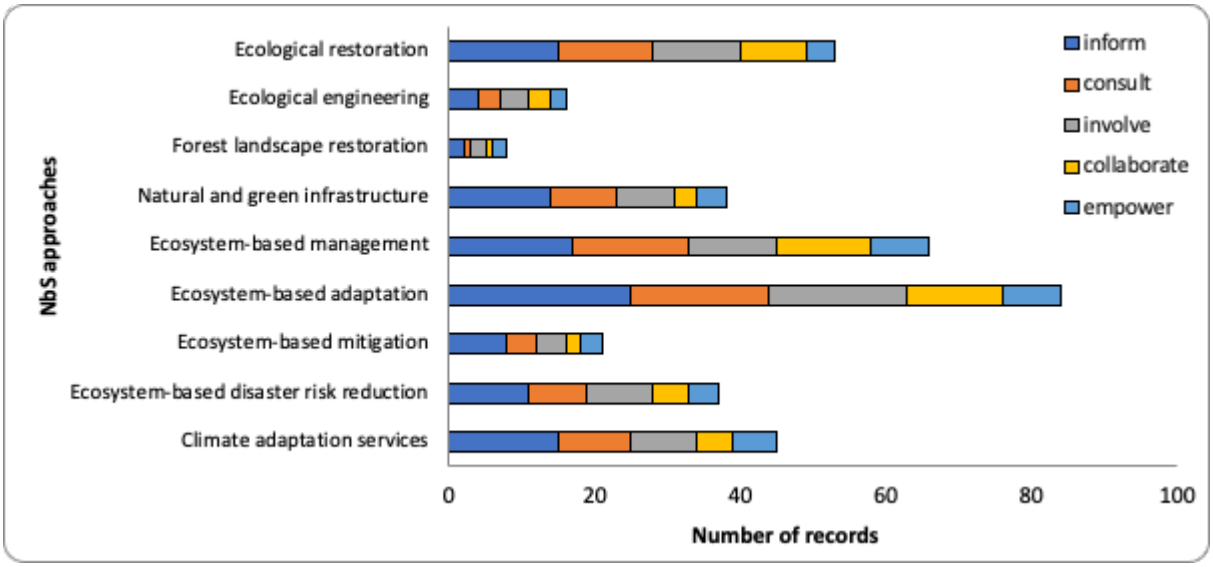

Figure A4.2. Levels of stakeholder engagement achieved according to different NbS approaches in the NbS literature (N=199).

Examples of references purely addressing a 'bottom-up' governance processes were more relevant in NbS approaches like 'ecosystem-based management'; while 'ecosystem-based adaptation' was the approach provided less evidence of directions of governance process in general (Figure A4.3.). For example, the study by Zari et al (2019) argues for the importance of bottom-up processes that engage the community and stakeholders effectively for the success of NBS in Pacific island cities.

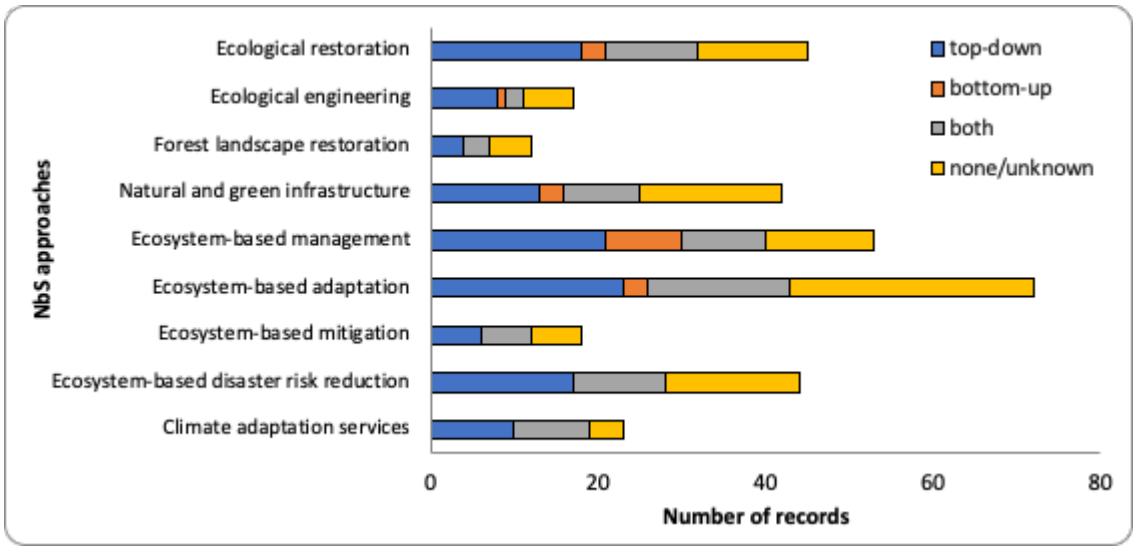

Figure A4.3. Directions of governance processes addressed in different NbS approaches in the reviewed NbS studies (N=199).

NbS project cycle stages' focus

Furthermore, it was observed that NbS approaches such as 'ecosystem-based adaptation' and 'climate adaptation services' were relatively more represented by studies focusing on the evaluation stage; while only approaches like 'ecological restoration', and 'natural and green infrastructure' provided evidence of studies focusing in all stages of the NbS project cycle (Figure A4.4.). A study by Wong et al (2020) evaluated the role of green infrastructure in addressing coastal storm damage in New York City-specifically, they found evidence on the various types, sizes, and configurations of green infrastructure that had helped reduce storm damage from Hurricane Sandy.

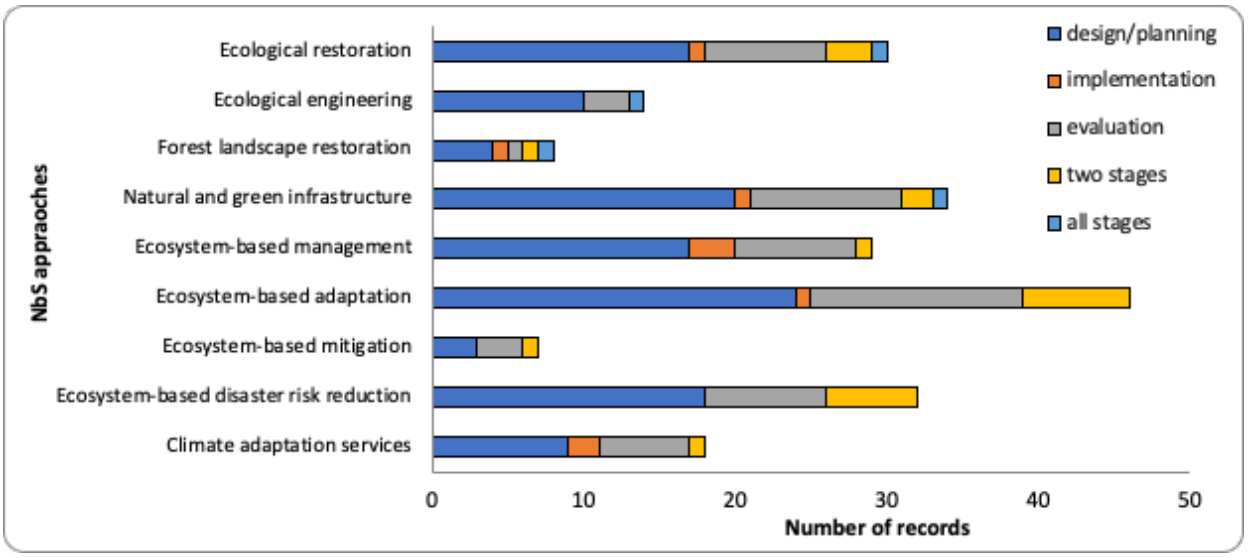

Figure A4.4. Stages of the project cycle addressed by different NbSs approaches in the NbS literature (N=199).

From scientific knowledge to praxis: addressing coastal challenges through NbSs

In our analysis of how various NbS approaches contribute to addressing TCL challenges, we noticed that the majority of these approaches concentrated on ecological/ecosystemic challenges, with socio-economic and knowledge-related challenges receiving comparatively less attention. Notably, legal/regulatory challenges were proportionately more tackled in approaches such as EbM, EbA, and natural and green infrastructure. On the other hand, socio-economic challenges garnered more relative relevance in EbM (Figure A4.5.). A study by Nelson et al (2020) argues that the key challenges relating to the implementation of NBS-ET approaches include lack of clear understanding, limited stakeholder involvement, unclear relations amongst actors, incomplete frameworks, lack of importance of sociocultural co-benefits, lacking long-term objectives, lacking political will, and complex knowledge gaps. The TCLs can help address some of these challenges through their living lab infrastructure, and thus ensure greater success of NBS-ET initiatives.

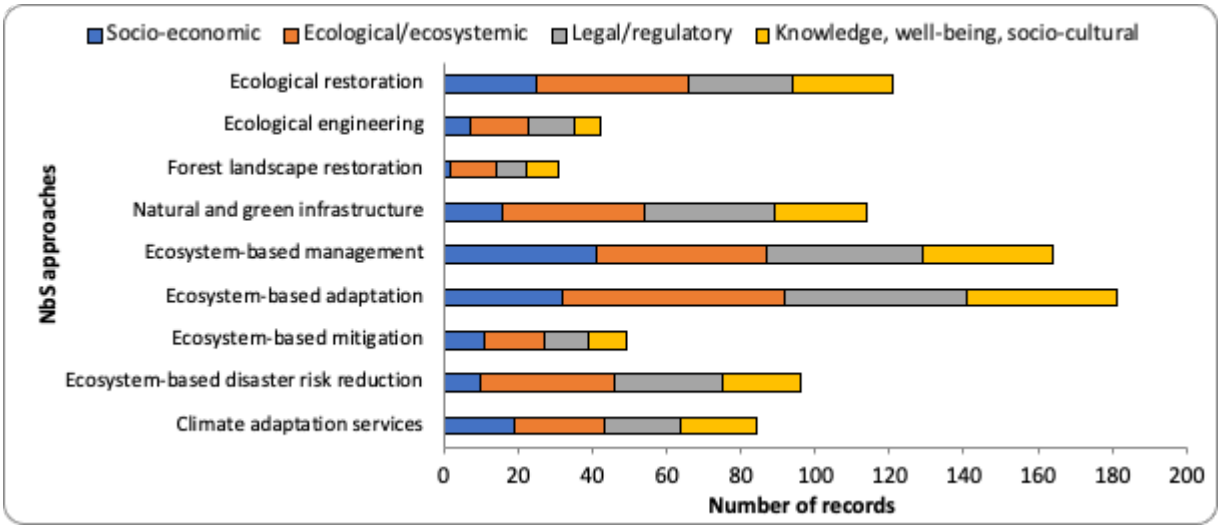

Figure A4.5. Contribution of distinct NbS approaches in addressing Living Lab challenges grouped by domains.

Actions within the community scope and socio-environmental justice were more targeted by studies focusing solely on ETs without NbS co-implementation (Figure A4.6.).

Scopes of action

Actions within the community scope and socio-environmental justice were more targeted by studies focusing solely on ETs without NbS co-implementation (Figure A4.7.). For the empowerment literature, such scopes of actions (ad apted from Salvador Costa et al., 2022) were found to be delineated, whereas papers on NbSs often described measures for specific climate action or adaptation targets but lacked descriptions of scopes and targets.

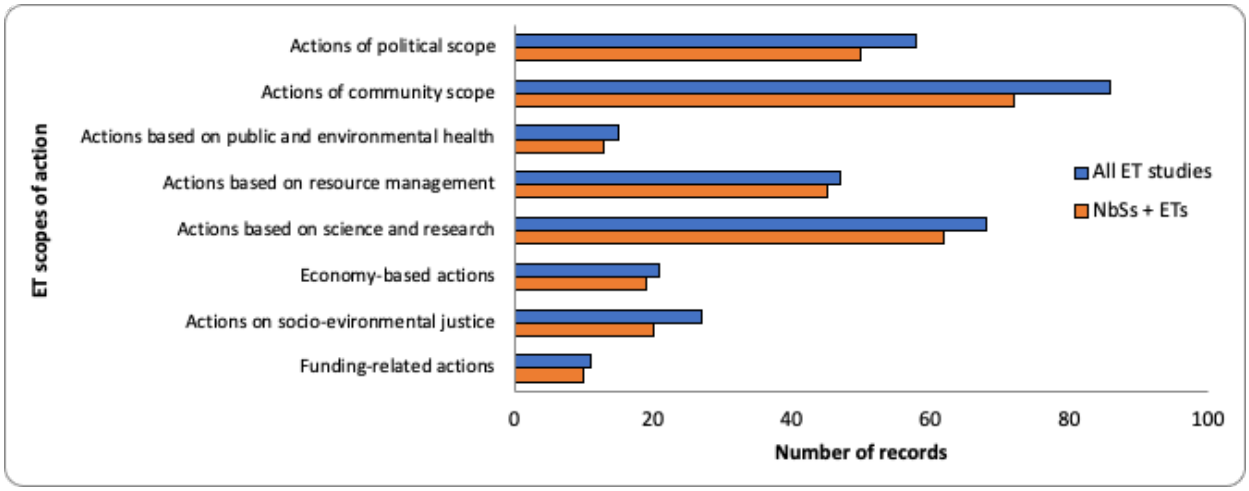

Figure A4.7. Distribution of ET scopes of action in papers addressing NbSs (N=199), and NbSs and ETs (N=132).

For the predominant scopes of action types, such as those of community action, scopes of political or scope and those based on science and research, the number of studies decreased as the level of stakeholder engagement showed ascended (i.e., from ‘inform’ to 'collaborate' or 'empower'). Conversely, other less dominant scopes of action, such as those centred on public and environmental health, economy-based initiatives, and funding-related actions, displayed more equitable proportions across each level of stakeholder engagement (Figure A4.8.).

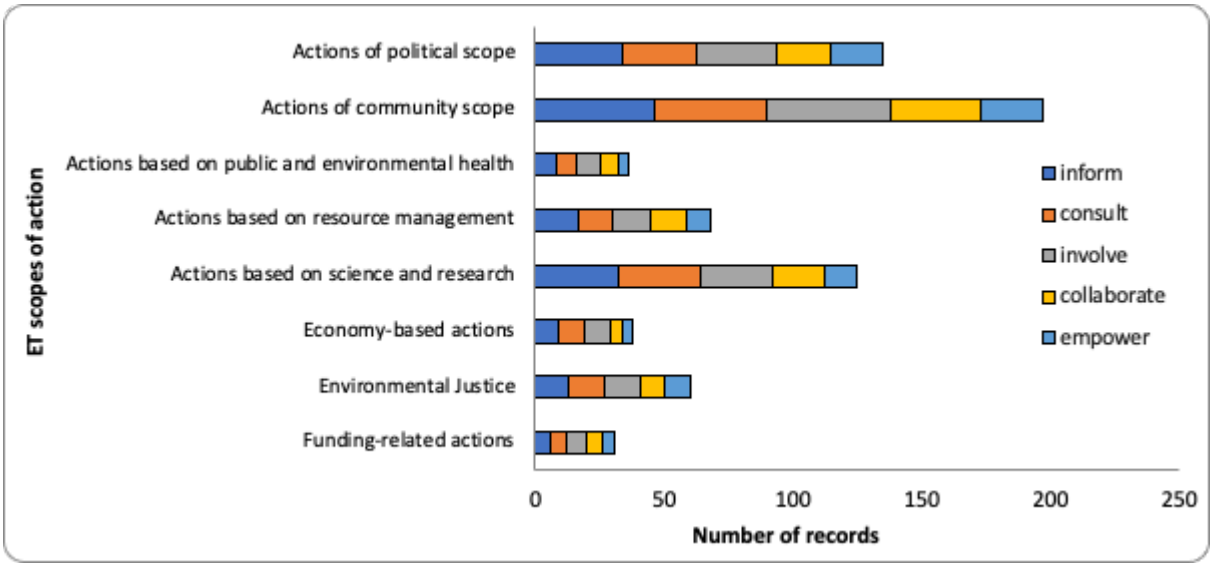

Figure A4.8. Levels of stakeholder engagement achieved according to different ET scopes of action.