PHUSICOS

According to nature

Deliverable 5.2

Opportunities and barriers to NBS at the EU, national, regional and local scales, with suggested reforms and innovations

Work Package 5 – Governance Innovation

Deliverable Work Package Leader: Revision: 0 - Final
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Summary

PHUSICOS is an Innovation Action project funded by the EU Horizon 2020 research and innovation programme (Grant agreement No. 776681). The main objective of PHUSICOS is to demonstrate that nature-based solutions (NBS) for reducing natural hazard risk of extreme weather events in rural mountain landscapes are technically viable, cost-effective, and implementable at regional scale. NBS have emerged as a critical umbrella concept encompassing all actions and measures that use nature's properties to systemically address societal challenges, simultaneously providing a variety of benefits for nature and people. Among their manifold co-benefits, there is great potential for NBS to contribute to disaster risk reduction, climate change adaptation and biodiversity conservation.

However, despite the significant political traction NBS have gained, their implementation often remains too fragmented or context-specific for their wider operationalisation. For NBS to meet their promise of addressing global societal challenges, it is vital to advance our understanding of the governance drivers, frameworks and instruments that can enable – or, on the contrary, hamper NBS implementation.

While PHUSICOS Deliverable 5.1 (D5.1) distilled key in-depth insights on the governance enablers of successful NBS cases at the local scale, here we take a broader approach by identifying governance enablers and barriers across different socio-ecological, geographical and institutional contexts. This deliverable therefore builds on the comparative case studies of D5.1 by identifying institutional, legal, regulatory, social and economic opportunities, as well as barriers to NBS implementation. Governance opportunities and policy bottlenecks are scoped out at the EU, national and regional levels (e.g., EU directives and frameworks, as well as policy and financial mechanisms) that can help promote and enhance the adoption of NBS.

Part I of this deliverable summarises current research findings on governance enablers and barriers of NBS implementation across different governance contexts and for different purposes. In Part II, we review how the identified barriers are addressed in selected EU legal frameworks. The methodology builds on a systematic review of workshop results (extracted from pre-workshop interviews and discussion groups), grey- and peer-reviewed literature. Following a screening process, a total of 26 data sources were included in the review and analysed in depth. Enablers and barriers were classified according to different criteria and evaluated using quantitative content analysis methods. The meta-analysis identifies a total of 252 NBS governance enablers and opportunities, as well as 264 governance barriers and bottlenecks extracted from the selected records.

Results highlight critical governance factors that are currently facilitating or limiting NBS implementation and mainstreaming during their design, planning, implementation, monitoring and maintenance processes. The barriers to NBS implementation are manifold. Results highlight the lack of equity (both in stakeholder engagement and in NBS benefit distributions) as a key barrier to successful NBS implementation. Indeed, stakeholder conflicts were among the most cited hurdles. Results also emphasise the

importance of inclusive engagement of stakeholders in the NBS design, planning and implementation process. One way to tackle this challenge is through true co-design and co-creation processes.

The existence and further development of an evidence base on NBS performance and their co-benefits also emerged as a critical NBS enabler. Poorly staffed municipalities with little experience or expertise with NBS, combined with a dearth of evidence on their effectiveness and co-benefits, still appear to be the norm. Indeed, further studies are needed on the long-term benefits of NBS in comparison to grey solutions. In particular, more quantitative cost-benefits analyses capturing the multiple values of solutions are required.

A further common theme across enablers and barriers is the existence of or lack of knowledge products and NBS-specific expertise. Here, possible solutions include the creation of systematic NBS knowledge hubs accompanied by educational programs and trainings specific to NBS design (mainly targeting landscape architects and designers) and implementation (targeting contractors). Besides, the further development of nationally (and ideally, internationally) agreed technical standards, guidelines and legal norms for NBS implementation can help surmount this barrier. Lack of capacity and knowledge is compounded by a lack of funds earmarked for NBS. There is a fundamental problem in attracting private financing given the public-good nature of NBS and thus the shortage of bankable projects and business models. Among others, the establishment of the EU taxonomy for sustainable finance as well as other commitments to eliminate nature-harming activities are crucial to overcome this challenge.

Enablers and barriers differed in several points. Most prominently, a major factor limiting NBS implementation is path dependency, i.e., the difficulty in breaking away from current legal and social norms which favour grey infrastructure. Shifting the burden of proof to traditional grey infrastructure projects, for example by making the consideration of nature-based alternatives obligatory for any infrastructure project, would help reshaping NBS governance. Moreover, the focus on short-term goals that bring voter support does not match the long-term impact and gestation periods of NBS. Polycentric governance arrangements to overcome siloed administrations present an important enabler that appears somewhat unique to NBS implementation due to the often complex mosaic of actors, sectors and government levels involved in NBS projects. Polycentric governance arrangements, which foster cross-sectoral and cross-scale cooperation, offer an important opportunity to overcome these barriers.

In Part II of the Deliverable, we examine three selected EU strategies: the Farm to Fork Strategy, Biodiversity Strategy and Adaptation to Climate Change Strategy and how the earlier identified enablers and barriers are addressed in these strategies. Here, we focus the analysis on key enablers to NBS action in the agriculture, adaptation and biodiversity spheres. We find that financial tools for NBS implementation are at the forefront in all three strategies with focus on funding, innovation and research, as well as developing business models to engage private financing. We do, however, observe gaps in the strategies regarding the integration of practical knowledge and the inclusion of stakeholders.

Contents

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1   Introduction

Biodiversity - the diversity of all life on earth - is declining globally at unprecented rates (WWF 2020). In Europe, 60 % of species and 77 % of habitats show a predominantly unfavourable conservation status (EEA 2020). Nature-based solutions (NBS) have emerged as a critical umbrella concept encompassing all actions and measures that use nature's properties to systemically address societal challenges, including biodiversity loss (UNEA 2022). By representing actions to protect, sustainably manage, and restore natural and modified ecosystems, NBS must simultaneously benefit people and nature (IUCN, 2020).

Hence, NBS have been proposed as promising solutions to help tackle disaster risk reduction (Ruangpang et al., 2020; Faivre et al., 2018; Debele et al., 2019), climate change adaptation (Frantzeskaki et al., 2019; Chausson et al., 2020; Kabisch et al., 2016) and biodiversity conservation (Maes & Sander, 2017; Seddon et al., 2019; Gómez Martin et al., 2020), among others. NBS are emerging on an ever-expanding number of political agendas, most recently and noteworthy on the Convention on Biological Diversity's Kunming-Montreal Global Biodiversity Framework (Conference of the parties to the Convention on Biological Diversity, 2022; p.10) and the Conference of the Parties (COP 27) decision text (UNFCCC 2022).

An increasing number of studies have emerged on the co-benefits and technical performance of NBS (Raymond et al., 2017; Calliari et al., 2019; Epelde et al., 2019; Kumar et al., 2021). However, governance issues relating to NBS have been less systematically addressed. A simple Scopus search reveals that the search terms 'nature-based solution*' and '*benefit*' yields 615 results, whereas 'nature-based solution*' and 'governance' produces 180 results (search on 21 June 2022). In a recent review, Li et al. (2021) found that most NBS literature focuses on one or more specific NBS benefits, in particular water management, human wellbeing, urban development and greening. Although the authors found that the impact of NBS on economic development and its governance were least accounted for, they also recognised NBS governance as an important emerging theme in NBS research, especially in the last few years.

Despite NBS' increasing political traction and recognition in Europe (Davies et al., 2021; European Environment Agency, 2021) and beyond (Seddon et al., 2020; Cohen-Shacham et al., 2016), information on how NBS can successfully be implemented in different governance settings, and what may hamper their realization, is still fragmented. Yet, for NBS to meet their promise of addressing global societal challenges, it is vital to advance our understanding of the governance drivers, frameworks, strategies and instruments that have enabled NBS across different contexts. Likewise, further research is needed on the barriers and policy bottlenecks currently hindering the uptake and mainstreaming of NBS into governance regimes. In a communication on the EU Biodiversity Strategy for 2030, the European Commission had highlighted that "*Particular attention will be paid to measures to incentivise and eliminate barriers for the take-up of nature-based solutions, as these can lead to significant business and*

employment opportunities in various sectors and are the key to innovation for economic or societal needs that rely on nature." (EC, 2020a; p.68).

So far, studies addressing the governance enablers of and/or barriers to NBS have mainly focused on specific geographic settings, such as cities and urban areas (Sarabi et al., 2019; Frantzeskaki, 2019; Dumitru et al., 2020), specific NBS actors, such as nature-based enterprises (McQuaid et al., 2021), or a specific NBS purpose, such as climate change adaptation (Kabisch et al., 2016; Calliari et al., 2019) or disaster risk reduction (European Environment Agency, 2021; Anderson & Renaud, 2021).

PHUSICOS Work Package 5 (WP5) aims to fill this gap by addressing governance innovation, where NBS governance goes beyond 'government' and the legal, institutional and policy arrangements it encompasses. It also includes a network of state and non-state actors (e.g., businesses, civil society, NGOs and expert communities) in the process of deciding on and implementing NBS policy (Lemos & Agrawal, 2006; Steurer, 2013). As such, governance also encompasses the social, ecological, political, and financial conditions through which NBS are implemented (Bernardi et al., 2019; Sekulova & Anguelovski, 2017). As part of Task 5.1 (T5.1) on 'NBS in-depth case study analysis of the characteristics of successful governance models' (see Martin et al., 2021; Martin et al., 2019), WP5 aimed to identify the pre-conditions, policy processes and institutions that proved helpful or even essential for the initiation, planning, design and implementation of NBS – in short, their governance enablers.

Results were derived from semi-structured interviews and a desk-based review of three case studies in Nocera Inferiore (Italy), Munich (Germany) and Wolong (China). Findings indicated that the most critical enablers involved governance innovation in three areas: polycentric governance (novel arrangements in the public administration that involved multiple institutional scales and/or sectors), NBS co-design (innovative stakeholder participatory processes that influenced the final NBS) and financial incentives (financial incentives for community-based implementation and monitoring of NBS). Further enablers for realizing NBS, as demonstrated in the three cases, included environmental advocacy coalition groups, along with their individual champions, and a major triggering or modelled event, which opened a window of opportunity to advocate for a nature-based or hybrid green-blue-grey solution. While T5.1 distilled key in-depth insights on the governance enablers of successful NBS cases at the local scale, Task 5.2 (T5.2) seeks to take a broader approach by identifying governance enablers and barriers across different socio-ecological, geographical and institutional contexts.

T5.2 therefore builds on the comparative case studies of T5.1 with the aim of identifying institutional, legal, regulatory, social and economic opportunities, as well as barriers to NBSs at the EU, national, regional and local scales. It scopes out governance opportunities at the EU, national and regional levels (e.g., EU directives and frameworks, as well as policy and financial mechanisms) that can help promote and enhance the adoption of NBS. Likewise, T5.2 explores current policy bottlenecks and barriers to wider NBS implementation and upscaling. This deliverable is therefore broadly composed of two parts:

1) A review of enablers of and barriers to NBS implementation.
2) A deep dive into selected policy documents and how they address the enablers identified in 1).

By identifying the principal governance barriers to NBS implementation, T5.2 sets the scene for two further WP5 tasks and their associated deliverables, namely D5.3 'Governance innovations for the design, financing and implementation of NBS, and their applications to the concept and demonstration projects' and more importantly, D5.4 'Learning from NBS implementation barriers'.

2   Part I: Review of enablers of and barriers to nature-based solutions

2.1   Methods

In Part I of this deliverable, a scoping study of NBS enablers and barriers using a systematic literature review and content analysis is performed. Governance enablers and barriers of NBS implementation were extracted from three types of sources, namely i) findings from workshop and discussion sessions (using interviews and focus group discussions), ii) grey literature and iii) peer-reviewed literature. The data search was performed in May 2021 – April 2022. Peer-reviewed literature was identified using a Scopus search (Elsevier, 2022) due to its broad scientific literature coverage. In addition, grey literature was identified through Google Scholar as well Overton. Only articles published after 2010 were included in the study due to both the recent emergence of NBS as a concept and the wish to represent the most recent research advances in this study.

A total of 83 records were screened, from which a total of 26 data sources were selected to be analysed in depth using the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) method (Moher et al., 2009). The data selection process is detailed in figure 1. Particular emphasis was given to scientific reviews in order to maximise data entries. Selection criteria included the focus on NBS or related concepts as well as the specific mention of enablers and barriers (see table 1 for the keyword list).
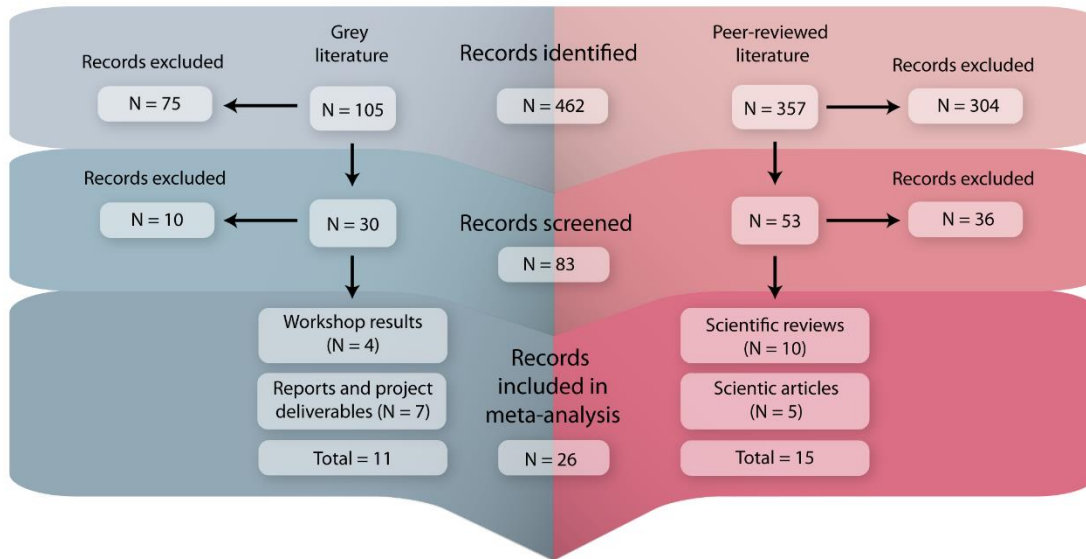
Figure 1: Data source selection process for meta-analysis (Design: Juliette Martin)

Table 1: Scopus search terms for peer-reviewed literature search

Theme	Scopus search terms
Nature-based solutions	("nature-based solution*") OR ("hybrid solution*") OR ("NBS") OR ("eco-DRR") OR ("green infrastructure*") OR ("ecosystem-based adaptation") OR ("natural infrastructure*") OR ("blue-green infrastructure*") OR ("blue green infrastructure*") OR ("natural engineering")
Barriers	(barrier*) OR (obstacle*) OR (challenge*) OR (bottleneck*) OR (limitation*)
Enablers	(enabler*) OR (driver*) OR (catalyser*) OR (opportunit*)
Exclusion criterion	PUBYEAR > 2010

A quantitative content analysis of the selected records was undertaken using NVivo version 12.4.0. (Swain 2018). A total of 252 NBS enablers and opportunities, as well as 264 barriers and bottlenecks were extracted from the selected sources. It is important to note that these are not all unique enablers or barriers, rather, they are the total number of times any barrier or enabler was mentioned in the analysed sources – they can thus be seen as enabler/barrier statements, which sometimes overlap.

Enablers and barriers were classified according to different criteria, presented in table 2, and coded and evaluated using NVivo. Bearing in mind the diversity of interpretations and definitions of governance (Rhodes 2007; Ruhanen et al. 2010; Fukuyama 2013), governance barriers/enablers can be of many different types. Here, we define governance in its broadest sense by encompassing all aspects related to collective and networked decision-making, including the social, ecological, political, and financial conditions through which NBS are implemented (Sekulova & Anguelovski, 2017).

A thematic content analysis approach (Vaismoradi et al. 2016; Swain 2018) was used to classify enablers and barriers. This means that the presence of certain words, themes, or concepts were coded in (qualitative) text, and subsequently counted in a quantitative way to identify data trends. Broader categories were partially based on the governance

categories identified in D5.1, which were in turn adapted from existing work on governance and/or NBS indicators (Kabisch et al. 2016; Swain, 2018; Raymond et al. 2017; Huthoff et al. 2018; Schmalzbauer 2018; Somarakis et al. 2019). The framework was expanded to include selected 'ambits' developed by PHUSICOS WP3 (Service innovation: stakeholder participation through Living Labs), specifically to cover technical and environmental aspects deemed important despite them straying from the traditional governance definition. An explanation of each category can be found in Martin et al., 2021. Enabler and barrier themes were identified using a grounded theory approach (Walker and Myrick 2006), meaning that themes were derived from the data rather than using a pre-existing theory to create them.

Table 2: Categories used for NVivo coding and analysis

Category	Codes	Source
Enabler/ barrier type	Policy and institutional; Socio-cultural and cognitive; Economic and financial; Technical; Regulatory and legal; Political; Educational; Environmental; Human resources and capacities; Other	Adapted from: Martin et al., 2021
Geographic setting	Urban; Rural; Mix	n/a
Scale	Local; Regional; National; Global; Mix	n/a
Location	Europe; Asia; Australia; North America; South America; Africa; Global	n/a
Data source	Scientific article; Scientific review; Grey literature; Workshop findings	n/a

Care was taken to (where possible) include sources from a variety of scales (EU, regional, local) and contexts (urban, rural, different NBS types). Particular attention was also paid to include enablers and barriers coming from practice as well as theory, i.e., both revealed and hypothetical enablers and barriers. Where enablers and/or barriers were mentioned more than once for the same case or study, double counting was avoided.

2.2 Data distribution

This section describes how the extracted data were distributed. Out of the 26 reviewed data sources, five were from grey literature (mainly project reports), four were from workshop results, and seventeen were from peer-reviewed articles (figure 2). Most peer-reviewed articles were reviews, which were purposefully targeted to include a wider variety of data. In terms of extracted enablers and barriers, these were relatively evenly distributed across sources (figure 3). A more detailed list of the extracted enablers and barriers can be found in Appendix A.
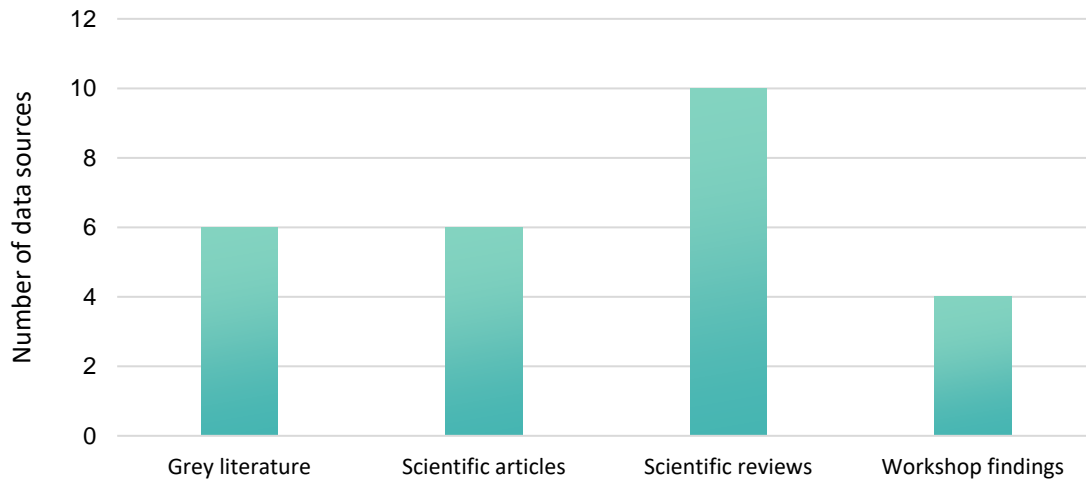
Figure 2: Sources of reviewed literature
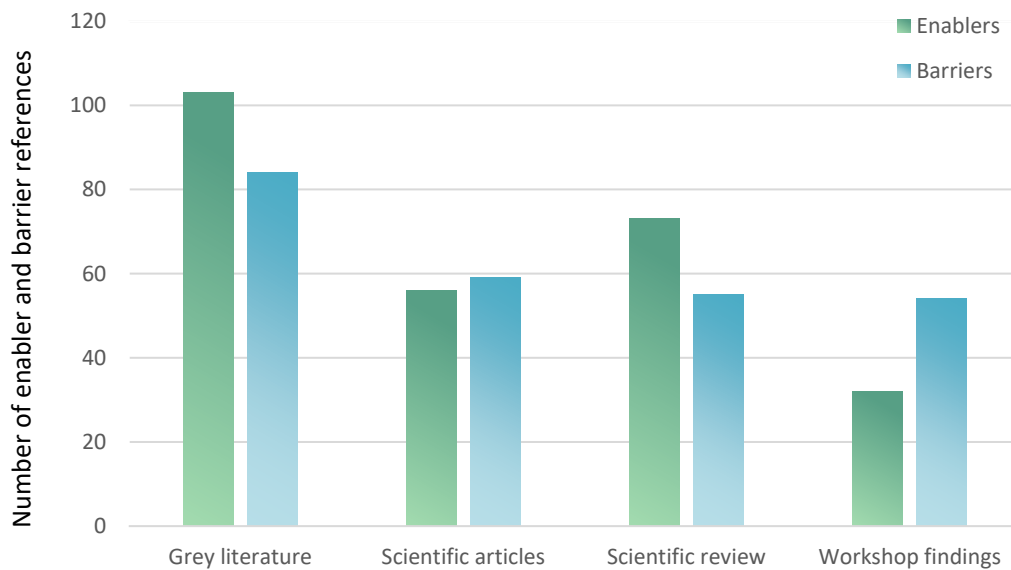
Figure 3: Enabler and barrier distribution by data source

Our data show a bias towards urban studies, which represented 49% of the included sources, whereas rural studies only represented 13%. The remaining 39% represented reviews that included a mix of urban and rural cases, yet here, as well, the focus was often on urban areas. Most data from rural areas came from the PHUSICOS project's own sites. Likewise, most studies came from a European context (67%), which points towards a bias towards NBS implementation in the Northern hemisphere.

2.3   Barriers to nature-based solution implementation

As previously noted (Section 1), NBS are emerging in an increasing number of national actions plans (e.g., in the US, the White House Council on Environmental Quality, White House Office of Science and Technology Policy White House Domestic Climate Policy Office, 2022), global targets (e.g., Díaz et al., 2019) and regional policies (e.g., Davies et al., 2021). NBS' potential to help tackling some of our global crises such as increasing disaster risks, climate change or biodiversity loss are thus widely recognised. For example, it was estimated that NBS could provide 37% of climate change mitigation needed to limit climate warming to below 2°C until 2030 (Díaz et al. 2019). Likewise, due to the diverse co-benefits of NBS, UNEP estimated that for every dollar invested in NBS, almost seven more can be generated within five years (United Nations Environment Programme (UNEP) 2022).

Yet, this urgent call for NBS action seems to be accompanied by the sobering realisation that significant governance hurdles still exist for NBS to be upscaled to a level at which they can fulfil their ambitious promises (Mendes et al. 2020; Nelson et al. 2020; Seddon et al. 2020; Solheim et al. 2021). Here, we compile and compare NBS governance barriers distilled from a variety of sources to enhance our understanding of the key bottlenecks standing in the way of NBS mainstreaming. Barriers were first classified according to broader governance categories, as defined in section 2.1 (figure 4).
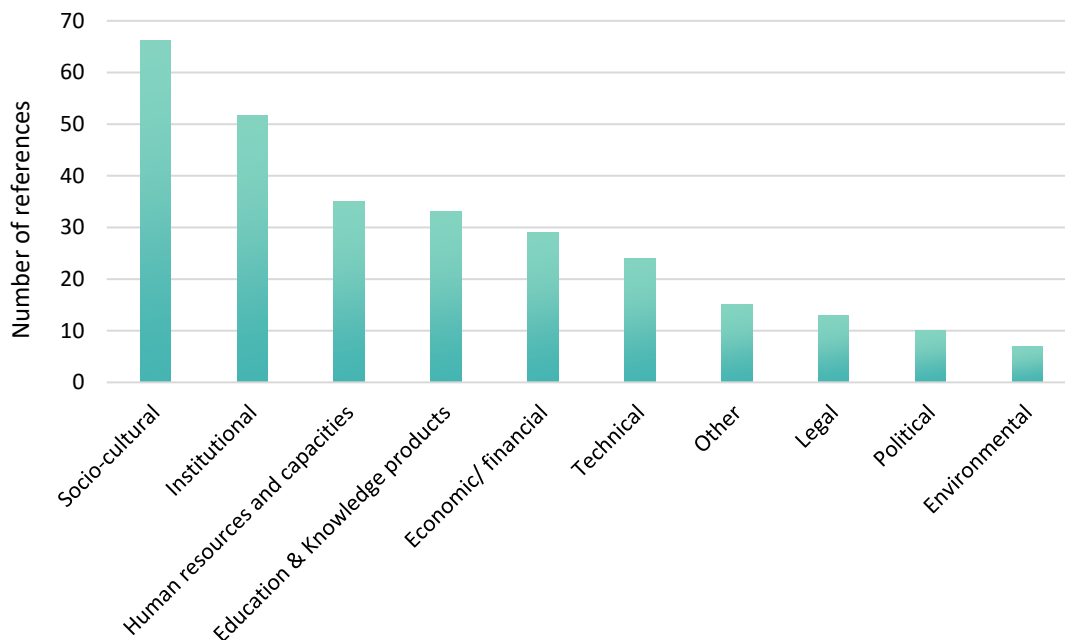

Figure 4: Distribution of barriers by broad categories

Results show that barriers related to socio-cultural factors were the most prominent (N=66), closely followed by institutional factors (N=51) and human resources and capacities (N=35). It is noteworthy that the most frequently encountered barriers are of

a less tangible nature than, for example, economic or technical barriers, which were cited less often. Interestingly, the smallest numbers of barriers were found for legal (N=13), political (N=10) and environmental factors (N=7).

While the benefit of using broad categories is that they help abstract complex results into digestible results (Collier et al. 2012), this also comes at a cost. Thus, these initial results provide an overview of the type of barriers that often stand in the way of successful NBS implementation. Yet, it is also apparent that depending on how categories are defined, results may vary. For example, in many comparable frameworks and typologies, institutional, political and legal factors are merged (e.g., McQuaid et al., 2021; Schmalzbauer, 2018), which would result in the highest number of barriers. Additionally, there can be a fine line between certain categories, such as human resources and capacities and education and knowledge products. Thus, a lower level of classification was necessary to fully understand governance barrier trends. To do this, twelve barrier themes we identified (figure 5). Among the 264 barriers, 12 themes emerged.
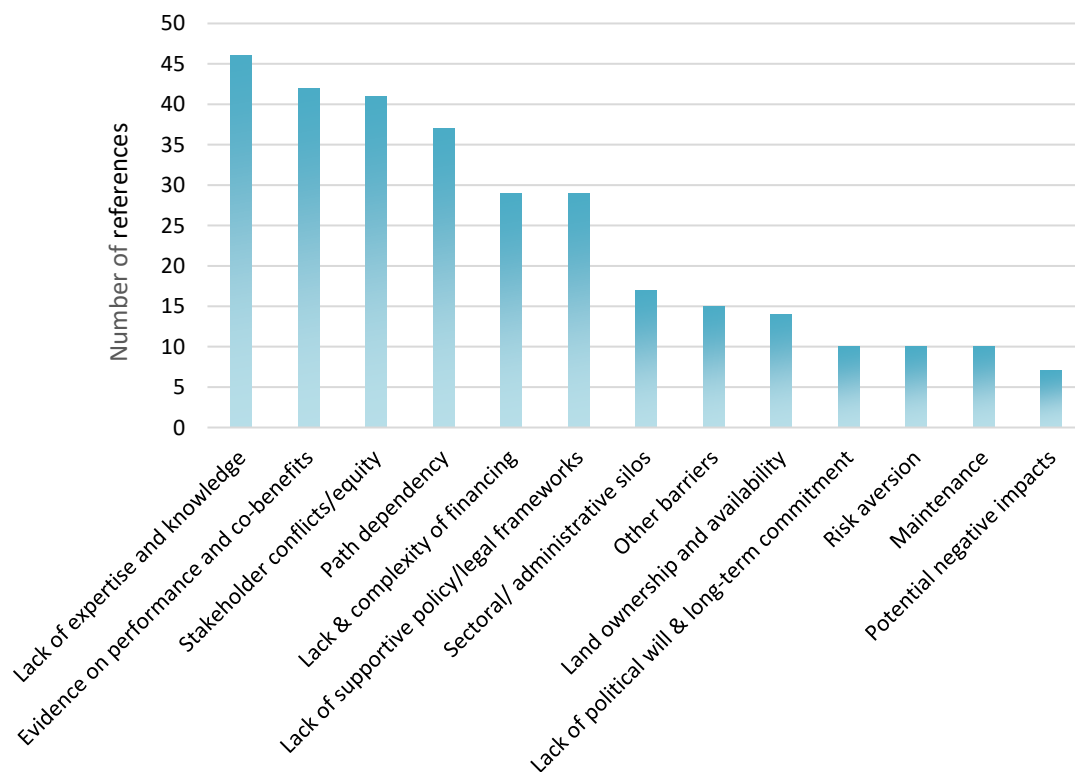

Figure 5: Barrier themes identified in literature and workshop sessions

The most prevalent barrier theme is the **lack of expertise and knowledge** throughout the NBS implementation stages, including NBS construction (Bernardi et al. 2019) compounded by limited standards, technical guidelines and legal norms for the

monitoring and maintenance of NBS (Sarabi et al. 2020). Chausson et al. (2020) observed an acute lack of robust, site-specific investigations of the effectiveness of NBS interventions compared to traditional alternatives. Similarly, Han and Kuhlicke 2019 found that there is still a lack of long-term data and knowledge on NBS. Solheim et al. 2021 also note a clear lack of skilled knowledge brokers and training programs on specialised NBS skills. This particular barrier theme is addressed in more detail in PHUSICOS D5.4 (Linnerooth-Bayer et al., forthcoming).

The **lack of evidence on NBS delivery, performance and co-benefits** is an almost equally important barrier. This theme comprised both the lack of robust and consistent approaches for measuring the monetary value and returns of co-benefits (Scolobig et al. 2021) as well as their performance (Nelson et al. 2020; Solheim et al. 2021). This is particularly problematic for justifying the use of NBS over traditional infrastructure to decision-makers (Welden et al. 2021). Indeed, multifunctionality is a critical and unique NBS selling point, therefore not being able to fully account for co-benefits in cost-benefit analyses remains a formidable challenge (Bernardi et al. 2019). Josephs and Humphries (2018) noted that we still have a long road ahead to be able to move beyond ecological definitions of NBS success, particularly when it comes to integrating socioeconomic and non-monetary co-benefits in NBS assessments.

The third most important barrier theme was identified around **equity issues, stakeholder engagement and conflicts** thereof. The importance of wide and just stakeholder engagement was proven to be a key success factor of NBS implementation by entailing stakeholder buy-in, ownership and dissipating potential scepticism towards NBS (Raymond et al. 2017; McVittie et al. 2018; Martin et al. 2021). Yet, there are two sides to every coin. Indeed, conflicting worldviews and interests of stakeholders can also lead to policy stalemates (Linnerooth-Bayer et al. 2016; Best and Hochstrasser 2022). For example, Solheim et al. 2021 found that in one of the cancelled PHUSICOS NBS implementations in Gudbrandsdalen, considerable conflicts arose due to the economic value of gravel extracted from the Gudbrandsdalslågen river following floods. An NBS altering the river's flow and thus gravel deposition therefore met the strong opposition of local landowners. Additionally, NBS might generate inequities e.g., associated with how the costs and benefits accruing from NBS initiatives are distributed among the local population (Toxopeus et al. 2020).

A further major factor limiting NBS implementation appears to be (grey-measure) **path dependency** (Barnes et al. 2004), which denotes a system in which pathways are irreversibly 'locked-in' due to habituation (David 1985). Here, this theme mainly refers to the difficulty in breaking away from current and deeply ingrained legal and social norms that still favour grey infrastructure. For example, Bernardi et al. 2019 found that landscape designers are more familiar with traditional infrastructure, both from a technical point of view and with respect to legal compliance. Indeed, as remarked by Davies and Lafortezza 2019, many institutions have evolved in a deeply set grey infrastructure culture, which means that system reforms are rare and require substantial agents of change and transformations. Unfortunately, NBS are not an exception and remain a neologism within many institutions. This theme also included the notion of

resistance to change (Sarabi et al. 2020) and resulting behavioural lock-ins, a general clash between grey- and green paradigms (IIASA 2020).

Lack of funding and high costs of NBS were also among the top five barriers mentioned in the analysed data sources. This is in line with the recognition that most NBS are currently financed by (often limited) public funds (Sekulova and Anguelovski 2017). This lack of public financing has in part been ascribed to limited municipal spending autonomy on budgets (Toxopeus and Polzin 2021) and the incapacity to co-finance NBS (Bernardi et al. 2019). Additionally, high costs (or perceived high costs) compared to grey infrastructure and its maintenance represent a further challenge (Martin et al. 2021). This theme barrier also included challenges with how funding is allocated, e.g., sectoral silos leading to silo budgeting that therefore disregard NBS' co-benefits (Bernardi et al. 2019).

Further important barriers include **sectoral and administrative silos**. As was already emphasized in PHUSICOS D5.1 case studies, institutional fragmentation and siloed administrations present a difficult challenge that appears especially salient to NBS implementation (Sarabi et al. 2019; Scolobig et al. 2020; Suleiman 2021). This is undoubtedly related to the fact that NBS require the joint expertise of actors, including ecologists, hydrologists, engineers and city or landscape planners. Suleiman 2021 highlight in particular a disconnect between water and landscape planners for blue green infrastructure implementation in Stockholm, who were not treated as equals when it came to NBS design and decision-making process.

While barrier themes related to the **lack of political will and long-term commitment** as well as **lack of supportive policies** were slightly less represented in our results, this might be due to the fact that they are often underlying and implicit obstacles, which then translate into other challenges that are more prevalent in our results, such as the earlier mentioned dependence on grey infrastructure or lack of funding. Possible explanations are the novelty or immaturity of NBS, which are often not yet fully integrated in legal systems (Davies and Lafortezza 2019), and the lack of legally binding mechanisms (Davis et al. 2018). For example, many NBS policies at the EU scale are grounded in 'soft' measures, meaning that they do not require member states to implement them at local level and remain fully voluntary (Scolobig et al. 2020).

Associated to this type of barrier is the **risk aversion and scepticism** that NBS often face. Indeed, many of the analysed sources observed that stakeholders attribute a higher uncertainty to NBS than traditional infrastructure (Sarabi et al. 2020; Solheim et al. 2021; Toxopeus and Polzin 2021). Kuban et al. (2018) also note that private companies have a greater incentive to provide standard solutions at reliable profits than to take the uncertain risks involved in implementing or investing in innovative solutions, such as NBS.

2.4 Enablers of nature-based solution implementation

While it is essential to recognise governance barriers to NBS implementation in order to identify causes of failed NBS projects (or impeded existing projects), it is equally critical to learn from those practices that led to successful implementation. A total of 252 enablers were extracted from the included sources. These were first classified according to the broad governance categories defined in section 2.1 (figure 6).
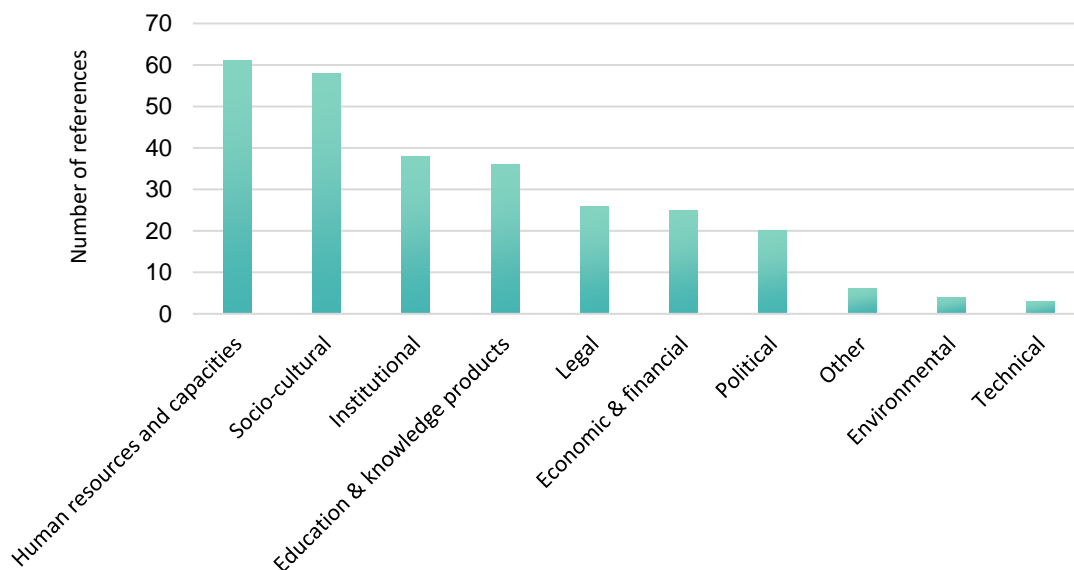
Figure 6: Distribution of enablers by broad categories

Results show that enablers related to human resources and capacities were the most prominent (N=61). It is noteworthy that this enabler only ranked 3rd as a type of barrier. Human resources and capacities were closely followed by socio-cultural (N=58) and institutional enablers (N=38). Interestingly, here again the smallest number of enablers was found for environmental (N=4) and technical (N=3) factors. Thus, in terms of broad types of enablers, results were similar to the broad types of barriers. This is not surprising given that enablers are for the most part (but not always) the inverse of barriers.
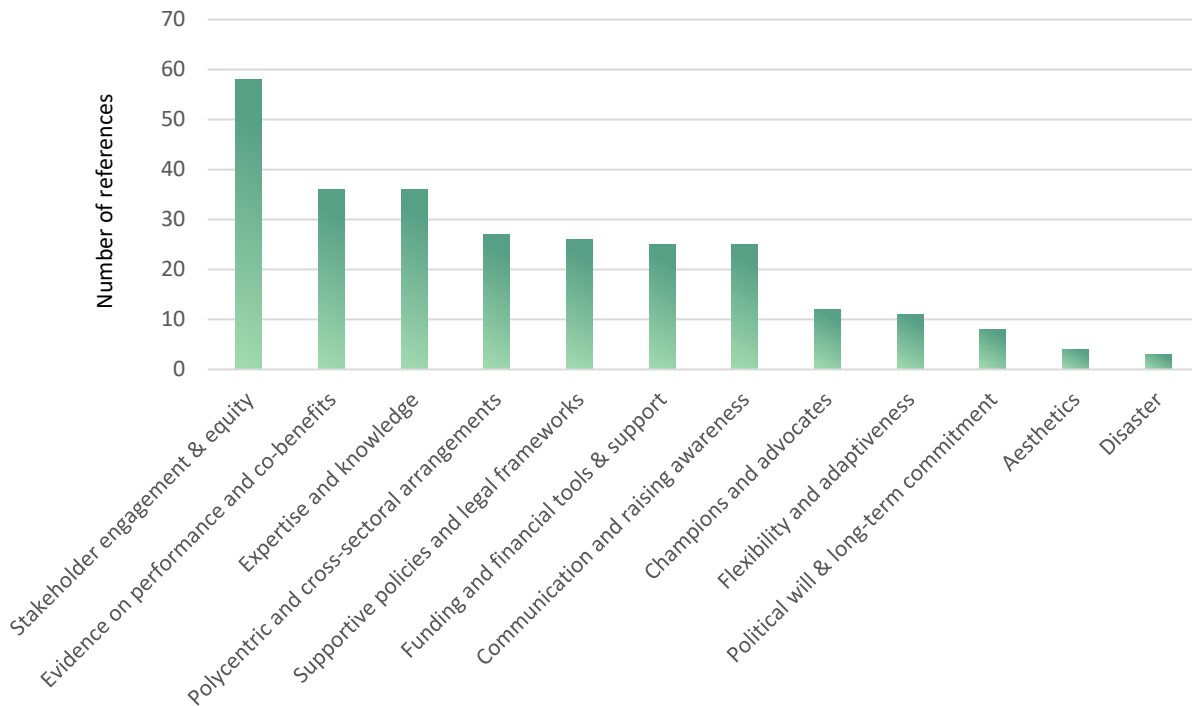
Figure 7: Enabler themes identified in literature and workshop sessions

The 252 enablers were subsequently split into 12 themes, of which **stakeholder engagement and equity** ranked highest by far (N=58). This theme mostly included factors relating to how and if stakeholders were involved in the NBS decision-making process, such as the social inclusion of a variety of stakeholder and citizen groups (Nesshöver et al. 2017; Schmalzbauer 2018), a relationship of trust emerging among stakeholders (Han and Kuhlicke 2019) as well as trust in the local government (Frantzeskaki et al. 2019). Enablers also related to good practices regarding stakeholder identification, for example, by identifying the social networks that affect NBS governance (Albert et al. 2019). The concept of 'true' co-creation and co-design – meaning the creative engagement of citizens and stakeholders to co-generate solutions to complex problems (Blomkamp, 2018) - was also mentioned in the analysed sources. Equity was an integral part of this theme, and primarily emerged as wide and just stakeholder involvement, voices being heard and responded to, and fair NBS benefit sharing. For example, in the PHUSICOS Serchio River Basin case, the involvement and compensation of farmers lending their land to NBS was a key success factor (IIASA 2020).

Evidence on performance and co-benefits also emerged as a key enabler. However, it should be noted that literature predominantly cited this enabler as a proposed (rather than a proven) enabler. This highlights the need for further evidence on NBS' multiple co-benefits. Specifically, the need to enhance valuations of NBS versus grey alternatives was cited (Scolobig et al. 2020) as well as clear quantitative and qualitative targets and indicators to track NBS performance (Huthoff et al. 2018; Scolobig et al. 2021). In

relation to this, the enhancement and harmonisation of the knowledge towards the formulation of a global NBS standard was also mentioned (Somarakis et al. 2019). However, things have since then evolved with the publication of the 2020 IUCN global standard for NBS (IUCN 2020), which intends to help practitioners to design effective and standardised NBS. Yet, due to its novelty, on-the-ground experience and evidence on the application of the standard across different regions of the world are still scarce (Châles et al. 2023).

As for the main barriers, **expertise and knowledge** ranked high in terms of enablers. Similarly, the need for 'traditional' sectors involved in infrastructure construction to expand their portfolios to include NBS emerged (Bernardi et al. 2019). In short, this theme encompassed the general need to overcome knowledge gaps relating to NBS, be it in terms of the functioning and dynamics of ecosystems (Fisher et al. 2019), socio-economic systems and governance structure in which NBS are embedded (Albert et al. 2019) or the aforementioned specialised contractor skillsets (Bernardi et al. 2019).

Polycentric and cross-sectoral arrangements also emerged as a key enabler. This maps directly onto the barrier of sectoral silos, discussed in section 2.3. Polycentricity denotes a system in which decisions are taken at different jurisdictional levels and scales (e.g., national, regional, global) and/or sectors through sometimes formally independent decision-centres (Ostrom 1999). While the concept is far from new, it seems to have gained a renewed importance in the context of NBS, which require the cooperation and collaboration of actors across different scales and sectors (Martin et al. 2021). While polycentric arrangements are increasingly (re)surfacing to mainstream and upscale NBS implementation (European Environment Agency 2021), few examples of their practical application for NBS exist. One exception is the Isar restoration or Isar Plan in Munich, which brought forth the creation of a multi-scale and multidisciplinary working group that dispersed the decision-making process across different scales (city and state level) and sectors (flood control, environmental organisations, city planning and more) (Zingraff-Hamed et al. 2019). Similarly, the **adaptiveness** of governance systems was highlighted in our results, even if less frequently than other enablers. Adaptiveness is seen as an essential part of polycentricity (Carlisle and Gruby 2019) and arose as the need to retain a level of flexibility of NBS in light of a changing climate (Kabisch et al. 2016; Suleiman 2021) and rapidly evolving societal challenges (Nesshöver et al. 2017; Bernardi et al. 2019).

Supportive policies and legal frameworks are evidently a further important enabler for NBS implementation. Noteworthy here is the fact that legal frameworks were predominantly mentioned as being important for *potentially* enhancing NBS uptake, rather than as enablers that were proven to be effective. This can be attributed to the current lack of NBS-specific policies in Europe and national NBS-specific action plans (Calliari et al. 2022). Indeed, the reviewed literature and workshop findings hardly mention specific policies and frameworks. This theme can therefore be seen as more of a gap or a potential enabler than a current enabler. Current policies favouring NBS uptake are summarised in section 3.1.

Other themes, such as funding, financing tools and political will and long-term commitment, are very much in line with corresponding barriers and therefore already discussed in section 2.3. Yet, results show a number of unique enabler themes, such as **communication and awareness raising**. This theme includes aspects relating to how NBS results are communicated, such as avoiding the use of jargon (Bernardi et al. 2019), adopting more clarity on NBS definitions (Scolobig et al. 2020) or similarly communicating NBS benefits in simple terms easily understood by decision-makers (IIASA, 2020). The need for further awareness raising on NBS was also highlighted, both in terms of dissipating the 'fear of the unknown' NBS often face (Schmalzbauer, 2018) and their multiple socio-economic co-benefits (Chatzimentor et al. 2020).

Results also show that **champions and advocates** are a crucial enabler for NBS. While this enabler goes hand in hand with **political will and long-term commitment**, 'champions' emerged as a theme of its own, which was not the case in the barrier analysis. Here, the importance of forerunners and early adopters of NBS (Naumann et al. 2014; Bernardi et al. 2019; Martin et al. 2021), who spearhead the NBS concept, was stressed, as well as agents of change that can transform institutions from within (Davies and Lafortezza 2019).

Finally, the **aesthetics of NBS** in contrast with grey solutions was seen as a relatively minor enabler, followed by the **occurrence of a disaster** in triggering NBS actions. Neither theme has a corresponding barrier, thus they are unique as enablers.

An obvious, yet important, observation is that many of the identified enabler themes have direct counterparts as barrier themes (and vice versa) – the former often representing the availability of a given factor, and the latter its absence. As an obvious example, the *lack of* expertise and knowledge represents a significant barrier to NBS implementation, yet its *availability* was found to be a key enabler. This finding is not unexpected since for enablers that are deemed critical for NBS implementation, their absence would naturally emerge as important barriers. Likewise, many of the identified enablers represent advantages of NBS, such as their reduced environmental impact or their multiple co-benefits.

2.5 Limitations

While the analysis fills an important research gap by providing an overview of NBS enablers and barriers across different governance and geographic contexts, it also presents several limitations, which are discussed in this section.

First, it is important to note that as with any data classification exercise, the selection of data bins and themes remains subjective and open to different interpretations (Collier et al. 2012). While a grounded theory approach was used to define themes, many enablers and barriers span across multiple themes and categories, which makes definitive classification difficult. For example, there are strong overlaps between the lack of *NBS-specific knowledge* and e*vidence on NBS co-benefits*. Both in fact represent different types of knowledge, yet the decision was made to separate them into two themes due to the recurrence of challenges relating to quantitative NBS performance and co-benefit appraisals. Similarly, many enablers/barriers relating to funding can be traced back to institutional factors. Nevertheless, this caveat was addressed by involving multiple authors in reviewing NVivo coding structures and identified themes.

Secondly, as with any systematic literature review, there is always the risk of data biases, for example by excluding important literature, omitting relevant keywords or not covering the entirety of terminologies used to describe NBS. Selection/sampling biases as well as coding biases can of course be mentioned as general limitations of systematic literature reviews (Moher et al., 2009). Additionally, NBS research is still expanding, with new studies constantly entering the scene. Therefore, the analysis cannot be fully comprehensive. While the question of 'how much data is enough' is a recurrent one in social (and other) sciences (Goertz 2006), one can argue that by extracting over 500 enabler/barrier statements from literature and workshop sessions, the most important factors will most likely be covered. Thus, adding more data sources to the analysis would likely not lead to significantly different results. Our data present further biases, including a higher proportion of European studies, as well as a focus on urban settings. Efforts were made to circumvent these biases. Yet, they also reflect the current state of knowledge on NBS research.

Related to this, while the scoping study focused on mentions of enablers and barriers in literature and workshops, the absence of data might be just as telling. For example, if a given barrier is not mentioned in the literature (presumably because it is not deemed to be a salient hurdle), this would point towards successes in NBS governance. However, the nature of the analysis entails that it can only capture what is explicitly mentioned. Likewise, the analysis is limited by the way enablers and barriers are framed by authors or workshop participants. For example, 'high costs' emerged as a critical challenge for NBS implementation. Yet, many different aspects of costs exist, e.g., long-term and short-term, indirect and direct costs, all of which would need to be differentiated to better understand hurdles to financing NBS. Nevertheless, the analysed sources mainly mentioned 'high costs' as a general statement, without going into detail about which aspect of these costs is problematic.

As highlighted earlier, a last important limitation is the fact that the analysed literature and workshop findings listed enablers and barriers that were both hypothetical and experienced, thus confounding theory and practice. For example, stakeholder conflicts might have been cited as a barrier that was experienced in the implementation of a given NBS, or they could have been mentioned as an anticipated and therefore hypothetical hurdle. Most data sources did not make this distinction clear, which makes it difficult to estimate the proportion of enablers and barriers cited in this analysis that emanate from practice, and those that are theoretical. To address this limitation, data from a variety of sources were included in the analysis (interviews, discussion groups) where possible to complement theoretical studies.

3 Part II: Exploration of Enablers to NBS in selected EU Policy

Policymakers and researchers increasingly recognise the necessity for a socio-ecological transformation in parallel to climate change mitigation and adaptation efforts (Olsson et al. 2014). In this regard NBS, proposers seek to reimagine infrastructures that have previously been "grey" by default (Sowińska-Świerkosz & Gracia, 2022). As such, NBS have gained increased recognition for their capacities to sustainably manage and restore ecosystems (Davies et al., 2018). Furthermore, a significant body of scientific literature has emerged addressing NBS. This literature was analysed in Part I of this study to identify enablers and barriers to NBS implementation within NBS literature.

Given the EU's emphasis on evidence-based policy making, we expect recent strategies to reflect the status of knowledge and to include policies and actions that enable NBS. Therefore, we further expand upon this study by examining recent EU strategy documents and their capacity to enable the scaling of NBS in Europe. A significant body of literature has analysed NBS in global, EU and national policy frameworks (Davis et al. 2018; EEA, 2021; OECD, 2020). Thus, we focus our policy analysis exclusively on three recent strategies, namely the EU Biodiversity Strategy, the EU Adaptation Strategy and the Farm 2 Fork Strategy. Specifically, we direct our attention to three of the main enabler themes identified in section 2: financing, knowledge, and stakeholder engagement.

Doing so, we address the following questions:

- Which enablers are reflected in the strategies?
- Are enablers followed up by specific action points?

3.1 Methods

Three key EU strategies - the EU Adaptation to Climate Change Strategy, the EU Biodiversity Strategy, and the Farm to Fork strategy - were systematically analysed in two steps applying a thematic content analysis approach using the qualitative data analysis software Nvivo (Swain 2018). We conducted an in-depth content analysis to distil references to the three main enablers identified in Section 2 (table 3). Using a Grounded Theory approach further sub-codes were added to the analysis such as references to specific legal and policy frameworks and directives, policy instruments that were specifically mentioned in context of NBS implementation, as well as general mentions of NBS within these policy documents (Clarke, 2005).

The main objective is to create an in-depth understanding of the state of integration of NBS considerations and actions towards enabling NBS on an EU level and the capacities of these frameworks to constructively advise and enable the implementation of NBS measures in the EU.

Table 3: Codes by category for the thematic content analysis.

Category	Codes	Source
Enabler/ barrier type	**Financing***: Lack of funding*; Financial tools and support schemes** **Stakeholder engagement***: Diverse stakeholder inclusion**; Industry stakeholder engagement**; Polycentric and cross-sectoral arrangements*; Sectoral and administrative silos* **Expertise and knowledge products***: Knowledge for implementation**; Research and development**; Knowledge dissemination**; Lack of expertise and knowledge*; Integration of practical knowledge**	*Adapted from: Martin et al., forthcoming ** emerged through Grounded Theory approach
Data source	**EU Frameworks**: EU Strategy on Adaptation to Climate Change of 2021; EU Biodiversity Strategy for 2030; EU Farm to Fork Strategy 2020	n/a

3.2   The NBS policy landscape

3.2.1   NBS measures at the international scale

To understand NBS policy gaps, a central first step is to review the current NBS policy landscape. NBS are emerging on an increasing number of international commitments and agendas. The most recent key milestones in the global recognition of NBS are summarised in this section. A seminal milestone was the 2019 NBS for Climate Manifesto, launched at the 2019 UN Climate Action Summit and signed by over 70 governments and many further actors (including NGOs, civil society and private sector actors). By emphasizing NBS' potential for combatting climate change, the Manifesto attracted significant political attention. A year later, as previously mentioned, the 2020 IUCN global standard for NBS (IUCN 2020) was developed to help practitioners design NBS in an effective and coherent way. The finalisation of the standard represents a crucial step towards creating a shared language and understanding of NBS practices globally. Nevertheless, the Standard remains a voluntary guidance tool for self-assessment, which means that it is not legally binding or enforceable.

Similarly, 2022 marks the year where a definition of NBS was agreed by 193 Member States at the United Nations Environment Assembly (UNEA 2022). The definition states that NBS are '*actions to protect, conserve, restore, sustainably use and manage natural or modified terrestrial, freshwater, coastal and marine ecosystems, which address social, economic and environmental challenges effectively and adaptively, while simultaneously providing human well-being, ecosystem services and resilience and biodiversity benefits*'(UNEA 2022; p.2). An important aim of this internationally consistent definition of NBS was to foster a common understanding of NBS goals and benefits. It also places biodiversity at the heart of NBS.

Most recent and noteworthy, at the 2022 Convention on Biological Diversity, where the Kunming-Montreal Global Biodiversity Framework (GBF) was accepted, NBS were

featured in two targets: target 8 reads "*Minimize the impact of climate change and ocean acidification on biodiversity and increase its resilience through mitigation, adaptation, and disaster risk reduction actions, including through nature-based solution and/or ecosystem-based approaches, (...)*", as well as target 11, which reads "*Restore, maintain and enhance nature's contributions to people, including ecosystem functions and services (...) as well as protection from natural hazards and disasters, through nature-based solutions and/or ecosystem-based approaches for the benefit of all people and nature*" (COP to the CBD 2022; p.10). The inclusion of NBS in the GBF builds the case for mainstreaming NBS globally, as they will accordingly play an increased role for achieving the GBF '30 by 30' target of 30% of terrestrial, inland water, coastal and marine areas being conserved by 2030.

These recent international commitments and standards represent critical milestones for promoting the uptake and upscaling of NBS. Despite promising progress in giving NBS international prominence, the international commitments are voluntary pledges and not legally binding, thus their non-fulfilment bears no legal consequences or sanctions. Moreover, the commitments only become partially or fully actionable through national action or regional plans and policies, for instance at the EU and its member states. The following sections, therefore, focus on a selection of EU policies for and actions towards NBS uptake.

3.2.2   NBS measures in Europe

In the European Union (EU), NBS are increasingly promoted as a means for ecosystem management, disaster risk reduction and nature restoration (Faivre et al. 2018). Indeed, research on and implementation of NBS have provided significant insights into NBS good practices (see Part I). Accordingly, NBS are embedded in a variety of cross-cutting European policy frameworks (EEA 2021). Strategies at the EU level are developed by relevant departments within the Commission and lay the foundation for the development of concrete action and policies which may include financing or legally binding legislations such as directives or regulations to be voted upon in the EU Parliament.

A number of NBS policy analyses have examined if and how European Member States (MS) and regional policy frameworks address the concept of NBS (e.g., Davis et al. 2018; Davies et al. 2021; EEA, 2021). Multiple European Framework Directives, strategies, action plans and resolutions mention NBS explicitly or implicitly (Davis et al. 2018). For example, NBS are included in the new EU Strategy on Adaptation to Climate Change, in which they are considered essential for increasing climate resilience and sustaining healthy water, oceans, and soils (EC, 2021). Additionally, the recently released EU Biodiversity Strategy for 2030 and Forest Strategy (EC, 2020a)- all representing key pillars of the ambitious European Green Deal (EGD) (EC, 2019) - rely on NBS to both preserve and restore ecosystem integrity and increase resilience.

A further crucial milestone of the biodiversity strategy is the recent proposed Nature Restoration Law, also referred to as the Regulation on Nature Restoration, which is pioneering the inclusion of legally binding nature restoration targets across Europe

(Directorate-General for Environment 2022). Legally binding targets were proposed because evaluations of the EU's biodiversity strategy up to 2020 identified voluntary rather than legally binding targets as a reason for the EU's failure to restore its ecosystems (*ibidem*). This proposed law requires MS to develop National Restoration Plans (earliest by 2026), to restore 20% of the entire EU's land by 2030, and to restore all ecosystems in need of restoration by 2050. Nevertheless, the Restoration Law is also currently contested by several MS, and has been subject to critique in terms of its flexible enforcement and compliance mechanisms (Hoek 2022). An analysis of EU-funded projects also emphasised the direct relevance of the EU Flood Directive and Water Framework Directive for NBS implementation (Vojinovic et al. 2017; Scolobig et al. forthcoming). Although these actions have advanced the conceptualization and operationalization of NBS in Europe, a much wider adoption is needed to reach the ambitious goals of the EGD (Calliari et al. 2022).

In this section, we review recent EU strategies on biodiversity, disaster risk reduction and agriculture to explore the stated capacities of these documents, and in a broader sense of the EU, to scale and mainstream NBS in Europe. This analysis not only provides insights on the role of these strategies for future implementation and scaling of NBS but also highlights where NBS enablers, defined in Part I above and analysed below, are highlighted.

- The 2021 **EU Adaptation to Climate Change Strategy** acknowledges that greenhouse gas mitigation measures are insufficient towards mitigating the effects of climate change on nature and society. Referring heavily to the European Green Deal, the strategy lays the foundation for adaptation action within the EU to maintain well-being and foster economic growth sustainability till 2050. Special focus is placed on weather extremes related to heat and drought. Further focus is placed on the importance of ecosystems in climate change adaptation by acknowledging the knowledge gaps that still persist in this regard (EC, 2021). The strategy identifies NBS as a cross-cutting priority and maintains that the EC will: propose NBS for carbon removals, including accounting and certification in upcoming carbon farming initiatives; develop the financial aspects of NBS and foster the development of financial approaches and products that also cover nature-based adaptation; continue to incentivize and assist MS rollout of NBS through assessments, guidance, capacity building and EU funding.
- The **EU Biodiversity Strategy for 2030**, published in 2020, highlights the essential role of nature and biodiversity in maintaining well-being and resilience (EC, 2020a). It places special importance on the economic and business cases for biodiversity and makes a strong case for the integration of biodiversity considerations across sectors and scales, while calling for specific action. As part of the Biodiversity Strategy, a new Nature Restoration Law has been proposed in June 2022. The Restoration Law is the first of its kind insofar as it will include legally binding restoration targets across Europe and, if endorsed by the EU Parliament and MS, comes into force within the next two years.

- The **EU Farm to Fork Strategy**, as an appendix to the European Green Deal, calls for action towards fair, sustainable and resilient food systems. It addresses issues of agricultural production practices, as well as societal issues such as diets and health. As such, it seeks to steer sustainable transitions across the value chain while maintaining food security (EC, 2020b).

3.3 Analysis of NBS enablers at the EU level

The focus of this section is on three major themes of enablers and barriers and how they are addressed in the three EU policy documents to assess their capacity to enhance NBS consideration and implementation in the MS. The three selected enabler and barrier themes are those most mentioned in the NBS enabler literature (section 2) and complemented using Grounded Theory (see table 3): financing, expertise and knowledge products, and stakeholder engagement.

An initial analysis of references to NBS enablers shows a large emphasis on financing and support for NBS (Table 4). Knowledge dissemination, research and innovation are also emphasised, albeit neither is the lack of knowledge acknowledged nor is the integration of practical knowledge into policy making and planning included in the strategies. We further observe that sectoral silos are not addressed, despite being a major barrier to NBS. The following section reviews planned and existing policy actions around three main enabler themes: financing; expertise and knowledge products; and stakeholder engagement.

Table 4 Targeted actions by enabler theme mentioned in the strategy documents

Strategy	Enabler theme	Corresponding actions
EU Biodiversity Strategy	Financing	Fiscal recovery policies to restore carbon-rich habitats
EU Biodiversity Strategy	Financing	Afforestation, reforestation, tree planting, and ecosystem restoration promoted by CAP Strategic Plans and Cohesion Policy funds
EU Biodiversity Strategy	Financing	€20 billion should be unlocked for spending on nature by mobilising private and public funding at national and EU level
EU Biodiversity Strategy	Financing	Establishment of dedicated natural-capital and circular-economy initiative under Invest EU to unlock €10 billion over next 10 years
EU Biodiversity Strategy	Financing	Commission to promote tax systems and pricing that reflect environmental costs
EU Biodiversity Strategy	Knowledge for implementation	Commission will develop guidelines on biodiversity-friendly afforestation
EU Biodiversity Strategy	Knowledge for implementation	Commission will work with data providers to further develop Forest Information System for Europe
EU Biodiversity Strategy	Knowledge for implementation	Commission will support MS through technical guidance, help mobilizing funding and capacity building
EU Biodiversity Strategy	Knowledge for implementation	Commission to establish Knowledge Centre
EU Biodiversity Strategy	Knowledge- capacity building	Skills Agenda for capacity building
EU Biodiversity Strategy	Knowledge- research and development,	Horizon Europe to fund research and innovation
EU Biodiversity Strategy	Stakeholder engagement	Urban Greening Platform under Green City Accord'53 to be established

Strategy	Enabler theme	Corresponding actions
EU Biodiversity Strategy	Stakeholder engagement	Commission will help to build European Business for Biodiversity movement through existing platforms
EU Adaptation Strategy	Financing	Non-financial disclosure obligation
EU Adaptation Strategy	Financing	EU taxonomy for sustainable activities
EU Adaptation Strategy	Financing	Renewed Sustainable Finance Strategy
EU Adaptation Strategy	Financing	Financial support available through European Structural and Investment Funds, CAP, LIFE Programme, Recovery and Resilience Facility
EU Adaptation Strategy	Financing	Carbon farming to be promoted as business model
EU Adaptation Strategy	Financing	New financing approaches and products under InvestEU[1]
EU Adaptation Strategy	Polycentric & cross-sectoral arrangements	Policy integration and support of policy planning and development at all governance levels
EU Adaptation Strategy	Polycentric & cross-sectoral arrangements	Engagement of Common Implementation Strategy of Water Framework and Floods Directive
EU Adaptation Strategy	Knowledge	Information services such as Copernicus and engage in other global networks
Farm to Fork Strategy	Financing	EU carbon farming initiative under Climate act to promote new business model for carbon sequestration
Farm to Fork Strategy	Financing and Knowledge- research and development	Horizon Europe to be funded with €10 billion for R&I

3.3.1   Financing

Financing is widely recognised as a major challenge to NBS scaling and mainstreaming (UNEP, 2022). NBS financing refers to securing funds for NBS planning, implementation or/and maintaining and operating (McQuaid, 2020). This especially relates to the question whether NBS can be publicly or privately financed, as nature has traditionally been financed by public entities (Mayor et al., 2021). Yet, to rapidly upscale NBS, it is often proposed that private investors are to an increasing extent engaged. Lessons can be drawn from the scaling of low-carbon energy technologies, including public-private partnerships and state investment banks (Toxopeus and Polzin, 2021).

Our analysis shows that a significant number of goals and actions at the EU scale are supported by existing or planned financial mechanisms and support. The Biodiversity Strategy for 2030 aims mainly at financing green infrastructure and restoration, including developing a nature-positive taxonomy to steer green investment; the Farm to Fork Strategy focuses on supporting ecosystem services as business models; and the Adaptation to Climate Change Strategy includes schemes for financing disaster risk response and risk management. Furthermore, the gap in research, development and innovation is addressed in all three policy documents, each of which includes recommendations for increased funding for knowledge production.

The EU **Biodiversity Strategy for 2030** includes detailed plans for financing NBS to conserve, enhance and restore biodiversity. It foresees nature restoration to make up

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[1] The InvestEU programme connects several EU investment funds and financial instruments and aims to mobilise and trigger sustainable investment, innovation and job-creation throughout Europe. It will do so through a Fund which includes €26.2 billion EU budget as backing, the Advisory Hub which offers technical support and capacity building, and the Portal which serves as a networking platform for investors and project promoters (EU, 2021). This Programme, as part of the European Green Deal, may present an interesting case for both creating major enablers through mobilising private and public financing to NBS as well as capacity building and knowledge dissemination and stakeholder engagement.

25% of the EU climate action budget. As such, the strategy plans for at least €20 billion per year to be unlocked by mobilising private financing and public funding as part of the European Green Deal Investment Plan. This is to be further supported by a "Renewed, Sustainable Finance Strategy" as well as a nature-capital and circular economy initiative under Invest EU, which is expected to generate €10 billion over the next decade. In several instances it also calls for a re-evaluation of criteria established under the EU taxonomy to support biodiversity-friendly funding (EC, 2023).

Here, for example, the Strategy mentions that "The EU sustainable finance taxonomy will help guide investment towards a green recovery and the deployment of nature-based solutions." And the Commission is to "strengthen its biodiversity proofing framework" by including criteria established under the EU taxonomy (EC, 2020a, p.17). The establishment of the EU taxonomy, which was part of the European Green Deal, seeks to enable the scaling up of sustainable investments both private and public (EC, 2023). It does so by providing a science-based classification system that can be used by private and public actors to assess financial decisions in terms of their contribution to the EU environmental objectives. Its overarching goal is to direct finance towards the "green transition" (EC, 2022).

The **Farm to Fork strategy** specifically recommends carbon sequestration to be rewarded through compensation schemes for farmers and foresters via the Common Agricultural Policy (CAP), the Circular Economy Action Plan (CEAP), as well as other public and private investments. The latter for example includes actors across the food value-chain investing into environmentally sustainable inputs (EC, 2021). Additional funding, namely €10 billion, for research and innovation (R&I) as key drivers to the sustainability transition is to be provided under the Horizon Europe scheme.

Meanwhile, a key financial aid mechanism mentioned in the **Adaptation to Climate Change Strategy** is the EU Solidarity Fund (EUSF), which rapidly releases funds to governments in the event of a disaster for emergency and recovery operations. The aim of the EUSF is to provide support to the most vulnerable EU countries, but it has been shown that the fund has not fully achieved this aim (Hochrainer et al. 2010). The strategy highlights that this and other funds must include "build back better" considerations which, including NBS, increase resilience in the future.

The strategy urges increased investments in NBS through InvestEU's provisions for financing new approaches and products, support under the Cohesion Policy programmes as well as the CAP. It also highlights the possibility for business models for carbon removal that include financial incentives to increase the implementation of NBS. Furthermore, the European Investment Bank (EIB) will publish a revised roadmap to support the EU Adaptation Strategy in addition to its recent commitment to financing NBS. Additional funding may be provided by the Regional Development Fund, the Cohesion Fund, and the Just Transition Fund.

As the EU Biodiversity Strategy, the Adaptation to Climate Change strategy highlights the value of private investments into NBS and as such seeks to "… support the private

sector to identify risks and steer investment towards action on adaptation and resilience (and avoid maladaptation). By offering solutions to help meet the rising awareness of climate impacts (such as the non-financial disclosure obligations, the EU taxonomy for sustainable activities and the Renewed Sustainable Finance Strategy), it will help large companies, SMEs, local administrations, social partners, and the public." (EC, 2021, p. 4).

3.3.2 Expertise and knowledge products

Expertise and knowledge play an important role in the uptake and upscaling of NBS, including encouraging private investments (Mayor et al., 2021). They can initiate transformative change through, for instance inclusion of practical knowledge in political and practical decision-making processes (Palomo et al. 2021; Wickenberg et al. 2021). Our analysis shows that both research and innovation are highly valued and encouraged in the EU Biodiversity Strategy and the EU Adaptation for Climate Change Strategy. The EU Biodiversity Strategy for 2030, for example, encourages the creation and dissemination of implementation knowledge. The Biodiversity Strategy 2030 aims to "promote and facilitate partnerships, including a dedicated Biodiversity Partnership, to make the bridge between science, policy and practice and make nature-based solutions a reality on the ground. The Commission will also establish in 2020 a new Knowledge Centre for Biodiversity in close cooperation with the European Environment Agency." (EC 2020a, p.18).

Both the EU Biodiversity Strategy for 2030 and the EU Adaptation Strategy call for increased and improved dissemination of NBS-specific knowledge supported by funding schemes such as Horizon Europe. We observe however, that knowledge, research, and development are largely unmentioned in the Farm to Fork strategy. Yet, the integration of practical and local knowledge and expertise remains unmentioned with regards to NBS, pointing to a lack of understanding and acknowledgement of the importance of practical and inter-disciplinary expertise into knowledge production exercises.

The **EU Biodiversity Strategy for 2030** highlights the importance of data and knowledge for successful implementation: "The fight against biodiversity loss must be underpinned by sound science. Investing in research, innovation and knowledge exchange will be key to gathering the best data and developing the best nature-based solutions." (EC, 2020a, p.18). In addition, emphasis is placed on the importance of disseminating knowledge, skills and information on guidelines for biodiversity-friendly practices, specifically forestry. This will be further supported by the Skills Agenda which "…will play a key role in the transition to a green economy and the fight against biodiversity loss, focusing on training and reskilling of the workforce across a wide range of sectors." (EC, 2020a, p.18).

In the context of expertise and knowledge the Biodiversity Strategy further links the EU Forest Strategy, the Commission shall work with data providers to develop the Forest Information system for Europe. The strategy calls for increased research, innovation, and knowledge exchange in order to continuously generate data and develop improved

NBS. Specifically in terms of forests, the Strategy states that "To gain a better picture of the health of European forests, the Commission will work with other data providers to further develop the Forest Information System for Europe. This will help produce up-to-date assessments of the condition of European forests and link all EU forest-data web-platforms. This will also be presented as part of the EU Forest Strategy" (EC, 2020a, p.10).

The **Adaptation to Climate Change Strategy** highlights the importance of data and improved knowledge as a key contributor to international action. The strategy calls for knowledge and data to support policy development and climate risk management. This is to include awareness raising, capacity building in MS and planning across governance and societal levels. Specific attention is dedicated to make EU funding available for these activities.

3.3.3 Stakeholder engagement

The inclusion of stakeholders into policy-making processes was highlighted in both the EU Adaptation Strategy and the EU Biodiversity Strategy for 2030. The latter specifically mention the inclusion of industry stakeholders as a means to create economic synergies with NBS. Both strategies further encourage polycentric and cross-sectoral governance across scales, and cooperation on the multi-national level. The analysis, however, shows little acknowledgement of existing sectoral silos and, subsequently, of the ways to overcome this barrier. One exception can be found in the Climate Adaptation Strategy implementation report that promotes the reinforcement of "links between public health and adaptation, notably to improve cross-sectoral cooperation on risk assessment and surveillance and to increase the awareness and capacity of the health sector, including at local level, to address climate-related health risks" (EC, 2018, p.16).

Furthermore, we find that measures and actions for stakeholder engagement are not included in the Farm to Fork Strategy. This represents a considerable shortcoming given the substantive body of literature that argues for inclusive governance processes being key for the equitable development and implementation of transformative measures in socio-ecological systems (Andrews-Speed, 2016; Raymond et al., 2010).

Acknowledging the role of cities for biodiversity efforts, the Commission is to set up an EU Urban Greening Platform connected to the European Covenant of Mayors. Furthermore, the **Biodiversity Strategy** displays an appreciation for diverse stakeholder networks, which can implement biodiversity solutions and NBS, and highlights the importance of close cooperation with farmers for exploiting opportunities in sustainable practices while also increasing the sector's resilience. To this end the strategy mentions the establishment of a European Business for Biodiversity movement as a part of the European Climate Pact.

The **Adaptation to Climate Change Strategy** provides in-depth plans for stakeholder inclusion specifically the inclusion of industry stakeholders. It specifies that "It is vital

for the private and public sectors to work together more closely, in particular on financing adaptation. The strategy, with the focus and the tools it provides, will support the private sector to identify risks and steer investment towards action on adaptation and resilience (and avoid maladaptation)." (EC, 2021, p.4). As such the review of the EU taxonomy and the Renewed Sustainable Finance Strategy seeks to aid large companies, SMEs, local administrations, social partners and the public by raising awareness of climate impacts and providing tools to support these actor groups in taking action towards adaption and resilience, including NBS, highlighting further the avoidance of maladaptation.

3.3.4   Limitations

This analysis gives a brief but detailed overview of thematic foci and specific enabling activities for NBS within the three strategies. Yet it does not provide a complete and comprehensive overview of actions at the EU level. Furthermore, given the purpose of strategies to plan and communicate the Commissions foci for the relevant legislation period, the analysis highlights possible policy pathways rather than policies and policy instruments themselves. This would require an in-depth review of all thematically relevant policies, directives, and communications at the EU level and beyond. For example, an in-depth policy analysis of the EU Biodiversity Strategy for 2030 would require a study of connected legislations including the Restoration Law, CAP, or the InvestEU Law, relevant strategies such as the EU Forest Strategy, and other programs such as the European Urban Greening Platform and Horizon Europe.

Yet in a fast-changing policy landscape we believe this study to provide a useful complement of existing literature focusing on the analysis of NBS in global, EU and national policy frameworks (e.g., Davis et al. 2018; EEA 2021; OECD 2020). For example, the previous H2020 research project NATURVATION conducted an analysis of 23 EU directives and strategies (Davis et al., 2018). Furthermore, insights gained can be expanded upon in future research projects, including NATURANCE which shall focus on issues of financing NBS.

This study does not address aspects of efficiency and implementation of policy actions referenced in the strategies. Given the socio-political, economic and ecological complexity of the EU, assessing the efficiency of policy actions on the implementation levels would provide valuable insights into policy-related challenges and enablers to NBS.

4 Governance innovation for NBS: overcoming barriers and mainstreaming NBS into policy

The EU strategies that form the focus of this analysis will or have introduced far-reaching reforms, particularly in unleashing significant EU funds, revising the EU taxonomy to include nature-positive investing (and nature-negative divesting), and (potentially) enacting legally binding nature-positive targets. Having come into force since 2020, the strategies are all recent (and the Restoration Law is not yet passed). Additionally, the European Commission (EC) itself recognises the need for a reform of biodiversity governance by proposing a new European biodiversity governance framework to map obligations and commitments regarding biodiversity (EC, 2020a). Therefore, it may be too early to suggest reforms.

Still, we need to ask if these ambitious new strategies will comprehensively address the current barriers and support the enablers to NBS implementation. In what follows, based on our results we highlight governance innovations that can help strengthen NBS implementation. We deliberately formulate these suggestions as potential focus areas where efforts could be directed, rather than suggested reforms, as these would inevitably have value judgements attached (reforms for whose benefit? for what purpose?) (McMullin 1982), and need stakeholder legitimation.

Yet, based on a meta-analysis of grey- and peer-reviewed literature and a review of three key EU strategies, a variety of innovative approaches to tackling NBS governance barriers are highlighted. We also include potential innovations that emerged from PHUSICOS partners at the PHUSICOS Consortium meeting in Orléans (6th of October 2022).

4.1 Innovative stakeholder engagement and co-design

As a start, the importance of equity (both in stakeholder engagement and in NBS benefit and cost distributions) appeared repeatedly as a key enabler to successful NBS implementation, and stakeholder conflicts were among the most cited hurdles. This emphasises the importance of inclusive engagement of stakeholders and genuine co-design and co-creation processes. Innovations for achieving this include developing living labs and other stakeholder deliberative processes (Lupp et al. 2020). For example, a state-of-the art approach to co-producing an NBS for landslide risk mitigation was carried out in Nocera Inferiore and is documented in PHUSICOS Deliverable 5.1. A three-year process, which involved stakeholders and experts who worked together in co-designing grey and NBS risk mitigation options, resulted in the implementation of one of the first landslide NBS in the region (Scolobig et al 2016; Linnerooth-Bayer et al. 2016). Yet, despite a growth of NBS co-design processes, these are often single and isolated practices that are not strategically planned or integrated at larger scale. Indeed, while networking and stakeholder-to-stakeholder communication platforms were frequently mentioned in the three recent EU strategies, there is also a lack emphasis on inclusive and transdisciplinary research processes. Identifying powerful actions to mainstream these practices can be crucial for driving innovation (Foxon 2011; Irshaid

et al. 2021). The systematic implementation of NBS knowledge hubs where stakeholders can exchange on NBS may be an effective model (Scolobig et al. forthcoming).

4.2   Innovative approaches to address equity and justice

Additionally, better ways to appraise and address potential equity and justice issues associated with NBS outcomes are required. In the PHUSICOS Serchio River Basin (Italy) site, innovation was noted in the form of benefit sharing and compensation of landowners who give up their productive land for NBS. Currently, farmers are implementing vegetation buffer strips on their fields, for which they are compensated by the local authority. One suggested solution to maintain these strips in a more sustainable way is to use their revenues, e.g., from hay production, to compensate farmers.

Regarding distributive justice, Sekulova et al. (2021) recognise the socio-environmental contradictions and contestations that can emerge from NBS. Trade-offs may, for example, occur when seeking biodiversity conservation goals that conflict with urban development goals (Davies et al. 2021). In their study, Anguelovski et al. 2018 compare three urban greening cases across the world. They find that urban NBS have often led to the creation of a 'green gap' in property markets, effectively excluding socially vulnerable and racially marginalized groups from green spaces for which they sometimes fought for generations. This green paradox is documented in numerous further studies (e.g., (Czembrowski and Kronenberg 2016; Toxopeus et al. 2020; Tozer et al. 2020; Davies et al. 2021)). Yet, there is also potential for NBS implementation processes – when inclusive of diverse visions, understandings, knowledge, livelihoods and experiences - to help tackle social justice and integrate indigenous knowledge into NBS projects. For example, two green spaces in Melbourne (a community garden and a waterway restoration project) were shown to contribute to social inclusion and community participation (Bush and Doyon 2017). Authors highlight the importance for these NBS to invite locals to use and contribute to (e.g., by growing food or help maintaining the waterways) in an inclusive and non-discriminatory way. This success was also largely driven by local champions (partnerships of local residents and community groups).

4.3   Innovative evidence provision

The existence and further development of an evidence base on NBS performance and co-benefits also emerged as a critical NBS enabler. This was reflected in findings on NBS barriers, where lack of knowledge on NBS and their effectiveness was seen as a formidable challenge. Indeed, further studies are needed on the long-term benefits of NBS in comparison to grey solutions. In particular, more quantitative cost-benefit analyses as well as quantitative indicators capturing the multiple values of solutions are considered a priority. This also emerged in the PHUSICOS Pyrenees (Spain/France) case, where improved cost-benefit analyses were highlighted as an important innovation for convincing local decision-makers of the value of NBS. In the PHUSICOS Kaunertal

case (Austria), enhanced frameworks for assessing, communicating and understanding NBS co-benefits were highlighted for NBS to be further upscaled.

However, while there is a great deal of current emphasis given to quantifying NBS effectiveness and co-benefits, this ambition is limited by difficulties in valuing non-monetary impacts and also by the 'deep' uncertainties in how these co-benefits manifest. This limits the application of quantitative decision tools, such as cost-benefit analysis, in providing evidence for NBS decisions. NBS is not alone in this limitation. Indeed, Fischer and Forrester 1993, in their early book, "The argumentative turn in policy analysis and planning", present alternative approaches to policy analysis that emphasise rhetoric and values in different forms of policy argumentation, persuasion and justification. This does not mean that quantification is not desired, but that in its absence, even qualitative evidence on NBS co-benefits has an important role. Thus, arguments in favour of NBS that are grounded in normative evidence, rather than being solely based on empirical evidence, may legitimately play a role in policy deliberations. Indeed, qualitative data and narratives emerging from stakeholder deliberations are increasingly recognised as invaluable for developing policy options or scenarios. For example, narratives on flood risk perception were shown to play a vital role for promoting NBS as flood risk protection strategies in the Glinščica catchment (Slovenia), and led to the development of a compromise vision for flood risk management (Santoro et al. 2019). A further example is given in the above-mentioned stakeholder deliberation for landslide risk mitigation in Nocera Inferiore. As data were limited in estimating the risks of landslides to the town, experts worked with stakeholders to develop policy options with qualitative justification. These later served as basis for the negotiation of eventual compromise on a NBS.

4.4 Innovative knowledge generation

A further common theme across enablers and barriers is the existence of or lack of knowledge products and NBS-specific expertise. Here, possible innovations include the creation of educational programs and trainings that are specific to NBS design (mainly targeting landscape architects and designers) and implementation (targeting contractors). Due to the multifaceted nature of NBS, which need to be part of a functioning landscape and ecosystem, the multidisciplinarity of these programs is of particular importance.

In line with this, the PHUSICOS Gudbrandsdalen (Norway) demonstration site leaders noted that training courses for NBS contractors would be an important way forward. Likewise, in their review, Vera-Puerto et al. (2020) identify the competencies that would need to be added to engineering education curricula to include NBS concepts (Vera-Puerto et al. 2020). Amongst others, results revealed a need for multidisciplinary competencies, such as knowledge on stakeholder engagement and NBS legislation. Yet, their study also showed that engineers' views on which skills are most important for NBS projects differed, highlighting the complexity of this endeavour. Still, innovative capacity building options emerged in the PHUSICOS Policy-Business Forum (Scolobig et al. D5.3, forthcoming), include developing project preparation facilities for the private

sector, creating and facilitating capacity building for NBS contractors, and creating communities of practice for NBS contractors with the public, academia and civil society. As a complementary approach, accelerator programs, could offer the private sector learning and development opportunities through intensive but brief funding and mentoring (*ibidem*).

Tools for stakeholder engagement, inter- and transdisciplinary knowledge production to address complex societal challenges such as the abovementioned have been researched and compiled into a toolbox by the EU-funded SHAPE-ID project. The project further highlighted the need for revised funding structures to enable inclusive and transdisciplinary knowledge production (Baptista et al., 2020). Yet reviewed strategies set few goals for transdisciplinary research for innovative NBS.

4.5   Innovative legislation and policy support

Enablers and barriers differed in several aspects. Most prominently, a major factor limiting NBS implementation is path dependency, i.e., the difficulty in breaking away from current legal and social norms which favour grey infrastructure. This challenge is addressed in more detail in PHUSICOS D5.4, where we explore whether NBS failure can be explained by the same factors as grey infrastructure failure. A far-reaching innovation to emerge from D5.4 (Linnerooth-Bayer et al, forthcoming) is to change the burden of proof on proposed public and private 'grey' infrastructure projects. Currently the default option for infrastructure is a grey solution with the burden of proving or demonstrating (quantitatively) the effectiveness and co-benefits of NBS residing on NBS infrastructure proposers. Consistent with the EU Precautionary Principle, the burden of proof might be switched to the proposer of 'grey' infrastructure to show (quantitatively) that there are no or limited nature-negative impacts. In other words, the default option would switch from 'grey' to NBS. This could be implemented by further revisions of the EU Environmental Impact Assessment Directive (EC, 2014) that would require all 'grey' infrastructure project proposals to undergo an assessment that accounts for their long-term impact on the environment.

The Norwegian Environment Agency is a pioneer in enabling a change in the burden of proof by publishing guidelines that recommend that an NBS be considered as an alternative to any planned grey solution, and the grey solution must then justify its supremacy (see Scolobig et al., forthcoming). Nevertheless, these guidelines - as their name suggests - are to date voluntary.

The development of nationally (and ideally, internationally) agreed technical standards, guidelines and legal norms for NBS implementation can also help surmount this challenge. Indeed, when available, NBS policies in Europe are based largely on voluntary action and often lack quantitative and measurable targets for NBS deployment and quality evaluation (Davis et al. 2018). Furthermore, there is poor application of NBS policies at the regional and local scales (Davis et al., 2018; EEA, 2021). Risk reduction standards, insurance standards, implementation guidelines and risk management tools (including liability related guidelines) are innovations that could be established or

updated to pave the way for NBS (Scolobig et al., forthcoming). Moreover, to close the 'implementation gap', further work is needed to identify all relevant policy mechanisms, along with levers for institutional reform, that can help bridge the gap between policy uptake and on-the-ground implementation (Fedele et al. 2019). Still, as documented in this study, the Restoration Law (Directorate-General for Environment 2022) promises an important innovation in the form of legally binding targets for biodiversity. Indeed, if endorsed by EU MS, the Restoration Law could have a significant impact in accelerating NBS uptake in Europe by enforcing large-scale restoration across EU habitats. In the PHUSICOS Gudbrandsdalen case (Norway), the idea of compensation for any type of land use change by setting ratios of land requiring restoration was suggested as a potential innovation.

4.6   Innovative governance arrangements

Polycentric governance arrangements to overcome siloed administrative bodies present an important enabler, which is not unique to NBS, but is perhaps more salient for NBS due to the need for cooperation among all sectors and governance scales co-benefiting from the intervention (Martin et al. 2021). Nevertheless, such arrangements still lack practical applications in the NBS sphere. An important innovation in this direction emerged from PHUSICOS D5.1 (Zingraff-Hamed et al. 2019; Martin et al. 2021). Indeed, the restoration of a stretch of the Isar river in Munich (also known as the Isar-Plan) gave rise to an unprecedented and polycentric governance arrangement: the Isar-Plan Working Group (Zingraff-Hamed et al. 2019). This interdisciplinary group brought together actors from different sectors and scales. It marked a critical milestone in the Isar story, as it dispersed decision authority across multiple organizations and authorities that went beyond just flood protection. The Isar-Plan Working Group proved key to enabling the successful implementation of the Isar-Plan.

Somarakis et al. (2019) note the lack of coherence in EU policies relating to NBS. Further alignment of sectoral policy instruments is thus needed to facilitate cross-sectoral (and by extension polycentric) governance arrangements for NBS (EEA, 2021). Likewise, the EEA (2021) calls for the better exploitation of synergies and for addressing trade-offs between NBS and other policy domains. Indeed, there is potential to build policy synergies, e.g., by linking NBS policies to well-being and preventative health care policies as well as to green infrastructure, transport and mobility policies (Scolobig et al., forthcoming). More precisely, the complex mosaic of policy instruments addressing NBS in Europe can lead to fragmented applications and eventually, policy stalemates. There are several options to reduce policy fragmentation, including the development of a dominant steering instrument that can establish a clear pathway for NBS policies at the MS level (e.g., as advocated for forest policies, see Aggestam and Giurca 2021).

4.7   Innovative financing of NBS

Financial support and tools (and the lack of) emerged strongly as critical enablers (as well as critical barriers) to NBS implementation, both in the reviewed literature and the

three EU strategies. Currently, NBS financing relies heavily on public financing (representing 83% of global NBS investment efforts), with limited participation from the private sector (UNEP, 2022). It should however be noted that an increasing number of funding opportunities have been put into place for supporting NBS in Europe, as documented by Trinomics & IUCN (2019) in their inventory of financing tools for NBS. Likewise, the Global Biodiversity Framework aims to eliminate $500 billion of nature-harming subsidies (Target 18) (COP to the CBD 2022). The Framework further commits parties to voluntarily mobilise a minimum of $200 billion USD per year to finance nature (*ibid*). Yet, the nature funding gap, estimated to be $700 billion per year, is still nowhere near filled by this commitment even if it is met (United Nations Environment Programme (UNEP) 2022). The inception of the EU Taxonomy for sustainable finance also provides a novel classification system for sustainability assessments of public and private investments, which may be a first step towards a re-thinking of environmental costs and benefits of investments.

We cannot hope to close the financing gap with public funding alone (UNEP, 2022). Interestingly, research shows that increasing private investment into NBS faces similar hurdles to the barriers identified in this deliverable. They include sectoral silos, path dependency, lack of expertise (Mayor et al. 2021), challenges in valuing and accounting for multiple benefits and co-benefits and lack of predictable long-term revenue streams (Toxopeus and Polzin 2021). Uncertainty in the effectiveness of NBS represents a formidable barrier for private investment in NBS infrastructure, which might be overcome by deploying innovative financial instruments to de-risk projects (e.g., private or public insurance and provision of public guarantees). The lack of 'bankable' projects may however be the most difficult barrier to overcome. Investments in 'green' funds have increased dramatically, but with portfolios dominated by profitable renewable energy investments. The public-good nature of NBS precludes companies from seeking financing and raises the question of how the public sector might assist by sharing costs and responsibility.

Much can be learned in this respect by examining innovative experience with regard to public-private partnerships, blended financing, subsidies, and other public financing schemes (see, e.g., McQuaid and Fletcher 2020). Indeed, co-financing options and other blended financing models can also provide incentives for private investors, such as subsidies and tax rebates (Scolobig et al., forthcoming). For example, the Labiomista park in Belgium was funded through an innovative public- private partnership (PPP): an artist whose studio is located on site invested approximately €8 million in the project, which was matched with €12.6 million public sector funding (Rhodes et al. 2021). To finance ongoing costs, pay-per-use income from tourists visiting open-air art exhibitions in the park is used. The three reviewed strategies also include significant efforts in increasing PPPs to encourage sustainable business model development.

The OECD has called for formal mechanisms or bodies for the coordination of public investment across sectors and government scales (OECD 2020). Likewise, Scolobig et al. (forthcoming) call for semi-permanent institutional frameworks that are adaptive, multi-scale, cross-sectoral, and well enough established to guarantee the delivery of

NBS. For instance, this could entail the creation of new institutions devoted to NBS promotion with their own budgets and a clear political mandate (Runhaar et al., 2018). A further innovation could be the establishment of cross-sectoral offices or secretariats (e.g., on biodiversity and climate change adaptation) to assist agencies in the implementation of NBS strategies. Successful examples are provided, for example, in Braunschweiger and Pütz (2020). This institutional innovation would simultaneously address the barrier of sectoral and administrative silos by engaging a centralized and professional agency for integrated and long-term NBS infrastructure planning and implementation (Wegrich et al. 2017).

5   Conclusions

To summarize our results, table 4 provides an overview of the principal barriers identified in this review, as well as suggested innovations that can help overcome them.

Table 5: Summary of principle enablers/barrier themes and corresponding potential innovations

Barrier theme	Potential governance innovation
Lack of expertise and knowledge	Development of educational and training programs specific to NBS design and implementation
	Integration of multidisciplinary competencies in NBS curricula, including on e.g. NBS legislation
	Developing NBS project preparation facilities for the private sector
	Creating and facilitating capacity building for NBS contractors
	Creating accelerator programs that offer the private sector NBS learning and development opportunities through funding and mentoring
	Creating communities of practice for NBS contractors with the public, academia and civil society
Evidence on NBS performance and co-benefits	Development of long-term studies on the co-benefits of NBS in comparison to grey solutions
	Development of quantitative decision-making tools, such as cost-benefit analyses and indicators
	Integration of qualitative evidence on NBS, such as stakeholder narratives, in NBS policy options
Stakeholder conflicts and equity	Development of living labs and other stakeholder deliberative processes
	Genuine co-design and co-creation processes
	Systematic implementation of NBS knowledge hubs where stakeholders can exchange on NBS
	Innovative benefit sharing and compensation mechanisms for landowners giving up land for NBS
	Development of stakeholder engagement processes that are inclusive of diverse visions, understandings, knowledge, livelihoods and experiences
	Integration social justice and equity considerations in NBS development and appraisals
	Integration of indigenous knowledge in NBS decision-making processes
Path dependency	Shift in the burden of proof to traditional grey infrastructure projects, for example by amending the EIA Directive 2011/92/EU
Lack and complexity of financing	Establishment of the EU Taxonomy for sustainable finance
	Pledges and commitments to eliminate nature-harming subsidies through the Global Biodiversity Framework
	Deployment of financial instruments to de-risk projects (e.g., private or public insurance and provision of public guarantees)
	Deployment of public-private partnerships, blended financing, subsidies, and other public financing schemes for financing NBS
	Establishment of formal mechanisms and bodies coordinating NBS public investment across sectors and government scales
	Creation of new institutions with independent budgets and clear political mandates, devoted to NBS promotion

Barrier theme	Potential governance innovation
Lack of supportive policy and/or legal frameworks	Development of risk reduction standards, insurance standards, liability guidelines and risk management tools
	Development of nationally (and ideally, internationally) agreed technical standards, guidelines and legal norms for NBS implementation
	Enforcement of legally binding biodiversity targets through the proposed New EU Restoration Law
Sectoral and/or administrative silos	Polycentric governance arrangements
	Alignment of sectoral policy instruments to exploit synergies and address trade-offs between NBS and other policy domains
	Creation of a dominant steering instrument that can establish pathways for NBS policies at the MS level
	Establishment of semi-permanent institutional frameworks that are adaptive, multi-scale and cross-sectoral to guarantee the delivery of NBS
	Establishment of cross-sectoral secretariats to assist agencies in the implementation of NBS strategies

Thus, if the European Union is to meet its ambitious biodiversity and climate goals, it will need to considerably accelerate the implementation and upscaling of NBS. Nevertheless, our analysis shows that NBS implementation faces numerous challenges requiring transformations in the way we design, assess, value, finance, and implement NBS. This deliverable provides an in-depth overview of NBS implementation barriers, as well as important enablers, across a rich and extended literature. It also documents the extent to which three recent EU policy strategies addressing biodiversity, climate adaptation and agriculture intend to help enable NBS, especially by explicitly supporting NBS funding and financing, knowledge and expertise, as well as stakeholder engagement.

Based on a meta-analysis of grey- and peer-reviewed literature as well as workshop results, our study reveals the most important institutional, legal, regulatory, social and economic opportunities, as well as the key barriers to NBS implementation. Interestingly, results on barriers and enablers were very similar, which can be attributed to the fact that many enablers represent the counterpart of barriers, and vice-versa. By far, the most cited barrier in the NBS literature is the lack of specialized expertise and knowledge regarding the design, on-the-ground implementation, performance, benefits and co-benefits of NBS. This 'knowledge' barrier has been identified as a major concern across the whole NBS policy cycle. It is compounded by the still limited standards, technical guidelines and legal norms on NBS performance. The newness and novelty of NBS interventions are a major factor for the dearth of NBS standards and liability measures. This also translates into a limited willingness to invest in NBS, particularly for otherwise promising public-private partnerships.

A further major factor limiting NBS implementation appears to be path dependency, i.e., the difficulty in breaking away from current and deeply ingrained legal and social norms that still favour 'grey' infrastructure as well as general resistance to change in the choice of infrastructure delivery and responsible persons or entities. The continuing lack and

complexity of financing was also among the top five NBS barriers. Indeed, complexity is manifest in the assorted portfolio of public and private instruments, made more complex by 'silo budgeting' and the consequent disregard of NBS' co-benefits. This also stresses the importance for NBS projects to be embedded in cross-sectoral policy agendas, bringing together different environmental issues through novel governance arrangements, such as polycentric arrangements.

Finally, stakeholder conflict, often associated with perceived inequities in sharing NBS costs, burdens and benefits, is a major factor inhibiting or delaying NBS implementation. Many of these barriers have led to an 'implementation gap' regarding NBS, where policy ambition seems to outweigh on-the-ground implementation. As such, there is still limited integration of NBS in legal systems, especially at regional and local scales. Indeed, NBS policies in Europe are based largely on voluntary action and often lack quantitative and measurable targets for NBS deployment and quality evaluation. Yet, many of the EU's recent strategies, in particular the proposed EU Restoration Law, as well as the recent Sustainable Finance and EU Taxonomy, are seen as potentially powerful and innovative turning points.

Based on the analysis of three recently published strategies (The EU Biodiversity Strategy, the Farm to Fork Strategy and the Adaptation to Climate Change Strategy), we have explored three major themes for enabling NBS implementation: financing, expertise and knowledge products and stakeholder engagement. Indeed, our analysis shows an emphasis on financial tools for scaling NBS in three recent EU strategies. Planned actions to incentivize more private financing include a revision of the EU taxonomy to enable and support biodiversity-friendly investments (and divest out of nature-negative projects) and the exploration and establishment of sustainable business models. Emphasis is further placed on the need for research and development, dissemination and capacity building as a key driver of NBS and the scaling thereof. Perhaps due to the nature of these strategies, integration of and guidance on practical knowledge and action-oriented transdisciplinary knowledge was given little attention. A third area of emphasis emerged on stakeholder engagement. While specific action for stakeholder engagement is lacking in the Farm to Fork strategy, the Biodiversity Strategy addresses stakeholder engagement through cooperation with farmers and the establishment of business plans, and the Adaptation to Climate Change Strategy provides plans and suggestions for the inclusion of industry stakeholders as well as polycentric stakeholder inclusion.

To conclude, our results highlight enablers that are crucial for NBS as well as the most formidable barriers that they currently face to contribute to transformative agendas. NBS have emerged as one of the most paramount topics to achieve the ambitious goals of global and European policy agendas, including the recent EU strategies, EGD and the CBD's Global Biodiversity Framework. Yet, the success in achieving these goals will depend on a multi-faceted understanding of the governance enablers and barriers to NBS implementation that can help policies tackle the existential risks that biodiversity loss and a warming climate pose.

6 Acknowledgements

7   References

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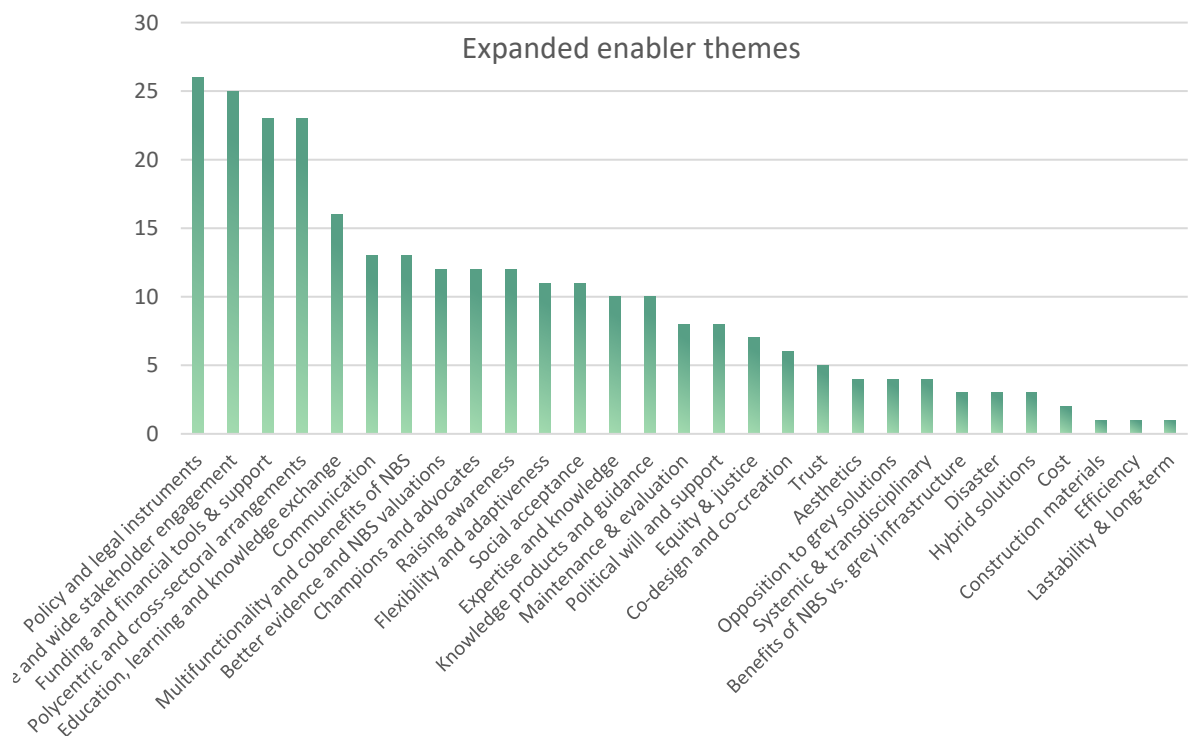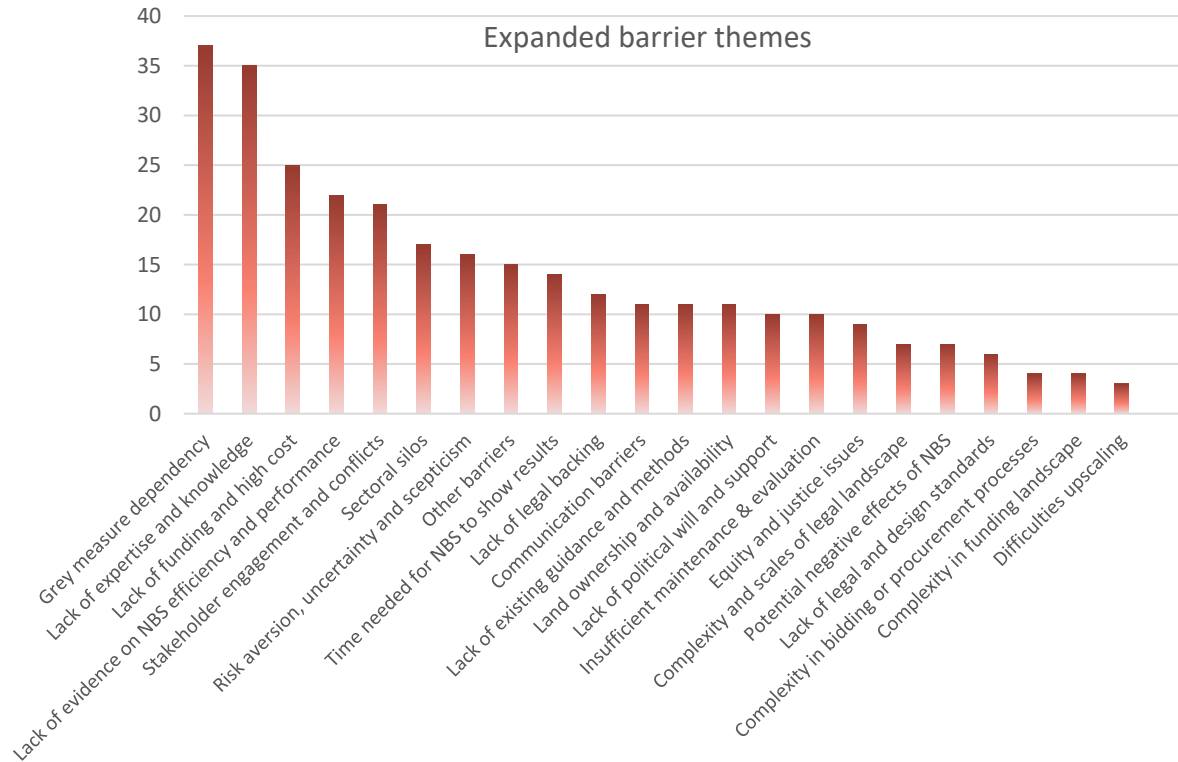
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Appendix A: Detailed enabler and barrier themes

Expanded barrier themes

Expanded enabler themes