Nature-based Solutions for climate adaptation in the European Union

PART II ANALYSING GOVERNANCE AND FINANCING BARRIERS

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Sciences Po Paris
September 2023

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This report can be cited as follows:

De los Casares, V. and Ringel, M. (2023). Nature-based Solutions for climate change adaptation in the European Union, Part II: Analysing Governance and Financing barriers, European Chair for Sustainable Development and Climate Transition, Working Paper Series.

Nature-based Solutions for climate adaptation in the European Union:

PART II ANALYSING GOVERNANCE AND FINANCING BARRIERS

Valeria de los Casares and Marc Ringel

"Any region's economic competitiveness and security— in the long run—depends directly on sustainable use of natural resources."

(Maes and Jacobs, 2017)

Abstract

The first of this two-part working paper on nature-based solutions for climate adaptation in the European Union provided a mapping exercise of NBS activities at EU and Member State levels. This analysis highlighted the gap between EU ambitions for institutionalising NBS and the low uptake of the concept by Member States in their national climate adaptation policy. In this paper, we review barriers to adopting NBS, particularly those related to governance and financing aspects. We conduct a literature and case study review and 19 in-depth interviews to experts working in different aspects of NBS research and implementation to identify barriers. We find that NBS adoption faces a 'multi-barrier situation', where no single barrier can be pinpointed as the main cause hindering institutionalisation. Governance and financing barriers emerge in both literature and throughout the interviews as key themes underpinning these barriers. Acknowledging this and tackling barriers through an integrated approach will be crucial for the success of nature-based solutions for climate change adaptation in Europe.

Acknowledgements

We would like to thank Sandra Andreu, McKenna Davis, Pavel Dostan, Aitziber Egusquiza, Markus Erhard, Elsa Favrot, Niki Frantzeskaki, Caroline Gamper, Ariane Kaploun, Joachim Maes, Siobhan McQuaid, Virginie Quilichini, Benedetto Rugani, Raul Sanchez, Anne Teller, Axel Timpe, Fleur Van Ooststroom-Brummel, Laura Wendling and Marianne Zandersen for dedicating their valuable time to take part in our interviews and providing us with meaningful insights on the challenges for implementing nature-based solutions that strongly helped to shape our research.

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1.Introduction

The European Union (EU) has emerged in recent decades as a leader in the adoption of ambitious climate targets and policies. Although many efforts have been concentrated in the reduction and mitigation of carbon emissions, it is widely acknowledged that, even if most of these efforts prove to be successful, climate change will bring important short and medium-term adverse effects across regions and cities (Biesbroek et al., 2009; Emilsson & Ode Sang, 2017; Madsen et al., 2014). Moreover, while climate change mitigation relies on estimated metrics to quantify the amount of carbon that is emitted, offset, or even captured from the atmosphere, we find that "there is no single, uniform and universally applicable metric to measure progress with adaptation in the same way as mitigation can be measured through greenhouse gas emission reductions" (Pringle & Leiter, 2018: 32). This comes due to factors such as the unpredictable nature of abnormal weather events and other climate-related impacts that can have wide-ranging implications for diverse areas such as infrastructure to transport or food networks (Lesnikowski et al., 2019).

Against this backdrop, researchers and policymakers have studied a wide range of tools to promote and assess climate adaptation (Bours et al., 2013; Desai & Hulme, 2004). Among these, considerable attention has been paid to the role of ecosystem-based approaches (Brink et al, 2016; Chausson et al., 2020; Geneletti & Lardo, 2016). Ecosystem-based adaptation (EbA) is defined as "the use of biodiversity and ecosystem services as part of an overall strategy to help people adapt to the adverse effects of climate change" (CBD, 2009, p. 41). Moreover, this term is part of a wider range of related concepts that are rooted in the idea of ecosystem services, that is, the understanding that ecosystems can provide multiple social and economic benefits to society (Maes et al., 2012; Pauleit et al., 2017). Nature-based solutions (NBS) represent the most novel concept that has emerged in recent years (Escobedo et al., 2019) as an umbrella for a range of ecosystem-based approaches, including EbA (Naumann et al., 2014; Pauleit et al., 2017). NBS constitute an important tool that can serve to promote the role of

ecosystems in cities and landscapes, as well as the associated social, environmental and economic benefits that they can bring. Among these benefits, the potential for NBS to contribute to climate change adaptation has been widely documented (Calliari et al., 2022; Chausson et al., 2020; Geneletti et al., 2016; Zandersen et al. 2021). These benefits can include, but are not limited to, a reduction in the heat island effect (Emilsson & Ode Sang, 2017; van den Bosch & Ode Sang, 2017), an improvement in air quality (Calfapietra et al., 2015; Wang et al., 2015) or the reduction of local flooding (Davis & Naumann, 2017; Emilsson & Ode Sang, 2017). Following recent studies (Calliari et al., 2022; Chausson et al., 2020; Geneletti et al., 2016) we choose to employ the concept of nature-based solutions for climate adaptation, as opposed to earlier concepts related to ecosystem-based approaches. We find that NBS represents a more flexible lens to capture the diversity in approaches to adaptation and it emphasises their social and economic co-benefits. In this sense we understand NBS as a way to leverage ecosystem services (Thompson et al., 2022).

Over the last decade, the European Union (EU) has integrated the concept of NBS and positioned itself as a frontrunner in promoting and developing the framework of nature-based solutions for climate adaptation (Faivre et al. 2017; Davies et al. 2021). As defined by the European Commission, NBS are "solutions that are inspired and supported by nature, which are cost-effective, simultaneously provide environmental, social and economic benefits and help build resilience".[1] These solutions range from green and blue infrastructure to natural water retention measures (NWRM) or sustainable forest management (SFM), and they often represent an alternative to "grey" infrastructure or approaches (Seddon et al., 2020). Other international institutions, such as the International Union for the Conservation of Nature (IUCN) or the World Bank Group, have also been ramping up their support for NBS in recent years. The IUCN developed standards to further conceptualise and give a framework to NBS, and has been promoting the financing of projects, particularly in developing countries, which has been rapidly increasing in the past decade (IUCN, 2020).

[1] https://research-and-innovation.ec.europa.eu/research-area/environment/nature-based-solutions_en

Today, the NBS concept is present across key international and European policies (EEA, 2021), and the research and innovation agenda on nature-based solutions has served to unify efforts in building a knowledge base (EC, 2015). The EU has also financed several implementation and research and innovation (R&I) projects through instruments such as the Horizon 2020, LIFE or Interreg programmes (EC, 2020a; EC, 2020b). These projects have been developed under targeted calls and have focused on aspects such as rendering NBS accessible to policymakers, building business models or best-practice case books.

The first part of our working paper focused on carrying out a stocktaking exercise of EU and Member States' actions and provisions on NBS for climate adaptation. This analysis highlighted the gap between EU ambitions and the low uptake of the concept by Member States in their national climate policy. Following up on this, the present paper looks into the barriers for implementing nature-based solutions. Calliari et al. (2022) provide a review of case studies and identify challenges for the implementation of NBS. The three core challenges that they found were those related to knowledge frameworks, financing of NBS and opportunities for stakeholder engagement. Building on this work, we analyse barriers for NBS diffusion in two main areas: governance of NBS and financing of NBS. Moreover, some of the challenges related to knowledge frameworks are discussed in either of the two sections. To carry out this analysis, we have enriched our literature and policy review with 19 in-depth interviews to experts in the field. We conduct a thematic analysis to identify trends and compare views across different groups of respondents.

1.1. Motivation of paper and research goal

Since the concept was introduced in Europe, nature-based solutions have served to unify efforts in advancing projects that promote resilience and biodiversity, and that simultaneously serve other goals in areas such as health, well-being, or mobility. Promoting NBS can offer a cost-effective option for advancing climate change adaptation, but institutionalisation of NBS remains limited (Davies et al., 2021; Griscom et al., 2017).

In this context, our study positions itself alongside previous efforts that have aimed at understanding how to successfully implement and upscale the deployment of nature-based solutions for climate change adaptation in order to mainstream them in the European Union. Following a mapping of NBS provisions at the EU and national levels in the first working paper, we now look at barriers against adoption. In particular, we look at governance and financing aspects. These are key to developing an approach for implementing these projects, especially considering the stage we are in –that is, previous to an institutionalisation of NBS (Davies et al., 2021). Our research goals for this working paper comprise the following points:

1. Take stock of current EU strategies, policies and mechanisms to support NBS solutions.
2. Analyse national schemes and action plans concerning their support for NBS solutions and dedicated financing and governance schemes.
3. Gain a deeper understanding of the choices for dedicated financing and governance provisions as well as for barriers hindering the implementation of these institutional settings.

The first Working Paper focused on research goals number one and two, while this second paper will look at the third question. We analyse the literature on barriers to governing and financing nature-based solutions and conduct in-depth expert interviews to respond to this question.

1.3. Organisation of paper

This working paper is organised as follows: Section 2 presents the methodology. Sections 3 and 4 discuss the background for multilevel governance and financing of NBS. Section 3 looks at the concept of multilevel governance of nature-based solutions including the horizontal and vertical governance of NBS. In section 3.1 we discuss governance models for NBS projects, with particular attention to co-governance and stakeholder engagement. Section 3.2 provides a review of actors and cooperation structures at the EU level. Then, in Section 4, we discuss financing sources and instruments for NBS. We look at mobilisation of financing in the European context (Section 4.1).

Section 5 presents the results from the 19 in-depth interviews and the discussion of the barriers identified throughout the literature review and interviews are then presented in Section 6. Here, Section 6.1 looks at the interplay between governance and financing barriers, Section 6.2 zooms on the identified barriers for multilevel governance of NBS and Section 6.3 at those for financing nature-based solutions. Finally, based on these findings, we discuss policy recommendations to address these barriers and further enhance uptake of NBS in Europe.

2. Methodology and data used

We examine governing and financing barriers by carrying out a two-step analysis. First, we provide a comprehensive review of relevant literature and NBS case-studies from different publicly available databases. In a second step, we complement this by conducting 19 in-depth interviews to NBS experts focused on barriers to implement and promote the diffusion of nature-based solutions. The literature review serves also to inform the questionnaire for the interviews.

2. 1. Data

In a first step we review relevant literature and available databases to contextualise and identify barriers to implementing and diffusing nature-based solutions that have been discussed by the literature. Table 1 presents a summary of the resources accessed and Table 2 of the databases consulted for case studies.

Table 1. Resources accessed

Name of type of resource	Number of resources accessed
Academic literature on aspects of nature-based solutions	47
Academic literature on barriers to NBS adoption	13
Academic literature relevant for nature-based solutions (ecosystem services, adaptation, climate governance)	30
Other	4
Total	94

Table 2. List of consulted databases on NBS projects[2]

Database	Author	Nature of entries	Number of entries
Urban Nature Atlas	NATURVATION	A collection of urban NBS case studies globally with a European focus.	1240
NBS Knowledge Database	NetworkNature	A database of European research, policy, projects and market-based tools	708
Oppla Case studies	Oppla	A collection of NBS case studies globally with a European focus.	520
Research and innovation projects on nature-based solutions	NetworkNature	A database of EU-funded R&I projects working with NBS	262
Atlas of Natural Climate Solutions	European Chair for Sustainable Development and Climate Transition	A collection of Natural Climate Solutions case studies globally.	148
Urban Innovative Actions project list	Urban Innovative Actions	A list of projects on sustainable urban development supported by European and in particular ERDF funds.	86

[2] Last accessed July 2023

2.2. Methods

Survey design

The purpose of the interviews was to obtain a deeper insight into the interplay of barriers for implementing and diffusing NBS from the point of view of policymakers, researchers and enterprises working in the field and validating our findings from the literature and case-study review. The literature review carried out prior to the interviews informed the design of the questionnaire.

The interview questionnaire was divided in four sections: (1) introduction, (2) governance aspects, (3) financing aspects, and (4) a final section asking respondents to evaluate an assessment grid that was prepared for Working Paper 1 to assess the level of uptake of NBS in Member States' climate adaptation policy. Interviews were semi-structured and thus questionnaire presented respondents with a mix of rating and open questions (see Annex 1 for the interview questionnaire).

In the introduction, respondents were presented with some "ice breakers", including questions on their occupation and the role of NBS in their work as well as the time when they became acquainted with the concept of NBS. The last question in the introduction was the first rating question and included the rating of four barriers previously identified throughout the literature review: the lack of financing options (Wickenberg et al., 2021, Toxopeus, 2021), the lack of successful governance models (Calliari et al., 2022, Kabisch et al., 2021), the lack of evidence or research on NBS viability (Chausson et al., 2020) and the lack of coherent policy to incentivise NBS (Calliari et al., 2022).

The section on governance aspects began with a rating question on four different governance models. The models were identified following Zingraff-Hamed et al. (2021). Then, open questions were asked regarding the most common governance models or set ups that respondents were familiar with, how to promote better governance and on developing centralised policy for all nature-based solutions.

The section on financing first asked respondents to rate the level of development of financing options for NBS, based on their perceptions. It included open questions on the most common source or sources of NBS financing (presenting respondents with four sources identified by the IUCN (2020)) and on the

role of policy to promote financing options for NBS. Moreover, this section included two rating questions. The first one asked respondents to rate a series of potential financing instruments identified throughout the literature review and case studies, including grant funding and donations (Baroni et al., 2019; Urban Nature Atlas), green finance (Baroni et al., 2019; Urban Nature Atlas), instruments generating revenue (Baroni et al., 2019; Kooijman et al., 2021), public-private partnerships (Baroni et al., 2019) and market-based instruments (Baroni et al., 2019; IUCN, 2020). The second rating question consisted of the rating of five identified barriers to financing NBS, namely the lack of private sector interest, the challenges associated with valuation and accounting, the lack of science or evidence to back-up the business case and the coordination between public and private financiers.

Expert interviews

Prior to conducting the interviews, we established and contacted a pool of academics, researchers, relevant policy authorities and private sector experts working either with (1) nature-based solutions as a concept or framework; or (2) a commonly understood subtype of nature-based solutions, such as green infrastructure, urban NBS projects, or sustainable water management. We contacted over 100 identified experts to cover a broad range of organisations and institutions. Contact was established via e-mail or online contact form between February and April 2023. In total, this led to 19 interviews with sector experts from the mentioned stakeholder groups (see Table 3 for an overview). We refer to interviewees by ID numbers designated with 'I' for 'Interviewee' and a distinguishing number from 1 to 19. Questionnaires were sent in advance to participants and pretesting was conducted to ensure precision and clarity in the interview process (Buschle et al., 2022:1).

Table 3. Interview participants.

ID	CATEGORY	OCCUPATIONAL POSITION	DATE
I1	POL	Policy Officer	13/03/2023
I2	RES	Chair Professor	17/03/2023
I3	POL	Programme manager	20/03/2023
I4	PRIV	Innovation Deputy Director	20/03/2023
I5	RES	Senior Fellow	22/03/2023
I6	POL	Policy Officer	27/03/2023
I7	PRIV	Nature Initiatives Leader	27/03/2023
I8	PRIV	CSR Director	27/03/2023
I9	PRIV	CSR Project Lead	27/03/2023
I10	RES	Senior Researcher	28/03/2023
I11	RES	Head of Natural Resources Area	12/04/2023
I12	RES	Senior Research & Technology Associate	12/04/2023
I13	POL	Project Manager Ecosystem Services	13/04/2023
I14	RES	Landscape Architect; Research Associate	14/04/2023
I15	POL	Senior Expert	17/04/2023
I16	RES	Architect, Researcher	18/04/2023
I17	RES	Research Team Leader	18/04/2023
I18	PRIV	Vice President of European Federation; CEO	19/04/2023
I19	RES	Associate Director of Innovation Centre; Start-Up Co-founder	27/04/2023

Note: We group participants in three categories according to their main professional occupation. Categories are: 'RES' for participants working in academia as well as private research centres; 'POL' for participants working in policymaking or policy institutions, such as European institutions; and 'PRIV' for participants working on the private sector.

Interviews were conducted via Zoom or Microsoft Teams between March and April 2023. They lasted on average between 35 to 60 minutes, depending on the interviewee's availability.

Coding of interviews

Interviews were recorded and transcribed following Mayring (2021). Based upon White (2006), we performed a qualitative content analysis employing the qualitative research software MAXQDA for computer-aided text analysis (CATA) and established theory methodology (Charmaz, 1990). The analytical strategy involved a process of re-reading the transcripts and encoding the collected data. Beginning with open coding, we marked the relevant content that was connected to our research question, so to barriers for implementing NBS. In subsequent steps, codes were aggregated into sub-categories and subcategories (see Table 4).

These subcategories represent identified barriers for NBS implementation, which were grouped under three themes or categories: 'governance', 'financing' and 'knowledge frameworks'. One subcategory was put under both 'governance' and 'financing' categories.

During the interviews, it must be noted, however, that respondents were allowed to skip questions if they desired to, so not all questions received 19 responses. Moreover, while we distinguish among groups of respondents (see Table 3), these were clustered priorly to the qualitative analysis in order to investigate if there were differences among groups. Nonetheless, we did not find significant differences or trends between groups unless explicitly mentioned so during the 'Results' section. The small and uneven sizes of groups (number of respondents per group: POL: 5; RES: 9; PRIV: 5) also difficulted adequate comparison.

Table 4. Categories and sub-categories identified throughout the qualitative content analysis of the interviews.

CATEGORY	SUB-CATEGORY
GOVERNANCE	Lack of integrated approach
	Collaboration between stakeholders
	Lack of public-private collaboration
	Lack of resources at local level
	Silos
	Lack of standards or common frameworks
	Lack of community involvement
	Lack of integration of NBS in policy
	Lack of skills or expertise
	Lack of incentives or regulation
FINANCING	Lack of financing instruments
	Lack of Business models
	Lack of incentives for business
	Return on Investment (ROI) or bankability issue
	Scale of projects (for investing)
	Crowding out effect from public money
	Lack of private sector readiness
KNOWLEDGE FRAMEWORKS	Scalability and replicability
	Lack of comparable data
	Accounting for (intangible) externalities
	Information failure
GOVERNING & FINANCING	Sustainability timeframe

3. Multilevel governance of nature-based solutions

The concept of multilevel governance is widely present in (although not restricted to) analyses of EU policy governance, and particularly useful in the context of climate policy action (Jänicke & Wurzel, 2020; Jordan et al., 2012; Kern, 2019). It refers to the vertical but also horizontal dispersion of governance on a particular policy subject. Moreover, multilevel climate governance is grounded in the understanding that effective climate action requires collaboration and cooperation among governments, organisations, and stakeholders at multiple scales, and it emphasises the interconnectedness of climate challenges and the need for coordinated efforts across different levels of governance. In the case of climate change adaptation, the effects of climate change will be felt unequally by different European cities and regions (Biesbroek et al., 2010; EEA, 2009). Nonetheless, the scale and required investments needed for adaptation render this issue as one that goes beyond the scope of local and regional authorities (Puig et al., 2016). Policy is required to be implemented through local and regional lenses, but limits in the capacity of local public authorities pose challenges to develop transformative and oftentimes costly climate measures. In this context, the European and National Adaptation Plans constitute key milestones in the development of a coherent multilevel governance framework for climate change adaptation in the European Union.

In the case of nature-based solutions, we see that these projects are usually initiated and implemented by local governments or in close collaboration with them. Nonetheless, the role of the European Union in developing the concept of NBS and promoting research and innovation on the topic has been key in shaping the present NBS scenario in Europe and facilitating diffusion in cities and regions (see EC, 2015; EC, 2020a; EC, 2020b). In terms of EU climate and environmental policy, the concept of NBS is well incorporated into key policy documents such as the 2030 Biodiversity Strategy, the Floods Directive or the EU Adaptation Strategy and NBS is identified as a key strategy to advance the goals of these policies (EEA, 2021) (see our previous working paper for a more extensive discussion). Moreover,

the European Union has a dedicated research and innovation agenda for nature-based solutions and has invested more than 240 million EUR in R&I projects in the last fifteen years (Cohen-Shacham et al., 2019). Finally, the recently passed in Parliament EU Nature Restoration Law (EC, COM(2022) 304) will help guide efforts that contribute to preserving nature and biodiversity, an objective that is directly related to the promotion of NBS. All this contributes to a consolidation of the role of the EU in driving and accelerating the institutionalisation of nature-based and is reflected in political and economic efforts that materialise in policy and funding instruments.

3.1. Governance set ups of NBS projects

Table 5 presents different types of governance set ups or models and identifies examples of projects. These models have been identified through an analysis of the literature and of NBS project databases but do not constitute an exhaustive list of all possible models. Instead, they are general models that can have variations or can also evolve over time.

Table 5. Types of governance set ups in NBS projects.

Governance models	Description	Examples
Hierarchical model	Led by the public authority both in terms of design and management of the project	Large green infrastructure projects i.e., rehabilitation and restoration projects, large parks, re-naturalisation of rivers
Closed co-governance	Managed by two or more actors, usually government and a private or civil society actor, through a partnership set up. The co-management can happen at different stages of the project and have different configurations. The project is not open for external actors to join.	Projects developed under a public-private partnership (PPP), sustainable water management projects, sustainable forest management projects, restoration projects
Open co-governance	Managed by two or more actors, usually government and a private or civil society actor. The co-management can happen at different points of the project and have different configurations. The project is open for external actors to join, such as through public consultations.	Community or open gardens, urban farms and gardens, restoration or greening of abandoned / underused urban space
Community-led	Led and managed by a community of people or by civil society actors. Can have some form of public sector involvement such as through funding or giving resources for the project, notably land.	Community gardens, green roofs and walls, nature-based enterprises.

Traditionally, NBS are associated with providing public value, as their benefits include those that can be enjoyed by entire communities that are in the proximities of the intervention, such as clean air, public green areas for recreation, or increased biodiversity. In this sense, we see that public authorities such as local governments are, in the majority cases, the ones initiating and managing NBS, given that private sector is not usually willing to pay for benefits that accrue for all consumers -and which are also difficult to quantify or monetise. In this type of set-ups where the governance is centralised around a public figure, collaboration with stakeholders is encouraged to foster inclusive and appealing interventions for communities (Bulkeley, 2016; Malekpour et al., 2019; Zingraff-Hamed et al., 2020).

Regarding studies that have aimed to identify governance models of NBS, Zingraff-Hamed et al. (2020) investigate governance models for nature-based solutions by clustering seventeen cases of NBS for flood risk management and mitigation in Germany. They find four clusters or types of governance models based on different dimensions such as financing source, institutional setting, lead coordinating actor, level of the implementation, and others. These four model types are reflected in Table 6, alongside the governance features of each type of model. In their study, they emphasise that, while there isn't a 'one-size fits all' model, the notions of 'polycentric governance' and collaborative governance emerge as a common trend among NBS projects.

Table 6. Types of governance models identified by Zingraff-Hamed et al. (2020) from studied case studies.

Governance features	Type 1 Cooperation and Initiatives	Type 2 Co-Design	Type 3 Citizen Power	Type 4 Top-Down
Framing and implementing organisational structures			Entities smaller than the municipalities as the dominant implementation level (100%)	Implementation under the lead of the State (70%)
Project coordination	State			
Participation level	Central	Co-design	Citizen power	
Institutional setting	City government and private		Entities smaller than the municipalities as the dominant decision level (100%)	EU, Decision taken at the level of the State (70%)
Financing model	No regional funding	Regional funding (100%)	Private contributions (70%) or Municipal	EU and State (100%)
	Municipal funding (100%)			
Property rights constellation	No land transactions	State or City government (100%)		
Localization	River bank (100%)	River restoration		No implementation in the river bed

Source: Zingraff-Hamed et al. (2020).

3. 2. Initiatives and cooperation structures on NBS at European level

While the implementation and management of nature-based solutions has traditionally fallen under the scope of public authorities and, particularly, local public authorities, there has been a push in recent years for more diversified governance models and the EU has identified and encouraged collaborative governance models as a success factor for NBS (EC. Directorate General for Research and Innovation, 2015). At the EU level, we find that there have been several initiatives put in place to develop cooperation structures and to give policymakers the tools needed to foster stakeholder engagement. Innovative policymaking, such as the case of Urban Living Labs (ULL)[3] (see Bulkeley et al., 2016 for more on ULL) or the development of co-creation tools, has been prominent throughout research & innovation projects on NBS and offers significant potential for the co-governance of NBS.

As mentioned in Part I of this working paper, programmes such as Horizon 2020 or LIFE have financed research and innovation projects that aim to enhance stakeholder engagement in governance models and make NBS more participatory and inclusive. In other words, the initiatives are designed to create a knowledge framework that allows for mutual learning from the individual initiatives and projects. This is the case, for example, of the Urban Living Labs (ULL)[4] project, with a similar concept also present in the REGREEN project[5] or the NICE Urban Real Labs[6]. These initiatives focus on improving urban governance of NBS by fostering participatory approaches to policymaking and, in the case of ULL, they represent innovative hubs for stakeholder engagement in policy processes (Bulkeley et al., 2016). In this sense, they bring together citizens, companies, research and public sector to enhance collaboration and co-creation of sustainability policies in cities. Furthermore, as they are part of a larger network, these labs benefit from a space to exchange experiences and exchanges between labs are encouraged and enabled by these projects.

[3] ULLs can be understood as explicit forms of interventions intended to "design, demonstrate and learn about the effects of urban interventions in real time" (Bulkeley et al., 2016: 13)
[4] https://unalab.eu/en/urban-living-labs
[5] https://www.regreen-project.eu/
[6] https://nice-nbs.eu/urban-real-labs

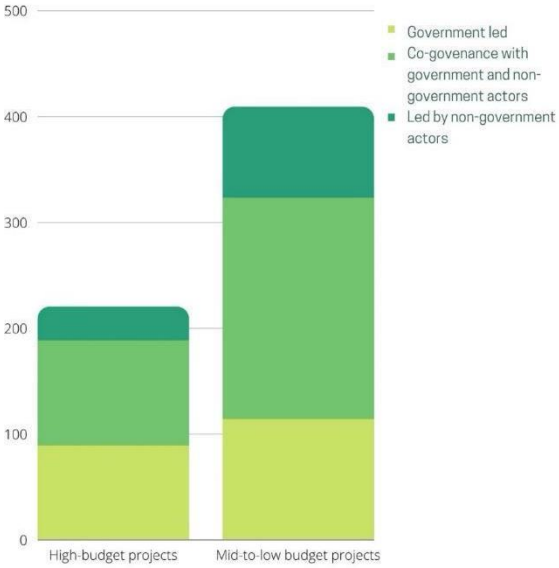
Other projects have focused on creating cooperation structures to promote NBS. For example, NetworkNature[7], has put in place country and regional hubs whose goal is to "bring researchers, policy-makers, businesses, and the public sector together to create long-lasting structures for NBS uptake (...)". Similarly, the Naturvation[8] project has partnered up with city governments, city councils and other research institutions to work together with policymakers and guide them on how to implement nature-based solutions. Another example, Connecting Nature, is a €11.4m five-year project funded by the Horizon 2020 Innovation Action Programme (2017-2022). Its aim was to scale out NBS in cities, by "working together with 30 project partners from industry, local authorities, local communities, NGOs and research in 16 countries, and hubs in Brazil, China, Korea & The Caucasus"[9]. While these are only some examples of medium-scale projects with a focus on governance, they showcase EU's ambition to employ NBS as an opportunity to foster participatory urban governance in cities for sustainable policies.

The benefits of following a collaborative approach in the design, implementation and evaluation stages are stressed by both research and policy literature; and several authors highlight the importance of co-governance as a way to reap all the benefits of these projects (see, for example, Frantzeskaki, 2019; Frantzeskaki et al., 2019; Mahmoud and Morello, 2021). In this sense, including the local communities at different stages of the NBS process can enhance the effectiveness of the intervention, given that they understand the area, and, in most cases, their increased wellbeing is an objective of the project. Moreover, adopting this approach tends to improve the community's perception of the project, which means they are more likely to engage with it and to favour future related projects (O'Sullivan et al., 2020). All this considered, a notable limitation of co-governance approaches is that they are mostly observed in small-scale projects, such as community gardens, urban parks, green corridors or roofs, and so on. In the case of large-scale or more technical projects, collaborative governance remains limited and difficult to implement. As such, these projects usually rely on the public figure as the main actor in charge of designing and managing the intervention.

[7] https://networknature.eu/
[8] https://naturvation.eu/
[9] https://connectingnature.oppla.eu/

Figure 1 illustrates this difference when comparing management set-ups between high budget projects (220 case studies with over 4M EUR) and mid-to-low budget projects (409 case studies with less than 4M EUR) on urban NBS found on the Urban Nature Atlas[10].High budget projects are led by government in 40% of cases and by a co-governance model in 45%, compared to 28% and 51% respectively for mid-to-low budget. Moreover, we see that in the case of non-government-led projects with a high budget that translates into private sector green infrastructure development projects or construction projects including greening in buildings, sometimes in the form of a public-private partnership (examples include 'Green Roof of the Veneto Eye Bank Foundation'[11] or 'Green roof on the 'Castle Terraces shopping mall'[12]). In contrast, in the case of mid-to-low budget projects we observe both projects involving private sector investments and led by community groups or NGOs, as well as EU-funded projects, such as through the LIFE financing programme (examples include 'Social garden at Lucie-Flechtmann-Platz'[13], 'Community Garden Emma's Hof'[14] or 'Ljublanica Connects'[15], a LIFE+ funded project).

Figure 1. Managing set-up by project size for European case studies.



Source: Adapted from Urban Nature Atlas, database with 1003 urban NBS case studies (for Europe).

[10] https://una.city
[11] https://una.city/nbs/venezia/green-roof-veneto-eye-bank-foundation
[12] https://una.city/nbs/lublin/green-roof-castle-terraces-shopping-mall
[13] https://una.city/nbs/bremen/social-garden-lucie-flechtmann-platz
[14] https://una.city/nbs/hague/community-garden-emmas-hof
[15] https://una.city/nbs/ljubljana/ljubljanica-connects

4. Mobilisation of finance for nature-based solutions

Understanding ecosystem services as the benefits provided by implementing a nature-based solution (Lam & Conway, 2018), we find that these often form the logics used to value nature and natural capital for decision-making purposes (Dorst et al., 2019; Thompson et al., 2023). These services or co-benefits produced by the intervention can accrue for public (common) or for a particular group of stakeholders, which will have implications for the project's management and governance (Ostrom, 2010, in Toxopeus et al, 2017). In this sense, we can distinguish between those NBS types whose co-benefits make them more easily marketable and thus more compatible with private sources of financing, and those whose remain largely public-oriented. In Europe today, the public sector constitutes the single largest financier of nature-based solutions with a market dominated by public grants (EIB, 2023).

4 .1. Financial support and mobilisation of finance

The data on the financial scale of NBS projects in the European Union remains largely incomplete, and thus the level of investment available for these projects can be hard to grasp and often relies on estimations based on identified case studies (see EIB, 2023). The breadth of the concept also constitutes a significant barrier for gathering data, given the heterogeneity of projects in scale, goals, medium or required financing (ibid.). Particularly for the case of NBS, the recent application of this concept (Escobedo et al., 2019) also becomes a difficulty for identifying case studies that might not self-report as a nature-based solution. The recent EIB report (2023) on NBS investing addresses this issue by gathering data from projects that self-report as related NBS concepts or subtypes, such as "ecosystem restoration", "green/blue infrastructure" and "ecosystem-based adaptation". The same report represents a novel approach to studying financing for NBS as it draws from different databases to paint a picture of the current NBS financing landscape; nonetheless it acknowledges substantial limitations in doing so. Notably, it reports missing information on the financial investment size (57% of projects), investor splits (82% of projects), financing instruments (30% of projects) and land tenure (49% of projects).

The largest database that this report uses is the one developed by the EU-funded Naturvation project, the 'Urban Nature Atlas' which compiles over 1,200 urban case studies, out of which 1,003 are found the European region[16]. This database shows that almost 75% of projects received financing coming from public budgets, direct funding or subsidies (See Table 7). Here, we also observe that, within these public sources, there is a predominance of projects that are financed by local authorities, with more than half earmarked under local budgets, compared to less than 20% for projects under national public budgets or regional public budget. Similarly, only around 150 European projects are financed, totally or partially, through corporate investments and 113 received funds from NGOs. While these estimations are based only on urban NBS, they are roughly in line with other NBS financing projections, that attribute the biggest role to public financing (EIB, 2023; UNEP, 2021). A notable limitation of the Urban Nature Atlas, however, is that the projects' main financier and financial investment sizes are often not specified.

Table 7. Projects on the Urban Nature Atlas by sources of financing.

Urban Nature Atlas projects by financing source	Count
Public local authority budget	580
Public national budget	178
Public regional budget	157
Corporate investment	155
Other	120
Funds provided by NGO	113
Private Foundation	103
Crowdfunding	102
Voluntary commitments	1
Commercial banks	0

Note: A single project can be financed through more than one source of financing. **Source: Urban Nature Atlas.**

[16] https://una.city/

In terms of financing instruments for NBS projects, we find subsidies and grants as the most diffused mechanisms (based on Urban Nature Atlas, Oppla and EIB (2023) estimations). In the Urban Nature Atlas, we see that most European cases (among those that report information) receive financing through direct funding or subsidies (56%) or/and earmarked public budgets (51%). Only about a 10 percent of projects reporting information received financing through donations and an even lower number by other types of funding, e.g., membership fees or loans. Moreover, these were often present only in particular types of NBS; for example, we see that membership fees can be often applied in community gardens.

Among other potential instruments that can be used to finance these projects, several different options are identified by the literature and international organisations working on the topic, but we find that most of these options still represent a very small fraction of projects. For example, the GrowGreen (Baroni et al., 2019) project identified twelve potential instruments to finance NBS (also in EC, 2020). They present these instruments and discuss prerequisites for fostering them as well as limiting factors and they illustrate these instruments with case studies. In Table 8 we present a synthetised version.

Table 8. NBS Financing instruments identified by GrowGreen project.

Type of instrument	Definition	Subtypes if applicable
1. Innovative use of public budgets	Green infrastructure creation, improvement and maintenance are often funded from local authorities' own budgets. However, budgets specifically for nature and green space are usually insufficient. A partial solution is for local authorities to find creative ways of channelling funding from other relevant government departments.	Pool funding from different departments; attract funding from public health budget (see Drayson, 2014), police budget (see Drayson, 2014) or education budget
2. Grant funding and donations	Local authorities can access external grants for GI creation and maintenance from a variety of sources, including public sector bodies and charitable or philanthropic organisations.	European Structural and Investment Funds (ESIF) ; Programme for the Environment and Climate Action (LIFE) ; Horizon 2020 ; Philanthropic contributions ; or crowdfunding
3. Instruments generating revenue	City governments can raise revenues to develop NBS through land sales or leases, taxation, developer charges, or through a range of 'value capture' mechanisms.	Land sales/leases; taxes; user fees; Developer contributions/ charges; Betterment levies; Voluntary beneficiary contributions; Sale of development rights and leases; Funds linked to offsetting/ compensation requirements; Other voluntary schemes

4. Green finance	Debt instruments	Loans; Green bonds; Natural Capital Financing Facility (NCFF)
5. Market-based instruments	A range of instruments that use markets or price mechanisms can be used to create incentives for private parties to invest in NBS, and/or to ensure a more efficient allocation of resources	User charges ; taxes (as incentives); Subsidies (for developers) ; Tax rebates ; Credit-trading systems ; Payments for Ecosystem Services (PES)
6. Business improvement districts (BIDs)	Originally introduced in Ontario, Canada, BIDs have been widely used in the US and Europe since the 1960s to finance and deliver improvements to commercial and industrial environments, as well as to GI improvements in some cases (McNeill and Rayment, 2015). Businesses and other stakeholders enter an agreement with local government to contribute an additional levy to finance improvements in a specific area. Once established, BIDs are free to constitute their own management body, make spending decisions, and seek additional income through various instruments (Sandford, 2018).	
7. Endowments	A fund is established – e.g., through donation of property or money, developer contributions, land sales, or other finance sources – and the interest accrued from investment of the funds is used to pay for the maintenance of the green infrastructure, leaving the original endowment untouched (Drayson, 2014).	
8. Public-private partnerships	PPPs can be defined as "long-term contracts between a private party and a government entity, for providing a public asset or service, in which the private party bears significant risk and management responsibility" (UN-Habitat, 2017). PPPs can be developed for the delivery and/or maintenance of GI and they can take various forms, including operation and maintenance contracts, leases, concessions, etc. (UN-Habitat, 2017).	
9. Revolving funds	A revolving fund is a fund replenished through repayments of the loans drawn from the fund or by a constant flow of financial contributions (UN- Habitat, 2017).	
10. Community asset transfer	Local authorities may transfer to community organisations the management or ownership (usually via long leasehold) of public land or buildings. In some cases, the transfer can be made at less than market value, if it promotes economic, social or environmental well-being (Drayson, 2014).	
11. Regulation & Planning Standards	Although not a financing instrument as such, local authorities can apply regulatory and planning instruments to mandate GI implementation by private stakeholders, such as grey infrastructure developers and homeowners. For example, development planning regulations may require that new residential neighbourhoods incorporate a certain percentage of green space.	
12. Leveraging existing regulatory requirements	A number of entities with environmental obligations can leverage these requirements to invest in alternative nature-based solutions. Entities, particularly in the water management sector, face regulatory standards that	

	require large investments, usually in high cost and high energy- intensive solutions such as wastewater treatment plants. Green infrastructure alternatives can be implemented instead, to meet environmental regulations by alternative means.

Source: Baroni et al. (2019).

As mentioned, some of these instruments represent a very small percentage of NBS financing (<1%) or are more developed for certain scales or types of projects (Calliari et al., 2021). For example, in this scheme, Baroni et al. (2019) identify regulation and planning standards as a tool to incentivise private actors to invest in nature-based solutions such as greening on buildings. We find that the progress with this type of mechanism is highly uneven across countries, with some nations such as Germany leading in green roof regulation as well as implementation in buildings (Castleton et al., 2010; Ngan, 2004).

4.2. Public funding by the European Union

As part of the Biodiversity Strategy for 2030, the EU pledged to ensure that a significant fraction of the 30% budget dedicated to climate action is invested in "biodiversity and nature-based solutions", showcasing the Union's interest in promoting NBS as an adaptation and mitigation tool. As part of Horizon 2020 and LIFE programs, the EU has funded several research and innovation initiatives that have at same time contributed by promoting NBS investment at city or region levels (EC, 2020a; EC, 2020b). Cohen-Shacham et al. (2019) estimate that the European Union has invested more than EUR 240 million in R&I projects in the last fifteen years. Moreover, most recently, nature-based solutions have been identified as a tool that can be implemented as an economic recovery measure or through recovery funds[17], given their potential to contribute to sustainable, cost-efficient infrastructure (IUCN, 2021). In March 2023, the NetworkNature initiative partnered with WWF-Ukraine to launch a Nature-

[17] While so far no publication has quantified the potential contribution of the NextGenerationEU funds to financing NBS, this could represent an important pathway for new NBS financing research.

based Solutions Hub in Ukraine that "lays the groundwork for a post-war reconstruction and recovery that includes Nature-based Solutions".[18]

EU financing instruments, such as the European Regional Development Fund (ERDF), while not dedicated nature-financing funds, have contributed to financing nature-based solutions and other climate adaptation projects (Naumann et al., 2011; Negreiros & Falconer, 2021). Among the initiatives financed by the ERDF we find notably the Urban Innovative Actions[19], with an ERDF budget of EUR 372 million for 2014-2020. This fund is dedicated to "identifying and testing solutions for sustainable urban development" and finances NBS actions among other urban projects. Complementarily, the European Investment Bank set up the Natural Capital Financing Facility in 2017, alongside the EIB-funded Urban Framework Loan[20]. While this initiative is being replaced by InvestEU, it served to fund a dozen mid to large scale projects in green infrastructure but also reforestation or water management.

In this sense, we see that nature-based solutions are being increasingly recognised and integrated as a priority for sustainable development policy in the EU (EC, 2015). Several of the EU-funded projects have specifically focused on working with stakeholders and developing successful business models in order to create positive spill overs and synergies, as well as to promote NBS implementation in European cities. A significant area of focus for these projects as well as for NBS researchers has been the development of evaluating frameworks for investors and implementors (EC, 2021; Geneletti et al., 2016; Wickenberg et al., 2021), which has been recognised as a main barrier for scaling up financing of NBS (Calliari et al., 2022; Dorst et al., 2022; Ershad Sarabi et al., 2019; Toxopeus & Polzin, 2021).

4.3. Market-based instruments related to NBS benefits

Nature-based solutions bring environmental, social and economic value to communities that have access to or are impacted by them. Recent studies have focused on identifying the value of nature-based

[18]https://research-and-innovation.ec.europa.eu/news/all-research-and-innovation-news/new-eu-supported-nature-based-solutions-hub-launched-ukraine-2023-03-09_en
[19] https://uia-initiative.eu/en
[20] https://www.eib.org/en/products/mandates-partnerships/ncff/index.htm

solutions, including accounting for all the co-benefits that they bring (Raymond et al., 2017; Van Zanten et al., 2023). While the knowledge base of NBS has significantly expanded and their net positive impact is widely accepted, a big proportion their benefits are not quantifiable in economic terms. Moreover, the distinction between 'public' or 'common' co-benefits of NBS and those co-benefits that accrue for a particular group of stakeholders pose an additional challenge for the accounting of NBS co-benefits for investment purposes.

Among the co-benefits that can be considered as a 'public good' or 'common service', we find clean air, infrastructure, or publicly accessible recreational green and blue areas. On the other hand, some types of NBS can entail benefits that go beyond these public goods, such as by providing a 'green premium' for apartments in buildings in the proximities of green areas (Anguelovski et al., 2019), or by providing a private service such as green roofs acting as natural water retention measure for buildings (Rosenzweig et al., 2009; Vijayaraghvan, 2016). This has raised the question on whether financing for nature-based solutions should go beyond public funding, and, in fact, companies and private actors today have begun exploring avenues for channelling private investment into NBS projects (Chausson et al., 2023). While so far success has been moderate and applied mostly to small scale projects (EIB, 2023), there are a number of areas where nature-based solutions have been identified as a potentially viable investment while boosting a company's engagement with nature and social goals. In this sense, we see that business models are emerging and the concept of 'nature-based enterprises'[21] is gaining traction among research and innovation initiatives (Kooijman et al., 2021). This development of market-based instruments could have the potential to scale up needed investments in NBS. Nonetheless, some studies have raised the question on whether this trend will contribute to a 'greenwashing' or to a socially speaking sub-optimal management of natural capital, such as by posing governance issues (Chausson et al., 2023).

[21] NBEs are defined as "an enterprise, engaged in economic activity that uses nature sustainably as a core element of their product/service offering" (Kooijman et al., 2021). Authors mention that this definition was developed as part of the Horizon 2020 Connecting Nature project (www.connectingnature.eu).

5. Barriers against NBS uptake

Following the analysis of governance and financing options, we now turn to the question which barriers stand against effectively taking up NBS, based on our interviews with experts in the field.

5.1 Assessment of overall barriers

To assess the existence of overall barriers against taking up NBS projects, we provided our experts with rating questions. The first question presented four general barriers to implementing NBS – previously identified through a literature review (see Figure 2). Respondents rated, on average, the 'lack of financing options' and 'lack of coherent policy to incentivise projects' as the more significant barriers that are hindering NBS implementation, with a mean of 3.71 and 3.53 out of 5 points, respectively. The lack of financing options was rated as a 'significant barrier' by over a third of respondents.

It must be noted, however, that some of the respondents specified that rather than the lack of options per se, they believed there were other issues associated with the nature of the options available. In this sense, one respondent commented that "financing options I think is still a barrier, not necessarily due to the lack of options as such, but because of the sustainability of the financing, that seems to be a main barrier because of all these funding lines are too short, so that companies and entrepreneurs and local actors can't implement nature-based solutions". Another respondent noted that it constituted a significant barrier "not necessarily for the implementation of an NBS project, but more for the implementation of NBS projects at scale" and a third one that "the problem isn't the lack of financing but a lack of access of knowledge on how to tap into the financing". One of the interviewees that rated this barrier with a low score specified that they did so given the abundant financing at the EU level, but acknowledged that the situation might be different for municipalities and local actors.

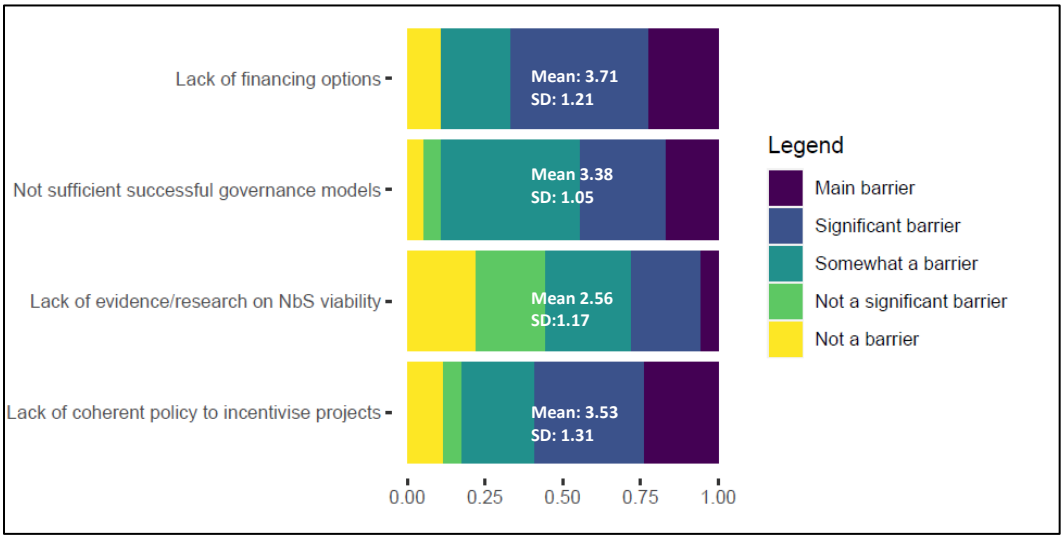
The second barrier presented to respondents, 'lack of sufficient governance models' was largely perceived as "somewhat a barrier" (by 9 out of 19 respondents), with an average score of 3.38.

Perceptions over different governance models were explored in more detail in the second rating question and related open questions during the interview.

The third identified barrier, 'lack of evidence or research on NBS viability' was the lowest scoring and thus less perceived as a significant barrier of all the options (mean rating of 2.56). Moreover, a fifth of respondents rated this option as "not a barrier", and at least one respondent from each group (policy, research or private sector) rated it as a 1 or a 2. One interviewee that rated this barrier high commented that "the research is there, but in terms of comparison and upscaling the research, results for the viability of the projects is limited and not always comparable".

Finally, the 'lack of coherent policy to incentivise projects' was rated as at least a 3 out of 5 or as "somewhat a barrier" by over 80% of respondents. Moreover, three respondents acknowledged the need to integrate NBS into different policy areas and beyond the competencies of environmental policies. In this sense, one respondent commented that "when you deal with a topic that is common or meaningful to different policy areas, it is always more difficult [to integrate]". Another respondent argued that there seems to be "a disconnection between policies and the realities in cities". Three respondents also stressed that the state of policy integration and incentives for different types of interventions or even across Member States countries is uneven and four highlighted that NBS are well integrated across EU policies.

Figure 2. Distribution of respondents' assessments of general barriers to NBS implementation

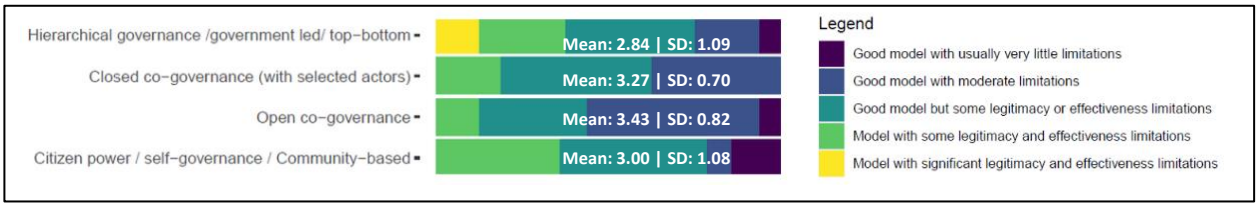


5.2 Governance as enabler or barrier for NBS uptake

The second rating question presented respondents with different governance models to rate based on their effectiveness and potential legitimacy limitations (see Figure 3). The first model, the hierarchical model was the least well perceived model, with an average score of 2.84 out of 5. The best scoring model was the open co-governance model (average score of 3.43), followed by the closed co-governance (3.27), with both models also having the lowest standard deviations, of 0.7 and 0.82, respectively. Finally, the community-led model was rated with an average score of 3, with a majority of respondents rating this model a 2 or a 3, with 14% of respondents rating it a 5.

More than half of the respondents specified that context played a big role on the best applicable model and four stressed the fact that governance can evolve throughout the different phases of the project. In terms of the contextuality, respondents particularly alluded to the role of scale and/or the level of technicality of the project. One respondent commented "the larger the nature-based solution in terms of financing scale, the more likely it is that you will have a very tight, top-down governance model", and another one, "stronger hierarchical governance in the implementation, for example, for NBS across an entire river system would be needed (…) [compared to] the need for more locally specific actors as part of the governance in smaller NBS interventions such as (…) community gardens." Three of respondents, nonetheless, stressed that including communities is generally beneficial or desirable for implementing nature-based solutions. One respondent commented "my experience with biodiversity is that you need to have the people working or living there involved and understanding, otherwise, it won't work". Similarly, two more interviewees emphasised the need for collaborative models of governance when developing NBS, even across government departments. Two respondents also mentioned the role of ownership in determining the applicable governance models and three respondents brought up the role of different countries' policymaking culture in developing mechanisms to include communities' views into policymaking. Finally, the main issue associated with the community-based governance model was the scale limitations of those projects implemented through this model, in this sense, one interviewee found that "engagement with the community is usually taking place at the local level."

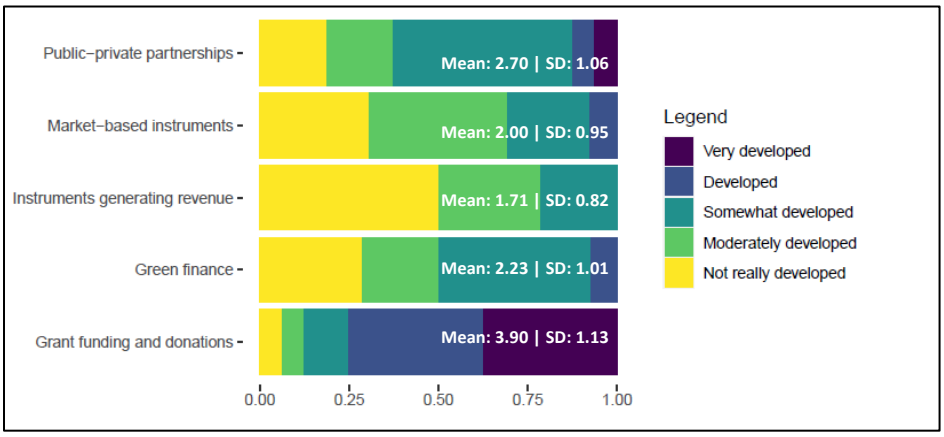
Figure 3. Distribution of respondents' assessments on different governance set ups for NBS



5.3 Finance options and barriers

The third rating question presented respondents with different financing options and asked them to rate them in terms of how 'developed' or diffused they are for implementing NBS projects (see Figure 4). Interviewees found that the option, 'grant funding and donations' was the most developed and widespread financing option for NBS, with an average score of 3.90, compared to 2.70 of the second highest rated option (public-private partnerships). All the other options scored an average of around 2 points, that is, respondents found them on average as 'moderately developed', with half of respondents finding one of the options, 'instruments generating revenue' as 'not really developed'. Respondents who justified their rating in this question mentioned the issue of return on investment (ROI) or bankability when looking at revenue from NBS. Finally, as a follow-up, we asked respondents to identify additional instruments for financing NBS and two respondents raised 'concession loans' and 'green public procurement' as additional options.

Figure 4. Distribution of respondents' assessments on different financing options for NBS



The last rating question asked respondents to rate barriers to financing NBS. The first barrier, 'valuation and accounting for NBS projects', was the highest scoring option, with an average of 3.91 out of 5. In fact, over 60% of respondents found it either a 'main barrier' or a 'significant barrier'. Over a third of respondents specified that it was mainly the lack of scalability and transfer of data that hindered the evaluation of NBS projects; and one respondent argued that the case-by-case evidence is there but "what we are lacking is a meta-analysis (…)".

One respondent commented on the issue of commodifying nature for accounting purposes: "there's a larger debate ongoing in terms of should we only be looking at monetary valuations of NBS versus how do you account for non-monetary and plural valuations. There is a big push for natural capital accounting but there is also a big push against natural capital accounting because if you value nature and quantify the value of nature then you must commodify it and can swap it for another commodity." A second respondent contended that recent efforts, such as the 2021 Handbook for practitioners[22] have rendered the evaluation of NBS a more widespread practice among cities and pointed that several cities have their own valuation systems.

[22] European Commission, Directorate-General for Research and Innovation, (2021). *Evaluating the impact of nature-based solutions: a handbook for practitioners*, Publications Office of the European Union. https://data.europa.eu/doi/10.2777/244577

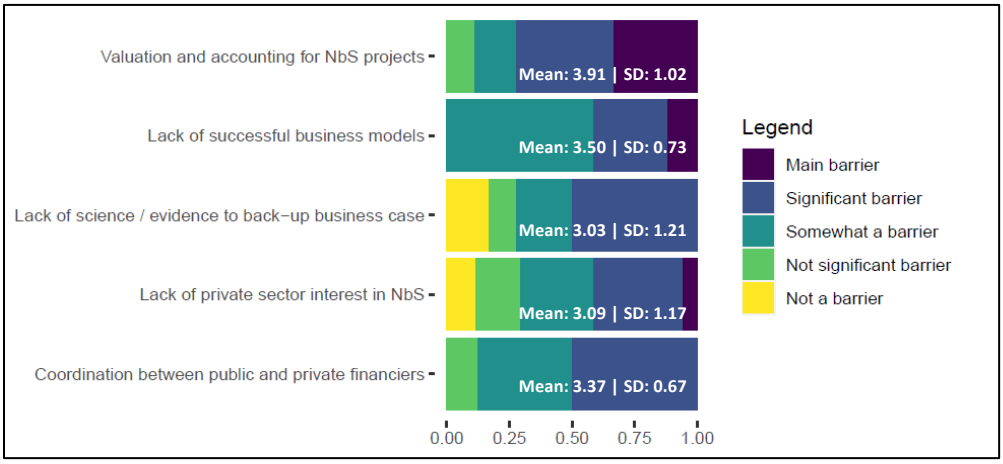
The barrier 'lack of successful business models' was perceived by over half of respondents as 'somewhat a barrier'. One of the respondents pointed out that the developing of business models was not only an issue of the private sector, "[business case] could also be the economic case for doing something that the local authority could see (…)."

The 'lack of evidence to back-up the business case' was found to be the less significant barrier by respondents, with an average score of 3.03. Here, respondents argued that the innovation and recent developments on NBS implementation is widespread in Europe, such that they have made projects attractive for those wanting to implement them. One interviewee commented "we have quite a few numbers of successful business models, but maybe not for every type of situation".

The fourth barrier was the 'lack of private sector interest in NBS', with an average score of 3.09 and a standard deviation of 1.17. Four respondents noted that the private sector interest in NBS is there but that the lack of engagement or of transfer of information hinders their involvement. One of the private sector respondents also noted that the lack of internal capabilities at the company level prevents their engagement.

Finally, 'the coordination between public and private financiers' was rated on average as 3.37 out of 5, or as 'somewhat a barrier'. This barrier, moreover, had the lowest standard deviation, with over 80% of answers concentrated in either 4, a 'significant barrier', or 3, 'somewhat a barrier'. One respondent commented that "[public and private financiers] they don't often speak the same language, or look for the same results, so it's hard to put these people sort of in the same room to get an outcome, or even where benefits are valued in the same way". A summary overview is presented in Figure 5.

Figure 5. Distribution of respondents' assessments on different financing barriers for NBS



5.4 Summary of identified barriers

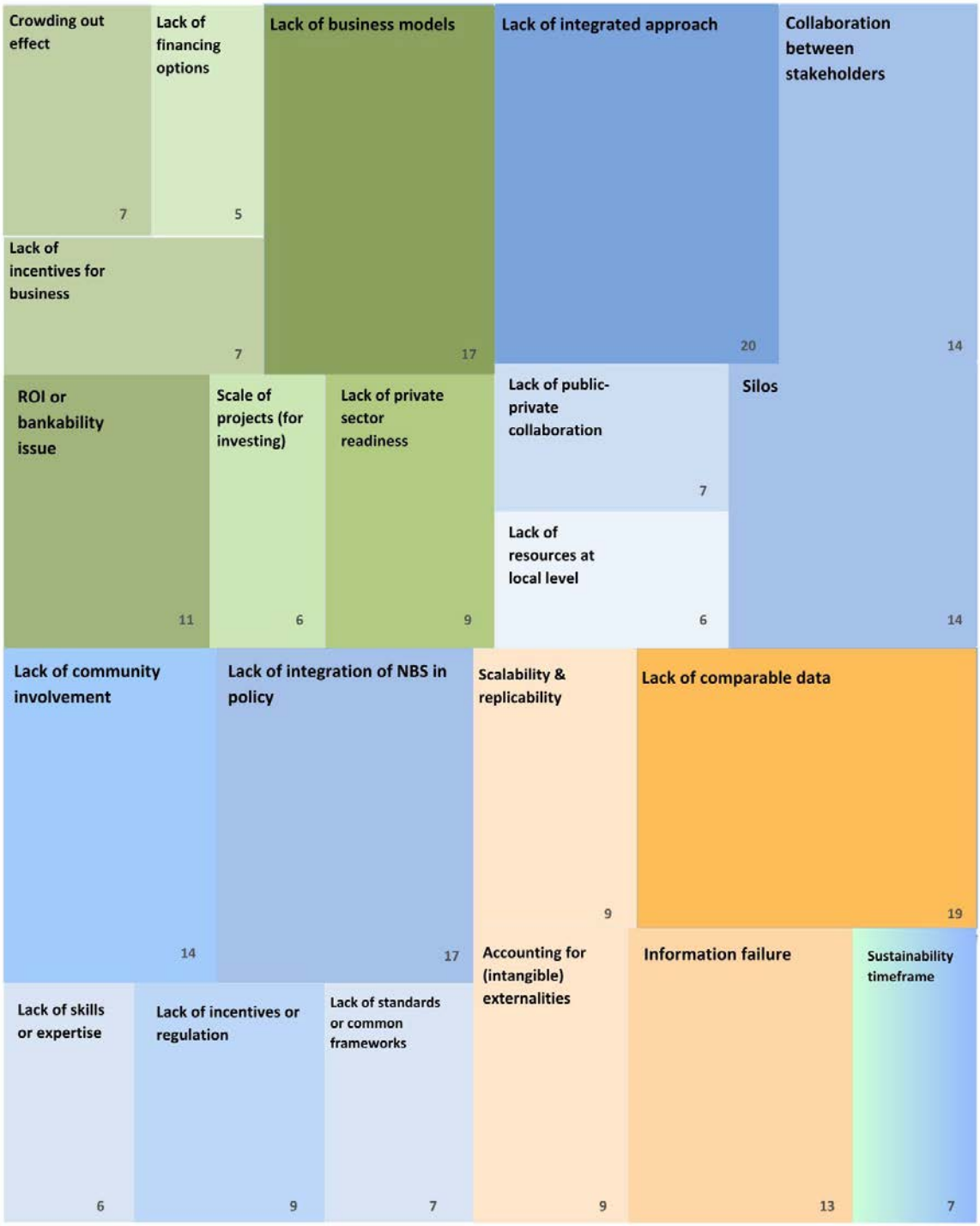
Figure 6 presents the barriers identified by respondents throughout the interviews, clustered into three categories: governance, financing and knowledge frameworks, and includes the number of times they were raised across all interviews. Only one barrier, 'sustainability timeframe' was identified as a barrier under both governance and financing categories.

In terms of barriers per category, we identified 10 barriers or subcategories under the 'governance' barriers, with the subcategories 'lack of an integrated approach' and 'lack of integration or uptake in policy' as the most mentioned barriers (20 and 17 mentions, respectively). In fact, the 'lack of an integrated' approach was the most raised barrier across interviews. Secondly, for the 'financing' category, we identified 7 barriers, with 'lack of business models' and 'ROI' or return on investment as the most significant barriers (17 and 11 mentions, respectively). Finally, for those under knowledge frameworks, 4 barriers were identified, with 'lack of comparable data' as the most mentioned barrier (19 mentions).

This figure reflects the multi-barrier scenario that is preventing the widespread adoption of nature-based solutions. In fact, all respondents identified at least two barriers in different categories. Moreover, several of these barriers were raised as interconnected or as a result of one another. For example, one respondent commented: "When we work with cities, the budget or the financing options to fund nature-

based solutions are very tight. So, I think that from that side, the lack of financing is the main barrier in the process of not only implementation of nature-based solutions but to integrate solutions with the rest of activities related to nature solutions (…)".

Figure 6. Identified barriers for NBS implementation



Note: Colour coding: green squares for barriers to finance; blue for barriers to governance and yellow knowledge frameworks. Sustainability timeframe was identified as a barrier for both governing and financing. Larger squares and darker shades of colour represent a higher number of mentions across interviews.

6. Explanatory factors for multilevel governance and financing arrangements

Despite their promising potential to address economic goals while sustainably managing natural resources (Maes and Jacobs, 2015), the diffusion of NBS across Europe has encountered significant obstacles preventing their widespread adoption. Through a comprehensive analysis of relevant literature, case studies and in-depth interviews with NBS experts, this research has identified that the adoption of nature-based solutions faces a multi-barrier situation, where no single barrier can be pinpointed as the main cause hindering adoption. Governance and financing barriers emerge in both literature and throughout the interviews as key themes underpinning these barriers. In this section we discuss and contextualise the barriers identified in the interviews.

6.1. Overcoming governance, knowledge and financing barriers: Developing integrated approaches

The multi-level governance of NBS goes back to the idea that effective climate governance requires collaboration among actors and groups, even at the same level of government. This is particularly relevant for NBS, as these projects are multi-functional, that is, they entail benefits in various areas or sectors (Seddon et al., 2020; EC. European Research Executive Agency, 2022). In this respect, respondents raised the 'lack of an integrated approach', the 'lack of common standards or frameworks' and the persistence of 'silos' as barriers for diffusing NBS. The lack of an integrated approach was identified with relation to different aspects of NBS, particularly, participants raised the challenge of accounting for the multiple benefits of interventions during evaluation processes. Moreover, three experts mentioned the need to better understand the trade-offs associated with NBS projects, including developing life cycle assessments, to understand potential negative trade-offs or suboptimal arrangements of NBS projects as well as understand social impacts. One expert brought up the concept

of ‘informed land planning’ to highlight the importance of assessment and evaluation systems to optimise the deployment of NBS.

In recent years, nonetheless we have seen a proliferation in efforts to address these challenges. Reports such as the NBS Handbook for practitioners (EC, 2021) or academic papers such as (Calliari et al., 2019; Dimitru et al., 2020; Wakin et al. 2019; Raymond et al., 2017) have contributed to building integrated approaches to evaluating NBS projects. While these efforts contribute to knowledge diffusion and the development of more integrated approaches, existing silos complicate the penetration of these frameworks and obstruct potential collaboration among areas of government. In this respect, Malekpour et al. (2021:1) argue that “mainstreaming nature-based solutions requires a change in the planning and governance systems and mediating new relationships and configurations between different actors through collaborative governance”. Participants raised the issue of silos several times throughout interviews (mentions=20); one participant argued that “the main barriers that are reported [with regards to NBS] tend to be associated with institutional practices, so siloing in institutions, very strict processes around procurement”. The same participant identified the obtainment of “easily verifiable data on benefits in comparison to more conventional approaches that have been used in the past” as a potential solution to this challenge.

Droste et al. (2017) explore the policy and governance implications for financing and argue that information on the co-benefits of NBS projects could be essential to draw municipal departments to collaborate in funding NBS interventions. Further to this, one participant noted that “those [municipal departments] who get to benefit the most might not be the ones who actually get to pay for it”. In this sense, accounting for all the benefits that NBS bring could help include these interventions in the agenda for areas beyond biodiversity and green spaces and render NBS a tool to achieve diversified policy objectives. Moreover, bridging this gap could contribute to finding alternative sources of financing. In fact, Baroni et al. (2019) identify the use of alternative budgets as a potential financing source for NBS.

6.2. Overcoming financing barriers: incentives for investing in nature-based solutions & natural capital accounting

The European Commission report (2022) on the role of NBS for a nature-positive economy highlighted four areas as challenges for the economic integration of NBS: (1) standards; (2) measurements and valuation, (3) public policy, (4) awareness and capacity building. These were all mentioned to some extent throughout interviews and respondents attributed different significance to these challenges. For example, two of the private sector respondents argued that the lack of standards constituted the main barrier for developing finance for NBS and mentioned the use of IUCN standards as a good practice and potential solution for this problem. They added that the diffusion of standards could help develop a market for NBS and create visibility for investments in nature.

In terms of measurements and valuations, as mentioned above, initiatives in recent years have aimed at creating valuation methods for NBS, but there is still a lack of comparability and harmony among employed approaches. Additionally, global efforts on strengthening non-financial disclosures, such as the Taskforce on Nature-Related Financial Disclosures'[23] work on developing a risk management and disclosure framework could accelerate adoption of standards for assessing companies' impact on natural resources. In terms of awareness and capacity building, respondents talked about the need to build skills and knowledge within local government and to engage with business and other stakeholders.

Finally, with regards to the role of public policy in leveraging finance, respondents generally attributed a sufficient uptake of NBS in EU policy and several argued that more and more cities were become aware and getting involved in implementing NBS. Interestingly, three private sector participants called for more stringent policy in terms of promoting private investment in NBS, arguing that "business itself is calling for it" and that investments for NBS could be fostered only if market conditions allowed it. EIB (2023) studied the potential conditions under which a private market for NBS could be developed and argued that, due to the lack of ROI, this would require at least one of three: a change in market

[23] https://tnfd.global/

structures (by providing incentives), the development of private markets for public goods (such as through extending carbon credit markets) or adopting more blended financing set ups. Other aspects that were highlighted as preventing private sector investment were the long timeframe of NBS (mentions=7) and the (small) scale of current NBS projects, which does not meet investor needs (often to "green" portfolios) (mentions=6).

However, two (non-private sector) participants held that helping cities tap into available public financing could already raise significantly NBS deployment and stressed this as a priority. Particularly, one participant pointed out that often cities and other actors are not aware of all the available financial options, such as funding through EU instruments, using the example of Cohesion funds or similar EU funds that, while not directly directed to NBS, can include NBS investments in their financing capacities.

Also in the literature, we find this debate between private and public sources of financing. In this respect, Chausson et al. (2023) debate the proliferation of market-based instruments for financing NBS. They argue that while there are trade-offs associated with this type of financing, focusing on developing private financing without looking at complementary funding or at the associated governance challenges could result in creating negative effects such as disassociating economic and social goals from NBS, as well as greenwashing. On the other hand, authors such as Kooijman et al. (2021) study the potential of private financing for upscaling NBS. Moreover, it must be noted that some forms of NBS already rely on industry or private-sector forms of governance (Sekulova & Anguelovski, 2017), such as green roofs or green walls. These types of NBS, are more widely established as profitable business models and they enjoy greater regulation and acceptance as investment options.

In terms of business models, some of the respondents (n=5) mentioned examples of 'Nature-based Enterprises' (NBEs) or of companies with projects investing in nature-based solutions. Generally, these investments are made by acknowledging a "social value" or "positive externality" of investing in nature and thus lower returns or higher investment timeframes are often assumed. So far, these types of interventions have been scattered and implemented at a small scale, but some initiatives are aiming to build a knowledge base around business models and creating a community for NBEs, such as the

Horizon2020 platform ConnectingNature[24]. EIB (2023) and Kooijman et al. (2021) study the potential sources of revenue and business models for NBS.

[24] https://connectingnature.eu/

7. Lessons learned & Policy conclusions

This paper has focused on providing an analysis into barriers for financing and governing NBS, particularly for countries inside the European Union. From this analysis we draw the following lessons:

General lessons:

1. Nature-based solutions represent an heterogenous group of interventions but there are common patterns in their governing and financing arrangements, such as a tendency to involve collaborative models of governance or a predominance in public sources of financing.
2. NBS knowledge and evidence is abundant, but communication of this knowledge across stakeholders remains challenging due to information failures and silos in institutions.
3. NBS projects lack a diffused common evaluation framework, standards for what constitutes an NBS and an integrated approach to its life cycle assessment. This poses significant challenges for evaluating and comparing the value of NBS projects. Progress within carbon accounting frameworks can be used as an example, although the value associated with nature and NBS is more difficult to quantify numerically.
4. The implementation of NBS is facing a multi-barrier structure that needs to be addressed systematically. Barriers in governing and financing are particularly predominant.

Lessons regarding governance arrangements:

1. Silos and rooted institutional practices hinder the diffusion of NBS knowledge amongst different government departments. This limits its potential for NBS to be employed through a horizontal lens to address goals beyond biodiversity and climate objectives.

2. Collaborative governance models are widely recognised as beneficial for NBS projects, particularly in cities, but there are still limitations, and these models are still mostly applied only for specific small-scale urban projects.
3. In the governance of nature-based solutions in Europe, we see that actors at local and EU levels play a main role and most of the policy and financing efforts are being made at those levels. Actors above the local level this must look at progress within cities in order to develop meaningful policy objectives.

Lessons regarding financing arrangements:

1. Financing of NBS remains mostly reliant on public budgets and public grants. EU grants are particularly widespread in Europe.
2. There have been efforts to boost private investment on NBS (such as the development of nature-based enterprises), but we have not observed a substantial change of paradigm as NBS is still typically regarded as a type of public good.
3. Private sector has interest in investing in NBS but mismatches in terms of project size or lack of evaluation methods and information limit its involvement.
4. ROI and business models have not yet been fully developed for NBS, but initiatives are on the rise.

Moreover, from these we draw **five key policy recommendations**:

1-Develop common evaluation and accounting frameworks:

Case study-oriented research is useful to identify good practices and implementation challenges but more meta-analyses of NBS projects are required to gather evidence to develop standards and common frameworks to evaluate NBS and account for the externalities they bring. There have been evaluation

frameworks developed but harmonised standards would help channel private investment help diffuse knowledge on the benefits of NBS and understand the potential and scalability of this approach.

2-Foster transformative change by building skills and encouraging collaborative approaches to NBS, particularly for local authorities.

It is necessary to accelerate transformative meaningful change on traditional forms of approaching urban infrastructure, urban planning and ecosystem management (i.e., forest management, water management or soil management). For this, investments are needed to promote reskilling, breaking old institutional patterns and bridging silos. It is important that researchers and other experts are in contact with local authorities and provide them with knowledge and the tools required to grasp the benefits of NBS, not only in the departments traditionally associated with NBS but also beyond these.

Collaboration between government departments should be encouraged by potentially conducting trainings on the multifocal benefits of NBS and aiming to foster exchanges withing departments in this area. More institutional forms of engaging with stakeholders should be also promoted to fully understand and cultivate the social dimension of NBS.

3-Explore financial instruments beyond grants and public budgets

While grants and other public instruments currently make up most of the available finance to NBS, developing instruments such as concession loans, green public procurement or blended financing could have the potential to continue funding NBS while minimising the crowding out effect. Developing sources of financing that are sustainable should also be priority, to ensure projects' maintenance. In terms of channelling private sector investment, this seems to be particularly challenging due to the lack of ROI for NBS projects. Moreover, some authors are worried about the potential governance issues of focusing solely on boosting private investment. Exploring private sources as complementary to public

financing and understanding what would constitute the optimal level of private investment would help to understand how these two sources can contribute to funding NBS.

4-Engage with private sector

Engagement with private sector that has an interest in NBS would be beneficial in order to channel new sources and instruments for funding NBS. One of the key barriers associated with this is the lack of standards or comparable information alongside the challenge of communication of this information. For addressing this, the most effective way to do so would be through promoting a single framework to evaluate NBS that is straightforward and comparable across projects. It is also important to further promote the concept by engaging with business on the topic. Guidance and clear information and standards could serve to avoid potential greenwashing.

5- Develop an integrated approach to NBS

An underlying thread present throughout the barriers to implementing NBS is the lack of an integrated approach to NBS. While nature-based solutions constitute different interventions with significant variations across aspects such as scale, natural elements targeted, location or goals, developing an integrated approach to NBS could entail significant benefits. Developing an integrated approach would mean investing in building comparable methods, life cycle assessment methods and to integrate the concept of NBS into policy as one tool that can be adopted to achieve different objectives. This would help to brand NBS as a tangible solution that can be implemented to solve specific needs for different actors and sectors, rather than a 'nice to have' green and blue in cities or as a competency reserved to the authorities that are responsible for greening or similar area. Moreover, it would help to build a common knowledge and diffuse the concept beyond researchers or practitioners working with the topic.

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Annex

Annex 1. Interview questionnaire

Interview questionnaire for Working Paper: 'Governing and financing of Nature-Based Solutions in the European Union'

Purpose of interview: Exploration of actors' perception on NBS governing and financing ecosystem in the EU and on how support for NbS can be evaluated in the framework of EU Policy and National Adaptation Plans and Strategies

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Questionnaire

[Interviewer briefly explains project background (i.e. that we have conducted a review of EU policy, and are conducting a review of Member States' adaptation policy on the subject of NBS governing and financing). On the basis of several interviews, we will conduct and review this analysis at MS level. Interviewer asks the interviewee if s/he agrees that the interview will be recorded for transcribing answers and ease the note taking during the interview.]

BACKGROUND

1. Can you introduce yourself, the organisation / institution / company where you work and what is your role here.
2. Since when are you familiar with the concept of 'nature-based solutions?
3. How do you incorporate NBS into your work at [insert organisation/company]?
4. How would you rate the following barriers to implementing a NBS project? Elaborate your answers where you wish. Please note that these are general and we will ask more in depth regarding finance and governance barriers.

Barrier	1-Not a barrier	2-Not significant barrier	3-Somewhat a barrier	4-Significant barrier	5-Main barrier
Lack of financing options	•	•	•	•	•
Not sufficient successful governance models	•	•	•	•	•
Lack of evidence/research on NbS viability	•	•	•	•	•
Lack of coherent policy to incentivise projects	•	•	•	•	•

Can you think of any other barriers that are not on this scale? Situate them on the scale.

GOVERNANCE

[(def) The question of governance is concerned with the structure and processes for decision making, accountability, control and behaviour at the top of an entity or project. In sum, who manages the intervention/ project that constitutes the nature-based solution and how.]

0. How would you rate the following governance models on the scale? Elaborate your answers where you wish.

Model	1-Model with significant legitimacy and effectiveness limitations	2-Model with some legitimacy and effectiveness limitations	3-Good model but some legitimacy or effectiveness limitations	4-Good model with moderate limitations	5-Good model with usually very little limitations
Hierarchical governance /government led/ top-bottom	•	•	•	•	•
Closed co-governance (with selected actors)	•	•	•	•	•
Open co-governance	•	•	•	•	•

Citizen power / self-governance / Community-based	•	•	•	•	•

Can you think of any other governance models that are not on this scale? Situate them on the scale.

0. Which ones are the most common models today? Do you think there is or has been a pattern in governance models applied to NBS projects? Which stakeholders are normally included in the governance of NbS? Which are typically excluded?
0. How can better governance models be developed or what would better models look like? How do you think they can be promoted?
0. Do you believe that there should be a decentralised, sector-based approach to NBS policy or that governments should adopt a specific agenda for all NbS? How do these two options compare? What barriers can you see with regards to these approaches?

FINANCING

0. How would you rate from 1 to 5 the level of development of financing options and readiness to finance nature-based solutions? Can you give more details on your answer?

1	Not really developed, the amount of financing options for NbS is very limited and interest to finance is little.
2	Moderately developed, financing options and interest for NbS remains limited and in early stages.
3	Somewhat developed, there are some financing options but interest for NbS remains somewhat limited.
4	Developed, there is demand from public and private actors and financing options are available.
5	Very developed, the demand for Nature-based Solutions is high and financing options are abundant.

0. Do you think NBS financing more often comes from: ‘market-based’, ‘public sector’, ‘voluntary commitments’ or ‘actions to support regulatory compliance’?
0. How would you rate the following financing options for NBS in terms of how developed they are? Elaborate your answers where you wish.

	1-Not really developed	2-Moderately developed	3-Somewhat developed	4-Developed	5-Very developed

Financing Option					
Grant funding and donations	●	●	●	●	●
Green finance	●	●	●	●	●
Instruments generating revenue	●	●	●	●	●
Public-private partnerships	●	●	●	●	●
Market-based instruments	●	●	●	●	●

Can you think of any other financing options that are not on this scale? Situate them on the scale.

Which do you believe are most important to further develop in order to speed up the roll out of NbS?

0. How would you rate the following financial barriers to implementing an NBS project? Elaborate your answers where you wish.

Barrier	1-Not a barrier	2-Not significant barrier	3-Somewhat a barrier	4-Significant barrier	5-Main barrier
Lack of private sector interest in Nb	●	●	●	●	●
Valuation and accounting for NBS projects	●	●	●	●	●
Lack of science / evidence to back-up business case	●	●	●	●	●
Lack of successful business models	●	●	●	●	●
Coordination between public and private financiers	●	●	●	●	●

Can you think of any other financing barriers that are not on this scale? Situate them on the scale.

0. How do you think policy can contribute to advancing the financing of nature-based solutions? What type of objectives should governments set at local, regional or national level? If you can, please give examples of good practices.

ASSESSMENT GRID

[Explain that we are preparing an assessment grid to evaluate the level of support for NBS and NBS governing and financing provisions in National Adaptation Plans and Strategies and that we will update it based on the feedback from these interviews. These following questions are to get impressions. We will later on send them the updated version for validation (i.e. to be able to affirm in the paper that this grid was prepared in consultation with interview partners).]

0. Are you familiar with the concept of National Adaptation Plans and Strategies? *[If the interviewee is not familiar with the concept of NAP and NAS we provide a definition]*
0. Taking into account the questions you have previously answered, how do you think the level of support for NbS governing and finance can be measured in National Adaptation Plans or Strategies? Do you think there is anything missing from this grid? [*Open question*]

TO CONCLUDE

0. Is there any other information that you think is useful for us to know in the context of our research that I have not asked you about?
0. Are you aware of any studies that have looked at NbS policy through a NAP or NAS point of view or similar policy documents? If so, can you name them?
0. Are there any other institutions or specific NBS experts you would recommend to further discuss these questions with?

[Interviewer to thank interviewee for time and insights that were shared. Ask if s/he wants to be informed about the report once it is published.]