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Research

Integration of nature-based solutions (NBS) in local policy and planning toward transformative change. Evidence from Barcelona, Lisbon, and Turin

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ABSTRACT. The attention given to nature-based solutions (NBS) in urban governance is often hindered by the fragmentation of responsibilities in technical and administrative services and by rigid structural conditions within urban regimes. This drastically harms NBS implementation and their co-benefits. There is limited information regarding NBS integration across levels and scales of urban governance, in particular a lack of studies that access such integration in urban policy and planning. This study aims to address this gap by exploring the integration of NBS in urban policy and planning in Barcelona, Lisbon, and Turin, the three European municipalities participating in the H2020 project CONEXUS. The objectives are: (1) to understand the state of top-down and bottom-up integration of NBS in urban policy and planning in the three cities; (2) to understand barriers in integration that might hinder the evolution of the NBS agenda in said instruments; (3) to identify policy and planning entry points that can catalyze forms of cross-sectoral, multi-level, and interdisciplinary governance of NBS toward transformative change. The methods used include an in-depth analysis of official municipal, metropolitan, regional, and national documents and expert interviews. The results show that NBS integration in urban policy and planning is novel in all cities but advancing considerably with initial dialogues among the public sector, academia, and local actors of various provenances. Planning in silos persists, negatively impacting any possible confluence of actions toward NBS integration and implementation. However, a constellation of national and international plans including NBS, combined with the development of cross-cutting policies and plans, and an increasing interest from the municipalities and citizens, reveal an enabling environment for NBS integration in urban policies. Our findings are translated into insights that can support policy and decision makers to operationalize NBS integration in their municipal agendas, policies, and plans.

Key Words: *governance; integration; nature-based solutions; planning; policy*

INTRODUCTION

The concept of nature-based solutions (NBS) has recently emerged in urban policy and science communities. The European Commission defines NBS as actions "inspired by, supported by, or copied from nature; both using and enhancing existing solutions to challenges, as well as exploring more novel solutions" to "help societies address a variety of environmental, social and economic challenges in sustainable ways" (European Commission 2015:24). They are seen as one of the most promising strategies to increase the environmental and social well-being of urban environments (Cohen-Shacham et al. 2016). Nature-based solutions provide the opportunity to generate ecosystem services and other benefits from nature that can be combined with conventional planning and development structures, turning environmental, social, and economic challenges into innovation opportunities (European Commission 2015, Cohen-Shacham et al. 2016, Scott et al. 2016). They offer a chance for transformative change because they contribute to "profound and fundamental alterations in social-ecological interactions in a way that sustains the Earth's biophysical systems, while meeting human needs" (Palomo et al. 2021:731).

Nature-based solutions bring the perspective to move beyond the site-based approach of protecting and preserving and provide instead a comprehensive pathway for the creation of social-ecological systems (Scott et al. 2016). In fact, NBS provide a broad set of ecosystem services that yield to society diverse co-benefits such as carbon storage, water flow regulation, reduction of air pollution and urban heat, as well as improved mental health, promotion of physical activity, social capital, and cultural values. The application of NBS to urban environments can significantly improve not only cities' environmental resilience but also social capacity, place making, physical and mental health, and reduce economic vulnerability, driving sustainable and healthier urban transformations (Kabisch et al. 2016, Dorst et al. 2022). Cities are constantly facing unique complex socioeconomic and environmental challenges that makes them an important site for transformative processes (Wolfram and Frantzeskaki 2016, Frantzeskaki et al. 2017). Urban environments have the resources, the confluence of actors, and the urgency to respond to the pressures induced by these challenges (Wolfram and Frantzeskaki 2016, Frantzeskaki et al. 2017, von Wirth et al. 2019). The need to innovate emerges as a key issue in approaching the transformative processes of cities facing socioeconomic and environmental challenges (Tura and Ojanen 2022).

The idea of NBS has been widely adopted by major research and innovation projects, mostly following a co-design process within real-life labs (European Commission 2015, Kabisch et al. 2016, Faivre et al. 2017, Lupp et al. 2021, Zingraff-Hamed et al. 2021). However, the concept has not yet been intrinsically integrated into urban governance and municipal agendas despite its potential. The "inconvenient truth" is that NBS are still far from being mainstreamed in urban development (Fastenrath et al. 2020, Dorst et al. 2022). They are often peripheral to many stakeholders' working routines, and consequently, to planning and governing cultures with knowledge segregated "in silos" among departments, disciplines, sectors, and jurisdictions, and often facing conflicting agendas (Clar et al. 2013, Pasquini and Cowling 2015, Timboe and Pharr 2021). Siloed thinking is often referred to in the literature as a critical barrier that challenges NBS successful uptake and implementation (Clar et al. 2013, Sarabi et

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al. 2019). Siloing in municipal governance appears to be the status quo in most city governments, in which different departments and institutions operate based on distinct visions, ways of thinking, objectives, and legal structures (O'Donnell et al. 2018).

The inherent multifunctionality, multidisciplinarity, multiform, and place-based characteristics of NBS bring the need for a cross-scale collaborative governance to efficiently achieve transformative change (Dorst et al. 2019). Nature-based solutions involve a large variety of actors ranging from the public to the private sector and require particularly strong participation from the local community, those experiencing their impact firsthand, and, for the most part, responsible for their upkeep (Randrup et al. 2020). To support positive connections with nature and acceptance of NBS planning and implementation, it is paramount to understand and include citizens' concerns, needs and preferences within programs, projects, and processes (Kabisch et al. 2022). Nature-based solutions should be locally implemented and social-environmentally embedded, using a systematic approach. Nature-based solutions need to be connected beyond physical, jurisdictional, and temporal boundaries, requiring the interaction of multiple governance levels (Timboe and Pharr 2021). These levels are intended on urban, municipal, metropolitan, regional, and national scale to allow a connection between the tactical and the strategic level development (Kabisch et al. 2022). Therefore, the implementation and optimization of NBS contributions to the quality of life of urban dwellers require an ongoing, robust, multi-level dialogue between strategies, decision makers, and the public they serve. Conventional urban development often follows a linear, hierarchical, and segregated (siloed) process, aimed to address a single purpose and designed based on past experiences (Timboe and Pharr 2021) rather than possible future needs. Nature-based solutions represent an alternative approach to development, a break of silos, and a shift toward a more collective, flexible, and adaptive way of development, which leads them to struggle to be integrated into urban governance and its instruments (Dorst et al. 2022), such as policy arrangements and planning mechanisms.

To date, limited attention has been given to the integration of NBS within urban policies and planning. Unlike non-urban environments, NBS in cities often do not focus particularly on the reduction of greenhouse gasses (GHG) emissions and climate change mitigation but they are more oriented to climate change adaptation, cultural (e.g., human health and well-being, aesthetic appreciation, and inspiration) and regulating (e.g., air quality, mitigation of heat island effect, regulation of water flow) ecosystem services, which may substantially influence urban policies when compared to non-urban ones. On one hand, literature suggests that urban policymakers, practitioners, and researchers advocate for the integration of NBS into urban development (Lafortezza and Sanesi 2019, Dorst et al. 2022, Frantzeskaki et al. 2020). On the other hand, it shows that the incorporation of new and interdisciplinary solutions such as NBS in urban governance and its instruments is a complex matter due to pre-existing socioeconomic and technical conditions (Bulkeley et al. 2014, Fuenfschilling and Truffer 2014) and path dependence (Davies and Lafortezza 2019). Cities governance is composed of norms, practices, and rationales difficult to change, combined with ongoing conflicts for resources and needs that can constitute a rigid barely mutable structure. There is a "governance gap" (Frantzeskaki et al. 2020), with a limited understanding of the collaboration between different urban actors and sectors required for the co-design and implementation of NBS (Davies and Lafortezza 2019). The integration of NBS in policy and planning instruments is acknowledged as a key catalyzer to the successful adoption of NBS in urban governance (Mendonça et al. 2021) and an important first step for their uptake. Policies and plans are responsible for guiding implementation in practice and allowing it to remain "open and flexible to adaptations coming from tacit (individual) knowledge, experience and learning during their implementation and environmental management" (Kabisch et al. 2022:4). However, it is still unclear how to assimilate NBS into dominant urban policies and plans and which entry points and potential challenges their integration can entail. Questions arise regarding: how can NBS be integrated into cities' policies and plans? What is their current state of integration? Are there clear common barriers and opportunities for NBS within urban policies and planning?

We aim to shed light on the integration of NBS in urban policy and planning processes in European cities. This study was conducted within the H2020 project "CONEXUS, i.e., CO-producing NBS and restored Ecosystems - transdisciplinary neXus for Urban Sustainability," taking Barcelona, Lisbon, and Turin, the three European cities of the project, as case studies. The three cities are in Southern European countries, and share similar climate, comparable social-environmental features, and common challenges toward sustainable urbanization. All cities have made increasing efforts to advance their NBS agenda and in attempting to incorporate them within their urban context and governance. The municipality of Barcelona is making a move toward a more sustainable and resilient city, aiming for greenery, more specifically urban agriculture, to play a more significant role in people's quality of life and a central place in its urban policies (Ayuntamiento de Barcelona 2012). Since 2005, Lisbon radically shifted its urban development approach toward a more people-centric urban regeneration, prioritizing the city's quality of life and carrying the re-naturalization of its urban environment high on its agenda, culminating with the 2020 European Green Capital Award (Câmara Municipal de Lisboa et al. 2021). Turin development plans not only place a significant emphasis on their green infrastructure and the promotion of a new, more circular economy toward an ecological transition but focuses on innovation of governance and management of public greenery and tree heritage, alongside public and private partnerships (Città di Torino 2020).

This study aims to bring evidence on how NBS can be integrated within the cities' urban policies and to analyze possible pathways and aspects that enable the implementation of NBS and their co-design, as well as highlighting lacunas of integration that are hindering the process of NBS. The study discusses and gathers insights on how to further increase NBS in municipal agendas. It draws upon the multiple meanings that compose the definition of integration: (1) to form, coordinate, or blend into a functioning or unified whole; (2) to incorporate into a larger unit or to unite with something else; and (3) to end the segregation and bring into equal membership in society or organization and use them as a frame for a comprehensive analysis (see Merriam-Webster, https://www.merriam-webster.com/dictionary/integrate). Therefore, this research delves into: (1) the overall integration of the NBS concept

in urban policies and all its relevant organizational spheres; (2) the horizontal integration of the concept, its integration among different public sector plans and external actors; (3) the vertical integration, which refers to integration among governance levels (public government and beyond) and plans (municipal to national); and (4) the transversal integration, i.e., its geographical integration among different territorial plans and cities. The integration of NBS in local policies and planning is understood as the strategic incorporation of the concept of NBS into the cities' action, strategic and master plans, and similar governing instruments. Furthermore, the concept should be tactically embedded to co-produce integrative and participatory planning instruments.

METHODS

For this study, we followed a qualitative, mixed-comparative case study methodology to allow for an in-depth exploratory analysis of how NBS can be integrated into local governance and planning. Three case studies (Barcelona, Lisbon, and Turin) were used to understand the similarities and differences between the challenges and opportunities behind the integration of NBS. To assess the different types of integration, two sources of data have been collected. First, official open access documents from the municipalities to take stock of the existing official governance structure in place; and second, primary data collected through expert interviews and oriented to compile further insights emerging from the experiences and perceptions of persons closely and actively involved in NBS development. After gathering, data have been analyzed and synthesized according to the multiple meanings of NBS integration. Four clusters of stakeholders have been identified to take part in the research: public sector, civil society, research, and private sector.

Document analysis

The document analysis of the three cities is a central element of this research. The analysis was conducted in the official written languages of the documents. Only pertinent municipal, metropolitan, provincial, regional, and national policy documents (action, strategic, and master plans) available online and currently in effect were collected. Their content has been analyzed taking stock of their inclusion of NBS, their relationships among each other, as well as their relationship with international documents (i.e., international agendas, treaties, goals, as the Covenant of Mayors, the UN SDGs).

In greater detail, the overall process followed three steps:

1. Data gathering: the collection of documents was conducted through the gathering of all official strategies, planning, and policy documents currently in force) of the municipalities studied and their relevant metropolitan, provincial, regional, and national strategies. The criteria for document collection were:

- Documents that were publicly available online at official government websites and official municipal online repositories. Offline documents were not considered nor collected.
- Documents that were effective at the time of data collection (year of 2021).
- Documents from all municipal fields and departments, ranging from environmental departments to health, education, and all other departments that do not directly address environmental issues with no discrimination between fields or topics addressed.
- Documents that have a focus on the urban environment.

2. Data screening and cleaning: after collection, an automated screening of all documents collected was conducted based on a predefined set of NBS-related keywords (Table 1) trialed by the authors and reviewed by partner researchers. The set of keywords chosen is composed of broader words, which allows also for the identification of more specific NBS. The automated screening was followed by a manual screening to discard any files that used the keywords within a different context (e.g., green: green economy, green energy) and to identify the documents that included NBS per se. The screening further analyzed the city departments that are assimilating NBS, the main purposes of NBS for the cities studied, and the main ecosystem services (ES) highlighted.

Table 1. Keywords set 1: keywords for the identification of possible nature-based solution (NBS) documents.

	Keywords for computer screening
Data screening and cleaning	green; nature; nature-based solutions; trees; natural; vegetation; shrubs; urban forest; urban agriculture; urban farm; gardens; parks

3. Data appraisal and analysis: an automated text mining based on a second set of keywords (Table 2) to identify and extract any NBS and cross-scale integration passages from the documents. Passages were manually analyzed to identify to what extent the documents integrate the NBS concept, contribute to its agenda within the municipalities, the relevant NBS visions, strategies, and actions in place, and the presented nexus among official documents and departments involved. The passages were also coded to assess the different possible forms of integration of stakeholders in NBS urban governance presented by the cities. The analysis considered the four clusters of stakeholders identified, and categorization was conducted based on three criteria for each cluster of actors:

- collaboration of the cluster in the elaboration of the analyzed document;
- the document calls for the involvement/integration of the cluster on the planning and implementation level;
- the documents put in action collaborative tools toward integration within each cluster and across clusters.

Interviews

The collection of primary data was conducted through the application of problem-centered (expert) interviews that allow for a qualitative discursive-dialogic collection, reconstruction, and validation of knowledge about a relevant problem from the interviewed participants' perspective (Witzel 2000, Witzel and Reiter 2021). This technique enables a collaborative relationship between interviewer and interviewee, therefore, between prior theoretical knowledge and practical experience, bringing forward

interactive interpretation and co-production of knowledge (Witzel 2000, Witzel and Reiter 2021). The interviews were conducted with stakeholders from all main clusters (public sector, private sector, civil society, and academia) for each city. However, despite efforts, experts from the private sector were not available to be interviewed. Interviewees were selected based on their (1) experience with NBS or similar activity (i.e., urban forest, urban agriculture, green infrastructure); (2) knowledge of NBS policies; (3) experience with NBS implementation in practice; and (4) availability to take part in the study. A total of 9 expert interviews were conducted, 3 per city, with interviewees complying with all 4 criteria and coming from the public sector, academia, and civil society (see the Appendix for more details of the interviews' content and structure). Interviews were held online due to COVID limitations, by associate researchers, and in the native language of the participants.

Table 2. Keywords set 2: keywords for the assessment of stakeholders' integration.

Stakeholder cluster	Keywords
Public sector	department; sector; directory; office; commission; ministry
Civil society	association; NGO; community; cooperative; citizen(s); participation; participatory; citizenship; community; co-production; co-design; co-management; grassroots
Research	research; university; academia; science; institute
Private sector	private sector; business; green jobs; company; corporation; circular economy

To ensure inter-coder reliability, both the content analysis of the official documents and the interviews were analyzed and discussed by at least two associate researchers, with a third one stepping in, in case of contrasting results. Lastly, formal narrative methods were used to identify NBS integration also allowing for additional categories (codes) to emerge from the data. The interviews were analyzed by categorizing the information into the overall integration of the concept, horizontal integration, and then vertical, and transversal integration. The results of the two analyses were then contrasted, to confirm or oppose the previous knowledge gathered and provide insights into NBS policy integration in theory and in practice.

RESULTS

Nature-based solutions' (NBS) integration in official documents

A total of 41 official documents that integrate NBS to some extent were identified: 10 in Barcelona, 17 in Lisbon, and 14 in Turin. The data collected revealed that NBS were integrated into different policy levels, from municipal to national: 23 were municipal, 3 metropolitan, 7 regional, and 10 national (Table 3), with the majority of them indicating or referencing connection with international agendas. The document's analysis also showed a predominance of framework plans and strategies (46%), equally followed by master and action plans (Table 4).

Table 3. Nature-based solutions (NBS) policies found per city and governance level.

	Barcelona	Lisbon	Turin	Total
Municipal	5	13	5	23
Metropolitan	1	1	1	3
Regional/ Provincial	2	1	4	7
National	4	2	4	10
Total	10	17	14	41

Table 4. Types of nature-based solutions (NBS) policies found.

Municipality	Frameworks and Strategies	Master Plans	Action Plans
Barcelona	50%	20%	30%
Lisbon	47%	24%	29%
Turin	43%	36%	21%
Total	46%	27%	27%

All municipalities adopted the term NBS within one or more documents, but infrequently (12%). Other keywords are more often used to refer to and describe NBS, such as urban forest, green space, urban greening, and urban nature. No document reviewed provided a clear definition of NBS or discussed the concept in depth, but they indicated the use of the meaning in line with the European Commission's definition, i.e., seeing the concept not only as an environmental solution but one that includes socio and economic spheres and can address multiple societal challenges (although the latter still in its infancy). Cross-cutting policies in all cities, such as resilience, climate change, or sustainability plans, presented the integration of the NBS concept and were common ground for cross-departmental integration. All the cities also presented specific plans for the planning and management of their urban forest, highlighting this typology of NBS. In Barcelona, a strong presence and emphasis on urban agriculture was identified.

Common purposes for NBS integration were found within the documents analyzed. The three main categories identified within the documents were: improvement of citizens' well-being and the quality of the built environment (39%); improvement of biodiversity and the natural environment (29%); and resilience, i.e., mitigation and adaptation to climate change (32%). The improvement of biodiversity and the natural environment as well as resilience/mitigation and adaptation to climate change discourses are linked, in the narrative of the documents, to the improvement of citizen well-being and the quality of the built environment. As an example, the resilience plan of the municipality of Turin sought to create a "high quality of life and urban environment, with widespread prosperity and an area rich in opportunities" (Comune di Torino 2019:7). Furthermore, there was limited mention of cultural ES and those linked to social benefits (i.e., mental health, social cohesion), in contrast with a predominance of regulatory ES, followed by support and provisional ES (as classified by the MEA 2005).

Different extents of integration among policies were found particularly in the more recent strategies and plans. Documents ranged from 2006 to 2021, and the newest, developed in particular after 2015, presented more interactions and dialogues with other documents (from all levels of government) than prior plans. A range of policies of NBS were identified, but they were often restricted to departments involved in the spatial development of the municipalities. In all case studies, the types of departments leading NBS policies (see Table 5) were mainly the environmental and/or planning departments. Only the municipality of Lisbon presented policies led by other departments. All three cities have incorporated NBS within their metropolitan and regional/provincial plans, across jurisdictional and spatial borders. Ecological connectivity at a municipal and cross-municipal level is largely present within the goals of Lisbon' policies and plans. The municipality of Turin, due to its location within the Alps, largely focuses its municipal and regional policies on the ecological connectivity between new and pre-existing nature. Barcelona, with its proximity to Catalunya, encompasses most of its plans through its metropolitan region, including NBS policies. At a national level, due to plans that involved both urban and rural environments, department types such as agriculture, fishery, tourism, commerce, and industry were supporting departments in NBS policies, but their presence was more commonly identified in rural areas.

Table 5. Type of public department involved in nature-based solutions (NBS) planning.

	Barcelona	Lisbon	Turin
Municipal	Planning[†] Environment[†] Mobility	Planning[†] Environment[†] Mobility[†] Energy[†] Waste[†] Social Rights; Housing Finance	Environmental[†] Planning[†] Mobility Infrastructure Social Rights; International cooperation Energy
Metropolitan	Planning[†] Environment[†] Mobility	Planning[†] Environment[†]	Planning[†] Environment[†] Mobility
Regional/ Provincial	Planning[†] Environment[†]	Planning[†]	Planning[†] Environment[†] Mobility
National	Planning[†] Environment[†] International cooperation Mobility Industry and commerce Agriculture and fishery Tourism	Planning[†] Environment[†] Energy[†]	Environment[†] Agriculture

[†] Type of departments leading a policy that influences NBS governance. The other typology of departments indicated collaborated with the policy development, but were not necessarily responsible for or hosting a policy of their own that included NBS.

The cities also disclosed different approaches to NBS governance. Lisbon showed the highest number of policies that integrated NBS, ranging from master plans and biodiversity plans, all the way to the drainage and transportation plans, presenting a cross-sectoral and polycentric approach to NBS policy. Turin was the municipality that showed the least diversity of policies and used a more centralized policy approach to NBS integration. The results also displayed differences in hierarchies. In Turin, the plans followed a more hierarchical approach with one specific plan that fostered a set of other plans. Lisbon, instead, showed a less hierarchical governance process with many two-sided relationships among plans and back-and-forth communication. Barcelona was a middle ground between the other two cities.

Regarding the integration of sectors beyond the public sector, the analysis revealed that all municipalities had, to some extent, the integration of civil society, academia, and the private sector, but it also revealed a large gap in the private sector integration. Only 13 out of 41 policy documents in the 3 cities integrated the private sector, whereas all documents integrated a diversity of public departments involved: 27 plans involved civil society and 22 academia. The categorization of stakeholder integration in NBS planning for each cluster of actors involved further revealed limited availability of participatory tools for NBS development for the private sector, and there were only presented by the city of Turin (Table 6).

Table 6. Categories of stakeholder's integration in nature-based solutions (NBS) planning per cluster of actors, per city.

Municipality	Civil Society	Academia	Private Sector
Barcelona	1, 2, and 3	1, 2, and 3	2
Lisbon	1, 2, and 3	1 and 2	1 and 2
Turin	1, 2, and 3	1, 2, and 3	1, 2, and 3

Category 1: collaboration in the elaboration of the documents.
Category 2: the documents call for the involvement/integration of the sector in planning and implementation activities.
Category 3: the documents put in action collaborative tools toward sector integration..

Furthermore, the analyzed documents considered the participation of the civil society for the elaboration of policies, and all cities presented documents that put participatory tools in action to promote civil society integration. Most of the tools presented relied mainly on consultation as a participatory process. Co-production and co-governance were in the minority and only found in Lisbon and Turin to a minimal extent (1 in Lisbon and 2 in Turin).

Integration in practice: local experts' perceptions of nature-based solutions (NBS) integration

Interviews were held in all cities with stakeholders from different sectors (public sector, civil society, and academia) to fulfill all criteria of the interview selection, i.e., knowledge holders of both NBS or related concepts and related urban policies relevant to their municipalities. Interviewees from the public sector were experts ranging from the municipal environmental and planning departments, which were involved in project implementation and policy development. People representing civil society were local actors participating in NBS and related projects who have navigated local policies for NBS implementation. Regarding academia, expert researchers in NBS-related topics working both on theoretical and applied research within their municipality and with knowledge of local urban policies were selected. Experts

confirmed that the main bodies responsible for NBS development and integration in urban policies were the environmental and planning departments. The majority of them, especially experts in the public sector in the three cities, reported a general lack of awareness and education regarding the benefits and requirements of NBS by the population and public workers, including decision makers. This lack of integration of the municipal education and communication departments into the planning process of NBS is perceived as harmful to NBS development. This lacuna was linked by some participants to barriers in NBS implementation, such as low allocation of budgets and resources toward NBS, reduced dissemination of adequate environmental knowledge and NBS benefits, and a considerable mismatch between urban dwellers' interest in NBS and their current lifestyle, the "not in my backyard" (NIMBY) phenomenon. It was reported that many dwellers were in favor of the implementation of NBS, however when it came to implementing it in the proximity of their houses or offices, many were opposed due to loss of parking space, the possible attraction of insects, and so on. In Lisbon and Turin, this effect was often cited as referring to the conflict between new green spaces and/or trees along the streets and the consequent reduction of available parking for private vehicles.

When asked about NBS integration with health departments, the interviews showed that, although many NBS health benefits were perceived as well known and acknowledged in some policy discourses, in practice there was no integration or limited interactions (some outdoors exercises being promoted in parks during the summer) with the health department. Interviewees added that integration with this department is desirable and could open new pathways for better NBS development and uptake, as well as possible funding. Bureaucracies and different levels of government were brought up as a barrier to NBS integration with health departments. In Portugal, for example, the health department works at a national level, and this was indicated as a factor that hindered its integration within the municipal NBS policies in Lisbon.

Experts in the three case studies all perceived an increasing municipal intention to co-produce NBS with citizens and with different stakeholders. The respondents expressed a perceived increase in promotion of participatory approaches by all levels of government, with emphasis on municipal ones, as well as increased demand by the local population. However, this increase was not noted in the actual application of participatory tools. Instead, conflicts of application of participatory process with local regulations, procedures and timeline demands were highlighted. A lack of integration concerning the inclusion of citizens' opinions in all levels of planning was reported, disturbing local ownership, stewardship, and co-production of NBS. In addition, a delay in including local communities in the NBS planning process was expressed in Barcelona. In Lisbon, limited transparency of actions of the municipality was further described as a barrier to civil society integration. Bias in the inclusion of stakeholders was noted in Turin, with more chances of collaboration being given to specific stakeholders' groups than others, through invitations or specific closed channels.

Likewise, an overall difficulty to integrate and collaborate with the private sector was detected. Interviewees perceived that, in practice, the integration of this sector "walks a fine and complex line" that is often hard for the municipalities to navigate. It was stated that cities have been making an effort, but there is a lacuna on how to scale up NBS co-production with the private sector transparently and efficiently, and limited knowledge on tools for this purpose.

An effort was noted regarding the integration of other municipalities in NBS policy development, but interviewees reported conflict of agendas and political competition among neighboring cities. From their perspective, change in political leadership combined with the novelty (uncertainty) of NBS further threatens NBS transversal integration in the long term. In two out of three cities that had undergone political change, concerns regarding the state of NBS governance in the long term were mentioned. Nevertheless, the interviewees expressed actions toward collaboration among NBS projects across municipal territories, especially projects deriving from international schemes. One example is the synergy among CONEXUS and the LIFE LUNGs projects financed by the EU, in Lisbon. In addition, the municipality of Turin fostered collaborations with cities outside of its region. The city largely collaborated with North American cities, considered front runners in city greening, to draw on the examples of the best practices of those cities.

The integration of academia was perceived as expanding and necessary. Respondents expressed a good relationship between academia and public administrators (within decision and policymakers as well as on an operational level), with increasing demand for scientific evidence, although every so often expressing difficulties in operationalizing them, i.e., co-governance.

Lastly, two major topics were systematically brought up within the interviews. On one hand, the challenge of budget allocation for NBS projects was provoked by limited knowledge of the monetary value of NBS benefits by decision makers and conflicts with local development regulations in force (i.e., local procurements process); on the other hand, the COVID-19 pandemic has been perceived in the three cities as a booster of citizen's interest in urban green spaces and nature, despite the crisis that it caused and competition with budgets. An emerging need and desire for accessible open green spaces for all citizens was noted by local communities and perceived as a stimulus for citizens to actively engage with the municipalities in the decision-making process and co-production of NBS. Local communities have been increasingly demanding green interventions within the three cities and demonstrating more openness to taking part in those initiatives. The interest in the development of NBS by both urban dwellers and decision makers was perceived as a combination of the influence of international agendas and an internal desire to reconnect with nature.

DISCUSSION

Overall integration

Our findings reveal a possible move toward a less fragmented NBS urban governance and a more integrated approach to NBS development, i.e., a step forward for the uptake of NBS in urban settings (Sarabi et al. 2020). The results demonstrate an increasing inclusion of NBS in urban policies in the last seven years and increased dialogue between said policies toward NBS development. This indicates a probable reaction to the emergence of the NBS concept in international agendas (Albert et al. 2019,

Sarabi et al. 2020, Li et al. 2021) and to the transition of how urban development is being perceived (Ovink and Boeijenga 2018). The findings positively show integration of NBS in a range of policies, varying from planning and territorial policies to climate change and resilience ones. Nature-based solutions were not necessarily expressed using the term NBS itself, but often were intended through concepts and definition relating to NBS structures and discourses, as found by Zwierzchowska et al. (2019). This result highlights the role of the NBS term in comprising insights from similar concepts and re-orienting existing conceptualizations of nature (Albert et al. 2017) but it also highlights the need to further discuss the concept for a better translation of its meaning to local cultures. Because urban policy documents are an expression of cities' intentions, their awareness, and desired evolution, the integration of NBS into their objectives and concept clarification can be recognized as important evidence of how the potential of NBS is perceived.

However, although some NBS integration in policy and planning documents can be found, the results revealed that lacunas still hinder the depth with which this integration takes place. The concept is still mainly assimilated in the environmental and planning policies, with its integration in other types of policies being rather an exception than the rule. Nature-based solutions still struggle to be integrated with education, health, and communication plans and strategies, thus highlighting the importance of dissemination and local understanding of the concept so that it can be accessible to all (Sowińska-Świerkosz and García 2022). The case studies show that a more comprehensive approach to NBS governance is desired and a limited view of NBS damages comprehension as social-economic solutions. There is a need to expand the concept's uptake in urban policies beyond the spatial realm and environmental policies. This need is confirmed by findings from Zwierzchowska et al. (2019), that encountered lacunas in supporting urban NBS policies not only in the transportation and construction sectors, but also in policies supporting citizen's health and economic development. Furthermore, Wickenberg et al. (2021) noted that NBS should not only be integrated in urban planning but aligned with other urban policies. Nature-based solutions should not be overlooked because they may have modest effects on specific issues, such as local air quality and greenhouse emissions offsets, but their contribution and co-benefits can complement other policies to meet their targets (Baró et al. 2014).

The direct and indirect link of NBS with the improvement of human health and well-being and the quality of the built environment constitute a strong entry point to policies and could serve particularly for the integration of NBS within health policies. The NBS agenda still narrowly incorporates human health, giving more emphasis to well-being (van den Bosch and Sang 2017), but urban policies referring to health have a huge potential for including NBS and enhancing this connection (van den Bosch and Sang 2017, Zwierzchowska et al. 2019). There was limited attention given to cultural ecosystem services linked to well-being such as recreation, education, sense of place, and social cohesion (Fastenrath et al. 2020). This demonstrates that "linkages between NBS and human wellbeing were increasingly understood, but the possibility to create and strengthen social cohesion based on NBS was rather rarely noticed" (Li et al. 2021:15).

The three cities presented singularities and specific desires and demands for NBS development, but with a large common ground of entry points and barriers indicating a possible regional or global reality. This indicates that general principles for its application in urban environments can be developed (Dorst et al. 2022, Kabisch et al. 2022), a systemic pathway for NBS integration into urban policies can also be identified, both for the overall uptake of the concept, as well as for their integration of different actors, governance levels, and municipalities.

Horizontal integration

In terms of integrating a more diverse set of disciplines to achieve inter-departmental planning in policy making, the results demonstrated growing efforts from the municipalities. In all case studies, different municipal departments have been involved in the elaboration of plans and strategies, and a call for further collaboration on the planning and implementation of NBS-related activities has been found. However, difficulty endures when translating cooperation into practice, indicating a persistence of the "planning in silo" barrier (Wamsler 2015, Sarabi et al. 2019, 2021). Mechanisms and processes for integrating environmental and climate issues into sectoral planning remain scarce, prompting policies to fail to be translated into practical outcomes (Wamsler et al. 2020). The environmental departments are the ones most commonly leading NBS policy development while other departments (i.e., mobility, energy, waste, drainage, and water) act as supporters. An absence of involvement of the health, economic, education, and communication departments can be noted as a lacuna that might be reflected in other cities as well, as identified by Zwierzchowska et al. (2019). Wamsler et al. (2020) found that although there is a widespread discourse on the importance of NBS within cities, they remain a low priority among overall municipal planning objectives, while economic development and other issues prevail.

Limited education and communication are already known crucial barriers to the scale-up of NBS and are acknowledged as important enablers of NBS uptake (Pauleit et al. 2017, Davies and Lafortezza 2019, Sarabi et al. 2019). In line with findings from urban NBS studies in other countries (Mendes and Oliveira 2019, Dorst et al. 2022, Vojvodíková et al. 2022), the results of this study identified the NIMBY phenomenon as a barrier for NBS integration and planning, despite commonly occurring in large infrastructure projects. This highlights the importance of creating synergies with municipal education and communication departments for enhancement of public awareness and NBS acceptance. In accordance with findings from Mendonça et al. (2021), a closer integration with the economic department was perceived as highly desirable within the case studies. A lack of this integration constitutes a barrier to the allocation of budgets and resources for NBS, confirming that NBS economic policy instruments represent a great challenge, determining the need for more effective methods for NBS financing (Mendonça et al. 2021). For instance, van der Jagt et al. (2023) found that the usage of certain well-established sustainability policy instruments, such as eco-taxes, for the uptake of NBS is still lacking. Hawxwell et al. (2019) further highlight the fact that economic instruments may represent a negative or a positive influence for NBS adoption, depending on how they are formulated, thus enhancing the relevance of integrating the NBS agenda with this municipal department.

Intentions toward tools for a participatory approach and recognition of the importance of civic collaboration were mentioned in all cities. However, there is a lack of knowledge and expressed difficulty of co-governance tools to engage the voices of the local community members who should or could be involved in the everyday uptake of NBS, in line with Mendonça et al. (2021) findings. There is a disparity between envisioned participation and current methods of governance. Constraints and criticalities in the participatory process due to governance structures persist. A gap in how to operationalize the participatory process within the demands of time, budget, and public procedures of local administration endures (Mahmoud and Morello 2021). At the same time, the late involvement of citizens in NBS project development (Ramírez-Agudelo et al. 2020, Zingraff-Hamed et al. 2021) constitutes a barrier to a community's ownership, stewardship, and participation in NBS decision making. Following findings from Puskás et al. (2021), our results demonstrate that consultation and partnership are the dominant levels of participation, as defined by Arnstein (1969). Often, citizens are involved when decisions have already been made, reported as a possible consequence of political time demands and already limited resources. Deeper levels of participation such as delegated power and citizen control, closer to shared governance, would be much more desirable (Mahmoud and Morello 2021).

The importance and positive impact of private sector integration have been already highlighted within the literature (van Ham and Klimmek 2017, Toxopeus and Polzin 2021), but its incorporation and integration in practices and policies remain a limitation. There is a lack of know-how of instruments, procedures, and knowledge, coupled with the concern that with the involvement of the private sector some actors might benefit disproportionately from NBS by the municipalities (Scott et al. 2016, Toxopeus et al. 2020). This gap regarding the private sector integration is possibly linked to the gap in economic policy instruments and the challenge of their application highlighted by Mendonça et al. (2021).

The perceived increased interest in re-naturing and greening the cities by the municipalities and the general public, in particular after the pandemic, shows contrasting data from those found by Lorenzoni et al. (2007). This reflects a possible shift in perspectives and a momentum for further advancing NBS integration and scholarship, in line with Li et al. (2021) who found an increase in focus of NBS studies on greening interventions in urban areas, such as urban forests, and Kim et al. (2023) who found increased usage of green urban spaces.

Vertical integration

Looking to NBS integration at different policy levels: municipal, regional, and national policies make constant reference to European policies (i.e., EU Green Deal, Urban Agenda for the EU), as well as international commitments such as the UN sustainable development goals and the Paris Agreement and Covenant of Mayors. This confirms the influence of international policies in local policy development and presents them as a larger enabler of NBS uptake (Kabisch et al. 2016, Faivre et al. 2017, Lupp et al. 2021, Zingraff-Hamed et al. 2021). Dialogues emerging from plans and policies reveal systematic thinking and efforts toward integrative planning and reducing possible conflicting mandates among government levels. This indicates that political support for further NBS development, alongside the increased interest in urban nature brought by COVID-19, can bring momentum to urban NBS that should not be overlooked. This momentum can highly benefit the co-production of NBS and their integration into urban policies, in particular with the increase of support for bottom-up initiatives. Instruments for promoting bottom-up NBS initiatives within the cities can be found, but are very limited. There is a need for increasing vertical integration and hybrid governance from the bottom up (Toxopeus et al. 2020, Puskás et al. 2021), and policy instruments and interventions, such as Living Labs, can be central to achieving transformative change (Wilk et al. 2021, van der Jagt et al. 2023). Although there is increasing political interest in local initiatives, tools and instruments for backing government participation are lacking. A mismatch between bottom-up initiative demands and the limits to acting and the willingness by local administrations to support these initiatives is often reported in literature (Wamsler et al. 2020, Puskás et al. 2021, Wilk et al. 2021). Government participation could be a more collaborative and responsive approach to enable and facilitate community initiatives that are self-governed by citizens (Mees et al. 2019).

The documents with cross-cutting topics such as sustainability, resilience, and climate change also demonstrated a higher level of integration across internal governance levels (national, regional, metropolitan, and municipal), implying a step forward toward comprehensive cross-jurisdiction integration as seen in the experiences of Living Melbourne, in Australia (Fastenrath et al. 2020). It is important to note that said integration is not just beneficial nor encountered for learning from top down (international to the municipal scale) but also from the municipal level up. As observed by van der Jagt et al. (2023), "in Spain, for example, the national government was considered a laggard on policy-based support for NBS when compared to some cities. Barcelona committed to an additional 1 m^2 of greenspace per inhabitant (1.6 km^2 in total) by 2030 as part of its 2015 Commitment to the Climate, evidencing policy integration, while it also produced a green infrastructure plan and green roof guidance ahead of national government strategy development" (van der Jagt et al. 2023:58). The different approaches to integrative planning confirm the need for context-specificity of NBS policies while addressing it systematically (Dorst et al. 2022). The results still highlight barriers to be overcome. As the case from Lisbon demonstrates, there are difficulties in integrating different government levels of different departments (i.e., health at the national level and environmental at the municipal level). Providing a diversity of national and regional supporting policy settings can improve NBS uptake locally, both by policymakers and other stakeholders such as the private sector (Sarabi et al. 2020).

Transversal integration

The findings reveal that all three case studies, Barcelona, Lisbon, and Turin, acknowledge the variation in bio-physical and institutional context across metropolitan and regional areas within their policies. However, the efforts toward transversal integration of NBS presented by those documents differ from the reality in practice. Lack of political commitment and will, a known barrier for climate change adaptation policies (Clar et al. 2013), hinder NBS integration across urban borders. Policies and decision makers tend to favor short-term benefits and outcomes

instead of the long-term benefits provided by novel approaches such as those that NBS can provide (Clar et al. 2013, Sarabi et al. 2020). Nature-based solutions' novelty and uncertainty in the long term combined with the need for short-term commitment and costs determine difficulties for development and implementation of NBS policies (Sarabi et al. 2020). Often, not all politicians are aware of the full potential of NBS and do not give proper urgency for them within their crowded political agenda (Sarabi et al. 2020). Unclear responsibilities and roles also influence NBS transversal integration and may cause policies to not be implemented. Different governments may be "waiting for others to act instead of taking the initiative themselves" (Clar et al. 2013:4). In addition, the findings disclose that conflicts between municipal regulations and governments create a discontinuity in the process of NBS planning and implementation across different political governments. This is in line with the outcomes of the project URBAN GreenUP (2019), which found difficulties in the achievement of a consensus for NBS development because across some municipalities, local ward governance may be held by local councils from different political groups. There is a need for more consistent NBS urban policies and municipal regulations.

Ultimately, the analysis reveals that conflicts for local cross borders integration may be found. Municipalities are also looking beyond and forging synergies and partnerships with other cities working toward bridging the knowledge gap across administrative boundaries related to ecosystem governance issues (Vignola et al. 2013). The case of Turin brings a good example of inter-municipal exchange of knowledge, as mentioned by Droste et al. (2017), Fastenrath et al. (2020), and Wamsler et al. (2020). Successful strategies to mainstream and integrate NBS in policies and planning demonstrate opportunities for international cooperation for NBS development. Sarabi et al. (2020) and Fastenrath et al. (2020) discussed the importance of the development of networks and platforms for learning, both among different levels of government, different departments and stakeholders, as well as different municipalities. The authors additionally highlight intermediaries or "transboundary actors," as agents of change or knowledge, for the dissemination of NBS knowledge among multiple stakeholders and governance levels (Fastenrath et al. 2020, Sarabi et al. 2020).

THE WAY FORWARD: INSIGHTS GAINED FOR NBS INTEGRATION IN URBAN POLICIES

The integration and development of NBS in urban policies need consideration of local context and should be adapted for the local reality. However, insights emerge from the present analysis to provide guidance to a variety of stakeholders in diverse settings to advance NBS scholarship on a regional and global level. First, NBS can be integrated in urban policies progressively and this should be done following local cultural context and values (Mendonça et al. 2021). It is important to note that even if highly supported by the European Union the concept needs to be better understood locally and disseminated through the policies and planning, as reflected in the low use of the term NBS along the analyzed documents (Kabisch et al. 2016, Nesshover et al. 2017, Albert et al. 2019, Zwierzchowska et al. 2019). There is an urgency to understand NBS and adapt them to local contexts on a global scale to be successfully mainstreamed and integrated into common urban development practices. Meanwhile, NBS integration can start through specific NBS typologies already accepted or familiar to the municipality, such as urban forest or urban agriculture. Nature-based solution benefits that focus on local demands can be a further entry point, for instance Lisbon's need for a more livable city to attract back lost citizens, Turin's need to preserve local natural resources while preparing for extreme events to come, and Barcelona's need for further provision of a better quality of life to its dweller amid a densely built environment.

In both pathways, it is essential, in the long-term, to create a portfolio of NBS, disseminating and engaging the co-benefits they provide within local policies and the diverse sectors that NBS can benefit. To fully embrace the concept, the diversity of NBS co-benefits should be widely recognized and disseminated within the policies, going beyond their mere environmental benefits. In particular, acknowledging benefits that are still overlooked such as cultural ecosystem services, human health co-benefits, and financial value is a crucial step. To enable transformative change, NBS governance is essential to go beyond silos and bring together actors and sectors from a diversity of disciplines, incorporating departments that do not usually have a direct responsibility on matters concerning the environment and nature (i.e., communication, transportation, education, health). Nature-based solutions can particularly benefit from the integration of communication and education departments and the subsequent creation of informational policy instruments (e.g., workshops, surveys, websites, articles, labels, and certifications) and economic instruments (Mendonça et al. 2021). In turn, those departments can gain from their co-benefits, i.e., citizens in better health, green prescriptions (Robinson and Breed 2019), green classrooms, increases in socio-emotional learning (Lanza et al. 2023), increase in property values (Sander et al. 2010), and improved mental health of city dwellers (van den Berg et al. 2015), among others.

Cross-cutting policies such as climate change, sustainability, and resilience are powerful entry points that can further promote the convergence of interests in NBS and integration among departments and stakeholders. The same can be conducted for other cross-cutting policies such as those referring to population health and well-being, such as the Natural Choices for Health and Wellbeing program in Liverpool, UK that improved local health and well-being through the creation and enhancement of green spaces and natural elements (Wood et al. 2013). Policies should not just include NBS, but also set development targets that can be achieved through NBS and provide policy instruments (plan/legislative, economic, and informational) for their actual application. Cross-cutting policies are strongly suited for this because NBS can provide multidisciplinary benefits, albeit NBS can be an instrument for achieving a diversity of policy goals. In addition, because NBS should not be integrated in one but several policies of a diversity of departments, multiple combinations of policy instruments can highly support their development (van der Jagt et al. 2023). There is a need to particularly enhance participatory tools to support bottom-up initiatives and higher levels of community participation, together with communication and educational ones. Research and innovation projects (i.e., Living Labs) as well as cross-border cooperation are perceived as

very inspiring (Sarabi et al. 2020, Wamsler et al. 2020, Voskamp et al. 2021). Nature-based solution policies should promote learning tools and pilot projects to overcome risk aversion and open room for the exploration of new models of public-private partnerships. The incorporation of participatory networks and learning platforms in policies can be strong instruments for horizontal, vertical, and transversal integration.

Policies need to be evidence based and oriented to support and promote the upscaling of scientific and technical capacities. Because NBS bring a new concept (or a combination of multiple fields and knowledge; Sowińska-Świerkosz and García 2022) and require new approaches to urban governance, policies need to be flexible to overcome bureaucratic procedures. Furthermore, they should address the production of knowledge when regulations need to be updated to incorporate NBS policies in the long run. There is a need for moving beyond the current governance models in place. This could better overcome sectoral and discipline isolation (silos), lack of promotion of shared knowledge, segregation of resources, and limited instruments and tools for different forms of collaboration in policy and planning. To this extent, polycentric and more flexible governance models that can be context sensitive, allow for a confluence of actors, deeper citizen relationships, learning and knowledge sharing, and power sharing such as adaptive governance (Egusquiza et al. 2019, Albert et al. 2021, Martin et al. 2021, Kauark-Fontes et al. 2023) or mosaic governance (Gulsrud et al. 2018, Buijs et al. 2019, Pauleit et al. 2019) are suggested by the literature. Lastly, policies should enable the participation of all stakeholders from the very beginning of NBS development within the policies themselves and at the very start of NBS programs and projects, with equal voices and needs.

To conclude, political interest and commitment should not be overlooked. It is important to highlight that consistent and long-term political support is not only essential for the successful integration of NBS in policies (Sarabi et al. 2020), but policies are also a means to promote political interest and commitment (Carmin et al. 2013) and should be used as such.

CONCLUSION

Nature-based solutions are increasingly emerging within cities' agendas and governance structures in the EU, but they still need to be better integrated into urban governance, particularly in plans and policies. The integration of NBS in policies has the potential to further "weave together multiple knowledge systems across and within institutions and governance processes" (Raymond et al. 2017:15). Integrating a transdisciplinary concept like NBS remains challenging, with limitations and lacunas still encountered during the process, but the conceptual framework used in the present research brings evidence of progressively initial steps in policy making toward a sustainable meaningful transition. The case studies of Barcelona, Lisbon, and Turin have demonstrated the growing opportunity for the subsequent integration, institutionalization, and development of NBS within urban governance and bring pathways on how to do so. The present research advances NBS stewardship by identifying persistent barriers to achieving NBS integration in policy and planning in the case-study cities. At the same time, it points out potential entry points for the enhancement of NBS policy development and integration. However, limitations of the research should be considered. First, a limited number of interviews were conducted. The absence of the private sector from the exercise is a major gap that limited results and insights into sector integration. Furthermore, this research brings evidence from European cities that are strongly supported by the European Union and influenced by their policies and mandates, recognized and contextualized by national policies. Although it brings important insights for NBS advancement that can be translated to a global level, additional research and case studies in other socioeconomic regions beyond Europe are desirable to gather a more diverse picture of what NBS integration in urban policies entails. The integration of the private sector and the co-production of NBS are likewise in need of further investigation, as well as additional research on how to enable a more robust participatory approach within public administration demands and NBS governance experiences in non-EU contexts.

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Data Availability:

The documents analyzed are openly available online. The data resulting from the document analysis presented in this study are available at CORDIS: https://cordis.europa.eu/project/id/867564/results - T22 Report. The data resulting from the interviews are strictly confidential and are not publicly available.

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