

An integrated process for planning, delivery, and stewardship of urban nature-based solutions: The Connecting Nature Framework

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ABSTRACT

Mainstreaming nature-based solutions in cities has grown in scale and magnitude in recent times but is still considered to be the main challenge for transitioning our cities and their communities to be more climate resilient and liveable: environmentally, economically, and socially. Furthermore, taking nature-based solutions to the next level, and scaling them out to all urban contexts to achieve a greater impact, is proving to be slow and often conflicts with other transitioning initiatives such as energy generation, mobility and transport initiatives, and infilling to combat sprawl. So, the task is neither easy nor straightforward; there are many barriers to this novel transition, especially when it comes to collaborative approaches to implementing nature-based solutions with diverse urban communities and within city authorities themselves. This paper reports on a new process that is systematically co-produced and captured as a framework for planning nature-based solutions that emerged during the Connecting Nature project. The Connecting Nature Framework is a three-stage, iterative process that involves seven key activity areas for mainstreaming nature-based solutions: technical solutions, governance, financing and business models, nature-based enterprises, co-production, reflexive monitoring, and impact assessment. The tested and applied framework is designed to address and overcome barriers to the implementation of nature-based solutions in cities via a co-created, iterative, and reflective approach. The planning process guided by the proposed framework has already yielded promising results with some of the cities of the project, though further usage and its adoption by other cities is needed to explore its potential in different contexts especially in the Global South. The paper concludes with suggestions on how this may be realised.

1. Introduction

Many papers in this and other journals, as well as large numbers of

reports, websites, and books, have outlined and discussed the potential of nature-based solutions to address societal challenges, while simultaneously creating the potential for economic, environmental, and

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economic co-benefits, especially in relation to building urban resilience [1–6]. Indeed, complex biodiverse ecosystems, including cities, can supply or even augment the ecosystem services necessary for high quality of life and the creation of sustainable and resilient environments [7,8]. In addition, researchers are beginning to examine and reveal the outcome of the interplay between biodiversity, and ecosystem services with respect to social capital networks, perceived and actual wellbeing, physical and psychological health, the transition to nature-positive economic development trajectories and productive, egalitarian and democratic livelihoods [9–14]. Based on this emerging research, as well as continuing dialogues within the urban climate resilience sector, the concept of *nature-based solutions* is viewed as being both a serious challenge for planners, architects, businesses, and urban communities [15–17]. However, it has been also viewed as a strong opportunity to assist urban communities in the transition to sustainability [18–21].

Ongoing analysis of research and practice has deepened our understanding of the potency and diversity of nature-based solutions, yet they present complex problems for those charged with implementing and mainstreaming them, especially planners, designers, managers, communities, investors and evaluators [20,22–25]. Due to their complexity and novelty, there are still many obstacles (physical, cultural, ecological, financial, legal, etc.), at all levels of city-making, to embedding these kinds of solutions into urban planning and implementation frameworks. It is true that many cities have been experimenting and testing countless site-specific or culturally specific solutions and strategies (from micro to macro scale), and these continue to be living local or case-specific examples of effective urban successful transition strategies. But how do we scale nature-based solutions upwards and outwards, from local contexts to city-wide contexts, in order to deliver on urban challenges such as climate impacts [26–28], biodiversity loss [29–31], and just transitions [16,19,32–34]? Drawing on the body of knowledge generated by and with selected cities engaged in such experimentation, this paper synthesises the work of the Connecting Nature project. This five-year research and innovation project engaged with 12 European cities to co-design and co-produce nature-based solutions with city planners, scientists, civil society organisations and small and medium-sized enterprises (SMEs). Paying specific attention to understanding the processes that gave rise to the experimentation with nature-based solutions, the Connecting Nature project co-created a novel, process-based Framework for the planning, delivery, and stewardship of nature-based solutions in cities, one that incorporates the tacit and expert knowledges of the diversity of stakeholders necessary for the co-production of nature-based solutions in cities. The aim of the Connecting Nature project was to engage cities in refining and then mainstreaming radically innovative mechanisms for climate change adaptation and greater human wellbeing through nature-based solutions in three ‘Frontrunner’ and seven ‘Fastfollower’ cities. From the outset, it was clear that the critical question that concerns those who plan and govern cities is *how* exactly to implement nature-based solutions across all urban communities, considering diverse communities and individuals while, in the process, maximising the co-benefits arising from them and dealing with the inevitable trade-offs that arise. The project has produced a wide variety of results and outputs, but this paper reports on the key foundation of the project and how it emerged. First, this paper looks at the background to challenges in cities. It continues with illustrating the context of the roll-out of nature-based solutions in the cities of the project. It then reports on and discusses the Connecting Nature Framework. It culminates in a discussion on the efficacy and potential of the Framework.

1.1. Background

Many authors have debated the definitions, evolution, and refinement of the nature-based solutions concept. Prominent amongst these papers are those that seek to clarify definitions of, and the potential for, nature-based solutions and how they fit with the ecosystem approach

and natural capital ([18,21,35,36]; e.g., [2,3,20,37,38]). This has resulted in a proposed UNEP [39] definition of nature-based solutions and the embedding of nature-based approaches into the EU Green Deal which may stimulate such initiatives for realising the ambition, such as the establishment of nature-based enterprises and nature positive financial incentives [23,40,41] and a general scaling out of the nature positive economy [13,42]. However, concerns remain in relation to the efficacy and impact of nature-based solutions for delivering on building urban climate resilience, augmenting biodiversity, and improving ecosystem services [43–46]. These laudable targets may take the combined efforts of the scores of nature-based solution research and innovation projects in Europe and elsewhere [47]¹. In addition, there is a strong impetus for a just transition to a nature-positive economy [13,19,24,48–50], with the urban citizen at the centre [51]. Therefore, much of the work of the numerous EC-funded nature-based solution projects, as well as those in other jurisdictions, involves co-creating solutions to build cohesion and fairness [52–56]¹. The Connecting Nature project was established in part to focus on this latter aspect of transitioning to an urban nature-based solution paradigm, as well as other nature-based goals such as improving biodiversity and supporting innovation and entrepreneurship. All the project challenges were formulated and researched using a co-creation, reflexive methodology, and this has given rise to a framework approach that will be described later, but first it is necessary to contextualise the specific challenges that the nature-based solution approach had brought about in cities.

1.2. Challenges for scaling nature-based solutions in cities

A key challenge for successful nature-based solution implementation relates to the complexity of dealing with trade-offs between ecosystem service outcomes that can be achieved with different planning approaches and designs of nature-based solutions [20,45]. With multiple potential benefits for both social, economic, cultural as well as ecological subsystems in cities, there will inevitably need to be scoping decisions when planning and delivering nature-based solutions [43]. For this to be effective, there needs to be a comprehensive understanding of both the needs of a locality [57] and the holistic performance of different nature-based solutions in different contexts [58,59]. A lack of standardised evidence gathering approach to the performance of a wide range of nature-based solutions remains a barrier to mainstreaming [60]. Without such knowledge, confidence of return on investment and the inclusion of nature-based solutions into broader policy and planning agendas cannot be achieved [13,21,24].

In addition, cities need to tackle many governance challenges when implementing and mainstreaming nature-based solutions [61] in a fair and just manner [62]. Facilitating governance for cross-sectoral, multi-scale and inclusive nature-based solutions can be a significant challenge to the ‘business as usual’ way of working within city governments and other organisations, that are used to working in (e.g. departmental) silos and not involving the broader public, resulting in dispersed knowledge, resources and priorities [57,63]. This means that it becomes necessary to re-think which urban governance approaches are suitable for the implementation and/or mainstreaming of nature-based solutions, including the organisational and institutional conditions such as skills, legal frameworks, resources and partnerships, to align nature-based solutions with broader social, political and business priorities and goals and facilitate collaboration [53]. Such a governance approach is the co-creation of solutions with cross-sectoral actors (as a mode of collaborative governance). The adoption of co-creation is growing worldwide bringing together diverse actors – for example, civic officials, practitioners, social innovators, scientists, entrepreneurs, and the wider citizenry [56,63,64]. However, co-creation is not a

¹ For more on this please refer to nature-based solutions repositories such as <https://networknature.eu/> and <https://oppla.eu/>.

'ready-made' and 'easy-to-implement' approach and past experiences show that, if not properly designed and implemented, it can reinforce disinterest and participation fatigue, mutual frustration, limited representation, and power imbalances [61,65,66]. The complexity of nature-based solutions further challenges the tendency of urban planning professionals and decision-makers to predefine problems and solutions, requiring more reflexive and adaptive approaches that allow an open-ended and iterative process of learning-by-doing and doing-by-learning [56]. Therefore, to address these challenges with respect to implementing nature-based solutions – ecosystem service provision, governance and equity, tacit and experiential knowledge production, and cross-sector collaboration, to name a few – it was deemed necessary to create and trial a novel process. The next section describes how this process was devised.

2. Methodology

In the Connecting Nature project, a co-creation approach was adopted and was combined with a process of reflexive monitoring [59, 67]. This was applied internally to the teams of cross-sectoral partners (which consisted of cities, small and medium-sized enterprises, and academics working in collaboration) as it was externally in the cities that were implementing it. To devise a functional and utilitarian framework, the project team adopted a 'learning-by-doing' approach based on science-practice collaboration, cross-disciplinary cooperation, and reflexivity [68–71]. This facilitated the integration of existing, and the generation of new, knowledge with a view to translate this knowledge into urban planning and policy frameworks and unlock existing barriers, as discussed earlier. A wide variety of nature-based solutions was examined in each city, and depending on their geographical location the nature-based solutions that were identified differed significantly. In practice, the project created a cross-partner 'co-creation team' (environmental and ecological sciences, business and enterprises, psychological and social sciences, and governance specialists) who worked with urban planners and managers from the three 'Frontrunner' cities: Genk (Belgium), Glasgow (United Kingdom) and Poznań (Poland). In addition, the team engaged the seven additional, or 'Fastfollower,' cities – A Coruña (Spain), Burgas (Bulgaria), Ioannina (Greece), Málaga (Spain), Nicosia (Cyprus), Pavlos Melas (Greece) and Sarajevo (Bosnia & Herzegovina) – in order to test and transfer the learning emerging from the frontrunner cities' process. Further tests were carried out in 'Multiplier' cities of Tbilisi (Georgia) and Yerevan (Armenia). There was a high diversity of the types of nature-based solutions chosen in the Frontrunner cities [72] and the Fastfollower/Multiplier cities [73]. Some commonalities included:

- living structures designed to mitigate the urban heat island effects or to attenuation of water;
- creation of urban gardens as health and wellbeing spaces for communities, children, and growing;
- rehabilitation of urban rivers from mining and toxic soils;
- developing open space strategies with co-benefits for diverse communities.

This process was designed, tested, re-designed, re-tested between 2017 and 2020 via various engagement and visioning workshops and, with the advent of COVID-19 restrictions, online discussion groups, in which cities provided cross-silo, peer-to-peer feedback and the co-creation team provided context and reflexivity. This process was constructed as a two-tiered approach that combined (1) the conceptual development of a series of Connecting Nature Framework elements, and (2) an overarching inter- and transdisciplinary integration and streamlining of, as well as reflection on, the emerging framework. Across these two dimensions, the team collaborated to translate the Framework and building blocks to the cities and learn from these applications.

3. Results

3.1. Description of development phases

Fig. 1 is a schematic overview of the Connecting Nature Framework, which is an iterative process that *revolves* around three distinct but intertwined phases of nature-based solution implementation: 'planning', 'delivery', and 'stewardship'. These three implementation phases were identified during the co-creation process as being fundamental to every city as both barriers as well as opportunities for mainstreaming nature-based solutions. For a deeper understanding of the resources that have emerged from implementing this, please refer to the accompanying supplementary information (SI1) which shows how this Framework was implemented in some Connecting Nature cities.

- 1 The **Planning** phase. Using the Connecting Nature Framework, the goals for the nature-based solution are defined, the various innovations needed to realise it are mapped out – including for example the technical design, business models, new governance models – and the activities required to implement it, for example a specific co-production process, are identified. The phase includes the following activities:
 - Develop a systemic understanding of the landscape context and ecosystem services needs of the locality.
 - Identify the key actors and stakeholders including roles, responsibilities and levels of involvement.
 - Co-define goals and impacts of the nature-based solutions, connect these to strategic goals and agendas and select indicators and baselines.
 - Formulate value propositions for the nature-based solutions, identify financing opportunities and nature-based enterprises for delivery and long-term stewardship and prepare bids, instruments and models for financing.
 - Review existing regulations and institutional conditions that influence the nature-based solutions delivery and stewardship.
 - Establish cross-departmental collaboration and public-private partnerships for joint delivery, stewardship and financing; Communicate about the goals and impacts of nature-based solutions to create awareness and support.
 - Ensure organisational space and skills for diverse elements associated with nature-based solutions' planning, delivery, and stewardship (e.g. technical design, ecology, financing, co-production, reflexive monitoring and impact assessment).
 - In this way, the planning phase is enriched with a context specific and place-based informed knowledge on 'what works' in the city for nature-based solutions.
- 2 The **Delivery** phase. The Connecting Nature Framework then graduates into the delivery phase, which is the process of implementing the nature-based solution including all its innovations – those existing through a scaling mechanism and emerging via the implementation of nature-based solutions. Again, the approach will be different in each city, but some characteristics are pervasive, including:
 - Setting in stone partnerships and collaborations and identify roles and responsibilities for joint delivery and stewardship, including financing and impact assessment.
 - Develop a hybrid governance model and co-financing mechanisms for ensuring delivery and stewardship.
 - Facilitate nature-based entrepreneurship by setting up NBE support programmes, such as upskilling, accelerators and 'hackathons'.
 - Continue to involve various stakeholders in the delivery of nature-based solutions and communicate about the story and achievements.

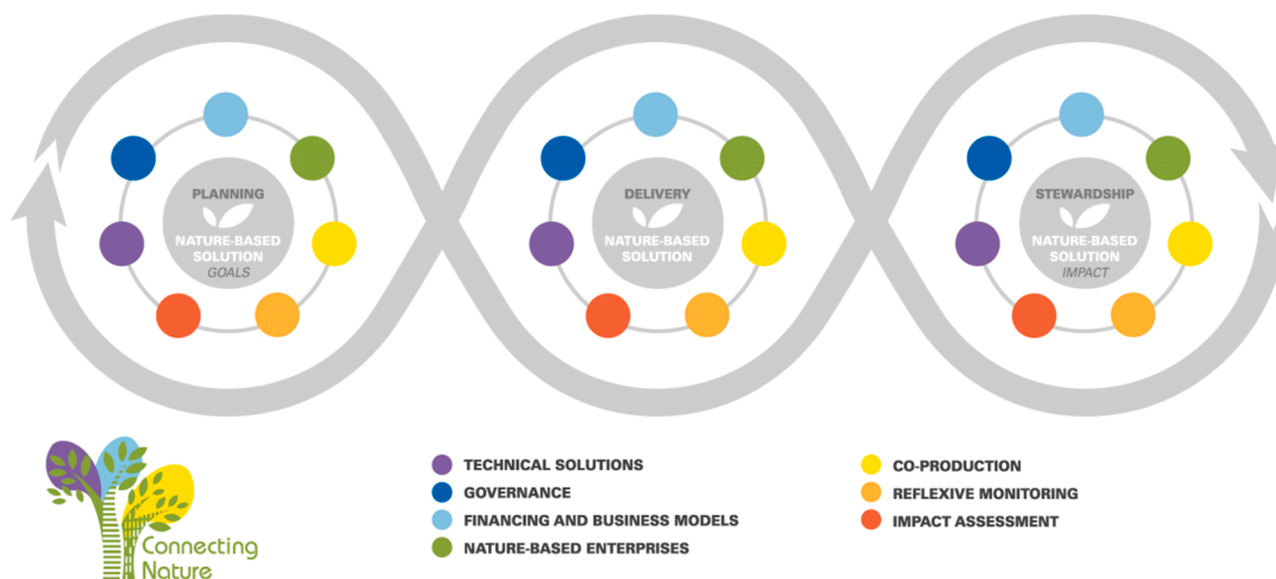


Fig. 1. The Connecting Nature Framework guides communities, city planners, managers, and policy makers through planning, delivering and stewarding nature-based solutions by highlighting seven elements at each stage of a solution's lifecycle. In effect, the Framework curates co-creation and decision-making processes in an iterative manner, and ensures continuity and delivery at each phase.

- Carry out environmental impact assessment to evaluate delivery, and put in place impact assessment plans and data collection methods for the Stewardship phase.
 - Continuously reflect on and monitor the process and impacts and adapt if needed, including indicators.
 - Implement organisational and institutional changes to facilitate nature-based solutions delivery and stewardship.
- 3 The **Stewardship** phase: The Connecting Nature Framework expects the various stakeholders to work on the ongoing participatory management and maintenance of the nature-based solution. Stewardship includes the monitoring and evaluation of the nature-based solutions, which enables adaptations to be made to ensure long-term sustainability and resilience through a variety of activities, including:
- Put in place partnerships for co-stewardship, including organisational structures with responsibility for management and operation.
 - Promote social activities (e.g. education, events), new products and services related to the nature-based solution, and nature-based enterprises.
 - Establish tactical citizen groups to become ambassadors of the nature-based solution and mediate between the city council and citizens.
 - Continuously monitor and assess the impacts of the nature-based solution and linking results to decision-making for adaptive management.
 - Identify proof-of-concept lessons, integrate design concept into existing procedures and regulations and showcase the nature-based solution as pilot for replicating and scaling.
 - Identify suitable areas, partners, roles and responsibilities for replicating and scaling.

Therefore, the Connecting Nature Framework proposes processes and mechanisms across all stages of nature-based solutions governance as provided by Wickenberg et al. [25]: strategic planning, implementation, monitoring and management while taking a multi-actor perspective at the centre. It is important to emphasise that the Connecting Nature Framework is not a static step-by-step process. While there is of course a direction of travel in terms of rolling out nature-based solutions and their co-benefits on a city scale, the steps

involved in this journey are interrelated and mutually supportive. The Framework encapsulates the many elements that need to be considered for the implementation of nature-based solutions on a large scale in cities, whereby starting points and order of steps per elements are determined by the respective cities' contexts, needs, and experience. The Framework is therefore not meant as a linear blueprint with each step leading to the next; instead, it is meant to raise questions about what are starting points and what steps are needed in a city's or community's context and needs and as thus, each step can be an entry point to the co-design and co-production of nature-based solution(s). In this sense, the Framework departs from conventional urban planning approaches that move in a linear process from planning to delivery and often do not contain the level of reflexivity and engagement implied by the Connecting Nature Framework approach. This iterative approach, where the interrelated elements can be revisited multiple times through the process of scaling of nature-based solutions, offers a more realistic representation of the complexities in such processes and is thus better able to guide cities through them.

3.2. Implementing the Connecting Nature Framework

After a critical review of published literature and an exploratory workshop process within all Connecting Nature cities [53], seven distinct elements were identified that would be vital in themselves as well as in combination for designing and implementing a large-scale nature-based solution in a city (for a more detailed report of this process please see [73,74]. These are:

- 1 *Technical solutions*: the detailed design of the nature-based solution and its features, and how they are informed by knowledge innovation through a local context as well as being tailored to it [75].
- 2 *Governance*: the process of interaction between different actors across sectors (shaped by organizational conditions and skills of those organising and participating in the process) aiming at bringing about a common vision of nature-based solutions in the city [76].
- 3 *Financing and business models*: the diverse opportunities for novel finances and business models for the delivery, long-term maintenance, and operation of the nature-based solution [77].
- 4 *Nature-based enterprises*: the stimulation of new market and business opportunities through and for nature-based solutions [23,40,77].

- 5 *Co-production*: the process of active involvement and part-taking of different actors in the planning, delivery, and stewardship of nature-based solutions [78,79].
- 6 *Reflexive monitoring*: the process of facilitated, continuous and adaptive monitoring and assessment of the whole planning process (from design to implementation) to capture lessons learned in real time and adapt the planning process [80]; and
- 7 *Impact assessment*: the set of indicators that will be used as a reference for monitoring and evaluating nature-based solutions implementation and scaling adaptable to every city context and open to inputs over time [81].

A full description of these seven elements, and examples of their implementation, can be seen in [Boxes 1–7](#).

4. Discussion

The Connecting Nature Framework is in its early days, and clearly more testing and refinement will be required. However, by encompassing multiple innovative methods, including reflexive monitoring, novel forms of co-production arts-based co-creation approaches, and

Box 1

Technical Solutions

Harnessing knowledge. Using the Connecting Nature Framework in the city of Glasgow, UK, an Open Space Strategy was created that draws on a wealth of local data and spatial analysis to identify open space in Glasgow, assess the quality of open space, and assess the needs of the local area, and use this to promote a nature-based solutions approach to its design and management. This demonstrates how the strategy and data can be used to support the development of locally contextualised nature-based solutions based on knowledge innovations to improve open space in Glasgow. To start this process, an Open Space Quality Assessment was developed and carried out on all amenity greenspace, parks, and public gardens and other open space types that can have multiple uses and are >0.3 ha across the city. This provided a foundation for understanding both the current state of open spaces and the future potential. A Geographic Information System database enabled quantification of how much open space there is in Glasgow, what is the quality of that space, and what are the local needs/challenges that could be addressed through nature-based solutions. Finally, Local Context Analyses were undertaken to show how to translate the strategic goals into operational projects within 15 areas of the city, with the aim that local communities will be embedded in developing projects at this scale. This Open Space Quality Assessment is now used by the city government as a tool for understanding the local context needs when planning optimal nature-based solutions design, delivery, and stewardship.

Multifunctional design. The Connecting Nature Framework was also used for the creation of a nature-based park in Pavlos Melas, Greece, on a former military site. The Framework revealed the site to be a place of special historical and environmental value for the city and integrates technical innovations and social innovations. Since its organisational abandonment in 2006, the ex-camp is declared as an “urban gap”: a space that lacks “the clarity of a specific use in physical and functional continuity”, while also being a place for spontaneous and informal appropriation. In addition, research on the conditions of poverty in the individual municipal units of Pavlos Melas municipality found the greatest deprivation to be concentrated in the neighbourhoods of the old residential core located in the immediate intervention pocket of the ex-camp. The Framework facilitated the project team in navigating the multiple competing demands on the site, supporting its transition into a nature-based solution. This has enabled Pavlos Melas to unlock multiple co-benefits including its potential as a valuable natural resource, historical site, and driving force for economic growth and job creation, social cohesion, and environmental sustainability.

Out-scaling. Using the Connecting Nature Framework, the city of Poznań, Poland, has successfully out-scaled and up-scaled their nature-based solution co-benefits relating to social cohesion, education, health and well-being. From a base of zero, there are currently 46 kindergartens with eco-demonstrators (e.g. insect houses, garden wooden pots/flower beds filled with compost soil for planting, live willow huts) that also include ecological education classes and 21 nature-oriented playgrounds in kindergartens. Building on this nature-based solution success story for the city, five floating gardens have also been completed in and around the Warta River. Through the Framework, Poznań identified that nature-based solution technical design out-scaling was not a copy and paste approach. Each time the concept is replicated there needs to be consideration of the local context and designs adapted to take this into account. This closely links to the co-production of nature-based solutions, which involves multiple local actors in the design and implementation as well as in the identification of financing opportunities.

Box 2

Governance

Actor networks. In Genk, Belgium, the Connecting Nature Framework was highly successful in devising a novel governance structure in the Stiemer Valley, which was a low-quality, highly neglected space left after mining ceased in the city. The Framework brought about several integrated urban projects in the Valley, involving numerous actors who had not interacted before. Specifically, by not considering the Stiemer as a specific project, but rather as a wide-ranging process, the governance model was fundamentally transformed towards a horizontal working process bridging multidisciplinary groups in sub-projects, with a clear implementation strategy for integrating across those. This resulted in a clear and integrated governance model characterised by a horizontal co-creative approach in which involvement and ownership are central principles. The structure is characterised by a working, advisory and steering body. The daily project management is carried out by city employees, who take on an equal, active roles and come from different departments as a horizontal operation. An advisory group composed of internal and external thematic experts, enriches and strengthens the project. Finally, a citizen steering committee ensures the monitoring of milestones in the project and strategic management to maximise the co-benefits.

Expert supports. In the city of A Coruña, Spain, the Connecting Nature Framework facilitated the self-management of the ecoHortas (community urban farming). This was supported by an expert trainer and facilitator of collaborative processes and teamwork who organised workshops and advised users with the objective of facilitating the provision of operation norms and the election of a management committee for each of the urban farms. At the same time, the municipality offered training in the field of organic agriculture to users of ecoHortas, with theoretical classes, practical workshops at the ecoHortas and an online platform in which users can ask their questions. In some municipal urban gardens associations of gardeners were created (“De leria na leira”) to manage the plots better (more direct contact, on the ground, with less bureaucracy).

Strategic Environmental Assessment. In Tbilisi, Georgia (one of Connecting Natures ‘multiplication’ cities), the Framework was used to exploit the fact that Strategic Environmental Assessment (SEA) are mandatory in Georgia, and thus an opportunity to specify nature-based solutions as part of the SEA for urban plans and deliver co-benefits. The Framework critically supported this process to generate knowledge about the benefits of nature-based solutions as well as catalogues of nature-based solutions. Due to the binding nature of urban plans and their SEA, the approach will sustain attention to nature-based solutions shaping citywide strategies for scaling nature-based solutions. Furthermore, the integration of nature-based solutions into land-use plans and SEAs was piloted in two cases in Georgia (Kutaisi municipality and small coastal settlement of Grigoleti), and an application is in the process for Kazbegi district/municipality and Stepantsminda township.

adapted business model canvas process for nature-based solutions, impact assessment tools, the Framework has a high potential for delivery of nature-based solutions in all contexts. The Framework was co-designed with cities to enable nature-based solution delivery at multiple levels and across diverse scales and delivering nature-based solutions at scale, cost effectively, socially-relevant, and providing co-benefits. While requiring new organisational conditions and resources, the Framework has already helped to change some urban planning practices towards more integrated, adaptive, and collaborative approaches, which has wider implications for other solutions aiming to deliver transitioning in cities [5]. This is shown in boxes I to 7, as well as in the supplementary information for this paper [PLEASE INSERT LINK TO SUPPLEMENTARY INFORMATION]. A key component of the Framework shown in the Supplementary Information is that it supported *all* Connecting Nature cities, who were facilitated in conveying their approach to mainstreaming nature-based solutions in an impactful way within the city authorities themselves, as well as to external stakeholders. In this way, they were able to create awareness, establish new collaborations, and further scale nature-based solutions and thus create linkages across the silos that are often seen as barriers to scaling out complex initiatives such as nature-based solutions. However, there are always questions that may arise.

4.1. Does the Connecting Nature Framework stand up to scientific scrutiny?

The process was initiated by a detailed analysis of the literature and intimate engagement with diverse cities. It was carefully co-created with diverse knowledge-holders and contained continual reflexivity within

Box 3 Financing and Business Models

Planning for financing of nature-based solutions is a critical element of nature-based solution implementation and includes both securing financing for capital investment as well as sustainable business models in the long-term to secure return-on-investment and stewardship. In view of increased pressure on public sector resources combined with a shift towards more collaborative governance models, there are calls to shift from primarily public sector financing to innovate financing and business models especially with a long-term view (Sekulova & Anguelovski, 2017). Against these backgrounds, key financing questions include: What is the business case for investing in nature-based solutions over other competing public sector priorities? To attract alternative sources of investment what return on investment can nature-based solutions deliver? How should return-on-investment be measured? A first step of all cities was to identify mechanisms for **long-term and collaborative financing** for a nature-based solution. To support cities for these purposes, the Connecting Nature project developed a Business Model Canvas tool (McQuaid & Fletcher, 2020), which was applied in all Connecting Nature cities as a co-production method.

In order to leverage public financing, the cities explored opportunities for **co-financing nature-based solutions with different public sector departments or agencies**. As examples:

- In A Coruña (Box 2) the cooperation between different municipal departments (urbanism, social services, education, economical promotion) was improved for joint capital investment;
- In Poznań (Box 1) the recognition of co-benefits of nature-based solutions facilitated co-financing of nature-oriented playgrounds together with the Department of Education.

The Framework assists in **preparing applications or bids for financing**, e.g. European grant financing opportunities but also financing from charities and philanthropic organisations. For example, in Pavlos Melas (Box 1), the capital expenditure costs of green infrastructure projects have been financed mainly from national funds and EU structural funds, while the respective ongoing operational costs are included in the annual budget of the municipality.

Using the Framework, several Connecting Nature cities developed **new instruments to stimulate investment in nature-based solutions** such as taxes and subsidies. Many Connecting Nature cities used the Framework to explore **hybrid public-private financing models**, building on public-private partnerships and attracting private investment especially for stewardship. Poznań (Box 1) developed a hybrid financing model for the implementation of nature-oriented playgrounds and also look into private sponsorship of nature-oriented playgrounds.

Finally, the Connecting Nature Framework revealed that it is possible to engage commercial enterprises to co-finance nature-based solutions through **linking civic budgets with corporate responsibility/sponsorship processes**.

the process. Thus, the Framework was created in as unbiased and stringent a manner as is feasible or possible in a real-world scenario. It can be argued that no process is truly dispassionate, particularly in the case of nature-based solutions where co-creation and transdisciplinarity are forging a new scientific approach. However, it is widely agreed that in order to provide the solutions element of nature-based solutions, it is necessary to adopt an applied approach where the aim is delivering on climate and other commitments whilst also building resilience and encouraging innovation. Thus the Framework has strong scientific foundation.

4.2. Does the Framework stand up to city expectations?

Again, because of the core involvement of several cities in different jurisdictions and with different cultural, social, economic, and environmental needs and goals, the Framework satisfies the city's desires for transparency, flexibility, adaptability, and future-orientated vision. Cities reported not only content, but surprise at the unexpected outcomes, such as the emergence of new innovations in knowledge gathering, co-creation, engagement, financing, and reflexivity. Inevitably, further considerations that cities may need to build into the Framework may emerge, but to date the process appears to adequately cover the necessary steps to scaling out nature-based solutions and achieving co-benefits.

4.3. Does the Framework deliver nature-based solutions?

Considering that nature-based solutions were practically unheard of

Box 4 Nature-based Enterprises

Health and well-being. The city of Burgas, Bulgaria used the Connecting Nature Framework to explore the opportunity to provide outdoor workplace in the Saint Trinity Park. This draws from the recognition that the need for a physical workplace is decreasing, because of digitalisation and underscored by the Covid-19 pandemic. At the same time, while companies look for attractive working conditions, it has been proven that spending more time outside in nature has multiple benefits for people's physical and mental health. Therefore, Burgas embeds the promotion of work, entertainment, sport, etc, in the concept for the renovation of Saint Trinity Park.

Accelerator. The city of Glasgow, UK used the Framework to develop a Nature-based Accelerator programme for early-stage nature-based ideas and enterprises that could create positive environmental, social, and/or economic change in Glasgow. The Nature-Based Accelerator was developed to stimulate local and resilient nature-based economies, creating more 'green' jobs, and helping achieve net-zero targets. Based on the success of this pilot, the city of Glasgow was able to secure funding to run a second mainstream programme.

Incubation. The city of Málaga, Spain used the Connecting Nature Framework to develop a comprehensive, incubation program for social entrepreneurs, based on IUCN Global Standard for nature-based solutions, and the principles of economic localisation, as defined by the non-profit organisation Local Futures. Activities include the identification and clustering of nature-based enterprises, providing training on nature-based solution and economic localisation and co-design projects.

Upskilling programmes. One of the barriers for the delivery of a nature-based solution exemplar in the cities of Poznań, Poland, and A Coruña, Spain, was the lack of skilled suppliers. In the city of Poznań, a training programme was developed to upskill landscape architects to deliver natural playgrounds. For this, they hired a landscape with expertise on this from Warsaw. In the city of A Coruña, a training course on urban gardening was co-developed with the employment department of the city. The aim of the course was to improve the employability of unemployed people, and therefore also included training on how to create an enterprise or find a job.

Social innovation. The Connecting Nature Framework created the Stiemerdeals programme in the city of Genk, Belgium (Box 2), who adopted an entirely novel social innovation approach for the city: a voluntary agreement between the city and other partners from across the city (other city services, citizens, organizations, companies) in relation to delivering mutually aligned ambitions associated with the Stiemer Valley. The Stiemerdeals are an effective mechanism for unlocking 'dormant' capacity but require a novel way of governing by the city team (e.g. with regards to the contact point and facilitating the network) and collaboration with the purchasing department. As thus, the Stiemerdeals also represent a new approach to collaborative governance. Through city Stiemerdeals, other actors – citizens, organisations, knowledge institutions, companies, project developers – are invited to play an active role in the development of the Stiemer Valley. Stiemerdeals are used for a social, cultural and economic upgrading of the valley.

in urban communities until very recently, it could be argued that the Framework is more like the beginning of a longer process for understanding how to mainstream and then scale-up and scale-out nature-based solutions. Early success, such as those described above, does not necessarily guarantee continued and/or long-term success. So, while the Framework is promising, it will need continual refinement as results from ongoing nature-based solutions research emerge, and as cities begin to experience the co-benefits of nature-based solutions in real time. Between 2016 and 2026 the EC will have committed over €400 m in research and innovation funding for nature-based solutions, all of which involves cities as core stakeholders, and so it can be expected that there will be considerably more knowledge and practical experiences of scaling nature-based solutions in the run up to 2026 [47]. Because the Connecting Nature Framework is open to refinement, it is necessarily flexible and able to adjust as new ideas and innovations emerge.

From the inception of the Connecting Nature project, it was evident that the most important contribution of this Framework would be to focus on three distinct elements of nature-based solutions implementation not just on delivery the phase which was the focus of discussions at the early stages of nature-based solutions discussions (e.g., [3]). This proposed Framework focusses on seven critical elements for implementing nature-based solutions in cities, elements that have been identified and discussed in much of the literature but remain elusive as actionable activities by cities seeking to implement nature-based solutions. The seven elements within the Framework emerged following a co-creation paradigm, drawing on diverse experiences and knowledges

Box 5 Co-production

Co-production is a novel form of collaborative governance, which allows for deep participation to leverage and weave together local, expert and tacit knowledge and ultimately to address complex urban problems in an inclusive way. Using the Connecting Nature Framework, cities first **set the scene for using co-production** in working on their nature-based solutions, including the identification of goals and actors to be involved. In effect, many cities employed **strategic co-production** to develop strategic agendas for nature-based solutions and connect them to broader city strategies and agendas. Strategic co-production involved mainly actors from different city departments or jurisdictions to build cross-departmental collaboration and alignment towards shared goals, while the wider public is involved through consultation processes. In others, **tactical co-production** was used to specify action agendas and build local coalitions and networks between public and private actors. Such tactical co-production has become embedded in formalised groups of engaged citizens with strong connections to the city government. Most cities employed **operational co-production** to design concrete initiatives and projects. In operational co-production, local communities are directly engaged in the co-design of the nature-based solution

Case example. The EM|Path approach was generated through the Connecting Nature Framework as a novel co-production method that supports preparing the ground for working on nature-based solutions by identifying local values, embedding the local narrative in the project, building new relationships and reconnecting with nature. The process invites creative encounters with the past, present and future, and inspires imaginative and innovative storytelling to support the design, delivery, and stewardship of nature-based solutions. The process builds on a process skeleton including methods like memory work, immersion- in-nature and embodied reflection, eco-therapy, body mapping and art map. It was first piloted in Sarajevo, Bosnia & Herzegovina as a driver for framing the intangible elements that are at the foundation of the tangible aspects of sensory gardens as nature-based solutions for cohesion co-benefits. It was then expanded in Nicosia, Cyprus, where it was employed to facilitate team building amongst the members of the Nicosia Development Agency working on the open parks network. It was expanded in A Coruña, Spain to reinforce the values underpinning their urban garden network (Box 2). The EM|Path approach was found a useful method to engage with citizens to tell their stories and to use these stories to design nature-based solutions.

as well as reviewing the literature, when the concept of nature-based solutions was still emerging and under-discussed at a city level. Thus, this Framework is not a 'finished product' *per se*, and there is a need to continue to test and refine the process, especially because the Connecting Nature Framework was applied and tested with a limited number of cities and over a limited and difficult time with respect to the COVID-19 restrictions in various jurisdictions. However, now that the potential of this Framework is yielding insights from the selected cities and is also delivering tangible outcomes for mainstreaming nature-based solutions in these cities, there is now an opportunity for the Framework to be adopted by other cities or agencies seeking to scale out nature-based solutions and validate its utility. Testing and validation will be ongoing, but dialogue fostered during the early sessions yielded insights that enabled the cities to learn from each other's experiences using the Connecting Nature Framework. This bodes well as cities often encounter the same barriers regardless of their location and size, and therefore there is now an opportunity for city councils to explore the Connecting Nature Framework and add to the experience and knowledge it generates for the benefit of other cities. Indeed, the Framework provides an effective structure for this knowledge exchange.

Most importantly, the Framework is not a panacea, but rather a guide that will need to be adapted and translated to the respective cities' contexts with a focus on reflexivity and learning. In the Connecting Nature cities, the Framework greatly assisted in tracking progress and results with a long-term perspective and helped the urban planners track all steps and considerations of the process, while identifying key learnings and integrating those in the next activities. In this way, the process may serve as a model for future implementations of nature-based solutions. It has enabled the identification of the needs for organisational capacity-building and by promoting multiple new practices, relations and rules, so the Framework application required (but also guided) the development of new organisational conditions and resources to cover expertise, time, and skills for implementing all its elements. Therefore, the Connecting Nature Framework has facilitated and

Box 6 Reflexive Monitoring

An integral part of the Connecting Nature Framework, reflexive monitoring enables systematic embedding of continuous and collaborative learning into urban policy-making, planning, and other project management practice from the start. Specifically, the reflexive monitoring methodology helps to identify (institutional) barriers that block the desired structural change of the project, and to formulate actions to address, navigate, and mobilise these. Reflexive monitoring thus becomes an instrument for learning that helps to evaluate the day-to-day activities, decisions and progress, and how these align with the long-term ambitions of the nature-based solution. Applying reflexive monitoring required all Connecting Nature cities to make space for and embed a reflexive way of working in order to integrate it into daily practice. Reflexive monitoring embodies a new way of working, which is reflexive, collaborative, and adaptive. Through the Framework, the cities highlighted that such an explicit learning process requires a considerable time effort and communication, though that nonetheless, it is worth it. Since the method was considered complex, it was important to simplify it and adapt it to the existing decision-making context.

Case example. The city of Ioannina, Greece use the Framework reflexive monitoring process via regular bi-weekly project meetings held with the participation of all the members of the city's Connecting Nature team, where the status of the project is discussed and the critical turning points are formulated. The reflexive monitor is responsible for updating the dynamic learning agenda with contributions of all the members of the team. Updates are made when a significant event happened. Since the Connecting Nature team in Ioannina consists of members from almost all departments of the municipality, all follow-up actions in the project are known to a member of different departments. One of the most important critical turning points was related to designing the key elements of the nature-based solutions in the city, which was a new park designed with multiple co-benefits in mind. The process asked its learning question "How do we determine the key design elements to include in the restoration of the park?". The follow up actions reveal all the methodology that was followed and involved internal and external meetings, city board decisions and public participation. Setting up reflexive monitoring in Ioannina was challenging due to the novelty of the process, which is quite different from the usual way of managing a project. In the beginning, every member involved in the project had to be persuaded of its value. Eventually, with more people participating, reflexive monitoring was appreciated. Through the identification of critical turning points and the formulation of learning questions, the team can be more proactive and anticipate possible problems, in contrast to the traditional way of managing a project, where a substantial amount of time is dedicated in dealing with problems after their appearance.

supported city authorities in developing new perspectives, approaches, and resources to address challenges to mainstreaming their nature-based solution exemplars. A further unexpected innovation was the development, *via* the learnings elicited through this Framework, of the Connecting Nature Enterprise Platform which emerged from a growing realisation of the need to build the capacity of the private sector at all stages of nature-based solution implementation. In essence, the Framework was generally viewed by all participating cities that nature-based solutions could *support* entrepreneurship, which is deemed to be critical for up-scaling and out-scaling nature-based solutions [13].

5. Conclusion

Encompassing multiple elements, the Connecting Nature Framework supports urban planners in creating a 360° picture of planning, delivery, and stewardship of nature-based solutions with transformative impact. The Framework offers opportunities for meaningfully engaging all stakeholders at different times in the cycle of mainstreaming a nature-based solution, and it facilitates action at any stage and with different urban context. But, how flexible to new and emerging solutions is this Framework? Because of the reflexive monitoring process cities continuously monitor and evaluate their learning questions and formulate follow-up actions. This allows them to connect the short-term actions including new and emerging solutions to the long-term goals of their nature-based solution. The iterative process allows for going back and forth between planning, delivery and stewardship based on this reflexive learning process. The Connecting Nature Framework was purposefully designed to be flexible rather than prescriptive, making it suitable for new and emerging solutions, for different user groups, and for different city contexts, policy frameworks, and political contexts. This means that,

Box 7

Impact Assessment

All Connecting Nature cities struggled with, yet appreciated, learning about how to clearly delineate the impacts of their nature-based solutions, including synergies and trade-offs between different types of impacts. Robust, flexible and cost-effective methods for their monitoring and evaluation are essential to building an evidence base for the performance of nature-based solutions to guide urban policy-making. Through the Connecting Nature Framework, the project cities each developed an impact assessment plan for their nature-based solutions. As a first step, this included the **selection of appropriate and robust indicators** to capture impacts across multiple categories. In order to select indicators, they first linked city strategic objectives to expected outcomes of their nature-based solution exemplars. This also provided opportunity to think over potential co-benefits and multiplier effects or potential trade-offs between objectives. To measure the expected results, the cities selected some of the indicators across multiple categories including environment, health and wellbeing, social cohesion, economic and participatory planning, and governance. The project cities highlighted the importance of specifying **indicators and impacts across scales and for different target groups**. After the final selection of indicators, the data collection methods were defined. This includes the identification of existing data gathering methods and possible data gaps where new data collection would be needed, as well as required technologies and software for implementation. Collaboration, especially across city departments, is an important condition for ensuring data collection and dealing with data gaps, because different departments already undertake evaluations and other actors such as from academia can further support impact monitoring.

Case example 1. As part of Glasgow City Council's work on building a baseline of health, social, economic and environmental data for impact assessment purposes, it became evident that data were not widely available between teams. In order to increase awareness of existing and newly collected data, a dashboard with graphical and mapping elements was created. This uses a customised ArcGIS Online platform of publicly-available data so that the dashboard provides a visualisation of commonly needed datasets across these topics. This has allowed non-technical colleagues to access and interrogate data that were previously out of their reach along with raising awareness of the data gaps and data quality issues present. The dashboard has raised awareness of the importance of data sharing and evidence-based decision making within the city council, thus bridging 'silos'. The Glasgow team also co-developed a tool called Co-Impact (<https://co-impact.app/>) to support their colleagues, and others, in selecting and implementing evaluation indicators.

Case example 2. The city of A Coruña, Spain used the Framework to analyse which data were available, including the source and year of the baseline, the granularity (specifying the level the baseline data refers to: street, district, neighbourhood or the entire city) and periodicity. In addition, it was indicated whether new data will be collected for the indicators. In terms of environmental indicators, it was found that the city council had a number of meteorological stations distributed around the city. One of them was relocated next to one of the urban gardens to provide very precise data like air temperature, humidity, wind. Similarly, it was found that the city council has already very accurate mathematical models to measure noise and air quality levels. The council has a lot of GIS data that is not necessarily organised in a user-friendly way, but the Connecting Nature Framework helped to identify the relevant department in order to access this data and include it in the assessment plan.

rather than a linear process that all users must go through, the Framework supports users at different stages of nature-based solution implementation and mainstreaming. Users can use all elements equally or can focus on their own perceived challenges at the three stages of nature-based solution implementation.

This paper address numerous impacts and implications for the planning, delivery, and stewardship of nature-based solutions in cities, based on a Framework developed in the Connecting Nature project.

- Environmental: the Framework delivers and impact guidelines for nature-based solutions.
- Economic: the Framework contains guidelines on novel financing and business models, nature-based enterprises, and the nature-positive economy.
- Social: the Framework contains guidelines and examples of nature-based solution governance, co-production and engagement, and reflexive monitoring for equitable and just transitioning in cities.

Declaration of Competing Interest

NA.

Data availability

No data was used for the research described in the article.

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References

- [1] Balian, E., Berhault, A., Eggermont, H., Lemaître, F., von Korff, Y. & Young, J.C. (2016) Social innovation and nature-based solutions. EKLIPSE/EPBRs/BiodivERsA Joint Foresight Workshop: Brussels, 6-7 December 2016. Workshop Report.
- [2] D. Bourguignon, Nature-Based Solutions: Concept, Opportunities and Challenges, EPRS, 2017. [https://www.europarl.europa.eu/thinktank/en/document/EPRS_BRI\(2017\)608796](https://www.europarl.europa.eu/thinktank/en/document/EPRS_BRI(2017)608796).
- [3] N. Favre, M. Fritz, T. Freitas, B. de Boissezon, S. Vandewoestijne, Nature-Based Solutions in the EU: innovating with nature to address social, economic and environmental challenges, Environ. Res. 159 (2017) 509–518, <https://doi.org/10.1016/j.envres.2017.08.032>.
- [4] C.M. Raymond, P. Berry, M. Breil, M.R. Nita, N. Kabisch, M.d. Bel, V. Enzi, N. Frantzeskaki, D. Geneletti, M. Cardinaletti, L. Lovinger, C. Basnou, A. Monteiro, H. Robrecht, G. Sgrigna, L. Munari, C. Calfapietra, An impact evaluation framework to support planning and evaluation of nature-based solutions projects. Report prepared by the EKLIPSE expert working group on nature-based solutions to promote climate resilience in urban areas, Wallingford, UK, 2017.
- [5] B. Sowińska-Świerkosz, J. García, A new evaluation framework for nature-based solutions (NBS) projects based on the application of performance questions and indicators approach, Sci. Total Environ. (2021), <https://doi.org/10.1016/j.scitotenv.2021.147615>.
- [6] B. Sowińska-Świerkosz, J. García, What are nature-based solutions (NBS)? Setting core ideas for concept clarification, Nat. Based Solut. 2 (2022), <https://doi.org/10.1016/j.nbsj.2022.100009>.
- [7] R. Aerts, O. Honnay, A. Van Nieuwenhuysse, Biodiversity and human health: mechanisms and evidence of the positive health effects of diversity in nature and green spaces, Br. Med. Bull. (2018) ldy021, <https://doi.org/10.1093/bmb/ldy021>, ldy021.
- [8] B.L. Keeler, P. Hamel, T. McPhearson, M.H. Hamann, M.L. Donahue, K.A. Meza Prado, K.K. Arkema, G.N. Bratman, K.A. Brauman, J.C. Finlay, A.D. Guerry, S. E. Hobbie, J.A. Johnson, G.K. MacDonald, R.I. McDonald, N. Neversky, S.A. Wood, Social-ecological and technological factors moderate the value of urban nature, Nat. Sustain. 2 (2019) 29–38, <https://doi.org/10.1038/s41893-018-0202-1>.
- [9] J. Babí Almenar, T. Elliot, B. Rugani, B. Philippe, T. Navarrete Gutierrez, G. Sonnemann, D. Geneletti, Nexus between nature-based solutions, ecosystem services and urban challenges, Land Use Policy 100 (2021), <https://doi.org/10.1016/j.landusepol.2020.104898>.
- [10] M.V. Balzan, G. Zulian, J. Maes, M. Borg, Assessing urban ecosystem services to prioritise nature-based solutions in a high-density urban area, Nat. Based Solut. 1 (2021), <https://doi.org/10.1016/j.nbsj.2021.100007>.
- [11] F.J. Escobedo, V. Giannico, C.Y. Jim, G. Sanesi, R. Laforteza, Urban forests, ecosystem services, green infrastructure and nature-based solutions: nexus or evolving metaphors? Urban For. Urban Green. 37 (2019) 3–12, <https://doi.org/10.1016/j.ufug.2018.02.011>.
- [12] D. Haase, Integrating ecosystem services, green infrastructure and nature-based solutions—new perspectives in sustainable urban land management. Sustainable Land Management in a European Context: A Co-Design Approach, Springer International Publishing, Cham, 2021, pp. 305–318, https://doi.org/10.1007/978-3-030-50841-8_16 (eds T. Weith, T. Barkmann, N. Gaasch, S. Rogga, C. Strauß & J. Zscheischler).
- [13] S. McQuaid, E.D. Kooijman, D. Rizzi, T. Andersson, J. Schante, The Vital Role of Nature-based Solutions in a Nature Positive Economy, Brussels, Publications Office of the European Union, 2022, <https://doi.org/10.2777/307761>.
- [14] E.E. Stange, D.N. Barton, E. Andersson, D. Haase, Comparing the implicit valuation of ecosystem services from nature-based solutions in performance-based green area

- indicators across three European cities, *Landsc. Urban Plan.* 219 (2022), <https://doi.org/10.1016/j.landurbplan.2021.104310>.
- [15] Z.J. Grabowski, T. McPhearson, S.T.A. Pickett, Transforming US urban green infrastructure planning to address equity, *Landsc. Urban Plan.* 229 (2023), <https://doi.org/10.1016/j.landurbplan.2022.104591>.
- [16] C.M. Raymond, R. Stedman, N. Frantzeskaki, The role of nature-based solutions and senses of place in enabling just city transitions, *Environ. Sci. Policy* 144 (2023) 10–19, <https://doi.org/10.1016/j.envsci.2023.02.021>.
- [17] M. Viti, R. Lowe, H.J.D. Sorup, M. Rasmussen, K. Arnbjerg-Nielsen, U.S. McKnight, Knowledge gaps and future research needs for assessing the non-market benefits of Nature-Based Solutions and Nature-Based Solution-like strategies, *Sci. Total Environ.* (2022), 156636, <https://doi.org/10.1016/j.scitotenv.2022.156636>.
- [18] EC (European Commission) (2015) Towards an EU Research and Innovation policy agenda for Nature-Based Solutions & Re-Naturing Cities. Final Report of the Horizon 2020 Expert Group on 'Nature-Based Solutions and Re-Naturing Cities'. Brussels, Publications Office of the European Union.
- [19] N. Frantzeskaki, J. Bush, Governance of nature-based solutions through intermediaries for urban transitions – a case study from Melbourne, Australia, *Urban For. Urban Green.* 64 (2021), <https://doi.org/10.1016/j.ufug.2021.127262>.
- [20] N. Frantzeskaki, T. McPhearson, M.J. Collier, D. Kendal, H. Bulkeley, A. Dumitru, C. Walsh, K. Noble, E. van Wyk, C. Ordóñez, C. Oke, L. Pintér, Nature-based solutions for urban climate change adaptation: linking science, policy, and practice communities for evidence-based decision-making, *Bioscience* 69 (2019) 455–466, <https://doi.org/10.1093/biosci/biz042>.
- [21] N. Kabisch, N. Frantzeskaki, S. Pauleit, S. Naumann, M. Davis, M. Artmann, D. Haase, S. Knapp, H. Korn, J. Stadler, K. Zaunberger, A. Bonn, Nature-based solutions to climate change mitigation and adaptation in urban areas: perspectives on indicators, knowledge gaps, barriers, and opportunities for action, *Ecol. Soc.* 21 (2016), <https://doi.org/10.5751/ES-08373-210239>.
- [22] N. Kabisch, N. Frantzeskaki, R. Hansen, Principles for urban nature-based solutions, *Ambio* (2022), <https://doi.org/10.1007/s13280-021-01685-w>.
- [23] E.D. Kooijman, S. McQuaid, M.L. Rhodes, M.J. Collier, F. Pilla, Innovating with nature: from nature-based solutions to nature-based enterprises, *Sustainability* 13 (2021), <https://doi.org/10.3390/su13031263>.
- [24] H. Toxopeus, F. Polzin, Reviewing financing barriers and strategies for urban nature-based solutions, *J. Environ. Manag.* 289 (2021), 112371, <https://doi.org/10.1016/j.jenvman.2021.112371>.
- [25] B. Wickenberg, K. McCormick, J.A. Olsson, Advancing the implementation of nature-based solutions in cities: a review of frameworks, *Environ. Sci. Policy* 125 (2021) 44–53, <https://doi.org/10.1016/j.envsci.2021.08.016>.
- [26] M.V. Balzan, D. Geneletti, M. Grace, L. De Santis, J. Tomaskinova, H. Reddington, A. Sapundzhieva, L.V. Dicks, M. Collier, Assessing nature-based solutions uptake in a Mediterranean climate: insights from the case-study of Malta, *Nat. Based Solut.* 2 (2022), <https://doi.org/10.1016/j.nbsj.2022.100029>.
- [27] C. Cortinovis, P. Olsson, N. Boke-Olén, K. Hedlund, Scaling up nature-based solutions for climate-change adaptation: potential and benefits in three European cities, *Urban For. Urban Green.* 67 (2022), <https://doi.org/10.1016/j.ufug.2021.127450>.
- [28] S. Goodwin, M. Olazabal, A.J. Castro, U. Pascual, Global mapping of urban nature-based solutions for climate change adaptation, *Nat. Sustain.* (2023), <https://doi.org/10.1038/s41893-022-01036-x>.
- [29] V. Hermoso, S.B. Carvalho, S. Giakoumi, D. Goldsborough, S. Katsanevakis, S. Leontiou, V. Markantonatou, B. Rumes, I.N. Vogiatzakis, K.L. Yates, The EU Biodiversity Strategy for 2030: opportunities and challenges on the path towards biodiversity recovery, *Environ. Sci. Policy* 127 (2022) 263–271, <https://doi.org/10.1016/j.envsci.2021.10.028>.
- [30] I. Key, A. Smith, B. Turner, A. Chausson, C. Girardin, M. MacGillivray, N. Seddon, Can Nature-Based Solutions Deliver a Win-Win for Biodiversity and Climate Change Adaptation? Preprints (2021) <https://doi.org/10.20944/preprints202110.0336.v1>.
- [31] L. Xie, H. Bulkeley, Nature-based solutions for urban biodiversity governance, *Env. Sci. Pol.* 110 (2020) 77–87, <https://doi.org/10.1016/j.envsci.2020.04.002>.
- [32] C. Davies, R. Laforteza, Transitional path to the adoption of nature-based solutions, *Land Use Policy* (2018), <https://doi.org/10.1016/j.landusepol.2018.09.020>.
- [33] J. Torrens, L. Westman, M. Wolfram, V.C. Broto, J. Barnes, M. Egermann, F. Ehnert, N. Frantzeskaki, C.F. Fratini, I. Håkansson, K. Holscher, P. Huang, R. Raven, A. Sattlegger, K. Schmidt-Thomé, E. Smeds, N. Vogel, J. Wang, T. von Wirth, Advancing urban transitions and transformations research, *Environ. Innov. Soc. Trans.* 41 (2021) 102–105, <https://doi.org/10.1016/j.eist.2021.10.026>.
- [34] I. Zwierczowska, C. Cortinovis, M. Collier, A. Mizgajski, Urban transitions towards nature-based solutions, *Urban For. Urban Green.* 74 (2022), <https://doi.org/10.1016/j.ufug.2022.127663>.
- [35] H. Eggemont, E. Balian, J.M.N. Azevedo, V. Beumer, T. Brodin, J. Claudet, B. Fady, M. Grube, H. Keune, P. Lamarque, K. Reuter, M. Smith, C. van Ham, W. Weisser, X. Le Roux, Nature-based solutions: new influence for environmental management and research in Europe, *GAIA - Ecol. Perspect. Sci. Soc.* 24 (2015) 243–248, <https://doi.org/10.14512/gaia.24.4.9>.
- [36] J. Maes, S. Jacobs, Nature-based solutions for Europe's sustainable development, *Conserv. Lett.* (2015), <https://doi.org/10.1111/conl.12216> n/a-n/a.
- [37] E. Cohen-Shacham, A. Andrade, J. Dalton, N. Dudley, M. Jones, C. Kumar, S. Maginnis, S. Maynard, C.R. Nelson, F.G. Renaud, R. Welling, G. Walters, Core principles for successfully implementing and upscaling nature-based solutions, *Environ. Sci. Policy* 98 (2019) 20–29, <https://doi.org/10.1016/j.envsci.2019.04.014>.
- [38] N. Seddon, B. Turner, P. Berry, A. Chausson, C.A.J. Girardin, Grounding nature-based climate solutions in sound biodiversity science, *Nat. Clim. Change* 9 (2019) 84–87, <https://doi.org/10.1038/s41558-019-0405-0>.
- [39] UNEP (United Nations Environment Programme). *Nature-based Solutions for Supporting Sustainable Development*. UNEP/EA.5/Res.5, United Nations, Nairobi, 2022.
- [40] S. McQuaid, E.D. Kooijman, M.-L. Rhodes, S.M. Cannon, Innovating with nature: factors influencing the success of nature-based enterprises, *Sustainability* 13 (2021), <https://doi.org/10.3390/su132212488>.
- [41] S. McQuaid, M.-L. Rhodes, T. Andersson, E. Croci, M. Feichtinger-Hofer, M. Grosjean, A.E. Lueck, E. Kooijman, B. Lucchitta, D. Rizzi, A. Reil, J. Schante. From Nature-based Solutions to the Nature-based Economy - Delivering the Green Deal For Europe. Draft White Paper for Consultation, Brussels, Publications Office of the European Union, 2021, <https://doi.org/10.5281/zenodo.5055605>.
- [42] N. Frantzeskaki, C. Oke, G. Barnett, S. Bekessy, J. Bush, J. Fitzsimons, M. Ignatieva, D. Kendal, J. Kingsley, L. Mumaw, A. Ossola, A transformative mission for prioritising nature in Australian cities, *Ambio* 51 (2022) 1433–1445, <https://doi.org/10.1007/s13280-022-01725-z>.
- [43] T. Croeser, G. Garrard, R. Sharma, A. Ossola, S. Bekessy, Choosing the right nature-based solutions to meet diverse urban challenges, *Urban For. Urban Green.* 65 (2021), <https://doi.org/10.1016/j.ufug.2021.127337>.
- [44] A. Galecka-Drozda, A. Wilkaniec, M. Szczepańska, D. Świerk, Potential nature-based solutions and greenwashing to generate green spaces: developers' claims versus reality in new housing offers, *Urban For. Urban Green.* 65 (2021), <https://doi.org/10.1016/j.ufug.2021.127345>.
- [45] C.M. Raymond, N. Frantzeskaki, N. Kabisch, P. Berry, M. Breil, M.R. Nita, D. Geneletti, C. Calfapietra, A framework for assessing and implementing the co-benefits of nature-based solutions in urban areas, *Environ. Sci. Policy* 77 (2017) 15–24, <https://doi.org/10.1016/j.envsci.2017.07.008>.
- [46] L. Tozer, K. Horschelmann, I. Anguelovski, H. Bulkeley, Y. Lazova, Whose city? Whose nature? Towards inclusive nature-based solution governance, *Cities* 107 (2020), <https://doi.org/10.1016/j.cities.2020.102892>.
- [47] M.J. Collier. Hyperlinked compendium of nature-based solutions projects 2016–2026, 2022, <https://doi.org/10.5281/zenodo.7338943>.
- [48] P. Crowe, M. Lyes, O. Murphy. *The town centre living initiative six pilot towns: synthesis report*, Space Engagers, Dublin, 2020.
- [49] N. Frantzeskaki, PhD Thesis, Delft University of Technology, The Netherlands, 2011.
- [50] L. Mabon, Nature-based solutions green economy, *The British Academy*, 26 (2021) COP Briefing.
- [51] M.J. Collier, Z. Nedović-Budić, J. Aerts, S. Connop, D. Foley, K. Foley, D. Newport, S. McQuaid, A. Slaev, P. Verburg, Transitioning to resilience and sustainability in urban communities, *Cities* 32 (2013) S21–S28, <https://doi.org/10.1016/j.cities.2013.03.010>.
- [52] M.I. DeLosRíos-White, P. Roebeling, S. Valente, I. Vaittinen, Mapping the life cycle co-creation process of nature-based solutions for urban climate change adaptation, *Resources* 9 (2020), <https://doi.org/10.3390/resources9040039>.
- [53] N. Frantzeskaki, P. Vandergert, S. Connop, K. Schipper, I. Zwierczowska, M. J. Collier, M. Lodder, Examining the policy needs for implementing nature-based solutions in cities: findings from city-wide transdisciplinary experiences in Glasgow (UK), Genk (Belgium) and Poznań (Poland), *Land Use Policy* 96 (2020), 104688, <https://doi.org/10.1016/j.landusepol.2020.104688>.
- [54] N. Kabisch, Transformation of urban brownfields through co-creation: the multi-functional Lene-Voigt Park in Leipzig as a case in point, *Urban Transf.* 1 (2019), <https://doi.org/10.1186/s42854-019-0002-6>.
- [55] J. Langemeyer, F. Baró, Nature-based solutions as nodes of green-blue infrastructure networks: a cross-scale, co-creation approach for prioritization in the Barcelona region, *Nat. Based Solut.* (2021), <https://doi.org/10.1016/j.nbsj.2021.100006>.
- [56] A.P.N. van der Jagt, M. Smith, B. Ambrose-Oji, C.C. Konijnendijk, V. Giannico, D. Haase, R. Laforteza, M. Nastran, M. Pintar, S. Zeleznikar, R. Cvejc, Co-creating urban green infrastructure connecting people and nature: a guiding framework and approach, *J. Environ. Manag.* 233 (2019) 757–767, <https://doi.org/10.1016/j.jenvman.2018.09.083>.
- [57] S. Connop, P. Vandergert, B. Eisenberg, M.J. Collier, C. Nash, J. Clough, D. Newport, Renaturing cities using a regionally-focused biodiversity-led multifunctional benefits approach to urban green infrastructure, *Environ. Sci. Policy* 62 (2016) 99–111, <https://doi.org/10.1016/j.envsci.2016.01.013>.
- [58] A. Dumitru, L. Wendling, Evaluating the Impact of Nature-Based Solutions: A Handbook For Practitioners, a, Directorate-General for Research and Innovation, 2021, <https://op.europa.eu/en/publication-detail/-/publication/d7d496b5-ad4e-11eb-9767-01aa75ed71a1#>.
- [59] A. Dumitru, L. Wendling, Evaluating the Impact of Nature-based Solutions: A Handbook For Practitioners, b, Directorate-General for Research and Innovation, 2021, <https://doi.org/10.2777/11361>. Appendix of Methods.
- [60] H. Dorst, A. van der Jagt, H. Toxopeus, L. Tozer, R. Raven, H. Runhaar, What's behind the barriers? Uncovering structural conditions working against urban nature-based solutions, *Landsc. Urban Plan.* 220 (2022), <https://doi.org/10.1016/j.landurbplan.2021.104335>.
- [61] K. Holscher, J.M. Wittmayer, F. Avelino, M. Giezen, Opening up the transition arena: an analysis of (dis)empowerment of civil society actors in transition management in cities, *Technol. Forecast. Soc. Change* 145 (2019) 176–185, <https://doi.org/10.1016/j.techfore.2017.05.004>.
- [62] M. Pineda-Pinto, N. Frantzeskaki, C.A. Nygaard, The potential of nature-based solutions to deliver ecologically just cities: lessons for research and urban planning

- from a systematic literature review, *Ambio* (2021), <https://doi.org/10.1007/s13280-021-01553-7>.
- [63] N. Frantzeskaki, Seven lessons for planning nature-based solutions in cities, *Environ. Sci. Policy* 93 (2019) 101–111, <https://doi.org/10.1016/j.envsci.2018.12.033>.
- [64] H. Mees, M. Alexander, M. Galepois, P. Matczak, H. Mees, Typologies of citizen co-production in flood risk governance, *Environ. Sci. Policy* 89 (2018) 330–339, <https://doi.org/10.1016/j.envsci.2018.08.011>.
- [65] T.A. Muñoz-Erickson, C.A. Miller, T.R. Miller, How cities think: knowledge co-production for urban sustainability and resilience, *Forests* (2017), <https://doi.org/10.3390/f8060203>.
- [66] E. Turnhout, T. Metz, C. Wyborn, N. Klenk, E. Louder, The politics of co-production: participation, power, and transformation, *Curr. Opin. Environ. Sustain.* 42 (2020) 15–21, <https://doi.org/10.1016/j.cosust.2019.11.009>.
- [67] B.V. Mierlo, B. Regeer, M.T.V. Amstel, M.N. Arkesteijn, V. Beekman, J. Bunders, T. D.C. Buning, B. Elzen, A.C. Hoes, C. Leeuwis, Reflexive monitoring in action. A guide for monitoring system innovation projects, 2010. Wageningen.
- [68] B. van Mierlo, M. Arkesteijn, C. Leeuwis, Enhancing the reflexivity of system innovation projects with system analyses, *Am. J. Eval.* 31 (2010) 143–161, <https://doi.org/10.1177/1098214010366046>.
- [69] B. van Mierlo, C. Leeuwis, R. Smits, R.K. Woolthuis, Learning towards system innovation: evaluating a systemic instrument, *Technol. Forecast. Soc. Change* 77 (2010) 318–334, <https://doi.org/10.1016/j.techfore.2009.08.004>.
- [70] J. Sol, M.M. van der Wal, P.J. Beers, A.E.J. Wals, Reframing the future: the role of reflexivity in governance networks in sustainability transitions, *Environ. Educ. Res.* 24 (2017) 1383–1405, <https://doi.org/10.1080/13504622.2017.1402171>.
- [71] B. van Mierlo, Convergent and divergent learning in photovoltaic pilot projects and subsequent niche development, *Sustain. Sci. Pract. Policy* 8 (2017) 4–18, <https://doi.org/10.1080/15487733.2012.11908092>.
- [72] P. Vandergert, M.J. Collier, S. Connop, G. Dick, A. Dzubiala, G. Gonzalez, S. Jelliman, L. Mowat, C. Nash, K. van de Sype, P. Vos, I. Zwierczowska, Connecting Nature Deliverable 9: an interim report on progress towards initiation of city-wide nature-based solutions exemplars, DG Research & Innovation, Brussels (2019), <https://doi.org/10.5281/zenodo.7458564>.
- [73] D. Xidou, E. Bakola, L. Beslagic, C.C. Garcia-Espina Adank, M.M. Gonzalez Vazquez, E. Malekkidou, M. Mavroudi, B. Pasic, A. Prieto Gonzalez, N. Suljevic, I. Trendafilov, V. Tsouris, V. Velikova, M.J. Collier, Connecting nature deliverable 14: report on the implementation of connecting nature frameworks in the fast follower cities, DG Research & Innovation, Brussels (2022), <https://doi.org/10.5281/zenodo.7340457>.
- [74] K. Hölscher, M. Lodder, K. Allaert, A. Janssen, C. van der Have, S. Asmaryan, E. Bakola, L. Beslagic, I. Boskidiş, S. Connop, G. Dick, A. Dumitru, D. Dymek, A. Dziubala, I. Fletcher, C. Garcia-Espina Adank, P. Georgiou, M.M. Gonzalez Vazquez, M. Gvilava, S. Kelly, N. Madajczyk, E. Malekkidou, M. Mavroudi, S. McCann, S. McQuaid, M. Osipiuk, B. Pasic, A. Prieto Gonzalez, M. Quartier, D. Rizzi, R. Serpezi, N. Suljevic, D. Tomé Lourido, I. Trendafilov, V. Tsouris, P. Vandergert, K. Van De Sijpe, V. Velikova, P. Vos, D. Xidou, M.J. Collier, Connecting nature deliverable 6: connecting nature framework reports for fast-follower cities, DG Research & Innovation, Brussels (2022), <https://doi.org/10.5281/zenodo.7319263>.
- [75] S. Connop, C. Nash, Technical Solutions: A Connecting Nature Guidebook, DG Research and Innovation, Brussels, 2022, <https://doi.org/10.5281/zenodo.7503898>.
- [76] P. Vandergert, K. Hölscher, S. McQuaid, Governance: A Connecting Nature Guidebook, DG Research and Innovation, Brussels, 2022, <https://doi.org/10.5281/zenodo.7504020>.
- [77] S. McQuaid, I. Fletcher, Financing and Business Models: A Connecting Nature Guidebook, DG Research and Innovation, Brussels, 2022, <https://doi.org/10.5281/zenodo.7503937>.
- [78] K. Hölscher, N. Frantzeskaki, M. Lodder, K. Allaert, I. Notermans, M.J. Collier, Co-Production: A Connecting Nature Guidebook, DG Research and Innovation, Brussels, 2022, <https://doi.org/10.5281/zenodo.7509645>.
- [79] Hölscher, K., Frantzeskaki, N., Collier, M.J., Connop, S., Dick, G., Dumitru, A., Dziubala, A., Lodder, M., Madajczyk, N., McQuaid, S., Osipiuk, A., Quartier, M., Van De Sijpe, K., Vandergert, P., Vos, P. & Xidou, D. Institutional mainstreaming nature-based solutions in urban governance in ten European cities. NPJ Urban Sustain. 2023. in press.
- [80] M. Lodder, K. Allaert, K. Hölscher, I. Notermans, N. Frantzeskaki, M.J. Collier, Reflexive Monitoring: A Connecting Nature Guidebook, DG Research & Innovation, Brussels, 2022, <https://doi.org/10.5281/zenodo.7503980>.
- [81] A. Dumitru, D. Tomé Lourido, M.J. Collier, S. Connop, G. Dick, M.L. Rhodes, R. Serpezi, C. Young, Impact Assessment: A Connecting Nature Guidebook, DG Research & Innovation, Brussels, 2022, <https://doi.org/10.5281/zenodo.7503843>.