Strategies for mainstreaming nature-based solutions in urban planning in ten European cities

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Abstract

This paper identifies and examines the strategies and governance conditions by which ten European cities have started mainstreaming nature-based solutions (NBS) as innovative systemic solutions in urban planning. The three sets of mainstreaming strategies focus on how teams of policy entrepreneurs within the cities experimented with innovative governance processes and mechanisms to strategically develop procedures, knowledge, skills, and relationships to integrate (a) a systems’ approach to link NBS to policies, regulations, and departments across goals and sectors, (b) inclusive collaborations for localised interventions, and (c) reflexivity and learning about how they interact with the (institutional, ecological, social, etc.) contexts and create impacts. The strategies demonstrate how starting from NBS as a type of systemic innovation can help promote shifts in urban planning to address complex sustainability problems in cities, and how starting points and specific processes depend on a respective city’s contexts and needs.

Introduction

Nature-based solutions (NBS) are widely advocated in global research communities and jointly with policymakers and practitioners as innovative and cost-effective measures bringing more and more diverse nature and natural features and processes into cities. Scholars have indeed evidenced the environmental, social and economic co-benefits provided by NBS to address multiple urban sustainability challenges simultaneously and build resilience. The lockdown experience during the COVID-19 pandemic has further underscored the benefits of green and open spaces for mental and physical health and wellbeing. Nonetheless, the on-the-ground implementation of NBS lags behind ambitions, often remaining limited to isolated pilots of innovation, and without attention to long-term management and maintenance.

A plethora of scientific literature has reported various institutional, organisational, and cultural barriers that city governments face when aiming to implement NBS as a principal reason for the observed implementation gap. The barriers signify a mismatch between NBS as innovative systemic solutions that require inter- and transdisciplinary collaborations and inclusive interventions, and the ‘business-as-usual’ way of working within city governments that is structured in departmental silos, follows rigid and narrow funding procedures that prioritise economic cost-effectiveness over social-ecological benefits, and does not involve the broader public. Even when city officials adopt novel governance approaches such as co-creation to support more inclusive NBS delivery, they struggle with mobilising the necessary skillsets, time, and institutional support with potentially detrimental consequences on public trust and disempowerment.

Urban policymakers, practitioners, and researchers advocate mainstreaming NBS in urban planning and policy practices. Nevertheless, what this mainstreaming will entail and how it can be realised is yet to be examined and systematically investigated. Research that identifies typologies of barriers or
provides guidelines for NBS implementation fails to contrive (how to achieve) the necessary changes in urban planning. Piloting and demonstrator projects have provided means for institutional learning about dedicated and targeted NBS mainstreaming across different geographies. Along these lines, several authors noted the importance of collaborative arrangements, including science-policy/planning-community collaborations and partnerships, when new solutions are to be integrated in urban planning, and to stimulate green jobs and enterprises. However, the barriers and implementation gaps will continue without a better understanding of strategically developing the processes, knowledge, skills, and relationships needed to move beyond individual projects.

This paper examines the strategies by which ten European cities have experimented with innovative governance approaches and have developed governance conditions to mainstream NBS in urban planning. Mainstreaming strategies target the uptake of NBS into “dominant urban governance and planning mechanisms and structures, either through their integration into existing structures or through the transformation of these structures.” The characteristics of NBS as systemic interventions provide directions for such institutional mainstreaming in terms of strengthening the capacities of urban planning to support coordination and integration across sectors and ensure the inclusion of stakeholders. Experiences with demonstrator projects highlight the procedural dimension of urban planning, including governance arrangements and approaches, as pivotal mechanisms for mainstreaming actions that develop new procedures, knowledge, skills, and relationships to reap benefits across social, political, and business priorities, and to localise and adapt NBS to specific contexts. Thus, strategies to mainstream NBS in urban planning signify investments in governance capacities by developing novel governance conditions.

The five-year research and innovation project Connecting Nature, funded by the European Union’s Horizon 2020 programme, experimented with innovative governance processes and mechanisms to enable those who plan and govern cities to implement NBS across diverse urban communities while maximising the co-benefits. A combined methodology of co-production and reflexive monitoring, led to the iterative development and application of, as well as learning about the Connecting Nature Framework: a process-based tool encompassing seven distinct activity areas that were considered vital for the planning, delivery, and stewardship of NBS in cities (Figure 1). The Connecting Nature Framework was applied in all ten cities participating in the project, building on several peer-learning activities with city planners from the respective cities (the ‘city teams’), scientists, civil society organisations, and small and medium-sized enterprises (SMEs). This was not done in a linear, step-by-step process, but rather by considering and raising questions and exploring governance approaches and processes developed for each activity area, whereby starting points and specific steps depended on a respective city’s contexts and needs. The three frontrunner cities participating in the project were Genk (Belgium), Glasgow (United Kingdom) and Poznań (Poland). The team engaged seven fast-follower cities – A Coruña (Spain), Burgas (Bulgaria), Ioannina (Greece), Málaga (Spain), Nicosia (Cyprus), Pavlos Melas (Greece) and Sarajevo (Bosnia and Herzegovina) – to test and transfer the learning emerging from the frontrunner cities’ processes.
The cities’ planning processes guided by the framework produced promising results in terms of refined and institutionalised innovative mechanisms and processes for the co-creative, integrated and reflexive implementation of NBS (Figure 1). The analysis inductively clustered and analysed all interventions and activities the city teams undertook to advance NBS planning, delivery, and stewardship concerning (i) the overarching mainstreaming strategy they contribute to, and (ii) the governance conditions mobilised or changed to deliver the strategy. Based on reflexive monitoring\textsuperscript{55,56}, the analysis was conducted throughout the project instead of ex-post. This enabled iterative discussion and exploration of insights with each city to refine and characterise them, and sharing between cities to explore transferability and exchange of best practices. The aim was to learn from specific observations in the cities and, rather than assessing or evaluating mainstreaming outcomes, identify and illustrate mainstreaming strategies and associated governance conditions.

[1] https://connectingnature.eu/

Results

strategies to mainstream NBS in urban planning

Three sets of strategies to mainstream NBS in urban planning are presented. Each set includes strategies that build on or mobilise governance conditions to invest in distinct capacities for (a) systems’ approaches to link NBS to policies, regulations, and departments across goals and sectors, (b) inclusive collaborations for localised interventions, and (c) reflexivity and learning about how they interact with the (institutional, ecological, social, etc.) contexts and create impacts. Table 1 gives an overview and examples of the set of strategies by which the cities started to mainstream NBS in urban planning through changes in rules, relations, practices and discourses (conceptualised as governance conditions) with respect to their contexts. Boxes 1-6 provide detailed examples of governance innovations piloted in the project, and how they were applied in cities to mainstream NBS. Supplementary Material A presents a detailed overview of the mainstreaming strategies and examples per city, which served as the basis for the following cross-case presentation of the results.

Table 1. Mainstreaming strategies, associated governance conditions and examples of mainstreaming activities.
<table>
<thead>
<tr>
<th><strong>Mainstreaming strategies</strong></th>
<th><strong>Governance conditions</strong></th>
<th><strong>Examples of activities and interventions</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>a) Mainstreaming a systems’ approach to nature-based solutions</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Generating systems’ knowledge about localised NBS</td>
<td>Discourse: Knowledge about local needs, landscape contexts, multiple benefits</td>
<td>Pavlos Melas: A Special Spatial Plan was prepared to determine land uses and urban planning of a former military camp area. The Special Spatial Plan included a geological suitability assessment, an environmental impact assessment, and a study of economic viability, supporting the planning decisions and approval.</td>
</tr>
<tr>
<td>Aligning NBS across policy programmes and goals</td>
<td>Rules: Cross-cutting goals and agendas that highlight co-benefits</td>
<td>Burgas: Burgas embedded the promotion of work, entertainment, sport, and health in the renovation of Saint Trinity Park. This draws from the recognition that the need for a physical workplace is decreasing and that spending more time outside in nature has multiple physical and mental health benefits.</td>
</tr>
<tr>
<td>Make NBS strategies operational and legally binding</td>
<td>Rules: Formalised roles, responsibilities, procedures</td>
<td>Glasgow: The adoption of the Glasgow Open Space Strategy (OSS) by the city council made NBS-focused open space development a key consideration for any planning activities in the city. A five-year Action Programme identifies goals, responsibilities, funding and time frames, and requirements like community engagement and improving community spaces.</td>
</tr>
<tr>
<td>Showcasing NBS as priorities for urban regeneration</td>
<td>Discourse: Localised narratives across communities</td>
<td>Poznań: A NBS catalogue was developed to raise awareness about NBS in urban planning and replicate open gardens and nature-oriented playgrounds in kindergartens. The catalogue presents concrete NBS (e.g. green/wooden/vegetal/plant-based elements and structures), how they are designed and can be used. The catalogue showcases how NBS have a long history in the city.</td>
</tr>
<tr>
<td>Working relations across sectoral policy agendas</td>
<td>Relations: (In)formal cross-departmental collaborations</td>
<td>Genk: City-wide thematic working groups, based on shared goals rather than projects, were established to facilitate discussions concerning safeguarding the masterplan's vision to redevelop the Stiemer Valley. This gave way to new working dynamics, creating direct collaborations with external partners that would previously have been managed by another department.</td>
</tr>
<tr>
<td>Integrating knowledge and skills in organisational structures</td>
<td>Practices: Dedicated positions, cross-departmental working groups</td>
<td>Poznań: ‘Green agents’ were identified across city departments to bridge across departmental siloes and facilitate collaborative working, as well as to ensure necessary skills for the replication of nature-oriented playgrounds and open gardens in kindergartens.</td>
</tr>
<tr>
<td>Embedding NBS in regulations, financing and stewardship</td>
<td>Rules: Management rules, taxes, fees, subsidies, business models</td>
<td>A Coruña: New conditions for granting a plot in an urban garden programme were created (e.g. adoption of organic agriculture) and plots were reserved for collective management by educational centres, non-profit associations and other groups to ensure long-term stewardship. Tenders were changed to make them more accessible to local SMEs.</td>
</tr>
</tbody>
</table>

**b) Mainstreaming inclusive collaboration**
| Connecting with diverse urban communities | Relations: Knowledge about multiple urban communities | Nicosia: To incentivise companies to invest in NBS in connection with Corporate Social Responsibility (CSR) strategies and reporting, the team contacted CSR Cyprus to access all large companies in the area of intervention. The city team also used the need of companies for outdoor socializing to promote engagement. |
| Supporting collaborative processes | Practices: Time, resources, skills, tools for co-production | Genk: A social innovation officer was hired with expertise in co-production. The officer's positioning in both the Department of Environment and Sustainable Development and the Social Department facilitated novel, horizontal exchanges, and collaborations. |
| Establishing informal spaces and platforms for engagement | Relations: Informal connections between actors across communities | Málaga: Málaga organised a bottom-NBS business cluster to promote NBE. The cluster has organised a hackathon on NBS in Lagunillas. The hackathon sought to increase the understanding of local climate impacts and risks, NBS for climate resilience in the local economy, and social entrepreneurship. |
| Continuous engagement and communication | Relations: Enthusiasm about and engagement with NBS | Sarajevo: The urban garden design includes educational activities and programmes for different target groups (youth, elderly, children with disabilities), including a weekly agenda for the urban garden (e.g. one day a week dedicated to urban gardening). All activities in the urban garden are followed by a journalist who promotes urban gardens on social media. |
| Formalising collaborative governance models | Rules: Formalised roles, responsibilities, working procedures | Poznań: A hybrid public-private financing model for the implementation of nature-oriented playgrounds involves an agreement with pre-schools to make their grounds available. The planning and upfront development costs are covered by different departmental and community budgets. The costs of ongoing maintenance and management are taken up by the kindergarten managers who access direct and in-kind contributions from various sources. |
| Strengthening capacities for empowerment and self-management | Practices: Training and information, contact points, space for education and community activities | A Coruña: The municipality offered training on self-management of the ecoHortas (urban gardens) and organic agriculture. This included theoretical classes, practical workshops, and an online platform. The urban gardens are available to NGOs to develop educational projects and support citizen engagement. An information point by the municipality provides information, advice, and workshops for citizens interested in urban gardening. One dedicated person from the municipality assists the gardeners. |

**c) Mainstreaming reflexivity and continuous learning**

| Supporting collaborative learning processes | Practices: Time, resources, skills, tools for reflexive monitoring & learning | Ioannina: Ioannina used reflexive monitoring via regular bi-weekly project meetings held with the participation of all the members of the project city team. The aim was to discuss the status of the project, and formulate critical turning points and follow-up actions. Since the city team consisted of members from almost all departments of the municipality, all follow-up actions were known across departments ensuring a cross-departmental collaboration and learning. |
| Identifying data needs and | Relations: Collaborations | A Coruña: The city team first analysed which data was available, and who 'owned' the data, to establish collaboration |
carriers for impact assessment to access data and knowledge for data exchange. As a part of the EidusCoruña urban sustainable development strategy a new Urban Observatory will be created to collect data on various indicators on urban sustainability.

Establishing platforms for continuous learning

**Practices:** Informal spaces for social learning

**Genk:** The Stiemer Conclave takes place every six months next to allow reflexivity and zooming out for a longer period. The conclave takes place for two days full-time to reflect on the progress of the Stiemer Programme. The agenda is determined in advance focussing on a number of fundamental aspects of the Stiemer Programme that require attention.

Embedding reflexive learning in collaborative decision-making

**Rules:** Integrating evidence and lessons-learned in planning

**Glasgow:** Glasgow employed citizen science approaches to involve citizens in the assessment of open spaces and trees across the city. The integration of the data collection and maps in the OSS supported its use across city departments and programmes, including the Development Plan, play space revitalisation, urban agriculture and water management.

### Mainstreaming a systems’ approach to NBS

A first mainstreaming strategy addresses the need to institutionalise a systems’ approach to NBS that recognises synergies and provides a reliable and consolidated framework for integrated governance across institutional siloes, priorities, and agendas. Established sectoral approaches in the cities, characterised by fragmented and narrow priorities, management responsibilities and financing frameworks, posed barriers to the prioritisation of NBS and the mobilisation of resources (across departments).

At the start, the city teams created narratives about how NBS contribute to broader social, political, and business goals and agendas for urban development to highlight co-benefits and gain support. This was crucial to linking NBS to multiple agendas, so they became recognised as a key topic when allocating limited economic resources or limited urban space – e.g., the creation of the urban garden network in Nicosia has been aligned with sustainable transport, health, and wellbeing policies by including active mobility connections through an integrated bicycle and pedestrian network. The connection to other goals and agendas also facilitated collaboration with colleagues from other city departments and private stakeholders. In Poznań, the recognition of co-benefits of NBS connected their concepts of open gardens and nature-oriented playgrounds to the Department of Education's agenda to modernise playgrounds in kindergarten, leading to co-financing.

To make these connections, the city teams needed to strategically recognise and connect the NBS demonstrator projects with ongoing policy, business, and community developments and obtain support from politicians and senior decision-makers. In every city, the mapping of NBS benefits against city strategic policy and the application of the Connecting Nature tool for the strategic alignment with the Sustainable Development Goals (SDGs) helped the cities present how their respective intended NBS demonstrators meet both local priorities and deliver on multiple global themes (Box 1). By strategically making informal relations with colleagues from other departments, the city teams were able to mobilise synergies: upon realising that one of their projects (Gardens of Waterschei) closely related to the
upgrading of the nearby trading street Stalenstraat, led by the Economic Department, the Genk team sought to develop a joint plan. Several cities successfully positioned their NBS programmes and pilot projects as high-profile flagship projects within broader climate adaptation policies, which increased political support and adoption across city departments. Glasgow used high-level initiatives such as COP26 in Glasgow and the climate emergency declaration to politically position their Open Space Strategy (OSS) and reach out to colleagues.

Moving ahead with the implementation, the cities sought to further embed NBS into existing regulatory frameworks and decision-making procedures to ensure long-term stewardship and scaling. Some cities developed their NBS strategies as legally binding documents to secure political commitment and alignment with priorities for budgetary decision-making. The Burgas Saint Trinity Park is included in the Plan for Development of Burgas Municipality 2014-2021, which makes it a priority site of the city and secure funding in the coming years. A key innovation in Glasgow was that the five-year Action Programme for the implementation of the OSS identified goals, responsibilities, funding sources and procedural requirements like (making obligatory) community engagement. Poznań has successfully replicated open gardens and nature-oriented playgrounds in kindergartens. This was achieved, in part, by developing a catalogue that illustrates (how to design), and supports capacity-building in relation to concrete options for planners, architects, teachers, and practitioners.

In some instances, existing regulations needed to be adapted, or circumvented, to either open up narrow tendering procedures or avoid specific planning rules or land ownership problems. New working relations and organisational resources were also formalised to mobilise the broad set of knowledge, skills, and collaborations needed for developing multi-functional designs, engaging local communities, and mobilising long-term financing. In Poznań, scaling-out nature-oriented playgrounds including the scaling of skills and ‘green agents’ across city departments to ensure influence beyond the immediate team. The Genk team hired a social innovation officer with expertise in co-creation and positioned them in both the Environment and Sustainable Development Department and Social Department, resulting in novel exchanges and collaborations among these departments.

Identifying multiple long-term (co-)benefits was complemented by elaborating wider value propositions of NBS for long-term and collaborative public-private financing. A Business Model Canvas (BMC) tool adapted to reflect the multiple value propositions of NBS, was developed. It was used in internal cross-departmental workshops to build recognition of strategic alignments. It was also used with external stakeholders to formulate value propositions, identify possible financing, business model, and governance mechanisms, and clarify how these will be delivered through key activities and partners (Box 2). This broadened the scope of funding applications from programmes like, in Pavlos Melas, the Integrated Territorial Investments that support projects contributing to social, economic, and spatial cohesion. It also prompted some cities to initiate new instruments and collaborations to stimulate investment in NBS such as plot fees for the users of municipal gardens or association fees for the urban...
gardens to create additional income streams in A Coruña. Another example is the ‘Adopt-a-Park’ scheme in Nicosia, a collaboration between local businesses and community groups to fund the development of 200+ small pocket parks throughout the city.

Recognising the wider value propositions of NBS resulted in alignment with economic policies and initiated new collaborations with departments and other organisations on job and enterprise creation. This resulted in Nature-Based Enterprise (NBE) support programmes, including training for the delivery of natural playgrounds with a landscape architect (Poznań), or the maintenance of urban gardens with the city’s employment department (A Coruña), and an enterprise accelerator programme with an existing social enterprise accelerator (Glasgow, Box 6).

**Mainstreaming inclusive collaboration**

Collaborative governance approaches, including diverse formal and informal, temporal or long-standing, location-specific or city-wide partnerships, and co-creative processes, respond to the need to deal with the complexity that NBS add to urban governance, as well as to engage and activate a wider range of ideas, needs and resources\(^{28,31,61}\). The cities’ approaches to NBS governance witnessed a multitude of novel collaborations across different city departments, levels of government, and between the city government and private actors. These diverse modes of collaborative governance underpinned the cities’ efforts to deliver systemic, inclusive and contextualised NBS by unlocking the necessary expertise and capabilities, breaking through silo thinking, navigating various hurdles and mobilising co-funding.

The ‘collaborative shift’ was supported through co-production as a form of collaborative governance, which included a plurality of interventions and processes in the cities to continuously collaborate with different (groups of) actors along the phases of NBS planning, delivery, and stewardship\(^{62}\). Depending on their objectives, the cities identified the target audiences and scope of individual co-production processes. For instance, strategic co-production to develop the OSS in Glasgow involved mainly actors from different city departments or jurisdictions to build cross-departmental collaboration and alignment towards shared goals, while the wider public was 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 – such as the ‘Friends of the Stiemer’ in Genk. Most cities employed operational co-production to engage local communities in designing concrete initiatives and projects. Innovative methods for co-production used included the BMC for NBS (Box 2) and the EM|Path approach\(^{63}\) (Box 3), which gave structures and tools for identifying key actors and goals, building partnerships, and developing common understanding and trust.

The collaborative governance approach is visible in formal and informal institutional spaces and the cities’ continuous engagement and communication activities to keep urban stakeholders informed and enthusiastic. Genk and A Coruña established accessible spaces where colleagues from different
departments or the wider public can continuously and informally interact with each other. The Connecting Nature Enterprise platform\textsuperscript{64} is an online marketplace connecting potential buyers with suppliers of NBS who can help to plan, and deliver NBS. Several cities expanded on the platform and created local versions: In Glasgow (Box 6) and Málaga (Table 1), a local cluster of NBEs was set up.

\textbf{INSERT BOX 3 ABOUT HERE}

Several cities have integrated collaborative governance approaches into novel governance structures that embed co-production in institutional structures, public funding, and tendering procedures. Prior to the project, in most cities, seeking collaborations across city departments and with a range of private stakeholders has been novel and faced substantial barriers due to existing planning routines and cultures, hierarchies, and disconnect between local governments and other urban stakeholders. The city teams thus needed to first create institutional space, support, resources and skills to prepare, facilitate and follow-up on collaboration. Against this background, the formalisation of co-production as a principle for the delivery of NBS and developing co-production capacity-building programmes within the city governments shows a great step forward. In Genk, the collaborative governance model pioneered by the city team has even been further adopted into other major city programmes (e.g. Energy Programme) (Box 4).

The city teams formalised established collaborations by clarifying roles, responsibilities and decision-making procedures. Overall, the city teams started to take up a more enabling role for private actors and citizens to participate in decision-making and co-stewardship. Co-stewardship that involves partners from cultural, sports, and educational sectors supports the organisation of events and initiatives. In A Coruña, municipal urban gardens associations of gardeners were created ("De leira na leira") to manage the plots better (more direct contact, on the ground, with less bureaucracy). Additionally, the urban garden is available to NGOs to develop educational projects and support citizen engagement. A main lesson was that having clear rules and a designated coordinator or coordinating team was important to keep track of the process, deal with conflicts and ensure that results would happen – a role which was mostly taken up by the planners of the city teams.

\textbf{INSERT BOX 4 ABOUT HERE}

The city teams realised that collaborative governance relied on providing support to the diverse actors and local communities, and developed capacity-building toolkits, educational projects and initiatives. In A Coruña, the self-management of the ecoHortas by its users has been supported by expert trainings on self-management and organic agriculture. Additionally, the city established an information point to provide advice, support, information and workshops for citizens interested in urban gardens. Poznań initiated the ‘NBS Academy’, an Entrepreneurship Programme to raise decision-makers' awareness and provide training on good practice for contractors and NBEs. To improve outreach and enhance inclusivity, and keep enthusiasm high, the cities organise – often together with local NGOs and artists – continuous engagement and information activities such as photo contests, exhibitions, and bike tours connected
with the NBS location. In Sarajevo, the urban garden includes educational activities and programmes for different target groups (youth, elderly, children with disabilities), including a weekly agenda for the urban garden (e.g. one day a week dedicated to urban gardening).

**Mainstreaming reflexivity and continuous learning**

The third mainstreaming strategy is about institutionalising reflexive and learning-based forms of governance that link emergent knowledge about the dynamic processes of how NBS are influenced by and influence the contexts in which they are positioned to localise and contextualise the design and (social, ecological, economic) performance of NBS\[^{28,31,65}\]. For the city teams, this meant they had to take a step away from the institutional expectation to predefine problems and solutions and act quickly – and move to a learning and reflecting mode. They needed to change how they interacted with their institutional, social, and political contexts: from controlling them and only assessing impacts on them retrospectively to reflecting and learning about the progress and direction of their NBS in real time and in relation to emerging context needs, barriers and opportunities.

By applying a method of reflexive monitoring\[^{55,56}\], the city teams were given a process tool to create institutional space away from the day-to-day policy and planning activities and demands and evaluate day-to-day activities, decisions and progress, how these aligned with long-term ambitions and what adaptations were necessary. The cities established dedicated reflexive monitoring teams with regular meetings and reflection and learning tools (Box 5). Upon embarking on reflexive monitoring, many city teams were sceptical of its value, because it was quite different from the usual way of managing a project and required considerable time and communication efforts. Eventually, as the cities became comfortable with the new approach to project evaluation and translated it to a format that suited their working approach, the method was highly appreciated and embraced. The involvement of actors from different departments and, in some cities, private stakeholder groups showcased the opportunities provided for social learning, raising broader insights, awareness, and support about barriers and follow-up actions.

The reflexive monitoring approach turned into a crucial process for the city teams to step away from their daily activities and navigate the complexities involved in NBS implementation, and thus act on opportunities and barriers for NBS mainstreaming. Through the identification of critical turning points and the formulation of learning questions, the teams could 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 to dealing with problems after their appearance. In Ioannina, one of the critical turning points was determining the key design elements in restoring an existing under-used or derelict urban park to transform them into NBS with multiple benefits. The follow-up actions identified all the process steps that needed to be followed, including multiple internal and external meetings, city board decisions, and public participation.

**INSERT BOX 5 ABOUT HERE**
Next to reflexive monitoring, the cities developed impact assessment approaches to build the necessary evidence base about the social, ecological and economic impacts of NBS and to communicate about those to gain support and guide policymaking. Applying a reflexive approach to developing impact assessment strategies changed what kind and how data was collected: more collaborative, flexible, and qualitative ways that start from systematically selecting context-specific indicators and include diverse actors in data collection and analysis. The city teams struggled with clearly delineating the impacts of their NBS and selecting appropriate indicators and data sources. The connection of city strategic objectives to expected outcomes of the NBS provided an opportunity to think over potential co-benefits and trade-offs between different types of impacts. It has been important to select indicators across multiple categories including environment, health and wellbeing, social cohesion, economic and participatory planning, and governance.

The reflexive monitoring sessions helped reveal that building collaborations and shared platforms were crucial to access existing data and embedding the learnings from reflexive monitoring and impact assessment into decision-making. By firstly analysing which data was available, the city team in A Coruña found that the city council already had a number of meteorological stations distributed around the city, which could be relocated next to one of the urban gardens to provide very precise data like air temperature, humidity, wind. Other identified indicator sources related to existing local implementation plans such as the Spanish Urban Agendas and REDS Indicators (Spanish Network for Sustainable Development). Several cities established partnerships with academia to support impact monitoring and evaluation when data was not readily available. Additionally, several cities sought to involve citizens to specify impacts for different target groups and support data collection and analysis. Glasgow has employed citizen science approaches to involve citizens in the assessment of open spaces and trees across the city (Box 6). The resulting publicly available maps provided a foundation for decision-making, building on understanding current state of open spaces/trees, future potential and impact measurement. The integration of the data collection and maps into the OSS, which has been adopted by the council, supports its further use across city departments and programmes, including the Development Plan, play space revitalisation, urban agriculture and water management.

The learning outcomes from reflexive monitoring and impact assessment exceeded the NBS implementation in scope, because they pointed to the institutional and organisational barriers the cities faced when aiming for collaborative, integrated and learning-oriented policy and planning. As such, some cities sought to set reflexive monitoring as a method for organisational learning to support regular management including identifying identified barriers. In Genk, reflexive monitoring has been institutionalised in the form of bi-monthly reflexive monitoring sessions and the bi-annual Stiemer Conclave. In A Coruña, the impact assessment approach was transferred to the development of other major programmes within the city government. As a part of the EidusCoruña urban sustainable development strategy, a new Urban Observatory will be created to collect indicators on urban sustainability. Additionally, in the Connecting Nature project, the reflexive monitoring method has also been adapted to facilitate peer-to-peer learning between the cities participating in the project by
identifying shared learning questions for NBS implementation and exchanging best practices for addressing barriers and opportunities\textsuperscript{53}.

**INSERT BOX 6 ABOUT HERE**

**Discussion**

The mainstreaming strategies demonstrate how NBS were integrated in urban planning across ten European cities by investing in and developing diverse governance conditions manifesting new capacities for the implementation of systemic, inclusive, and adaptive NBS. They specifically address policymakers and planners of city governments that continue to play key roles in implementing NBS\textsuperscript{14,17}.

In working their way through the Connecting Nature Framework\textsuperscript{54}, all cities were able to make important steps towards integrating NBS as a key city-wide urban regeneration priority across policy programmes, and establishing cross-departmental and public-private collaborations for financing, co-stewardship, and scaling, which address the need for integrative and inclusive NBS planning. The governance conditions incorported in the cities' mainstreaming strategies show that starting from NBS as a concept for systemic interventions requires, but also prompts, shifts towards more integrated, collaborative, and learning-based planning. In navigating many of the well-documented barriers\textsuperscript{17-27}, the city teams changed how problems are defined, solutions are sought and responsibilities are distributed: from narrowly pre-defining problems and solutions to be addressed by sectoral, and mainly public actors, the governance of NBS demonstrates enabled a shift towards shared responsibility in learning about and providing multiple benefits across diverse sectors and urban communities. Changes range from more intangible ones such as new narratives about regeneration and reflexive project management cultures, to more tangible one like shared physical spaces for actors to come together and institutionalised positions (e.g. GIS or social engagement officers). These changes were supported by the experimentation with novel governance practices and tools such as co-production, NBE accelerators, and reflexive monitoring. In turn, these experimentations led to the institutionalisation of new processes into organisational procedures and resources to cover expertise, time and skills and embed them in urban planning more broadly.

The results reveal how the cities adapted the innovative governance processes and mechanisms to their respective contexts. While, in comparison, the cities employed similar mainstreaming strategies across diverse urban contexts, differences related – additionally to the different involvement of frontrunner and fast-follower cities in the project – to different governance contexts (e.g. political prioritisation, level of institutional hierarchy, previous experience with co-production). Especially the frontrunner cities Genk, Glasgow, and Poznań have gone beyond isolated NBS implementation by integrating NBS and novel processes and tools (e.g. co-production, reflexive monitoring) in wider policy programmes, collaborative working structures and organisational resources. Several cities have specifically focused on formalising and supporting self-management of small-scale NBS such as urban gardens by providing incentives, capacity-building and connections. In all cities, the established collaborations extend to a range of actors and themes, such as NBEs, local communities, and academics.
The findings underscore the critical roles of policy entrepreneurs in mainstreaming NBS in urban planning\textsuperscript{14,31,58,67}. The city teams’ efforts illustrate how strategic action to build alliances and trust can develop and showcase new strategies, pilots, and practices, bridge across different agendas and networks, forge partnerships with key stakeholders and citizens, and contract necessary expertise and skills. In doing so, they were supported by Connecting Nature (e.g., funding of dedicated staff, technical design or co-production advice), which also shows how such projects may encourage governance shifts\textsuperscript{11,14}. Yet mainly, the cities’ mainstreaming efforts give witness to the team members’ motivation and openness to learn about, co-develop and trial new approaches for engaging with nature, such as EM|Path, and change their existing ways of working despite existing institutional hurdles and scepticism from colleagues. It was also these individuals who learned about the novel tools such as the BMC for NBS, co-production, and reflexive monitoring, and how to adapt them to their contexts. For instance, they stated that the increased knowledge of financing and business planning for NBS, including a better understanding of formal and informal processes around budget preparation, made them more confident in discussions with other departments and external partners to secure collaboration and financing.

In spite of, and in advancing, the mainstreaming of NBS, many barriers persisted in the cities. Hard-to-overcome barriers related in particular to those over which the city teams had little or no influence, such as opportunistic rather than consistent political support for NBS, short-term financing and procurement frameworks that emphasise costs over benefits, and insufficient organisational staffing. This underscores how the required changes of laws, organisational norms or administrative procedures would be the result of vertical mainstreaming, which relies on top-down action by executives and elected leaders\textsuperscript{68,69} and policies by (supra)national governments\textsuperscript{70}, and is thus more difficult to achieve due to lengthy and complex decision-making processes\textsuperscript{14}.

Nevertheless, several city teams achieved some remarkable progress related to vertical mainstreaming, illustrating the importance of building direct relations (especially in cities with less hierarchical structures), involving senior decision-makers and utilising high-profile events such as COP26 in Glasgow. Given the complexity of introducing NBS even as a concept\textsuperscript{29,71,72}, a main lesson learned was to communicate in a simple and appealing way, using principles of storytelling, to create new discourses around the significance of NBS and build and consolidate networks. For these purposes, the NBS catalogue in Poznań was deliberately developed to translate the complex concept into a visual language. By using existing examples of NBS from the local context, the catalogue demystified the concept and showed that it has been used throughout the city’s history.

Remarkably, in many cities, the governance conditions for more integrative, collaborative and learning-based urban planning extend beyond NBS to other priorities and programmes such as climate adaptation, energy, food, and mobility. In Genk, the Stiemer governance model has been replicated to support the city’s energy transition. Nicosia has adopted the EM|Path approach also in other urban planning projects. This highlights how NBS can be understood as a particular example of systemic innovations to address complex sustainability problems in cities, and how starting from specific systemic
interventions can help achieve planning shifts. In this understanding, transformative interventions like NBS are not “the solution’ or ‘means to an end’ but rather [...] emerging experimental processes that generate insights into desired transition pathways and the barriers to these transitions”73. In this context, reflexive monitoring crucially contributed to more adaptive approaches that are needed for systemic innovations to interact with and affect the contexts in which they operate66, and generate insights about barriers and root causes of risks (including organisational routines, power structures), failed approaches to overcoming them, and desired directions and pathways22,28,74.

**Methods**

The findings were derived based on a qualitative comparative case study of ten European cities that participated within the Connecting Nature project to scale NBS in cities. The overall research approach employed a combination of knowledge co-production and reflexive monitoring to generate and integrate existing knowledge about governance barriers, mainstreaming strategies, and institutional changes that could be directly translated in urban planning and policy.

**Case study cities**

The three frontrunner cities participating in the project were Genk (Belgium), Glasgow (United Kingdom) and Poznań (Poland). The team engaged seven additional fast-follower cities – A Coruña (Spain), Burgas (Bulgaria), Ioannina (Greece), Málaga (Spain), Nicosia (Cyprus), Pavlos Melas (Greece) and Sarajevo (Bosnia and Herzegovina) – to test and transfer the learning emerging from the frontrunner cities’ processes.

All cities focused on urban formal and informal green spaces that form the basis of green urban networks and include multiple interventions to transform them into NBS63,75. The entry points to the creation of green urban networks differed: Glasgow and Nicosia started from a strategic level building on the development of a city-wide (Glasgow) and district-level (Nicosia) strategies for networks of open green spaces to be rolled out through diverse small-scale projects. Burgas, Genk, Ioannina and Pavlos Melas focused on a particular urban area or park to be transformed into NBS through multiple interventions. The other cities started from small-scale interventions in specific areas that are to be replicated (out-scaled) across the respective cities – including open garden and nature-oriented playgrounds in kindergartens (Poznań), urban gardens for agriculture (A Coruña), urban gardens and sensory parks in schools (Sarajevo) and multifunctional urban gardens to flourish the Lagunillas neighbourhood (Málaga).

**Knowledge co-production and reflexive monitoring**
The project adopted an inter- and transdisciplinary knowledge co-production approach\textsuperscript{76,77} in combination with a process of reflexive monitoring to evaluate and adapt research and practice activities\textsuperscript{56}. Every project step and lesson has been co-defined involving city planners, scientists from different disciplines (e.g. ecology, business, psychology, governance), civil society organisations, and SMEs to facilitate peer-learning centred around the Connecting Nature Framework\textsuperscript{54} (Figure 1), and move beyond new knowledge generation to altering institutional arrangements and practices.

Between June 2017 and June 2021, diverse peer-learning activities (workshops, webinars, interviews, field visits) were undertaken to co-develop the Connecting Nature Framework and each of its constitutive elements, formulate and refine mechanisms and interventions to be undertaken in and by the city teams, and derive lessons about barriers, opportunities and institutional changes (see Supplementary B for a detailed overview of all activities per Connecting Nature Framework activity areas). The activities were different for frontrunner and fast-follower cities; the former participated earlier and more frequently and the latter were more deeply engaged during the later project phase through knowledge transfer. Monthly (later bi-monthly) reflexive monitoring sessions with each frontrunner city served to discuss their day-to-day experiences, questions, challenges and next steps, as well as to identify and reflect on learning outcomes for mainstreaming NBS across all activity areas of the Connecting Nature Framework and including corresponding scientific experts. The knowledge transfer sought to facilitate sharing of expertise and peer-to-peer support among all ten cities (and other project partners), as well as further capture learning outcomes. It included 1-to-1 learning sessions between frontrunner and fast-follower cities and knowledge hub sessions to zoom in on cross-city learning questions and objectives with all cities, and exchange on best-practices and lessons\textsuperscript{53}.

**Comparative analysis**

The comparative analysis sought to identify the strategies by which the cities have started to mainstream NBS in urban planning, including the resulting institutional changes and activities to achieve those. It built on a wealth of information and data generated and collected throughout the peer-learning activities outlined above, which were further substantiated by the reports written by each city to showcase how they have applied the Connecting Nature Framework.

The analysis proceeded in three iterative steps, for each individual city and the cross-city comparison. The steps followed an inductive research logic\textsuperscript{78,79}, i.e. it sought to learn from specific observations in the cities and, rather than assessing or evaluating mainstreaming outcomes, explore and illustrate possible mainstreaming strategies and associated governance conditions, best practices for achieving them and context-specific questions and challenges. The analysis was iterated with the cities during the above-mentioned workshops and webinar to refine and characterise the results, and promote sharing between cities to explore transferability and exchange best practices.
In a first step, all interventions and activities of the cities to advance NBS planning, delivery, and stewardship were clustered in reference to different mainstreaming strategies that they contributed to. An initial overview of mainstreaming strategies was developed from literature review, yet this was adapted based on the clustering of mainstreaming strategies evident in the cities. This resulted in the three sets of mainstreaming strategies, each including city-specific strategies to mobilise or invest in governance conditions (Supplementary Material A).

In a second step, the mainstreaming strategies were further analysed to identify the governance conditions mobilised or changed to deliver the strategy. Governance conditions refer to the more or less institutionalised working arrangements (e.g. organisational settings, rules, regulations, partnerships) that allow actors and organisations to collaborate, analyse, assess and act on information and deliver joint action in practice\textsuperscript{80,81}. The analysis of mainstreaming strategies distinguished between governance conditions in terms of: 1) rules guiding actors’ practices ( organisationally, legally, politically, symbolically), 2) relations between actors and between the initiative and context, 3) practices (common ways of working), and 4) discourses related to the future of the initiative\textsuperscript{66}.

Declarations

Data availability

The data generated and analysed during his study are described in the Supplementary Material. All publicly available data on the Connecting Nature projects and cities can be found on Zenodo: https://zenodo.org/communities/marcuscollier/?page=1&size=20.

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Author contributions

All authors contributed to developing and implementing the governance innovations reported in this paper, and to writing and reviewing the manuscript. KH analysed and interpreted the data regarding mainstreaming strategies. NF reviewed the mainstreaming literature. MC, SC, AD, IF, NF, KH, ML, SMQ, and PVG led the development of (elements of) the Connecting Nature Framework. SC and PVG led the implementation in the frontrunner cities, DX in the fast-follower cities. ML developed and led the reflective monitoring sessions in the frontrunner cities, SC, KH, SMQ, and PVG participated as scientific experts, AD, GD, KVDS, PV, AO, and MQ and as members of city teams. DX, SC, and ML co-developed and led the implementation of peer-to-peer knowledge transfer process between frontrunner cities and fast-follower cities, in collaboration with MC, SC, AD, IF, SMQ as well as all other authors. MC, NF, SMQ, AD, SC, IF and PV acquired the funding that supported this research.
Competing interests

All authors declare no financial or non-financial competing interests.

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Boxes

Boxes 1 to 6 are available in the Supplementary Files section

Figures
Figure 1

The Connecting Nature Framework guides communities, city planners, managers, and policymakers through planning, delivering, and stewarding NBS by highlighting seven activity areas (colored circles) at each stage of a solution's lifecycle. The experimentation with innovative governance approaches and processes across the activity areas manifests in three mainstreaming strategies (grey loops) (source: adapted from\textsuperscript{54}).

Supplementary Files

This is a list of supplementary files associated with this preprint. Click to download.

- SupplementaryMaterials.docx
- Box1Strategicandoperationalpolicyalignment.docx
- Box2TheNBSBusinessModelCanvas.docx
- Box3CoproductionwiththeEMPathapproach.docx
- Box4NewgovernancemodelinGenk.docx
- Box5Workingwithreflexivemonitoring.docx
- Box6PlacebasedapproachtoimpactassessmentGlasgow.docx