



nature-based urban innovation

NATURVATION

project

GREENING EUROPEAN CITIES: ACCELERATING THE UPTAKE OF URBAN NATURE-BASED SOLUTIONS

Alexander van der Jagt (UU), Helen Toxopeus (UU), Laura Tozer (DU), Hade Dorst (UU), Hens Runhaar (UU), Harriet Bulkeley (DU)

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Led by Durham University, NATURVATION involves 14 institutions across Europe working in fields as diverse as urban development, innovation studies, geography, ecology, environmental assessment and economics. Our partnership includes city governments, non-governmental organisations and business. We will assess what nature-based solutions can achieve in cities, examine how innovation is taking place, and work with communities and stakeholders to develop the knowledge and tools required to realise the potential of nature-based solutions for meeting urban sustainability goals.

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EXECUTIVE SUMMARY

This report provides a comprehensive overview of the barriers and opportunities influencing the uptake of nature-based solutions (NBS) in urban regimes, as well as the underlying factors or conditions explaining these. We understand urban regimes as being shaped by institutional structures across three broad domains: the regulatory, the urban development and the finance domains. Data was collected through interviews, desk study and placements in a total of seven cases – The Netherlands, Sweden, the United Kingdom, Spain, Germany, Hungary and the European Union. The findings show that actors in the regulatory domain such as the government and knowledge institutions often take a leadership position in advancing urban NBS uptake through actions such as providing a public mandate, facilitating co-governance of NBS, providing financial incentives and developing evidence and assessment tools. However, at the same time there is a relatively poor policy integration of NBS with other domains such as housing and mobility, constraining opportunities for NBS mainstreaming. Actors in the urban development domain experience an increase in market demand for NBS in some cities, leading to increased building of expertise in this area. However, proactive investment in urban NBS remains limited due to factors such as the lack of strict public mandate and challenges the assessment of NBS. Limited standardised evidence and indicators for NBS are also the prime reasons for why urban NBS are difficult to integrate in the investment portfolios of actors in the finance domain, which tend to operate following a high-gains, low-risk paradigm. However, an increasing number of banks, insurers and other investors are exploring the potential of investing in nature, which is fuelled by customer demand, government regulation and a desire to minimise climate-related risks to their investments. A final observation and future research opportunity is that the relevance of different actions to improve the uptake of urban NBS appears to vary across different contexts and levels of governance, depending on e.g. existing levels of community action and customer demand for urban NBS.

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Faced with multiple urgent sustainability challenges, cities are increasingly seeking ways to transform themselves in order to become carbon neutral, climate resilient and biodiversity-rich. The discourse on nature-based solutions (NBS) argues that the systemic integration of nature in cities provides a cost-effective approach to achieve this with many co-benefits. Examples of NBS include multifunctional urban parks, sustainable urban drainage systems (SuDS) and green roofs, including the innovative business models and governance approaches developed to realise these. Yet despite their promising potential, to date NBS remain marginal to mainstream urban development. In this report, we seek to understand the conditions, barriers and opportunities for accelerating the uptake of nature-based solutions in European Cities.

The uptake of urban NBS is influenced by a myriad of factors. While actions at the city level are crucial, innovations such as urban NBS are shaped by institutional structures (e.g. policy development, knowledge paradigms, dominant technologies and infrastructures) across multiple scales of governance from the local to the international. Furthermore, multifunctional interventions such as urban NBS that do not neatly fit within a single policy domain or professional discipline are structured by dynamics across the *regulatory*, *financial* and *urban development* domains of urban regimes (Table 1).

Table 1. Regulatory, financial and urban development domains of urban regimes in the NATURVATION project

	URBAN DEVELOPMENT DOMAIN	URBAN DEVELOPMENT DOMAIN	FINANCIAL DOMAIN
General description	The interests, practices, institutions and technologies of the urban development and construction industry, which is engaged in the design and provision of infrastructure and housing in cities	The interests, practices, institutions and technologies of regulatory actors involved in the governance of mainstream urban planning, as well as the wider policy paradigms and political power structures in which they are embedded	The interest, practices, institutions and technologies of organisations – notably financial players but potentially more broadly defined depending on the case, such as real estate agglomerates – involved in the provision of capital funding for investing in urban infrastructures
Function in urban infrastructure provision	Development of built environment – design, construction, maintenance, renovation, etc.	Regulation, policy-making, strategising, agenda-setting, political decision-making and planning – e.g. environmental limits, land use planning, etc.	Funding, investment, insurance – e.g. provision of loans to finance construction, cost recovery exploitation, financial risk-sharing, etc.

A key task for the NATURVATION project has been to analyse the factors in the regulatory, finance and urban development domains of urban regimes that shape the possibilities for the uptake of urban NBS. Working across seven cases - The Netherlands, Sweden, the United Kingdom (UK), Spain, Germany, Hungary and the European Union (EU) - we analysed barriers and opportunities for NBS, and the underlying factors or conditions that structure their uptake. In this report, we provide a comparative analysis across these diverse national contexts as to how factors from across the regulatory, financial and urban development domains shape the uptake of urban NBS. In each country and at the EU level we ask what are the main factors related to the uptake of NBS and what can they do to remove barriers or seize opportunities? We then turn our attention to understanding how and why the uptake of urban NBS varies across the cases in order to identify both country-specific and generic issues that explain why their uptake may be constrained and also so that we can identify key 'stepping stones' through which this can be accelerated. These are concrete actions that stakeholders can implement in order to reshape conditions, remove barriers or seize opportunities for mainstreaming urban NBS.

The report is structured as follows. Section 2 outlines our methodology. Section 3 provides an overview of the main conditions in each of the seven (country-level and EU) cases, as well as the barriers and opportunities that these conditions generate for the uptake of urban NBS. In Section 4 we discuss the extent to which regulatory, financial or urban development factors contribute to urban NBS uptake and which stepping stones might provide the most promising means to accelerate their uptake. Section 5 concludes the report with a summary of our key findings.

¹ The detailed findings corresponding to the regulatory, finance and urban development domains have been previously described in the three NATURVATION Project Reports on structural conditions for integrating NBS (regulatory/finance/urban development) that are available on the CORDIS portal of the European Commission (<https://cordis.europa.eu/project/id/730243/results>)



2. METHODOLOGY

2.1 RESEARCH STRATEGY

As set out in the Introduction, this report draws on research undertaken through a multiple case study design in which data are compared both within and between case studies. The selected cases were six European countries, Germany, Hungary, The Netherlands, Spain, Sweden, and the United Kingdom, with the EU level representing the seventh case. Each of the cases had three embedded units of analysis: the regulatory domain, the urban development domain and the finance domain.

We selected countries (+ the EU) rather than cities as cases to enable the study of how structural conditions at different scales influence urban nature-based innovation processes. The six country cases were chosen in a way to enable the study of different governance systems, e.g. those which are more or less centralised or where there are also regional levels of government, as well as where there are different traditions of governance between the public and private sectors. Moreover, from a practical perspective they represented countries with availability of local researchers within the research project mastering the language.

Selecting multiple countries enabled an exploration of the extent to which different contexts matter in terms of how structural conditions play a role in influencing urban NBS uptake. This in turn allows for the identification of areas where different countries and levels of government could potentially learn from each other. Additionally, through this approach, we can identify how structural conditions influence urban NBS uptake and which barriers or opportunities apply, independent of national context. This is important to inform sustainability action at transnational scales.

² This protocol is available on the CORDIS portal under the title 'Research Analysis Protocol: structural conditions & critical pathways', see: <https://cordis.europa.eu/project/id/730243/results>

2.2 DATA COLLECTION

A comprehensive data collection protocol was developed to guide data collection. The starting point for this protocol was the development of an analytical framework operationalising the urban infrastructure regime as a set of factors in each of the regulatory, financial and urban development domains which are likely to influence urban NBS uptake (see Appendix 1). For each of these factors, researchers analysed how they currently influence urban NBS uptake (i.e. *conditions*), the *barriers* they create, the *opportunities* that are emerging to improve their role in influencing uptake, as well as the actions that could be taken to contribute to removing barriers or seizing opportunities (Table 2). As set out in more detail below, this data was then used to derive promising openings or ‘stepping stones’ through which the mainstreaming of nature-based solutions could be accelerated.

Table 2. Reporting structure showing the structural dimensions and how these were explored in the case study analyses.

STRUCTURAL DIMENSIONS	CURRENT CONDITIONS	KEY BARRIERS AND OPPORTUNITIES	STEPPING STONES
Core mission, guiding principles and values			
Stakeholder landscape and organisational forms			
Knowledge paradigms and key expertise			
Funding structure and key resources			
Policy paradigms and key regulations			
Dominant technologies and infrastructures			
Mainstream markets and user groups			

Data was collected using a combination of methods, including semi-structured interviews, desk studies of grey literature and policy documents, participant observation in a range of events and placements at key organisations. The interviews were guided by the reporting structure in Table 2. Data collection was therefore always focused on questions around current conditions, opportunities and barriers as well as actions to achieve transformative practice regarding urban NBS uptake. The research was carried out by multiple researchers, all drawing upon the same analytical framework and who regularly met to discuss and coordinate their approaches and share their preliminary findings.

The interviews targeted key stakeholders within the regulatory, finance and urban development domains, specific to the six countries and the EU level. To this end, typologies of relevant stakeholder groups were made for the regulatory, urban development and finance domains (Table 3). Researchers sought to achieve a balanced representation of each of these domains in the study sample. In some cases the sample was skewed due to limited success in connecting to particular stakeholder groups or depending on which actors played an active role in a specific case. Interviews were held with stakeholders operating at the national level where possible. Stakeholders were identified through desk research, consulting the research consortium as well as the NATURVATION Task Force and the Urban Regional Innovation Partnerships (URIPs) active in all of the studied countries. Additional interview contacts were identified through recommendations by interviewees using the snowballing technique. There was some overlap in the types of stakeholders included across the regulatory, urban development and finance domains. For example, some government stakeholders were also interviewed by researchers of the finance domain to understand the specific role of policy and regulation on actors in this domain and nature conservation NGOs were interviewed as part of the urban development domain if these actively engaged with design and construction activities. Some interviewees corresponded to multiple of the categories in Table 3. In those cases, interview data was empirically mapped onto multiple functional domains.

Data collection took place between June 2018 and November 2019. A total of 243 actors were interviewed (Sweden: N=33; the United Kingdom: N=26; Germany: N=36; Hungary: N=38; The Netherlands: N=40; Spain: N=35; EU: N=35). These numbers cannot be further broken down to the level of the regulatory, urban development or finance domain given that the data of some interviewees was used for more than one of these, but per case, each domain analysis drew upon a minimum

Table 3. The stakeholder groups making up each of the functional domains

REGULATORY DOMAIN	URBAN DEVELOPMENT DOMAIN	FINANCIAL DOMAIN
<ul style="list-style-type: none"> • Supra-national government • National government • Sub-national government (regional, urban) • Government agencies (e.g. water dept.) • Lobby groups/Trusts/Charities • Politicians • Policy advisory organisations (e.g. knowledge institutes) 	<ul style="list-style-type: none"> • Development companies • Architects and landscape designers • Utilities • Transport infrastructure providers • Housing providers (e.g. housing corporations) • Urban development consultancies • Large landowners 	<ul style="list-style-type: none"> • Banks • (Re-)Insurance companies • Institutional and other investors • Financial consultants • Foundations • Networks of financial actors • Rating agencies

of 9 interviewees. The majority of interviews were conducted in-person and on-location in the office of the interviewee, while the remainder of interviews was done online via Zoom or Skype. Interviews were conducted in English where possible, but interviewees were offered the option to be interviewed in their native language too. Interviews typically were 1-1.5 hours in duration and audio-recorded. All interviewees were briefed about the aims of the study and provided written consent ahead of starting the interview.

For the desk study, relevant documents for each case were identified based on a national-level policy analysis done as part of this research project⁴, and suggestions made during interviews. Some documents were identified while researching background information regarding relevant conditions or opportunities mentioned during the interviews, or while searching for relevant interview contacts online. For each of the cases, we also aimed to carry out at least one placement at a key organisation, network or event influencing urban NBS uptake. Overall, we strived for a balance between placements relevant to each of three different functional domains. A total of 12 placements were carried out (Table 4). Placements served to observe day-to-day decision-making and practices that sustain existing conditions and give rise to new opportunities. They could also include activities such as a lunch lecture or hosting a focus group in order to facilitate a broad dialogue on the topic of urban NBS. The duration of a placement typically was 3-5 days, but sometimes took less time due to capacity limitations for either the host or the research team. Observations and key insights were recorded and shared in a placement reporting form (Appendix 2).

2.3 DATA ANALYSIS

2.3.1 Analysis of conditions, barriers and opportunities

The recorded interviews were transcribed and subsequently analysed using thematic analysis, taking the reporting framework (Table 2) as the basis for coding and analysis. Coding of the data and materials was done using NVIVO software or a similar tool. Data analysis was conducted separately for the regulatory, financial and urban development domains in each case study and the results were presented in 21 working papers prepared following the same template, including: a general description of the domain within the case; a methods section; a summary table following the same structure as Table 2; a narrative providing a detailed overview of the findings; and a synthesising section including critical reflection.

For this report, all working papers were studied to distil the key conditions, barriers and opportunities for improving the uptake of urban NBS. We drew upon the summary table and synthesis provided in each of the working papers to identify prominent conditions, barriers and opportunities. We prioritised the reporting of those conditions that could be linked to barriers and opportunities, as not all of the structural conditions that characterised the regulatory, urban development and

⁴ This analysis was done as part of the 'Project Report on the use of NBS by national and European agencies', which is available on the CORDIS portal, see: <https://cordis.europa.eu/project/id/730243/results>

finance domains contributed to the emergence of barriers or opportunities for urban NBS. The resulting analysis provides a rich synthesis of the relevant knowledge generated through the breadth of our research, although for reasons of space detailed information about specific examples or direct quotations from individual interviewees is not included.

Table 4. Overview of placements carried out as part of the data collection

No.	PLACEMENT ORGANISATION	DESCRIPTION	CASE	FUNCTIONAL DOMAIN(S)	PLACEMENT PERIOD	MAIN ACTIVITIES
1	City Deal "The Values of Green and Blue in the City" (<i>City Deal "De waarde van groen en blauw in de stad"</i>)	A public-private partnership to co-develop the Natural Capital Atlas (Atlas Natuurlijk Kapitaal – ANK) and TEEB city (TEEB stad) instruments to quantify and visualise the benefits of nature-based initiatives	The Netherlands	Regulatory	3 meetings: 6 Jun 2018; 21 Mar 2019; 9 May 2019	Observation, participation in discussion and workshop activities
2	Tyne Estuary Partnership	A catchment partnership, initiated by The Environment Agency and involving ca. 20 organisations, to enhance ecological and economic values of the river Tyne in Newcastle	United Kingdom	Regulatory	Various events: Jan - Jun 2019	Observation of events, meetings with organisers, informal discussions
3	IUCN European Regional Office	An international organisation that is a frontrunner in knowledge development and dissemination on nature based solutions, as well as the development of new tools and metrics.	European Union	Regulatory	19-21 Feb 2019	Delivering a talk; participation in relevant events; exchange with IUCN staff; observation of IUCN internal meeting
4	Urban Ecology Agency of Barcelona (AEUB: <i>Agencia de Ecologia Urbana de Barcelona</i>)	A public-private agency providing consultancy services to public institutions, foundations, organisations and firms on sustainable urbanism, including aspects such as mobility, energy, waste, water, biodiversity and social cohesion	Spain	Regulatory, Urban development	27-30 May 2019	Participation in staff and external meetings about current projects and adopted technologies; delivering a presentation; field visits of superblocks initiative
5	Building Agenda (<i>Bouwagenda</i>)	A 4-year program by a coalition of urban development industry professionals, setting an agenda to achieve sustainability objectives	The Netherlands	Urban development	3 meetings: 29 Oct 2018; 25 Jan 2019; 11 Apr 2019	Attendance of conferences and dedicated conference sessions organised by the <i>Bouwagenda</i>
6	Cologne Green System & Office for Landscape Management and Green Areas, Cologne municipality (<i>Grünsystem Köln & Amt für Landschaftspflege und Grünflächen, Stadt Köln</i>)	Cologne Green System is a citizen initiative to raise awareness about and lobby for the green belt system in Cologne, the 4 th biggest city in Germany. They are supported by the municipality's Office for Landscape Management and Green Areas	Germany	Urban development, Regulatory	3 Oct 2018	Participation in guided cycling tour of Cologne's green belt, followed by an interview with municipal officials and members of the <i>Grünsystem Köln</i> NGO
7	Sustainable Use of Land and Nature Based Solutions (SUL-NBS) Partnership	The SUL-NBS Partnership is the 12 th Partnership of the EU Urban Agenda involving DGs, knowledge institutions, Member States and cities interested in supporting NBS uptake	European Union	Urban development, Regulatory	Three 2-day meetings: 17-18 Jan 2019; 10-11 Jul 2019; 2-3 Oct 2019	Taking part in the discussions, development and implementation of some of the NBS Partnership Action(s) defined in the Draft Action Plan
8	White Architects (<i>White Arkitekter</i>)	An interdisciplinary firm for architecture, urban design, landscape architecture and interior design, with a commitment to sustainability	Sweden	Urban development	5 Feb 2019; 30 Apr – 2 May 2019	In-office observation and informal discussions

No.	PLACEMENT ORGANISATION	DESCRIPTION	CASE	FUNCTIONAL DOMAIN(S)	PLACEMENT PERIOD	MAIN ACTIVITIES
9	European Conference on Innovative Financing for Green Cities	This conference, organised by the H2020 project Grow Green, brought together city representatives, investors and businesses to find joint solutions for financing urban greening	United Kingdom	Finance	26-27 March 2019	Organising a conference session, delivering a talk, observing, 'catalysing' follow up action
10	The 4 th Climate Finance Day and the UN Environment Finance Initiative's (UNEP FI) biennial Global Roundtable	Two flagship events co-organised by EUROPLACE and UNEP FI aimed at mobilising the financial sector to deliver a sustainable financial system	European Union	Finance, Regulatory	26-28 Nov 2018	Participating in plenary and break-out sessions, networking with delegates and collecting printed information
11	Budapest City Planning Ltd., Nature planning office (<i>Budapest Főváros Városépítési Tervező Kft., Környezettervezési iroda</i>)	A municipality-owned organisation responsible for environmental planning	Hungary	Finance, Regulatory, Urban development	23-26 Apr 2019	Taking part in meetings and a focus group
12	Green Deal Green Roofs, later National Roof Plan	A national network set up to speed up the uptake of green roofs in The Netherlands involving green roof firms, water boards, municipalities and sector organisations / consultants. After 2019 this network was rebranded the National Roof Plan.	The Netherlands	Finance	2017 – 2020	Participating in conferences, working groups, presenting findings from NATURVATION work and receiving feedback, co-developing strategies for finance and business models for green roofs



3.1 GERMANY

3.1.1 Conditions

The *regulatory* domain in Germany is characterised by strong leadership from the national government as well as various federal states and municipalities acting as frontrunners on the topic of urban nature. We found that in the case of Germany, an expert-driven approach is combined with incentives to activate cross-disciplinary partnership working for the increased uptake of urban NBS. Different levels of government successfully integrate their policies e.g. the national government sets German Building Law, the Nature Conservation Act and principles for spatial planning for sectors, including nature conservation, which are in the national interest, while the federal states have responsibility for supralocal infrastructures and the municipalities for urban planning and development. The municipality is most directly responsible for the



Figure 1. Prinzessinnengärten in Berlin is one of the most well-known communal gardens in Germany (Photo credit: Stephanie Braconnier / Shutterstock.com)

development and protection of urban NBS. To this end, they use a combination of Landscape Plans, setting out the regulatory framework for nature development and protection, and Preparatory and Binding Land Use Plans. The Binding Land Use Plan can be a powerful instrument to enforce urban greening measures as part of new urban development projects. For example, about half of cities and towns in Germany have made green roofs a compulsory component in new urban development projects. Municipalities sometimes also prepare informal strategies, e.g. on urban green infrastructure, to guide urban development.

Other prominent actors within, or closely affiliated with, the regulatory domain include knowledge institutions (both public and independent), municipal alliances (e.g., 'Municipalities for Biodiversity'), universities, regional associations and NGOs (both at national & local level). As a result there is much expertise available, which has been used to inform the preparation of policy advice relating to NBS as well as in lobbying efforts to better preserve and further improve urban nature. Among knowledge institutions advising on urban greening policy are: the Federal Agency for Nature Conservation (BfN), the Federal Institute for Research on Building, Urban Affairs and Spatial Development (BBSR), the Federal Environment Agency (UBA), the Advisory Council on the Environment (SRU) and the German Institute of Urban Affairs (DIFU). An example of a leading regional association for urban greening is the Regional Association Ruhr (RVR), which is responsible for regional planning in the Ruhr metropolitan area along with tourism, culture, business climate, public relations, green infrastructure and regional parks. There are a number of very large nature conservation charities in Germany, among which NABU (Nature and Biodiversity Conservation Union) and BUND (German Federation for the Environment and Nature Conservation) have the highest membership, which engage in public outreach, political lobbying, 'whistleblowing' and research, including on the role of nature in urban development. Germany has a strong tradition of allotment gardening (e.g., 38,000 plots in Leipzig) and citizens are generally highly engaged with urban nature with some high-profile examples of urban greenspaces preserved from development due to civic activism (e.g. the Schöneberger Südgelände, Gleisdreieck and Tempelhofer Feld cases in Berlin).

As we have found in other countries, there is a perceived shortage of (affordable) housing in many parts of Germany due to an ongoing urbanisation trend even in cities (e.g., Leipzig) that have faced considerable population shrinkage in the second half of the 20th century. The German urban development domain comprises a mix of larger and smaller firms involved in project development, strongly influenced by municipal planning regulation as outlined in the Binding Land Use Plans, and utility providers. Although German society is known for its ambitious climate mitigation agenda ('Energiewende'), the prioritisation of sustainability in the urban development sector is relatively modest, albeit perceived as increasing, with current efforts mainly aimed at achieving higher resource efficiency and circularity. The current housing shortage has led to a rapid expansion of the urban development domain. The DGNB certification scheme for sustainable buildings is dominant in Germany, although LEED and BREEAM are also in use. German homebuyers tend to prefer living in detached homes; price, location and dwelling type are still often more important considerations than sustainability performance in home buying decisions.

Aside from the role of different levels of government in funding urban NBS through subsidies, grants and capital investment, the banking and insurance sectors are important pillars of the German finance domain. There are three broad groups of banks: private credit banks (mainly regionally operating), public sector banks and cooperative banks. The financial products (e.g., loans) offered by public sector banks such as KfW at the national level, and the development banks at the level of federal states (e.g. 'Investitionsbank Berlin' - IBB) are influenced by political priorities. They support investments that help deliver government policy (e.g. regarding housing, sustainable energy or infrastructures). The insurance sector has a more international orientation with big players such as Munich Re and Allianz, some of which are actively integrating sustainable development in their corporate strategies. Although this is contributing to more sustainable investment, the majority of private investors still prefer to invest based on high returns in short timeframes, which is not supportive of NBS development. Germany

⁵ GLA (2008), Living Roofs and Walls, Technical Report: Supporting London Plan Policy, Greater London Authority, London. Available from: <https://www.london.gov.uk/sites/default/files/living-roofs.pdf>

hosts a number of sustainable finance networks, aiming to get the German financial sector up to speed with respect to sustainable finance. Furthermore, urban nature / biodiversity regulation at city or state-level requires 'no net loss', which generates funds from developments to replace lost urban nature elsewhere in the city.

3.1.2 Barriers and opportunities

An opportunity to mainstream urban NBS is emerging at the national government level through a combination of mainly financial and voluntary instruments. Particularly the recent development of authoritative guides and knowledge repositories for urban greening is noteworthy. Federal government and agencies have: (co-)developed the White Paper 'Green Spaces in the City' (2018); provided a detailed action plan for the national government, the Green Paper 'Urban Green Spaces' (2015); and supported the creation of state-of-the-art in knowledge on the values of urban nature, through The Federal Green Infrastructure Concept (2017), the Urban Green Infrastructure Guide for Municipal Practice (2017) and the TEEB report 'Ecosystem Services in the City' (2017). The German National Strategy on Biodiversity (2007) and the 2011 Climate Protection Amendment of the German Climate Change Adaptation Strategy also highlight the need to increase urban greenspace. The National Climate Action Plan 2050 describes the strategy to meeting the goal of becoming carbon neutral by 2050, but renaturing cities is not clearly highlighted as playing a role in this. Both a barrier and an opportunity to urban NBS is that the German Building Law prioritises urban densification over urban expansion, potentially reducing the amount of greenspace within the city perimeter. No compensatory measures are required to mitigate any such losses, but municipalities have the option to include these in their Binding Land Use plans.⁵ The term 'dual inner development' is used by government to highlight the need for both urban densification and urban greening; BfN has produced a guide showing how to resolve conflicts and which planning principles can be applied to achieve this. However, planning is largely decentralised and not all municipalities have adopted this principle; stricter regulation and better enforcement were perceived as important opportunities for enhanced uptake of urban NBS.

Silos between different departments and sectors are perceived as a barrier to NBS uptake. The value of bridging departmental boundaries is demonstrated at the national level, where the Federal Ministry responsible for the natural environment merged with the Federal Ministry responsible for development, creating the Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety (BMUB), for a four-year period until March 2018. It is no coincidence that this was also the time when e.g. the Green and White Papers on urban green space were published. National government and several federal states are also providing grant-based funding to support more transdisciplinary working on sustainable urban development. This is important given that municipal budgets have been squeezed since the economic crisis, particularly affecting green space maintenance. As part of the Urban Development Funding ('Städtebauförderung') framework, the BMUB introduced a new funding stream 'Future Urban Greenspace', specifically for integrated urban greening measures that help regenerate socio-economically disadvantaged areas. Other funding streams in this framework (e.g. Social City) can also be used toward funding urban greening delivering co-benefits. Up until 2016, the Federal Biodiversity Programme supported cities in developing urban wilderness projects and the conversion of grey to green spaces. An example of a federal state fund, drawing upon EU funding, is the 2014-2020 ERDF Green Infrastructure Fund provided by North Rhine-Westphalia targeting municipalities and planning agencies to develop proposals for holistic and multifunctional green infrastructure.

Experimenting with new policies to protect and/or support urban NBS represent important opportunities as well. For example, Berlin has mandated the use of the Biotope Area Factor (similar to the Green Space Factor described for Sweden and UK) for development proposals in densely developed districts. The Binding Land Use Plan also provides a powerful tool to mandate the installation of green roofs in new urban development, while cities like Hamburg and Munich also have green roof subsidies. NABU is lobbying politicians to transform the property tax system to help protect urban greenspace and

⁵ There is normally a need for offsetting environmental loss as a result of urban development on greenfields under Impact Mitigation Regulation (IMR). A negative development for urban nature at the time of data collection is that the requirement to conduct a Strategic Environmental Assessment for development proposals on greenfields in the urban periphery, used as a basis for determining compensatory measures for the loss of nature, had been temporarily lifted under §13b of the Building Code in order to accelerate housing development.

encourage sustainability innovation. Their proposal is to tax land value rather than property value. This would disincentivise land speculation, while simultaneously taking away the tax penalty for sustainable investments such as green roofs and solar panels that increase property value. Finally, there is scope for increased engagement of the private sector and civil society. Innovative governance models, such as green barter where public and private actors (e.g. in retail) together fund public green spaces for the beautification of a district or town, or community management of public parks (e.g., Bürgerpark in Bremen), provide potential in this regard. Private sector engagement would also likely benefit from the development of tools for urban ecosystem service assessments, although these do not account for the softer social values of nature, particularly important in cities. Furthermore, different communication formats and media should be considered for increasing environmental awareness (e.g. video clips rather than brochures). This could be aided through strategic collaboration with associations such as The Green City (Die Grüne Stadt), representing the landscaping and plant nursery industries, that have specialised in communication on urban nature with the general public, large businesses and politicians.

For the *urban development* domain, many of the same barriers apply as to the regulatory domain, particularly the existence of internal silos and the lack of reliable information on the cost effectiveness of urban NBS. The issue of a fragmented approach to planning and construction combined with a short-term value-capture orientation by most actors in the value chain comes at the expense of sustainability measures, particularly if the client does not show a clear preference for these. Nevertheless, the green roof sector is expanding, but most people still consider green roofs to be an expensive luxury product and so these are not routinely implemented in affordable housing projects. The BIM (Building Information Modelling) tool is a promising development to help address this issue as it provides a lifecycle assessment of a building and improves coordination of activities by different parties (e.g. architects or development companies) along the value chain. It also allows for optimising building design (e.g. interaction with sunlight). An alternative is investing in pilot projects for urban NBS that bring together actors from multiple domains (public, private, civic) and sectors, such as was done by the water board in the Ruhr area ahead of developing the large-scale Emscher Landscape Park. While the costs of NBS are perceived as high, the benefits are unclear and distributed among different groups of actors (e.g. urban heat island mitigation), which makes clients often unwilling to invest in these without the co-investment of others. In addition to improved assessment tools (see above) and knowledge sharing (e.g. green roof guides for builders, owners and tenants), this calls for new business models and co-investment, such as tax incentives or semi-public greenspaces on private property. Market demand could also be fuelled by integrating NBS in sustainable building certification. For example, the federal republic has pledged to review their Assessment System for Sustainable Building (BNB), which they apply to their own buildings, for scope to include indicators for the use of NBS.

The general impression by actors in the *finance domain* is that Germany is lagging behind regarding the uptake of sustainable finance, which limits current contributions to NBS development. Several large (re-)insurance companies form an exception to this rule. Aside from supporting sustainable investment they also collect (worldwide) data regarding the climate risk to their investment portfolios, some of which is available to the business sector (e.g. the NATHAN portal by Munich Re), but none of this is clearly positively contributing to urban NBS yet. An interesting development is that some insurance companies have been approached by The Nature Conservancy and other NGOs to develop insurance products for natural assets (e.g. coral reefs), and there could be an opening to expand this to urban nature as well if investment portfolios could be co-developed with city administrations. There are several initiatives to improve sustainable finance in this domain, mainly around setting up new networks to improve knowledge exchange and advice. Amongst these are the 'Hub for Sustainable Finance' set up by the federal Council for Sustainable Development, FNG (a network active in the German-speaking countries for sustainable investment) and the Green and Sustainable Finance Cluster Germany. Germany also has a network for ethical investment, popular among churches, called CRIC, which could be particularly relevant to urban NBS as they are also important landowners. Such networks also contribute with new accreditation schemes and metrics; for example, FNG created a label for sustainable investment and a transparency index for investment funds, the 'Transparency Codex'.

3.2 HUNGARY

3.2.1 Conditions

The *regulatory* domain comprises multiple layers: national government, regions, counties (excl. Budapest), districts and municipalities. As Hungary's capital, Budapest remains independent of any county and is further divided into 23 districts, each with their own administration. Most relevant in terms of their influence over the uptake of sustainable development and urban NBS are the national government and municipalities. The European Union is an important funding partner in the areas of nature conservation, wastewater treatment and sustainability innovation through structural funds and targeted funding programmes (e.g. LIFE, Horizon 2020). The national government sets the national development strategy (National Development and Territorial Development Concept), the building code, the climate change strategy (Hungarian National Climate Change Strategy 2008-2025), the biodiversity strategy (National Strategy for the Conservation of Biodiversity) and provides core funding to municipalities. Taking into account the vision of the national-level strategy, counties prepare regional development concepts and spatial plans. The municipalities are responsible for urban land use planning and local building codes within the strategic direction set by higher levels of government. For the city of Budapest this responsibility is further devolved to the city district level. However, the management of large public parks, some tree-lined streets, and other public spaces with e.g. high heritage value remains the responsibility of Budapest municipality. Sustainability is one of the national government priorities, which it mainly seeks to advance through technological innovations with limited integration of urban nature. The impression held by stakeholders is that the natural environment is not really a priority for the national government has been reinforced by discontinuing the Environment ministry, whose responsibilities were split up and allocated to several other ministries, including the Ministry of Rural Development, the Prime Minister's Office, Interior Ministry, and the Ministry of National Economy. At the city level, the non-binding Structural Plan and the Regulatory Plan (a binding land use plan) combined with the Local Building Code are important for urban development. Urban nature reserves and street trees are well-protected in planning regulation, while other types of public greenspaces (e.g. parks) are not.



Figure 2. Ersebet Park in Budapest (photo credit: Photo Oz / Shutterstock.com)

Only a small number of civil society organisations and knowledge institutions have direct links with Ministries. Most relevant amongst these regarding the topic of urban nature is the Lechner Knowledge Centre, a knowledge institution under the Prime Minister's Office that is advising the government on architecture policy. There is also a National Council for Sustainable Development with members from different parts of Hungarian society and economy (NGOs, academia, faith communities, trade unions, civil society, etc.). There are a number of professional bodies and non-profit organisations engaged in conducting research, professional training and/or advocating for better integration of urban nature in urban planning. These include the Hungarian Urban Knowledge Centre (under the Hungarian Association of Urban Planners), the Green Roof and Green Wall Association, the Green City Association (representing the landscaping and horticulture sectors), and the Hungarian Green Building Council (representing the urban design and construction domain). The Clean Air Group and other sustainability-focused NGOs may have a more indirect influence. In Budapest, Fökert acts as the main (non-profit &

public owned) company responsible for managing green spaces on behalf of Budapest municipality, while also supporting innovation and knowledge exchange. Citizen participation and activism regarding urban nature is not very high in Hungary in comparative terms, although a number of citizen-led urban greening projects (e.g. community gardens) have emerged in recent years.

The urban development domain is dominated by a small number of powerful civil engineering firms with close ties to the national government. Engineers and architects are dominant professions in this domain, whereas landscape architects are less prominent. Smaller consultancy firms (e.g. ABUD) are often involved at the level of individual projects, e.g. to advise on sustainable building design. There is traditionally good expertise in surface and groundwater management as Hungary is historically a water-rich country with many flood plains. Sustainable building practices are increasingly valued, as reflected in the growing popularity of green building certification, particularly BREEAM and LEED. Currently, one third of Budapest's offices have such a certificate at some level. Green roofs are increasingly popular on non-residential buildings, in part because they enable a larger building footprint while still meeting the minimum greenspace criteria. Naturalised grasslands are also growing in popularity in Budapest, building on a successful pilot project demonstrating cost savings along with biodiversity benefits. Traditional NBS such as tree-lined streets and the commonly found drainage ditches with natural grass cover, a 200-year old practice in many cities, are in decline.

Banks and insurance firms are among the most relevant actors in the *finance domain*. Based on national programmes, banks are increasingly engaged in financing renewable energy projects, particularly solar PV and energy efficiency upgrades, both for commercial and residential buildings. However, even though they can result in energy savings and other ancillary benefits, urban NBS are considered higher risk and lower return investments, and lack government programs and subsidies that are available in the domain of primary energy supply. NBS are therefore not commonly financed by banks and other institutional investors. Rather, investment is channelled to technologically innovative solutions in areas such as clean and affordable water (e.g., see Susterra's Water Impact Fund). The publicly owned Hungarian Investment Bank supports the development of innovative enterprises and is one of the contributors to the Water Impact Fund. MagNet Bank is the only community bank in Hungary with a sustainable business model, which is going a step further than regular banks in e.g. assessing the social impact of their loans. However, this does not necessarily lead to higher investment in urban NBS at this stage. Many insurance firms are local subsidiaries of multinationals (e.g. Allianz) and increasingly prioritise sustainable development, as indicated by their investment portfolios. International networks like the local member of the World Business Council on Sustainable Development aim to support and advise on sustainable entrepreneurship by firms in Hungary. Finally, there are a number of large firms investing in urban nature to mitigate the environmental losses as a result of their activities. For example, Audi invested in improving the nature value of the habitats on their factory site in Győr, whilst bees introduced through beekeeping are used as bioindicators for monitoring emissions.

3.2.2 Barriers and opportunities

The general perception by the consulted actors in the *regulatory domain* is that government is not adequately prioritising the development and protection of urban nature, resulting in some cases in the loss of e.g. street trees and an insufficient and not properly maintained green infrastructure. The research unveiled several explanations. First, a centralised and strongly hierarchical governance regime limits the engagement of civil society and SMEs that might take innovative action at the local level. This also applies to the national government level, which works with a small number of designated knowledge institutions, which in turn act as gatekeepers and may represent a constraint for wider participation. Second, a highly fragmented traditional governance structure, particularly in Budapest, where districts are responsible for planning in their own territory and not incentivised to work cooperatively on strategic issues. Associated with this, there tends to be limited specialised knowledge regarding urban NBS development within planning authorities, and funding for large or innovative NBS can be inadequate. While there are exceptions, such as the Millenáris Park in Budapest, this limits enforcement of regulation and monitoring of NBS, constrains opportunities for capital investment in NBS and results in inadequate maintenance after NBS

have been installed. Furthermore, urban NBS are not perceived to contribute to economic growth, which is considered as high priority in decision-making processes related to urban development.

Several opportunities were identified to address this status quo. First, municipalities have the option to prepare a 'Green Infrastructure Development and Maintenance Action Plan' (ZIFFA) under the national government's Green City Programme, which also provides methodological guidance and funding to help support this. Budapest is one of the cities that have prepared a ZIFFA, which provides an inventory of greenspaces and directions to their maintenance. Planning authorities also have the option to prepare urban greening or green infrastructure strategies as e.g. by Budapest's 11th and 13th Districts, with some very positive effects on e.g. tree planting. At the national level, there is also a regulation on no net loss of biodiversity that requires developers to compensate for biodiversity loss that results from construction. Municipalities are mandated to pass regulations requiring the inclusion of a minimum percentage of greenspace in new developments. These could be improved by also setting regulations around greenspace quality e.g., the delivery of ecosystem services). The regulation of public procurement could also be improved by adopting a more 'functional' model, where applicants are required to deliver a certain mix of functions (e.g. local jobs or social cohesion) as opposed to a particular product (e.g., an office building). In addition, there is scope for increased engagement and support of civil society, particularly at the district or municipal level, e.g. through subsidies and public consultations. To increase collaboration between planning authorities and relevant disciplines, there is scope for creating new partnership structures, building e.g. on the example of the 'green office' in Budapest's 12th District. There is also a need for increasing the awareness of the monetary value of urban NBS e.g., through assessment tools, education, smartphone apps on available urban nature (e.g. 'Budapest Green'), information displays and campaigns or art-based approaches to accentuate the unique place identities created through NBS.

A major issue limiting the mainstreaming of NBS in the *urban development* domain is insufficient regulation related to high-quality nature. There are also no codes and standards for urban nature, which is in stark contrast with other aspects of construction e.g., HVAC (Heating, Ventilation, and Air Conditioning). Landscape architecture as a profession is often marginalised and landscape planners are either not consulted related to urban development projects or only at a late stage. The strong focus on cost saving in urban development projects often results in monofunctional greenspace, ignorance of planning regulations (e.g. cutting trees without a permit), the removal of sustainable building features from building designs during the construction stage due to cost cutting and the maximisation of floor space at the expense of urban nature. Powerful developers have strong leverage over zoning decisions by municipalities who are often in a weak financial position, often leading to the loss of nature.

In cases where the leaders of local municipalities put architecture and horticulture at similar levels in the planning hierarchy (e.g. in the town of Gyula), urban green infrastructure is managed at a much higher level. This shows that improving the status of urban nature in the urban development domain is possible. Aside from the measures outlined for the regulatory domain, there is a need for municipalities to more clearly demonstrate the cost-effectiveness of nature through pilot projects. Private sector innovations to strengthen the cost-effectiveness of urban nature (e.g. the nature-based wastewater treatment technology developed by Biopolus combining NBS with biomimicry) should also be stimulated where possible. In addition, there is scope for improving the uptake of tools such as BIM to improve collaboration and integrating the different sustainability parameters of buildings, starting at an early planning stage with simulating options and quantifying impacts and benefits. Furthermore, there should be a push to better integrate NBS into the vocational training programmes of urban development professionals, e.g. by offering an accredited green roof training programme. Finally, there is promise in the further advancement of sustainable building certification with indicators for the integration of urban nature. Newer certification schemes such as WELL have a much stronger focus on human happiness, wellbeing and productivity through biophilic designs, which could complement existing schemes.

Opportunities highlighted previously such as better NBS assessment frameworks, engaging civil society and increasing professionals' and public awareness about the values of NBS and sustainability more broadly, are likely to support market

demand and therefore investment by actors in the *finance domain*. In addition, there is an opportunity in the pursuit of increased public-private partnerships to leverage more funding for NBS. This could build on the example of the City Development Fund in the city of Kecskemét, which is funded at 70% by the municipality and at 30% by private investors. Dividends are higher for the private than for the public investors: losses of up to 10% are carried by the public investor, considerably reducing the investment risk by private partners. A final opportunity can be found in combining NBS with technological innovation, which enables tapping into existing investment funds. The above example of Biopolus shows how strengthening water purification properties of NBS with biomimicry to close urban metabolic loops can result in new types of NBS that can be commercialised domestically and internationally.

3.3 THE NETHERLANDS

3.3.1 Conditions

The *regulatory domain* in The Netherlands is characterised by decentralised responsibility for (urban) nature policy, with the national government taking a facilitating role. Consequently, the national government is not actively steering cities to develop NBS - there is no national policy or vision on urban greening. Devolution of environmental policy started in 2010 and was paired with budget cuts and more scope for regional and local variation in decision-making. The role of the national government regarding urban NBS is currently limited to investing in an improved knowledge structure (e.g. the Natural Capital Atlas ('Atlas Natuurlijk Kapitaal'), 'the Green Benefit Planner' (Groene Baten Planner) and facilitating strategic coalitions between different firms, levels of government and civil society, such as City Deals (Urban Agenda) and Green Deals (Government Vision on the Natural Environment). This has *inter alia* contributed to the development of innovative business models and piloting of assessment tools supporting NBS development. For example, there has been a Green Deal on Green Roofs, now evolved into the 'National Roof Plan' coalition, involving municipalities, water utilities and roofing contractors to tackle structural barriers to their uptake. Such a focus on partnership working fits well with the tradition of consensus-based policy making in The Netherlands.

Despite the lack of an explicit focus on urban NBS, The Netherlands has established regulatory capacities and expertise that are facilitating their uptake. As a country situated in a delta, there has been a long tradition of expertise and a strong policy framework regarding water management leading to e.g. compulsory stress tests for flood risk in urban areas and large-scale 'building with nature' projects, such as the creation of a 'river park' in the city of Nijmegen to increase water buffering capacity and provide opportunities for recreation. At the same time, the national sustainability policy places a strong emphasis on climate mitigation (yet less so on climate adaptation), energy transition, and circular economy, where urban NBS could play a clear role. Regarding spatial planning, the national government developed a vision 'National Strategy on Spatial Planning and the Environment' and provides a Building Code with sustainability criteria. However, the 12 provinces are responsible for the national nature network and spatial planning policy. Municipalities, along with the 21 water boards, are most directly responsible for realising, financing and managing urban green and blue spaces. They do so through a range of instruments including the Spatial Strategy, Green Structure Plans, Tree Strategies, subsidies (e.g. for green roofs or citizen initiatives), management of the procurement process and management/use agreements with civil society initiatives. Based on EU law, environmental considerations need to be taken into account in urban development through Environmental Impact Assessments ('Milieueffectrapportage') where needed. Societal concerns influence development plans through a Societal Cost-Benefit Analysis (MKBA), which is often used by municipalities to inform urban development decision-making.

Government bodies engaging in environmental management and nature conservation charities such as Staatsbosbeheer (National Nature and Forest Service), Vereniging Natuurmonumenten and LandschappenNL are acting as lobbyists, intermediaries and managers of some urban green spaces. Research and knowledge institutions can act as important drivers of urban development policy such as 'building with nature' or the policy discourse on healthy urbanisation, given a well-



Figure 3. The green bus stop in Eindhoven was created as part of a competition (photo credit: Alex Tihonovs / Shutterstock.com)

developed science-policy interface. Citizen engagement with nature conservation (e.g. through community gardening or investing in green roofs), and sustainable development more broadly, is relatively high in The Netherlands. They are also routinely consulted as part of urban development processes.

The *urban development* domain provides a complex landscape of specialised actors, including technical construction or sustainable building consultancies, construction firms, contractors (e.g. green roof specialists), housing corporations, architects and landscape architects, often working on different aspects of NBS projects. A number of these actors are increasingly specialised in the development of NBS (e.g. Synchroon development company). The construction sector is represented by industry associations NEPROM (Dutch Association of Project Development Companies), Bouwend Nederland (construction and infrastructure sector) and NVB-bouw (development companies). The share of social housing is relatively high at 30% of the housing stock, but these have relatively limited independence from municipalities on the design of public space while also seeking to minimise the costs of urban development. Green roofs are increasingly becoming a popular sustainability measure in The Netherlands, at least in part due to the growing number of municipalities providing green roof subsidies. A related factor is likely the trend for urban densification in large cities such as The Hague, Rotterdam and Utrecht, which calls for NBS to ensure climate resilience and sufficient recreational opportunities.

The *finance domain* is adaptively responding to the sustainability priorities at the national level, most notably to national strategies on energy transition and circular economy. Investors and clients increasingly demand their money to be sustainably invested through financial institutions, as well. For example, most banks include sustainability goals in their strategy and finance criteria and financial institutions jointly set up an industry initiative, "Platform Carbon Accounting Financials", aimed at implementing and harmonising a carbon accounting approach for the financial sector, an approach which is currently being replicated for biodiversity accounting. While Dutch institutional investors (such as pension funds) are steadily increasing their share of sustainable investments, urban NBS investment is not yet feasible for them because they require standardised, large scale investments. Real estate investment funds indicate increased interest in sustainable buildings, but this is mostly operationalised for energy efficiency, where clear labels and targets exist at national level. They finance buildings with green elements when this is demanded by clients, who recognise the branding and employee wellbeing value of green buildings (Heineken and Booking.com offices are landmark examples). Apart from these examples, mainstream actors in the finance domain provide little to no direct investment in urban NBS. However, in some cases they are making it easier

for others to invest in urban nature. For example, large non-profit foundations (like 'Stichting DOEN') provide seed funding for sustainability projects and start-ups with high innovation potential, while also providing finance advice to such ventures. Along similar lines, the two Dutch sustainability banks, ASN bank and Triodos bank, have biodiversity conservation as a main criteria for building their investment portfolios, and are co-developing methods to be able to assess this.

3.3.2 Barriers and opportunities

Given that urban nature is not a clear policy priority at the national level, an important opportunity to be seized by the regulatory domain is the improved integration of NBS into high-priority policy plans. Biodiversity conservation often perceived to limit economic development. NBS are therefore more likely to be implemented in urban development as part of other agendas, such as healthy (smart) urbanisation, green capital, resource circularity and climate change adaptation. Ongoing investment in facilitating the building of coalitions between different types of sectors could further contribute to this, as well as innovative business models and governance arrangements for urban NBS. For example, the energy transition calls for large-scale urban renewal projects to reduce the ecological footprint of the housing stock. By integrating NBS in such subsidised renovation activity, the costs of NBS can be lowered and the overall co-benefits (e.g. better insulation and more renewable energy output through green roofs) increased. Another important opportunity is offered by the rolling out of the Environment and Planning Act (expected in 2021). This calls for a more holistic and multi-level (nation-region-city-neighbourhood) planning of the environment in a way that meets the synergistic needs of various policy domains as well as those of private firms, non-profits and the community of residents. Health promotion and protection has been identified as one of the pillars for Environmental and Planning Visions which are to be developed at different levels, creating opportunities for increased prioritisation of urban NBS. Although the national government has invested in ecosystem services assessment tools for cities, their uptake remains limited. Another area for improvement is therefore to increase awareness of this tool as well as better integrating the use of it in governance processes, where also e.g. political priorities and citizen participation in decision-making are important, competing, considerations.

At the provincial and municipal levels, actors in the regulatory domain could expand their current support for urban greening through increasing available funds to subsidise green roofs and other NBS as well as through setting ambitious green structure policies and bold tendering targets calling for more urban nature. A caveat is, however, that projects including higher quality urban nature, which tend to increase the average price per housing unit, are often only competitive in tenders for highly sought-after inner-city mixed-use areas. This domain can furthermore contribute to urban NBS development by (co-)funding consultancies, e.g. Rooftop Revolution in Amsterdam is funded through the municipality and the water board, providing advice and support to organisations and individuals interested in greening their roof. The provinces, which are key to ensuring that NBS are integrated in the regional green infrastructure, could expand their role as mediators between investors and municipalities, while also facilitating more knowledge exchange among different municipalities.

Conditions in the *urban development* domain are generally not supportive of NBS development. Most decisions on property construction are based on quantitative data, but 'hard' evidence on NBS benefits is perceived to be lacking. Actors in this domain are therefore sceptical towards NBS and the benefits they bring; NBS are not always considered to be the most cost-effective and dependable solution to urban challenges. The availability of different models for assessing the value of urban nature, each producing different outcomes, is considered an issue as well. Moreover, the benefits of NBS are not always perceived to be reaped by those who invest in them. Another area of concern is that NBS are perceived to be costly in maintenance. Municipalities are often responsible for maintenance and are often lacking the capacity to deal with high-maintenance designs. It can be difficult to add urban nature to commercial buildings after these have been realised.

These properties are often managed by external asset managers that aim to maximise returns rather than engage in urban greening. Increasing use of digitisation has the potential to advance the mainstreaming of urban NBS. For example, BIM

(Building Information Modelling) software is often used in project design processes, allowing for the planning and modelling of building designs digitally. When using the full version all stakeholders have access to, and work together on, a single design to identify potential synergies or conflicts between different aspects. This could therefore potentially demonstrate how NBS contribute to e.g. improved insulation and effectiveness of solar panels. The increasing popularity of certification schemes for sustainable buildings such as BREEAM also provides an opportunity, but at present these schemes do not account for the ecological footprint of the building and its materials, nor for social aspects of sustainability (i.e. social cohesion or environmental justice implications). Actors in this domain could also take advantage of a perceived increase in active citizenship supporting urban NBS development as well as increasing demand for high-quality urban nature – and sustainable buildings more broadly – by potential property buyers. For example, NEPROM, Bouwend Nederland and NVB Bouw recently initiated a new knowledge platform on climate-adaptive and nature-inclusive building practice (KAN – ‘Klimaat Adaptief bouwen met de Natuur’). Furthermore, opportunities to address the issue of high maintenance costs of NBS can be found in innovative types of agreements (e.g., the DFBMO – “Design, Finance, Build, Maintain, Operate” contract) that transfers responsibility for maintenance to the developer for at least part of the life cycle of a new development.

The *finance domain* is moving toward a more holistic understanding of risk to their investment portfolios, which creates opportunities for NBS. For example, the Dutch Central Bank (DNB) aims to increase awareness regarding climate risks for the financial sector, which it recently expanded to environmental and social risks more broadly, including biodiversity and water management. DNB are one of the founders of The Network of Central Banks and Supervisors for Greening the Financial System (NGFS), which pushes for integrating a systemic risk perspective into portfolio management and disclosure, on climate risk and more recently in relation to biodiversity risk. Likewise, there is an increasing understanding within the insurance sector that climate change and other sustainability challenges are putting at risk both their assets (i.e. investments) and their liabilities (exposure to damage costs). Some insurers are responding to this by efforts to stimulate climate-risk awareness among households, firms and municipalities regarding their assets (e.g. Achmea’s BlueLabel tool, which maps urban flooding risk). An alternative approach is to stimulate market formation around NBS such as green roofs that could help mitigate climate-related risks (e.g. Interpolis is stimulating the green roof market through marketing campaigns and discounted prices).

3.4 SPAIN

3.4.1 Conditions

The development of urban NBS in Spain can be characterised as a largely top-down, expert-driven endeavour. The governing structure comprises an intricate multi-level model. The national government sets the overarching strategic framework regarding the environment, climate change mitigation and spatial planning, while each of the 17 regional ministries (i.e. autonomous communities) develops specific strategies within the boundaries of this framework. In addition, they fund efforts aimed at ecosystem services assessment and mapping through the Biodiversity Foundation. At the next level, provincial deputations act as supra-municipal entities. Smaller municipalities with less resources often receive technical support from provincial deputations, which do not have the authority to approve plans or budgets, but do have their own budgets assigned by the national government. This tier of government is also important for managing the peri-urban greenspaces that are popular destinations for recreation and tourism by many urban dwellers. A fourth tier of government is the metropolitan area, only existent for larger urban agglomerations, which manages green and grey infrastructures for the territory. Finally, the municipalities represent the most local scale of government with considerable autonomy to decide about environment and planning policies within the urban perimeter. Some cities in Spain (e.g. Barcelona or Vitoria-Gasteiz) are clear frontrunners regarding NBS mainstreaming. Engagement of academics with the topic of urban greening, including the active co-creation of knowledge with urban municipalities, is high. There is no strong tradition of civic engagement with the topic of urban greening, although there has been a considerable growth in the popularity of community gardening over the past decade.

The Network of Local Governments + Biodiversity is an alliance with over 300 Spanish municipal members, which is collaborating to develop new policy on different topics relevant to biodiversity. They are part of the Spanish Federation of Municipalities and Provinces (FEMP), and are one of the key contributors to the National Strategy on Green Infrastructure and Ecological Connectivity. This strategy, a draft version of which was made available in 2020, encourages multi-scale partnership working on green infrastructure and includes recommendations for the urban scale. The plan is prepared in line with the EU Green Infrastructure Strategy. The autonomous communities are required by law (Law 33/2015 on Natural Heritage and Biodiversity) to prepare their own green infrastructure strategies within three years following publication of the national-level plan. Other influential plans for urban NBS at the national level include the Spanish Urban Agenda (2019), listing the objective to conserve and protect undeveloped land with landscape, ecological or cultural value, both in and at the perimeter of cities; and the Green Book on Urban and Local Sustainability (2012). Generally speaking, however, urban municipalities have more advanced policies and regulation supporting NBS than higher tiers of government. For example, Barcelona municipality introduced a Climate Plan 2018-2030 calling for “many more green areas” as one of its central actions, published a Guide to Living Terrace Roofs and Green Roofs (2015), issued a Programme for Promoting Urban Green Infrastructure (2017), and committed to increasing the green spaces in Barcelona to an additional 1 m² per inhabitant (1.6 km² in total) by 2030 as part of Barcelona’s Commitment to the Climate (2015).

Identified as prominent actors in the *urban development* domain for urban NBS are the municipality, infrastructure providers, development companies, contracted utilities, architects and engineers. House ownership is very high (about 75%) while the percentage of social housing is very low (2%). A small number of multinational companies is taking a dominant position in the market, including the infrastructure companies Ferrovial, Acciona and Suez. Municipalities often contract companies deliver urban services such as utilities, often on long-term and inflexible contracts, limiting innovation potential. The sector is not clearly contributing to the mainstreaming of urban NBS, and is quite conservative regarding innovation in general. However, it is considered a theme that is becoming increasingly popular in professional education. Large companies like Ferrovial are developing their own expertise in environmental protection and climate change, considering this a future investment opportunity to increase competitive advantage. NBS are not clearly mainstreamed in Spain, although cities tend to have a high numbers of street trees and several large-scale traditional parks. Barcelona in particular is also supporting the development of green roofs and facades, and currently has 3.5 ha of green roofs. A number of cities have mapped and are improving their green infrastructure; e.g. Vitoria-Gasteiz has been improving their Green Belt since the mid-90s and Valencia is also creating one.

Different levels of government play a central role in stimulating actors in the *finance domain* to co-invest in sustainability innovation, e.g. through co-funding or the introduction of habitat banking⁶ as a new investment opportunity. For example, the public company Ihoibe based in the Basque Country region is working with private firms (e.g. construction companies) around financing NBS and other greening projects. The Spanish banking and insurance industry (e.g. Reale & Axa) are also central actors in this domain. Spain has several internationally operating banks (e.g. Santander & BBVA), which aim to be leaders in sustainability through promoting sustainable finance and transforming businesses. In 2019, the FINRESP (Centre for Sustainable and Responsible Finance) was founded based on an initiative by the Spanish Banking Association (AEB) and the Union for Insurers and Reinsurers (Unespa) to improve awareness about sustainable finance and investments. Despite this, the Ministry of Economic affairs expressed its concerns over unsustainable banking practices. Few examples were found of institutional investors involved in financing sustainability action. An exception is the Bank of Spain, which is participating in a green investment fund set up by the Bank for International Settlements to better include environmental sustainability objectives in investment decisions.

⁶ The format of habitat banking proposed in Spain was one where private firms could voluntarily buy credits to compensate for habitat loss as a result of their activities, which could then be invested in environmental restoration projects elsewhere.

3.4.2 Barriers and opportunities

One key barrier to more urban greening is that Spanish cities tend to be built in high densities, leaving little open space. Another challenge is posed by the hot and dry climate in many places, further exacerbated by climate change, making it difficult to maintain NBS as the 'green' spaces that many citizens prefer over the more arid-looking landscapes typical of southern Europe. In this context, there is a clear potential for technological innovations that make available more water for interactions with nature. For example, storing rainwater in underground basins for outdoor play with water by school children or on-site treatment and reusing of grey water for watering a green façade. This should, however, be complemented by efforts to educate society and the urban design and planning professions about the values of the flora and fauna that are typical for their own region. For example Barcelona is planning to set up an interpretation centre, to promote BioBlitz-style events for children and create educational resources on green infrastructure and biodiversity for schools. In addition, there is a need for better assessment tools for ecosystem services and (climate) scenario modelling. Some promising activities to this end are undertaken by universities, such as ICTA and UAB in Barcelona, which mapped ecosystem services for the city. To further facilitate this, there is a demand for ongoing EU funding as well as other climate and innovation funding. The environmental management agency Ithobe, owned by the Basque Ministry of Environment, Territorial Planning and Housing, was commissioned to carry out a study on identifying and mapping NBS, resulting in a methodological guide "Nature-based solutions for local climate adaptation in the Basque Country". However, there remains a need for better indicators and monitoring of the specific impact of NBS at site level, particularly because the functioning of NBS is strongly influenced by its context and there is much climatic variation across Spain. International collaboration of Spanish organisations in, e.g. the European MAES working group and the Natural Capital Coalition (NCC), introduced in more detail in the EU case, is expected to further improve such understandings.

In their desire to be frontrunners in sustainability, some Spanish cities are strongly engaged with international networks such as C40 Cities network of megacities in order to exchange knowledge with other metropolises. A number of Spanish cities are also actively engaged in EU-funded research and innovation projects (e.g. Valladolid in Urban GreenUP; Valencia in Grow Green), which helps to finance and experiment with new NBS and learn more about their potential. The recently published Guide of the Municipal Green Infrastructure (2019) provides another effort aimed at knowledge sharing between cities regarding the state-of-the-art in NBS development. This document was an initiative by FEMP, the Network of Local Governments + Biodiversity, Association of Green Infrastructure Management Companies (ASEJA) and the Spanish Association of Parks and Public Gardens (AEPJP), with the technical advice of a green infrastructure specialist. It is a comprehensive practitioner handbook providing definitions, international examples and pathways for improved uptake of NBS and green infrastructure.

It was sometimes reported that it is not a lack of knowledge availability per se which is the biggest problem for urban sustainability, but rather the fragmentation of this knowledge between different departments responsible for urban planning and development. To address this, some authorities have created new organisational structures that facilitate more integrated working between policy domains. For example, the regional ministry of Catalunya created a Department for Territory and Sustainability, bringing together mobility, infrastructure, environment and spatial planning in one place. This is mirrored in the city of Barcelona where the Urban Ecology Directorate brings together the Mobility, Environment and Planning departments. Together, they develop new policy such as the city's Climate Plan, in which urban greening plays an important role, as well as sustainability innovations such as the Superblocks programme. Madrid contracted design and engineering consultancy firm Arup to develop a vision on urban NBS, 'Madrid + Natural', as part of the city's climate strategy. Another opportunity can be found in integrating NBS into circular economy or mobility strategies that are currently developed at different levels of government. The regulatory domain could also still do more to facilitate public-private partnership working to increase available funding and expertise for urban NBS, which is experienced as inadequate. The Public Procurement Law (2017) was considered a promising development in this regard. This increased the duration of permitted contracts between public and private entities, which enables the latter to gain a better return on investment in NBS, which often deliver value over long time horizons. This incentivises



Figure 4. Example of a reclaimed road including mobile planters as part of the Barcelona SuperBlock project. (Photo credit: MaxPalla / Shutterstock.com)

investment in high-quality NBS with higher post-implementation returns. In addition, the new law also obliges contracting bodies to design award criteria around quality, specifically by including environmental, social and innovation indicators.

Co-funding opportunities, longer contract durations, stricter procurement quality criteria and less bureaucracy are all likely to contribute to increased engagement of the *urban development* domain in developing and maintaining sustainability innovations such as NBS. There is also a need for improved regulation to protect the natural environment. For example, demand for SuDS is likely to increase to meet regulations in the EU Water Framework Directive regarding water quality and management. Another major barrier to investment by actors in this domain is the uncertainty about returns on investment, and the issue of many co-beneficiaries of NBS who are not necessarily co-investors. In addition to developing tools for quantifying those benefits along with more knowledge exchange, as indicated above, there would also be merit in organising pilot projects in e.g. schools and other public buildings. For example, the 'Lanaland' project in Valladolid aims to reuse sheep wool waste as a substrate for growing plants on urban structures such as roofs. This can contribute to an improved understanding of why urban NBS are important and could increase customer demand for these as well, which is currently perceived as rather low. To support the development of markets, it is important to demonstrate how NBS contribute in cost-effective ways to addressing (multiple) urban challenges perceived as highly important, such as improving air quality and public health, responding to the threat of droughts and floods, sustainable mobility, circular economy and, to some extent, biodiversity and sociodemographic inequalities. There is also scope for developing new NBS as part of scheduled infrastructure maintenance works, which requires addressing silos as highlighted previously.

Our findings from the *finance domain* demonstrate that there is considerable commitment within the sector to move to more sustainable operational practices, but relatively minor achievements regarding investments in urban NBS. Tools such as habitat banking are promising but lack a legal mandate which could help to mainstream investment in nature and ecosystems. The insurance sector's role in mapping climate risk, e.g. by the public reinsurance organisation CSS (Consortio de Compensación de Seguros), could play an important role in better understanding the place-specific benefits of sustainability innovations such as NBS. In addition, there is potential for more insurers to follow the example set by DKV Seguros in raising awareness of homeowners about the value of urban NBS to improving health and mitigating climate risk. To improve the engagement of civil society, there is potential for the organisation of collective funding initiatives (i.e. crowdfunding), competitions and participatory budgeting.

3.5 SWEDEN

3.5.1 Conditions

The Swedish *regulatory* domain is an internationally recognised leader in urban sustainability and environmental planning. This also translates to the support for the development of (urban) green infrastructure and delivery of ecosystem services in policy documents at national to local levels. The recently established National Climate Change Adaptation Strategy and urban policy framework, including the Strategy for Liveable Cities (2018) and National Platform for Sustainable Urban Development, act as guidance documents for incorporating urban nature to create more resilient and liveable cities. Likewise, the Swedish Strategy on Biodiversity and Ecosystem Services (2014) led to the development of Regional Green Infrastructure Plans and a number of new green infrastructure initiatives. Responsibility for detailed and comprehensive planning is devolved to the relatively autonomous municipalities. Generally, they have enough funding to deliver and maintain high-quality blue and green spaces (e.g. parks, water management), meeting the demands for outdoor recreation by citizens. To further expand and broaden the benefits delivered by urban nature, the national government has adopted an environmental objective stating that by 2025 municipalities must apply ecosystem services principles and integrate urban greening in their planning processes. Public agencies, particularly the Swedish Environmental Protection Agency and the National Board of Housing, Building and Planning, advise and support municipalities on national and regional policy goals, which include enhancing green infrastructure and coordinating climate change adaptation. County Administrative Boards act at the regional level to coordinate climate adaptation action and review municipal planning documents to ensure that they deal with issues that are of regional or national significance.



Figure 5. Malmö's Western Harbour district was the first area to use a local green space factor
(photo credit: Lena Si / Shutterstock.com)

The urban development domain in Sweden is shaped by public-private cooperation to deliver urban infrastructure. Important actors include government-controlled infrastructure agencies, landscape architects, planners and engineers providing technical support, development companies, and housing associations under local government control that own about 20% of Sweden's residential buildings. Property development is usually delivered by interdisciplinary project teams, involving multiple companies for large projects, where expertise related to nature is not prioritised. The delivery of NBS in urban development, particularly green roofs and urban drainage systems for stormwater management, is becoming mainstream in frontrunner cities. Particularly regarding commercial buildings, a high level of environmental awareness in Swedish society

results in market demand for sustainability from tenants and clients, leading to a high level of adoption of green certification (e.g. LEED or BREEAM). An increasing number of commercial developers and housing corporations seek to build in more nature-inclusive ways as one of the ways to pursue a 'green' reputation.

The findings for the *finance domain* confirmed the role of municipalities as significant investors (both capital investment and maintenance) in urban NBS and other public amenities, given the highly decentralised nature of the Swedish government. The national government is also influential through the provision of subsidies and grants. Among key players in this domain influencing NBS mainstreaming potential are the public sector bank Kommuninvest, real estate companies and corporations, water utilities that have a legal responsibility for clean water provision and stormwater management, insurance providers and other institutional investors such as pension schemes. The role of the latter is noteworthy: although realising a high return remains a priority, the Swedish National Pension funds (AP Funds) are required to consider environmental and ethical aspects when making decisions about investment. Because of this, and given the high credit ratings of the public sector bank, they have been heavily investing in sustainable urban infrastructure.

3.5.2 Barriers and opportunities

The findings corresponding to the *regulatory domain* indicate how NBS mainstreaming can take place using formal planning approaches with considerable top-down steering by national government. Along with the Strategy of Liveable Cities, a new public agency called the Council for Sustainable Cities was established in 2018, involving the heads of other public agencies influencing sustainable urban development, which could play an important role in the prioritisation of NBS as sustainability solutions across other public agencies in due course. Despite efforts to improve this, the coordination of sustainability action between the local, regional and the national levels was reported to be a challenge. Stakeholders also highlighted issues around the sharing of lessons on urban greening and the application of ecosystem services principles between municipalities, resulting in variable approaches to urban greening with clear frontrunners and (most likely) a number of laggards. In addition, silos within municipalities were also regarded a barrier to the uptake of urban NBS. New partnerships such as the BiodiverCity programme in Malmö, bringing together ecologists from the municipality with knowledge institutions and urban development actors, therefore have high potential to accelerate the implementation of multifunctional NBS.

Although Sweden has already made good progress on this front, an ongoing discursive positioning of NBS in national policies as an essential strategy to realise sustainable, climate-resilient cities can likely contribute to the further mainstreaming of NBS. Opportunities to address coordination issues can be found in making knowledge on the multiple values of NBS more broadly available. In addition, providing knowledge on how to design for ecosystem services, rather than only on how to assess these, could also support NBS mainstreaming. The focus on top-down steering was by some perceived to come at the expense of innovation and citizen engagement. A significant opportunity to increase engagement of the private sector is offered by the Green Space Factor, a points-based system currently applied in Malmö and Stockholm for any new development on public land. This tool is used by municipalities to set targets for developers around required level of multifunctional green space in new developments. Different types of green spaces are weighted differently in relation to the social and environmental features that they offer and depending on their size in relation to the total plot area.

Regarding the *urban development domain*, the engagement of interdisciplinary teams in urban development projects is an opportunity for NBS mainstreaming. This potential is, however, not realised in many cases because expertise related to urban greening (e.g. landscape architecture, ecology etc.) is often not called upon until the end of the development process when most design decisions have already been taken. The improved integration of the ecosystem services concept in urban planning, as outlined previously, is perceived as a prominent route for turning this around. In addition, the current urban densification agenda of national government in response to climate mitigation goals is likely to increase demand for high-quality nature integrated with urban development. Opportunities can also be found in the tradition of strong public-private partnership working – linked to a tradition of consensus-based decision-making – in urban development, and the

relatively strong position of government-owned infrastructure agencies and housing corporations in this domain. High levels of environmental awareness and concern in Swedish society are stimulating market demand for NBS and sustainability more broadly. This is motivating companies in the urban development domain to develop more expertise in this area, and is likely to provide a new impetus to urban NBS mainstreaming.

There is great potential to increase the contribution of the *finance domain* to urban NBS mainstreaming in Sweden. First, there is an increasing popularity of green bonds, including green mortgage bonds for sustainable housing, offered by the public sector bank Kommuninvest and the corporate bank SEB (Skandinaviska Enskilda Banken), providing triple-A credit quality as well as investment in climate action and sustainable infrastructure. This can include investment in nature and biodiversity. Urban municipalities such as Malmö, as well as real estate companies, are among the actors that put forward projects for investment to these financial groups. A favourable rating of these green bonds can be used by lenders to demonstrate their legitimacy as frontrunners in a climate-resilient future. To further improve the uptake of NBS as a result of investment in green bonds, there is a need for more standardised indicators for NBS performance. The popularity of these green investment products is likely to increase in the future due to high levels of concern regarding climate among the Swedish population, who are increasingly demanding that their money is invested in sustainable ways. Second, there is an opportunity to improve awareness for the potential of urban NBS in the insurance sector as an investment to reduce the climate-related risks for its investment portfolios. Following the example set by SEB, who trained employees in sustainability-related matters, improving education of staff in this area could provide an important instrument in achieving this. Third, there is also potential to increase spending of municipalities on urban NBS development through more clearly highlighting the potential of NBS in providing multiple public services, which could make them cost-effective alternatives to other types of urban infrastructures if these are planned in more integrated ways. This requires reconsidering working relationships between different departments, including the possible pooling of budgets. A barrier to increased engagement of the financial sector is that investment in urban NBS for social well-being or biodiversity purposes is unlikely to generate a good return, which demands ongoing government and civil society investment.

3.6 UNITED KINGDOM

3.6.1 Conditions

For the *regulatory domain*, the United Kingdom (UK) takes a 'plan-led' approach to land use planning, which is the shared responsibility of the devolved countries, regional (where applicable) and municipalities. Municipalities have the duty to prepare a vision for, and policies guiding, local development. This takes into account national and regional planning policy and legislation, which varies across the four countries. These multi-level development plans are influencing urban NBS because these set out where development can take place and under which conditions, as well as which natural assets need to be protected from development (e.g., green belts). Natural capital and ecosystem service provision are dominant policy paradigms, which influences urban development since governance approaches often focus on mitigating the negative environmental impact of urban development. There is a strong push to increase the housing stock, while at the same time there is an understanding that this needs to go hand-in-hand with green infrastructure improvements. England is implementing a mandatory Net Biodiversity Gain policy, where developers will be required to achieve 10% net biodiversity gain through both on-site biodiversity enhancement and offsetting elsewhere. Urban NBS development is also, indirectly, influenced by country-specific regulation and policies in such areas as flood protection, water quality, biodiversity protection and open space. For example, the 'Natural Environment White Papers' (1990; 2011) and the 2010 biodiversity strategy 'Biodiversity 2020: A Strategy for England's Wildlife and Ecosystem Services' in England. More recently, the UK Government published the strategy 'A Green Future: Our 25 Year Plan to Improve the Environment', outlining government action in areas such as landscape restoration, biodiversity and sustainable development. The concepts of 'green networks' and/or 'green infrastructure' are well-integrated in the UK spatial planning policy. However, faced with (central) government austerity, municipal budgets for the delivery of urban greenspace have been declining across the UK over the past decade.



Figure 6. New housing estate with a sustainable urban drainage system
(photo credit: PhotoEngland)

The *urban development* domain is broad and diverse, including development companies, technical service providers, water companies, transportation agencies, professional bodies, non-profit housing associations and planning consultancies. Housing is very high up the political agenda, with a current target of 300,000 new units per year. There is also a strong push to improve infrastructure development, particularly for flood alleviation. Development companies make a significant contribution to green infrastructure to meet planning obligations, while water utilities are increasingly investing in SuDS as part of their climate change risk mitigation agendas. Engineering expertise is dominant in this domain, resulting in a predominance of grey solutions to sustainability challenges. Other contributing factors are the lack of metrics accounting for the multifunctional values of NBS and, associated with this, a fear that NBS are complicated and expensive. Despite this, there are an increasing number of contractors specialising in the delivery of NBS such as green roofs, while utilities are also increasingly experimenting with NBS such as SuDS. Some stakeholders (e.g. development companies or housing associations) develop their own green infrastructure strategies to guide large-scale (re)development projects (e.g. the Biodiversity Action Plan 2018-2028 for the Canary Wharf business district in London). Green roofs are becoming more common in larger cities such as London, but customer demand for urban NBS is generally perceived as low.

Within the *finance domain*, NBS are primarily funded through private developer investment in compliance with planning policies from local to national levels, while austerity governance has led to shrinking levels of public investment in sustainable urban infrastructure. Stakeholders such as banks, insurance companies, other institutional investors, economic consultancies, lotteries and other donor agencies play a role in shaping the funding landscape for urban NBS. There are also a number of public-private partnerships, including Local Enterprise Partnerships, and the recently launched Green Finance Institute focused on market innovation, data and analytics, education, and policy development to inspire a transition to a carbon neutral, climate-resilient economy. In alignment with the emerging international discourse in this domain, the UK financial sector (e.g. Bank of England) has adopted mitigating of climate risk as one of their core objectives. Despite this, few financial professionals are trained in green finance or sustainability. Within this domain, the insurance industry has relatively extensive knowledge regarding sustainability, particularly climate risk, which is accrued as a result of applying risk analysis tools taking into account climate change. Other types of institutional investors are currently not regarded as significant contributors to NBS investment given their prioritisation of high return rates over climate resilience. Community ownership and/or management of urban nature, with support of donor agencies, is increasingly prevalent as models for creating and maintaining public space, particularly in the context of austerity policies and reduced municipal budgets. Funds are also available to some municipalities and NGOs for developing NBS to meet strategic needs, such as improved access to nature for deprived communities supported by the Scottish Green Infrastructure Fund.

3.6.2 Barriers and opportunities

While the limited availability of public funding is considered an issue for the delivery of urban NBS, the present research identified some innovative policies in the *regulatory* domain that could contribute to the improved leveraging of private funds to this end. For instance, municipalities in England have been granted the powers under the National Planning Policy Framework to mandate the delivery of SuDS as part of new urban development proposals, unless it can be justified why these are not appropriate. This matches with a broader trend towards natural flood protection, as demonstrated in large-scale collaborative demonstration projects spearheaded by the Environment Agency. In addition, a new policy in the UK will mandate that new developments deliver Biodiversity Net Gain. Property developers will need to ensure a 10% net biodiversity gain, either by on-site provision or protection of biodiversity, or by off-setting this elsewhere in the local area. Moreover, The Office for National Statistics provides annual assessments of natural capital, including an overview for urban areas. There are also opportunities for policy innovation at the local level: London adopted the Green Space Factor policy (see description of Sweden case) as well as a Living Roofs and Walls Policy. Furthermore, there is scope to more clearly link NBS to statutory requirements around climate change mitigation, biodiversity conservation, flood mitigation and air purification in order to add legal weight to their implementation and maintenance.

There are also opportunities to accelerate urban NBS implementation through the expansion of engaged stakeholders. NBS policy entrepreneurs in regulatory spheres are working to influence partners (e.g. infrastructure agencies, urban planners) to incorporate NBS into their regular operations. Policy advocacy organisations are working to convince developers that NBS enhance, rather than threaten, the viability of their developments. Frequently, NBS policy entrepreneurs use examples where green infrastructure was cheaper than grey infrastructure to provide a particular service, or cases where greenspace added to the value of urban developments and increased the profit per unit. The role of experts in public agencies and NGOs in advising government and setting up pilot and demonstration projects is crucial to improve the broad understanding of NBS as cost-effective solutions. Despite progress made in some areas, the current situation remains one where grey infrastructure is often preferred over green infrastructure based on the ease of quantifying performance and risk (e.g. regarding flood management). For that reason, there is a perceived need for improved metrics to calculate the multifunctional benefits of NBS. A promising development is the Defra Biodiversity Metric that can be used for the biodiversity offsetting for new property development. The metric is due for an update to improve the capturing of multifunctional benefits associated with NBS. This environmental net-gain metric, called Eco-Metric, is being piloted in 20 case studies through a consortium led by the University of Oxford. However, a risk of using metrics remains that it will reward poor-quality NBS providing a set of ecosystem services that are easy to quantify but not those providing many co-benefits that are more difficult to quantify (e.g. social outcomes).

One of the key barriers identified in the domain was that NBS falls into the cracks between silos. These silos exist between professions, departments and stages of project management and occur because NBS often fall in between the interests or responsibilities of various stakeholders. Partly these challenges exist because successful NBS implementation requires that multiple disciplines and areas of expertise become involved. In addition, the benefits of NBS become clearer when silos are bridged; while NBS may not be the most efficient water treatment option available, it may be the best option once water, recreation, climate resilience and biodiversity enhancement are taken into account. Relatedly, there is an NBS knowledge gap in the construction sector in terms of understanding NBS benefits as well as in terms of technical implementation skills, although the policy commitment to biodiversity net gain was driving urban development stakeholders to build up these capacities. To address the issue of limited technical implementation skills affecting NBS uptake and to highlight the synergistic benefits of NBS across different policy domains, there is a need to overcome silos between different professions and stages of project management through collaborative learning. Collaborative learning can be supported through increased monitoring of in-situ NBS to provide feedback about effective NBS design and performance as well as the creation of processes that bring disciplines together in order to navigate the multifunctional benefits and potential trade-offs that take place during the design of NBS. In order to mainstream these new practices, it will be necessary to overcome practices that reinforce grey

infrastructure for sustainability solutions. Current knowledge practices, particularly related to how risk is calculated in project development, favour grey engineering solutions. The UK findings point to the need to develop new tools that clearly show the multifunctional benefits of NBS, such as the Building with Nature scheme which provides accreditation and training to support high-quality urban nature in new developments.

Investment in urban NBS from the *finance domain* could also be spurred through enhancing private developer investment in NBS through compliance with planning policies from local to national levels and incentive tools like accreditation schemes for urban nature. Better insight in urban natural capital can be used to build a portfolio of large-scale and low-risk NBS projects that are opened up for private investment. An example of this is the Natural Capital Investment Plan developed by the Greater Manchester Combined Authority. The Investment Readiness Fund under this plan collects investment-grade projects with known locations that are cross-referenced with natural capital accounts to show where investments are likely to support ecosystem services delivery. Various funding models can be used to coordinate long-term financing arrangements that convene public and private sources of financing.: 1) The 'place-based portfolio model' involves leasing urban nature sites to citizen groups or trusts, which could then exploit revenue opportunities (e.g., opening a café); 2) 'Habitat and carbon banking' involves selling credits from actions that increase biodiversity or carbon storage to organisations to compensate for negative impacts; and 3) The 'sustainable urban drainage systems' model provides a reduced water connection charge for new urban development projects.⁷ A fourth alternative funding model for urban nature based on public-private finance is the 'avoided damages market'. The Green Alliance and the National Trust charities are developing Natural Infrastructure Schemes, where landowners (e.g. farmers) are paid to invest in green infrastructure to reduce flooding risk further downstream. Capital could be provided by e.g. water companies, which have a mandate to address flood risk and improve water quality. Although such developments may appear promising, there are limits to the ability to express NBS in monetary terms. This calls for the development of complementary qualitative value indicators.

3.7 EUROPEAN UNION

3.7.1 Conditions

At the European Union (EU) level, the *regulatory domain* comprises a varied stakeholder landscape. The European Commission (EC) is the executive body comprising different departments, called Directorates-General (DGs), that directly engage with the topics of NBS and sustainable urban development through policy development and/or providing funding instruments. These include the DG for Environment (Biodiversity Strategy, Green Infrastructure Strategy, Action Plan for Nature, People and the Economy, Natura 2000, Water Framework Directive, Birds and Habitats Directives, LIFE funding programme), the DG for Regional and Urban Policy (Urban Agenda), the DG for Climate Action (Adaptation Strategy) and the DG for Research and Innovation (Horizon 2020 funding programme). The concept of NBS is embedded well within the programmes and policies developed by these DGs, while terms such as green infrastructure and ecosystem-based approaches are also used. The Europe 2020 Strategy for economic growth and jobs also emphasises the need for green growth and climate-resilient investment. The EC does have legal competence to act on environmental matters through proposing new legislation, whereas it lacks such discretionary powers for aspects such as spatial planning and development that are also central to urban NBS development. They do, however, still influence decision-making in these areas through e.g. non-binding strategies and guidance. It is the responsibility of individual Member States to implement EU Directives and manage the EU structural funds associated through their Operational Programme. The EU institutions responsible for legal and budgetary decision-making are the elected European Parliament and the Council of the European Union involving the national government ministers. The European Council, comprising the heads of national governments, is responsible for setting the political agenda. The European Environment Agency is an EU knowledge institute providing information on the state of the environment, which is used to inform policy in this field. The Joint Research Centre is the knowledge institution of

⁷ The 'sustainable urban drainage systems' model only works if the water company takes on ownership and maintenance responsibility for the surface water drainage after delivery, which is a legal requirement in Wales but not in England.

the European Commission and has recently prepared a report 'The Future of Cities' outlining the main urban challenges of which flooding, the urban heat island effect, air pollution and sustainable mobility bear particular relevance to NBS.

The development of relevant plans and programmes for urban NBS, such as the Biodiversity Strategy and the Green Infrastructure Strategy, involved extensive consultation of actors internal and external to the EU. Among internal actors are the European Economic and Social Committee (EESC), the European Committee of the Regions (CoR), both advisory bodies, the European Parliament and the Member States. Among consulted external stakeholders were NGOs and scientists, while also public consultations were held. Working groups drawing from different DGs, European institutions, civil society and research institutes were established to advise on these strategies (e.g. the Working Group on Green Infrastructure for the green infrastructure strategy). Local and regional authorities, either directly or indirectly through their representation in networks or membership organisations such as Eurocities, the network of Local Governments for Sustainability (ICLEI Europe) or the Council of European Municipalities and Regions (CEMR), also influence policy development relevant to urban NBS (e.g. the Urban Agenda). The lobbying influence of environmental NGOs is profound, particularly regarding the smaller DGs for Environment and Climate with relatively little research capacity. International agreements and fora played an important role in informing the development of strategies at EU level with relevance to urban NBS, most notably the legally binding Paris Agreement, the New Urban Agenda and the UN 2030 Agenda including the Sustainable Development Goals framework. In December 2019, the EC presented the European Green Deal, outlining the roadmap to restoring biodiversity and becoming a climate neutral continent by 2050.

The EU has a Research and Innovation policy agenda on 'Nature-Based Solutions and Re-Naturing Cities', which was developed by an expert group, and refined following a multi-sectoral stakeholder workshop and a public consultation process. In addition, there is a Partnership on Sustainable Use of Land and Nature-Based Solutions (SUL-NBS Partnership) with several associated Member States and cities, which was established following the New Urban Agenda in 2017. They seek to contribute to understanding the current role of NBS in urban development, identify best practices and make proposals for particular instruments available to encourage sustainable urban land use and the development of urban NBS. They aim to develop an Action Plan to share their insights. The Horizon 2020 programme has funded a number of Research and Innovation as well as Innovation Action projects on NBS, which contributed to enhanced knowledge on this topic by researchers and practitioners and the establishment of a mixed expert community.

The EC was also, together with the German BMUB, a key initiator of the international TEEB (The Economics of Ecosystems and Biodiversity) initiative running between 2007 and 2010. This was a study by scientific experts on economic assessment of ecosystem services to increase prioritisation of nature in policy-making. It prompted the development of national-level follow-up studies on valuing ecosystem services (e.g. Natural Capital Germany – TEEB DE in 2017), including for cities. This has prompted a better understanding of the benefits of urban nature in dealing with urban challenges and prompted initiatives for improved integration of the ecosystem services concept in urban decision-making, e.g. the TEEB City ecosystem services assessment tool used in The Netherlands. Considering this and the integration of NBS in several policy strategies (see above), the EU is a key driver of urban NBS mainstreaming. The EU Biodiversity Strategy to 2020 (Action 5 'Improve knowledge of ecosystems and their services in the EU') has been important to facilitate the ongoing investment by Member States in ecosystem services assessment and monitoring. This also informed establishment of the MAES ('Mapping and Assessment of Ecosystems and their Services') initiative to advise Member States and ensure coherent assessment approaches.

The influence of the EU over the *urban development* domain is restricted to non-binding measures, which is why there is no DG on spatial planning. Despite this, strategic collaboration between Member States takes place on this topic in the European Conference of Ministers responsible for Spatial/Regional Planning (CEMAT). There are a number of globally operating urban development companies, particularly regarding technical construction consultancy but increasingly also in architecture. The World Green Building Council is an NGO with national member organisations aiming to support sustainable building practice. There are various professional associations for urban development stakeholders that are operating at the

European level, including the Architects Council of Europe, European Council of Spatial Planners, the European Federation of Engineering Consultancy Associations and the European Landscape Contractors Association. These play a role in knowledge exchange, designing professional training programmes and lobbying politicians.

The EU plays a profound role in the *finance domain* as driver for improved regulation on sustainable finance, which could indirectly contribute to investing in (urban) NBS. Key to this have been the development of the EU Action Plan ‘Financing Sustainable Growth’ and the TCFD (Task Force on Climate-related Financial Disclosures) framework. The Action Plan was prepared in response to recommendations by the High-Level Expert Group (HLEG) on Sustainable Finance, involving specialists from European institutions and the finance, research and civil society sectors, in early 2018. The aims of the plan are to facilitate sustainable investment by institutional investors and asset managers, minimise climate risk on investments, and increase transparency. The TCFD framework was adopted by the EC as a voluntary instrument to compel financial institutions to disclose information about climate risk within their investment portfolios.



Figure 7. The Jardin Botanique in Brussels (photo credit: trabantos)

The EU has a number of financial instruments that can be used towards the development of urban NBS and relevant expertise, along with other types of ‘eco-innovation’. These include Horizon 2020, LIFE, Programme for the Competitiveness of Enterprises and Small and Medium-sized Enterprises (COSME), the Cohesion Fund and the European Structural and Investment Funds (ESIF). The LIFE programme funds environmental and climate action by public, private and/or third sector organisations, including some NBS projects (e.g. LIFE-myBUILDINGisGREEN in Spain). The ESIF consists of five streams and finances aspects of the Operational Programme developed by each Member State. Among the ESIF, particularly the European Regional Development Fund (ERDF), the European Social Fund (ESF) and the Cohesion Fund (CF) bear most direct relevance to urban NBS. The EC prepared a guide ‘Guide to Multi-Benefit Cohesion Policy Investments in Nature and Green Infrastructure’ to share knowledge on how green infrastructure could be funded under each of these funds in synergistic ways. For example, the ERDF could be used to fund green infrastructure for economic regeneration, while the ESF could fund new professional training opportunities associated green infrastructure development. The European Investment Bank (EIB) is a joint EU institution qualifying as the world largest provider of climate finance. Additionally, it has a loan programme dedicated to financing natural capital investments, the Natural Capital Finance Facility (NCFF), requiring a €5 million minimum investment (e.g. towards green infrastructure or other NBS) and a minimum rate of return. Athens (Greece) is the first city to make use of the NCFF to help deliver urban climate change resilience measures on over 400 sites through green-blue infrastructure.

Many of these EU funds, including the NCF, require match funding by local partners with the percentage varying depending on the fund (e.g. 60-70% for LIFE projects; 25% for NCF).

Beyond the EU institutions, globally operating actors in the finance domain are also themselves taking initiatives to support sustainable investment. For example, the Platform Carbon Accounting Financials (PCAF) acts on behalf of financial institutions worldwide to develop assessments of investment portfolios' carbon footprints. This could indirectly support NBS development as an offsetting activity. Likewise, the Global Alliance for Banking on Values (GABV) is an international network for sustainable banks and banking cooperatives, while the Network of Central Banks and Supervisors for Greening the Financial System (NGFS) is a global partnership of Central Banks interested in greening the financial system. Additionally, the European Central Bank is also encouraging national-level Central Banks (e.g. Bank of Spain) to engage in greening strategies. A number of globally operating insurance companies (e.g., AEGON, Allianz and Swiss RE) have signed up to the UN Environment Programme Finance Initiative (UNEP FI) Principles for Sustainable Insurance (PSI). There is also an increasing interest by internationally operating NGOs including The Nature Conservancy (TNC), World Wide Fund for Nature (WWF) and the International Union for Conservation of Nature (IUCN) to develop their own expertise and funds in sustainable finance, e.g. TNC co-developed Mexico City's Water Fund. WWF and IUCN are also among the founding actors of the Natural Capital Coalition (NCC), a worldwide coalition of public, private and third sector organisations involved in understanding the dependency of their production processes and long-term viability on natural capital, as well as their impacts on it, through the Natural Capital Protocol.

3.7.2 Barriers and opportunities

Despite the involvement of different DGs in plans with relevance to urban NBS, one of the main barriers hindering the uptake of NBS through action by the *regulatory* domain are the conflicting objectives and core principles of some of the EU policies influencing urban development. The dominance of economic affairs (i.e. green growth) over sustainable development in EU policy making allows for limited scope to support the uptake of (urban) nature for its intrinsic, relational or non-monetary instrumental values. This leads, for instance, to the subsidising of some activities (e.g. biofuels or intensive agriculture) that are harmful to the natural environment. Another challenge is that the cities with the mandate for urban NBS development are not always prioritising sustainable development and NBS either, despite available (financial) support programmes. Related to this, Member States do not always implement EU environmental regulation in a satisfactory way, there is limited cooperation between municipalities on this topic, and citizen awareness of NBS tends to be low (with the exception of the Nordic countries). A third barrier is the limited involvement of the business sector in environmental policy-making.

To address the issue of conflicting policies, there is potential in improved policy integration. For example, there is scope for better integrating the active policy communities on climate action and on biodiversity. The concept of NBS could be integrated in the upcoming New EU Strategy, and environmental considerations could be prioritised more in economic, transport, and agricultural regulations, policies, and funding programmes. To build support for sustainability and NBS at the urban level, the EU has been successfully rolling out events, competitions, and networks, most notably the European Green Week (with a city focus in 2018), the European Green Capital Award, the European Green Leaf Award, and the European Green Capital Network. Participating in these initiatives increases awareness and, in the case of the Award, also the building of new coalitions among different municipal departments relevant to urban NBS, which often has a lasting impact on the governance structure. International networks such as the Global Covenant of Mayors for Climate and Energy (GCoM), CoR, ICLEI Europe, Eurocities, United Cities and Local Governments (UCLG), and C40 Cities can play an important role in knowledge exchange on implementing NBS and other sustainability innovations between cities, while also contributing to their legitimisation. National networks (e.g. 'Municipalities for Biodiversity' in Germany) or even multi-city metropolitan area networks (e.g., Regional Association Ruhr in Germany) to some extent also fulfil this role. In addition, non-binding guidance documents could be developed along with efforts to disseminate success stories of urban NBS to a broad audience. Ongoing investment in science and demonstration projects on urban NBS, and making the knowledge acquired from these available to

practitioners and policymakers, provides another important route. Moreover, making funding available not only for nature-based innovation but also for the maintenance or further rolling out of proven highly effective multifunctional NBS could provide a way forward. To some extent, the ESIF allow for this, e.g. this is an important source of environmental funding in Hungary. Directives can be powerful drivers of large-scale NBS development; the Water Framework Directive contributed to the €5.3 billion Emscher River Restoration Project in the German Ruhr Metropolitan Area to improve water quality through e.g. renaturalising river banks. Increased NBS investment by cities could therefore be leveraged through better integration of NBS within Directives (e.g. Strategic Environmental Assessment (SEA) Directive, Environmental Impact Assessment (EIA) Directive or Flood Directive). However, this is challenged by the limited monitoring of how cities are implementing the SEA and EIA instruments, which raises questions regarding the extent to which environmental impact mitigation is taking place. To address the barrier of limited business engagement, more funding specifically targeting the private sector could be made available.

Regarding the *urban development* domain, existing EU regulation and policies are to some extent leading to improved integration of NBS within urban development. This could be improved with some of the recommendations regarding e.g. better policy integration and knowledge sharing stated previously. Another opportunity is provided by increasing the weighting of environmental criteria within public procurement. To this end, DG Environment has been publishing voluntary green public procurement criteria that public authorities can choose to adopt for different kinds of products and services in the procurement process. Raising awareness regarding the potential of NBS among urban stakeholders is a key action, supporting pilot projects and providing a generally accepted definition for urban NBS could contribute to achieving this in addition to the options (e.g. co-learning on NBS in city networks) outlined previously. It should also be considered to introduce NBS development as a new requirement for the Operational Programmes developed by Member States for the 2020-2027 period. These tend to have a considerable influence over what is prioritised in spatial development at national, regional and local levels.

There is still much ground to win within the *EU finance domain* given that the majority of European banks and insurance companies have not yet adopted sustainability as one of their core values. By implementing the measures proposed in the Action Plan 'Financing Sustainable Growth', the EU is planning to further propel sustainable investment. A particularly important action that the EC is planning to implement is the EU Taxonomy. This provides an agreed framework – effectively a certification system – of sustainable investment options for different sectors and activities. It is expected that this will stimulate the green bond market in the EU, where it is easier for public authorities to access private funding for sustainable investment (e.g. in large-scale green infrastructure). Along with showing the sustainable investment options, there is also a need for highlighting the (climate-related) risks of not investing sustainably, which is where the TCFD regulation could play a role, particularly if appropriate support is provided to organisations interested in implementing this. Additionally, initiatives (co-) developed by networks of financial institutions themselves, such as the recommendations by NGFS to mitigate climate-related risks, or the Water Fund in Mexico City, are also likely to make an important contribution. A caveat associated with the EU's push to sustainable finance is, however, that largescale investment in NBS as a sustainability measure remains unlikely provided that returns on investment cannot be demonstrated. The uncertainty around NBS benefits is a known barrier to investment, as shown in the overviews for the different countries above, which is why improved and universal indicator frameworks could be key to NBS mainstreaming. The need for this has also been recently stressed by European Commission, the Intergovernmental science-policy Platform on Biodiversity and Ecosystem Services (IPBES) and the Convention on Biological Diversity (CBD). In addition, there remains a need for public investment in NBS delivering non-instrumental (e.g. biodiversity) value. An opportunity would be the proposal of CoR to investigate options for financing biodiversity solutions, which would complement current climate finance recommendations. Another challenge is that many of the EU funds require match funding, and therefore commitment and resources at the local level, to get NBS off the ground. Co-investment by the private sector, e.g. the insurance industry to manage risk, could help to address this.



4. DISCUSSION

The above country-specific overview of conditions, barriers and opportunities influencing the uptake of urban NBS shows that urban NBS are implemented across all studied countries, but that the actors, structures and processes contributing to this vary between countries and the EU. This section will provide an overview of the main conditions influencing urban NBS uptake and highlight the relative contribution of the regulatory, urban development and finance domains. Where relevant, comparisons between countries are also drawn. This is followed by an overall analysis of how each of these are influencing opportunities to address barriers for improved uptake. Next, an analysis is made of what stepping stones seem most promising for accelerating the uptake of NBS in urban societies.

4.1 STRUCTURAL CONDITIONS, BARRIERS AND OPPORTUNITIES FOR URBAN NBS UPTAKE

This study found that in all countries, with exception of Hungary where overall adoption of NBS is low and no leading domain could be identified, the **regulatory** domain was the main driver of urban NBS uptake. This was achieved through a range of direct (e.g. green roof subsidies) and indirect measures (e.g. investment in NBS valuation tools). This finding can be explained by the responsibility of urban municipalities for detailed and comprehensive planning whilst also taking the initiative to develop NBS on public land and facilitating non-governmental actors to invest in NBS through financial support, public procurement regulation and knowledge sharing. In addition, public entities within this domain have a greater and broadly shared commitment to sustainable urban development than witnessed regarding the urban development and finance domains. Moreover, the regulatory domain is much more directly influenced by knowledge institutions and civil society than the urban development and finance domains, which provide vital expertise and advocacy regarding NBS. It was, however, noteworthy that the level of civil society engagement regarding urban NBS is much higher in some countries (the UK, Germany, The Netherlands) than in others (Sweden, Spain, Hungary). Those countries with high civil society engagement often were also advanced regarding public-private partnership working for urban NBS. This matched with a particular role of national government as a 'facilitating' (rather than regulating) actor, supporting partnership working through, for example, Green Deals (The Netherlands) on innovative solutions and business models. In these countries we also witnessed a strong national government buy-in to concepts such as green growth, natural capital and ecosystem services, as reflected in e.g. the funding of ecosystem services assessment tools (The Netherlands) or advisory committees on the value of natural capital to

the national economy (the UK). Such a government position also went hand-in-hand with a trend of municipal budget cuts, 'lean' government and decentralisation of environmental policies, identified as significant barriers to urban NBS uptake.

We found evidence that the uptake of urban NBS was also related to the governance structure of a country. Those that adopted national-level plans directly touching upon the need for urban NBS and/or urban green infrastructure delivery (Germany, Sweden), rather than devolving the responsibility for (urban) nature (The Netherlands), appear most successful in legitimising NBS as an urban sustainability measure. At the same time, the development of a national or EU-level plan highlighting the need for urban NBS is likely to be ineffective if there is a lack of harmonisation between different plans and policies relevant to urban development (EU, Germany), no legal mandate to enforce policies (EU) or an absence of associated policy instruments to create buy-in of both planning authorities and non-governmental actors (Hungary). The lack of direction provided by national government can to some extent be compensated by ambitious policy-making at lower levels of government but tends to result in profound variation in the level of urban NBS uptake between cities (Spain), or even city districts (Budapest, Hungary), depending on local political leadership. Some municipalities are actively engaging in knowledge exchange on urban NBS with other cities in (inter)national city networks (e.g. Communities for Biodiversity in Germany), which supports the integration of NBS into urban development.

Governments acting as frontrunners and influencing others in incorporating sustainability considerations into their decision-making regarding construction and investment is also key to urban NBS uptake. For example, the MKB housing association, owned by Malmö municipality, is investing in NBS such as green roofs in Malmö (Sweden), while the Swedish National Pension Fund (AP Funds) can only invest in funds with high environmental and ethical standards. Regarding the latter, recently introduced legislation mandates asset managers to take sustainable development into account through e.g. divestment in polluting companies. Furthermore, public investment banks translate government policy into financial instruments that stimulate underlying investment, for example for green roofs (Germany) or energy-efficient buildings (The Netherlands). The leading role of the regulatory domain in urban NBS development does not imply that actors in this domain are doing enough to stop the decline of urban nature or that not still more nature is lost than created in and around cities. For example, while the EC has championed the concepts of urban green infrastructure, ecosystem services and NBS, and developed a swathe of relevant legislation, policies and voluntary and economic instruments incentivising their uptake by cities in the Member States, progress is undermined by policies and investment strategies that prioritise activities that adversely affect the capacity to accelerate the uptake of urban NBS.

Generally, this study found that there is strong variation between cities, more so than between countries, in the extent to which they invest and prioritise urban NBS. Also the types of dominant NBS vary, with some cities investing in green infrastructure and green belts, and others prioritising structural greening such as green roofs or creating community gardens or naturalised grassland, often from a cost-saving perspective or as a response to competition for urban space. Such trends depend on political leadership, but also factors such as available expertise, urban density and the ratio of house ownership to rental and social housing.

Increased uptake of urban NBS will not be possible without addressing barriers in the **urban development** domain across the entire value chain that is involved in 'building cities' – planning, design, construction, maintenance, and operation. Our study identified several opportunities in this domain to enhance NBS uptake and overcome barriers. A key finding is that collaborative learning can address challenges to NBS mainstreaming such as disconnected silos and knowledge gaps about NBS. Often, perceived knowledge gaps stem from a lack of integration across disciplines and a lack of familiarity with NBS knowledge related to other disciplines (e.g. architect, planner, ecologist, highway engineer) (Hungary, Sweden). Collaborative learning builds capacity for stakeholders to work together and integrate knowledge and can take place through pilot projects, public-private co-funding, and/or formal processes. Urban development projects involve a wide range of expertise, but nature expertise is usually consulted during the final stages of project design. Instead, making wider use of 'design charettes' or other collaborative models of project planning where diverse professionals interact more directly could open more opportunities for NBS.

Technological and grey infrastructure sustainability solutions in urban development are often preferred over NBS and reinforced through urban development practices that prioritise quantitative data and engineering expertise. There were numerous references to the need for more quantified evidence on NBS impact and, at particular stages of the development processes, improved quantified data on NBS could be influential in determining whether or not NBS are incorporated. However, it is also important to find ways to accommodate the increased uncertainty inherent in NBS since their performance and design is contingent on local conditions. Knowledge practices related to the calculation of risk in project development favour grey engineering solutions (UK) and quantification of data still does not level the playing field.

Creating and capitalising on demand for sustainability solutions is another opportunity to increase NBS uptake. NBS proponents can target stakeholders that value a green reputation as a way to increase the integration of NBS into urban development (Sweden, Spain, Germany, UK). One method is to increase the prominence of NBS in sustainable building certifications such as LEED, BREEAM, DGNB, and WELL, which are in widespread use in several of the cases (Germany, Sweden, The Netherlands, Hungary). Positioning NBS as high quality green space with sustainability benefits for residential and commercial buildings may continue to increase NBS uptake since urban development stakeholders are responsive to 'green' demand from clients and tenants (Sweden, Germany). Customer demand for urban NBS, often at a price-premium, is now firmly recognised in wealthy countries such as Sweden and The Netherlands, leading to firms in this domain specialising in the development of nature-inclusive neighbourhoods. The findings also point to the importance of targeting urban development actors engaged in long-term thinking about urban buildings and infrastructure since many of the benefits of NBS accumulate over long timelines. Urban development stakeholders recognised that organisations intending to own building or infrastructure assets for decades (e.g. public/social housing) had more motivation to pursue sustainability initiatives with long-term benefits, such as NBS (Germany, Sweden). In addition, the study found that infrastructure stakeholders are becoming more interested in urban nature. There are opportunities to integrate NBS into planned infrastructure projects or infrastructure maintenance, which would allow for the integration of NBS into existing investments rather than requiring new investments. There are examples of young firms innovating with new urban NBS in the studied countries (e.g. the nature-inclusive water treatment facilities developed by Biopolis in Hungary), often supported by government incentives. If such innovations prove cost-effective and scalable, the role of the urban development domain in urban NBS uptake could be greatly increased.

In addition, urban development stakeholders working to implement NBS found that policies do not have to be specifically focused on NBS in order to present opportunities for NBS uptake. Urban development stakeholders found success by positioning NBS as a solution within a related policy paradigm (e.g. ecosystem services, circular economy, climate change etc.). In particular, significant climate change impact events (e.g. flooding, heat wave) created a new focus on retrofitting the existing city for climate change adaptation, which presented opportunities to mainstream NBS as a climate adaptation solution (EU, UK, Sweden, Netherlands).

The finance domain has a large unmet potential of contributing to the uptake of urban NBS by providing finance, in particular from the large, mainstream commercial financial institutions. The majority of banks, insurance providers, and other types of institutional investors (e.g. pension funds), are still investing based on a low-risk, high-returns philosophy, where sustainability considerations are taken into account only at a superficial and standardised level. Our study, however, established that an increasing number of financial actors are attempting to increase their share of sustainable finance and investment, while financial return remains non-negotiable. The sustainable banks operating in each of the studied countries are leading the way by only investing in activities that generate a positive social and environmental impact, often requiring a lower financial return. Public sector banks also tend to invest sustainably, supporting the implementation of government policy. However, in many of these cases, sustainable investments do not prioritise urban NBS as an investment target, due to the lack of standardisation and scale of these investments. Instead, climate mitigation (renewable energy, energy savings) are often prioritised. The lack of evidence and indicators to quantify the benefits of urban NBS is an oft-mentioned barrier for lack of investment (versus the one-size-fits-all indicator of CO₂ emissions, for example).

There are several promising opportunities in the finance domain that could drastically increase the amount of finance available for urban NBS. One, mitigation of climate-related risks by financial institutions can be an important rationale for investments into urban NBS. Climate risk is increasingly being viewed as ‘material’ and ‘systemic’, meaning that they can and will affect financial portfolios in a negative way at a global scale. Without having to change regulation, the re-framing of climate risk as ‘material’ and ‘systemic’ by Central Banks and regulators requires financial institutions to report on these risks. The Taskforce on Climate-related Financial Disclosures (TCFD) was advocating for this at a global scale, and the EU is mandating financial institutions in Europe to make the climate exposures in their portfolios transparent. Since higher risk carries a price for financial actors (higher cost of capital, lower ratings, lower expected financial returns), the value of urban NBS increases if this lower climate risks, making large-scale investments into urban NBS more attractive. This is particularly true for the insurance sector, which is directly affected by climate risks and costs through their liabilities and therefore have a lot of ‘skin in the game’. Engaging insurers more actively poses a specific opportunity because they are well positioned to raise awareness on risk mitigation with their customers, and they collect granular data collection on actual damage costs that can establish the value of (and stimulate investment into) mitigating measures such as NBS.

Finally, biodiversity is starting to show up on the radar of some financial institutions, both from an impact and a risk perspective. The European Investment Bank is pioneering Natural Capital investments through its Natural Capital Finance Facility Pioneers like the Dutch ASN bank have chosen biodiversity as a central objective of their investment policy.

4.2 Stepping stones for mainstreaming urban nature-based solutions

Taking into account the barriers and opportunities for mainstreaming NBS presented in this report, a final step in this research was to identify relevant stepping stones, or leverage points, for mainstreaming urban NBS. To this end, a generic list of stepping stones drawing across the empirical material generated for the regulatory, urban development and finance domains was prepared (Table 5). This overview serves as the basis for making recommendations for improved mainstreaming of urban NBS depending on the barriers and underlying conditions specific to a country. The method adopted to derive the stepping stones for mainstreaming urban NBS along with a break-down of these stepping stones into sub-actions is provided in Appendix 3. The present research provides indications that some of these stepping stones apply to nearly all of the cases whereas others are mostly relevant in a single or smaller group of countries, which we illustrate with some examples below.⁸

The stepping stone ‘Provide a public mandate’ as well as the closely related one on ‘Regulate for No Net Loss’ are among the key recommendations relevant to all of the cases studied for this research. This category covers the mandatory implementation of urban NBS (e.g. mandatory green roofs for new urban development in German cities), but also measures providing a competitive advantage to proposals for urban NBS (e.g. Green Space Factor in Sweden, the UK & Germany or ‘green’ procurement regulation in Spain) and urban greening strategies, including particular objectives (e.g. around greenspace quantity, quality or accessibility), at different levels of government (e.g. the White Paper ‘Green Spaces in the City’ in Germany or Barcelona’s ‘Program for Promoting Urban Green Infrastructure’). This stepping stone is relevant to all national contexts because many of the barriers influencing the uptake of NBS such as a siloed governance approach in urban municipalities, budget cuts for urban nature and low engagement of the private sector could to some extent be addressed by taking such an approach. In addition, this would facilitate co-investment by the urban construction sector which is still often prioritising grey over green infrastructure given uncertainty about the performance of urban NBS and lack of regulation to reduce their impacts on the immediate natural environment. The stepping stone ‘Regulate for No Net Loss’ is a specific example of a mandatory measure that has strong potential to counteract the current dominance of grey infrastructure in urban development, particularly if new developments need to deliver biodiversity net gain as recently mandated in England. At the

⁸ Note, the below discussion only touches upon a subset of the 20 stepping stones for explorative purposes. The role of national context in influencing pathways for mainstreaming urban NBS, made up of different combinations of stepping stones, will be more systematically explored in the final Project Report ‘Steps for Systemic Integration of NBS’, which is due by November 2020. This report will also provide more detailed descriptions of each of the 20 stepping stones along with detailed examples.

Table 5. Master list of stepping stones and their description.

Number	Name	Description
1	Provide a public mandate	The mainstreaming of nature-based solutions can benefit from policy-makers and investors giving a clear mandate for nature-based solutions to be included in urban development through tender and procurement policies, policy instruments (e.g. land use planning guidance), and where possible mandatory regulation.
2	Regulate for No Net Loss	No-net-loss / net gain regulation for urban nature (biodiversity) has the potential to generate greater interest in nature-based solutions across Europe. Developing harmonised regulation across Europe with strong monitoring and sanctioning to increase effectiveness has the potential to support nature-based solutions mainstreaming.
3	Include in contractual re-quirements	Utilities (e.g. water, waste, energy) and network service providers (e.g. road and rail authorities, waterway authorities) are either publicly owned or operate on long-term contracts that are bound by regulatory requirement for service provision. Including nature-based solutions as required for the delivery of mandated functions (e.g. water quality treatment) or for the upkeep of land-holdings (e.g. train sidings, roadside verges) provides an important avenue for mainstreaming.
4	Align with strategic priorities	Positioning urban nature-based solutions as generating benefits for prioritised policy goals through generating narratives and evidence (i.e. climate change mitigation & adaptation, circular economy and healthy urban living) can widen their relevance and community of practice.
5	Create intermediaries	In order to overcome institutional silos within both public and private sector organisations, new organisational forms that work across these divisions are required. Inter-mediary units can either be established within organisations or outside (by external bodies) and provide co-ordination between departments as well as platforms for innovation.
6	Generate partnerships	Stimulating partnerships between public, private and third sector organisations for the co-design, development and maintenance of urban nature-based solutions is critical for generating initial action on the ground and increasing support for mandatory urban greening policies.
7	Establish demonstration projects	Demonstration or pilot nature-based solutions projects, often involving research, can create shared learning and knowledge development as well as providing tangible demonstrations of how nature-based solutions can work in practice, creating confidence amongst partners about their potential.
8	Engage insurance sector	Engage the insurance sector to support upscaling of urban nature-based solutions based on their risk reduction needs and damage cost expertise
9	Facilitate community-based action	Facilitate and support community-based action for local urban nature-based solutions through improving citizen awareness and support
10	Provide economic incentives	Provide economic incentives (tax cuts, subsidies) to support the development and up-take of nature-based solutions
11	Develop markets	Positioning nature-based solutions as a sustainability solution offering wide societal and reputational benefits can support the development of demand for nature-based solutions projects which in turn can stimulate supply
12	Build co-financing arrangements	Build governance arrangements between the public and private sectors to enable co-funding for nature-based solutions development and maintenance
13	Work with investment cycles	Integrating urban nature-based solutions into infrastructure projects and renovation cycles increases their (multi)functionality and can save costs by reducing the need for additional outlay and drawing on existing budgets
14	Stimulate institutional investment for risk reduction	Institutional investment for urban nature-based solutions is likely to be forthcoming based primarily on their climate risk reduction value (adaptation and mitigation), and specific data/modelling may be required to realise this potential.
15	Target areas of low land value	Nature-based solutions can face competition from other land-uses which provide a higher return on investment. Using urban space with a lower value can suit some forms of nature-based solutions and provide a more cost effective means of urban greening (e.g. street green, pocket parks and building-integrated green)
16	Improve data & monitoring	Mainstreaming nature-based solutions will require the development of evidence on their performance urban nature-based solutions, through the use of 'big data' and new assessment tools that can support effective monitoring, evidence-building and assessments of their effectiveness in addressing key urban goals
17	Advance valuation models	Making the case for nature-based solutions requires that we develop and disseminate valuation models that specify the different (monetised) benefits and costs of nature-based solutions, to facilitate public and private investment decisions.
18	Grow practitioner expertise	Make practitioner-oriented expertise on urban nature-based solutions available to facilitate integration of nature-based solutions in the actual urban development process (i.e. practitioner guides and collaborative design).
19	Incorporate in green investment products	Include urban nature-based solutions into (existing and new) green/ impact/ sustainable investment products in order to enable projects to access this source of finance.
20	Promote certification schemes	Integrate urban nature-based solutions criteria into green certification schemes, in particular for buildings, based on recognition of the contribution nature-based solutions can make towards sustainability goals.

same time, this stepping stone may not be feasible in all contexts, especially when nature policy is decentralised, when there is no legal mandate to enforce policies (EU) or when there is limited buy-in to the NBS mainstreaming agenda from politicians.

Another stepping stone with high potential impact across a range of different contexts is to 'Grow practitioner expertise'. This follows from the observation that actors in the regulatory, urban development and finance domains were widely reported to lack expertise on the potential values of NBS, but also on how to finance or implement NBS in cost-effective ways. This is related to their nature as multifunctional innovations that do not neatly match the expertise specific to an established professional discipline or policy domain, but also to enable an adequate fit with place-specific conditions affecting the delivery of those values. This stepping stone is likely feasible across many contexts because this guidance could be either prepared by governmental departments and public agencies such as in Germany or by municipal networks (e.g. The Network of Local Governments + Biodiversity in Spain). Moreover, practitioner expertise in the urban development and finance domains is likely best shared through industry-specific networks (e.g. the KAN initiative by i.a. NEPROM in The Netherlands or the NGFS partnership aiming to green the European financial system) in order to adapt messages to the dominant rationales and institutionalised discourses within relevant sectors.

In all of the studied countries, we established an important opportunity around more institutional investment in sustainability by such actors as pension providers, insurance providers and banks. And even if sustainable investment by such actors was taking place, this was usually not channelled to urban NBS given its many diffuse and distributed values. Therefore, the stepping stone of 'Incorporate in green investment products' was also found to be relevant across a range of countries. Institutional investment in urban sustainability could benefit from the financial sector providing greater transparency on the sustainability of their funds (e.g. EU Taxonomy initiative). Investment in urban NBS specifically could be aided by the development of investment funds linked to natural assets (e.g. following the example of the Natural Capital Investment Plan in Manchester, UK). The impetus can come from the financial sector itself as a strategy to mitigate risk to their investment portfolios but there is also an important role to play by actors in the regulatory domain in requesting public investors to make more sustainable investment decisions, which is why combining this stepping stone with that on 'Stimulate institutional investment for risk reduction' is likely to further leverage institutional investment in sustainability. This could be achieved through voluntary measures such as the EC's TCFD framework providing a framework for disclosing information about climate risk, but also by mandatory measures such as the requirement imposed on the Swedish national pension fund to invest in sustainable industries.

In order to increase the attractiveness of urban NBS for public and private investment and outline its relevance for multiple policy goals, the two stepping stones 'Improve data and monitoring' and 'Advance valuation models' are relevant to a broad range of countries. Out of the studied countries, The Netherlands appears particularly advanced regarding ecosystem services valuation regarding urban development scenarios (TEEB City tool and Green Benefit Planner), although the uptake of such instruments appears rather limited. This calls for further improvements to tools (e.g. user-friendliness; taking into account area-specific sustainability challenges) as well as better understanding of how such tools could be integrated into urban governance processes that likely vary between countries. Related to this, there is also a need for improved metrics and monitoring (e.g. the Defra Biodiversity Metric in the UK) to ensure that biodiversity offsetting or net gain measures are implemented in a way that is truly to the best interests of wildlife and habitat conservation.

Examples of more context-specific stepping stones were also established. For example, Sweden and The Netherlands were among the countries with highest customer demand for sustainable living, resulting in customers willing to pay a price premium for living in a sustainable neighbourhood. In those contexts, the stepping stone of 'Develop markets' is especially relevant, which could be achieved through effective 'branding' of urban NBS as an important element of sustainable and healthy living. Likewise, in countries with a strong culture of participation by the private sector and lobby organisations in urban governance, the scope for the stepping stones 'Provide economic incentives' and 'Generate partnerships' is particularly high. For example, the Green Deal Green Roofs was a partnership, facilitated by the Dutch government, between a broad range

of public, private and civil society actors to stimulate green roof uptake. Among other activities (e.g. co-creating & sharing knowledge), the partnership lobbied for economic incentives to increase demand, such as the reduction of water authority tax rates. The stepping stone 'Engage the insurance sector' is similarly mostly relevant in those countries that are home to large insurance firms and with high customer demand for insurance. This is much more the case in The Netherlands and Germany than in Hungary, where the market is dominated by foreign insurance firms.

Another one of the rather more context-sensitive stepping stones is to 'Align with strategic priorities', for example through grant funding programmes stipulating a requirement for proposals to deliver both urban greening and economic regeneration (e.g. Urban Development Funding in Germany). Ultimately, mainstreaming urban NBS requires a need for more holistic planning of the urban environment, using an approach that transcends current boundaries between policy domains. However, such an approach carries strongest potential for those countries where there is a strong push toward policy development and enforcement on related topics such as climate change adaptation, biodiversity conservation, social justice or urban regeneration, which was more clearly the case in the EU, Sweden, Germany and the United Kingdom than in the other studied cases. This stepping stone closely ties in with 'Create intermediaries', which are organisational forms enabling a variety of policy domains to operate in more synergistic ways, e.g. following Barcelona municipality's newly created Urban Ecology Directorate bringing together different policy domains.

A final example of a context-specific stepping stone is to 'Facilitate community-based action' to improve urban NBS uptake, including activities such as setting up municipal support structures for active citizens and environmental awareness campaigns. We found that a number of studied cases (The Netherlands, Germany, the UK) are relatively advanced with this through e.g. citizen groups managing urban nature, whereas in other countries (Spain, Sweden, Hungary) such practices were less commonplace. This can be explained by e.g. either very high trust in government (Sweden), limited empowerment of civil society by different levels of government (Hungary) or limited citizen awareness of NBS values (Spain). Depending on context, different activities would likely have different pay-offs. For example, environmental awareness campaigns could address the barrier of limited citizen awareness in Spain but are unlikely to increase citizen engagement much in a country like Sweden.

Interestingly, this study also reveals a number of stepping stones that are likely more relevant to some types of NBS than to others. For example, the stepping stone 'Promote certification schemes' is mainly relevant for NBS such as green roofs than can be attached to buildings, but less relevant for larger-scale NBS such as green infrastructure, blue areas or community gardens. Future research is needed to further explore how stepping stones relate to specific types of NBS.



This study demonstrates how the uptake of urban NBS in different European countries and at the EU level is influenced by a variety of barriers and opportunities and their underlying conditions across three broad domains: the regulatory domain, the urban development domain and the finance domain. This confirms that a broad system perspective is required to understand the mainstreaming potential of urban NBS. We showed how the current impetus for developing urban NBS is mainly coming from national government, municipalities, knowledge institutions and civil society, clustered under the **regulatory domain**. This finding applied to six out of seven cases, whilst for Hungary the positive contribution of the regulatory, urban development and finance domains was more difficult to judge given that, despite the very best efforts of actors involved, less multifunctional urban nature seemed to be created than lost.

Although in general the regulatory domain is important to increase uptake of urban NBS, there are also clear counterforces, either because of an absence of vision or objectives regarding this topic or because 'progress' in other policy areas (e.g. agricultural output, economic growth) is prioritised. In some cases, there was also a general lack of societal awareness regarding the value of urban NBS or the engagement of civil society in co-designing NBS, or policies influencing these, was low. The engagement of knowledge institutions in the development of policy and demonstration projects was profound in nearly all studied cases, although Hungary is characterised by a relatively closed hierarchical governance system.

Actors in the **urban development** (e.g. construction companies or infrastructure providers) and **finance** (e.g. banks or insurance companies) **domains**, generally did not prioritise sustainability, let alone regarded urban NBS a sustainability measure potentially delivering a high return on value. This is because of a complex combination of factors including the lack of ambitious government regulation in this area and limited championing of NBS as a sustainability solution, lack of transparency on sustainability of investment portfolios and no broadly agreed way of measuring this, limited integration of NBS in sustainable building certification, the dominant high-gains, low-risk operating paradigm, sunk investments, the perception of limited market demand, the challenge of creating economies of scale (i.e. standardisation) around place-sensitive innovations such as NBS, the dispersed values of NBS, many of which are delivered over long time horizons, the difficulty of monetising some of the NBS values (e.g. social or biodiversity benefits), and the inability to adequately assess the value delivery of NBS in general.

In most countries the urban development sector had come to recognise the increasing market demand for urban NBS, leading to a trend for consultancies and contractors specialising in this area. Other urban development actors with social or sustainability mandates have started to integrate NBS (e.g. public housing). Pilot projects were allowing urban development actors to learn collaboratively about NBS in ways that challenged the dominance of grey infrastructure. Similarly, the financial sector, driven by (networks of) sustainable banks (i.e. market demand), Central Banks, frontrunners in the insurance sector, and voluntary policy instruments to increase transparency, is increasingly considering climate-related risk in their investment decisions. To some extent, it is also actively monitoring and sharing knowledge on climate-risk with businesses, municipalities and citizens about these risks or even providing financial incentives for sustainability measures such as green roofs. However, this remains the exception rather than the rule.

Building upon identified barriers and opportunities for NBS uptake, this study also identified 20 prominent stepping stones for mainstreaming urban NBS. These include key actions that are broadly relevant across a range of contexts such as providing a public mandate, growing practitioner expertise, incorporating NBS in green investment products and advancing valuation models. Other stepping stones bore higher relevance for some cases than others. For instance, facilitating community-based action is mostly relevant when citizens show high interest in urban greening for sustainability and there is a high demand for increased engagement in public space management. (e.g. community action), which could justify investment of scarce resources in other types of stepping stones. Therefore, this study moves beyond the notion that there are fixed pathways to mainstreaming urban NBS. Instead, a context-sensitive approach to providing recommendations should be taken.

The regulatory, urban development and finance domains were found to be intertwined and mutually influencing each other. Therefore, the actions nested within any particular stepping stone do not pertain to a single actor group. For example, while the stepping stone 'Provide a public mandate' demands action within the regulatory domain through alternative regulation and visioning, it intends to bring about behaviour change across the urban development and finance domains as well. Likewise, a rather specific stepping stone like 'Promote certification schemes' for sustainable building and the integration of urban NBS within these is aimed at influencing the urban development domain, but will also likely implicate the finance and regulatory domains given that these own, utilise and/or finance a significant amount of real estate.

In sum, this research found that urban NBS are still predominantly advanced by the usual suspects: the municipality, knowledge actors and civil society. However, actors in the urban development and finance domains are increasingly recognising the need to co-invest in urban NBS to help build a sustainable future for themselves and society. There is a variety of ways in which the EU, different countries, regions, and cities are aiming to facilitate the uptake of urban NBS. This research exposed many innovative and fascinating approaches by highly committed and creative people. We hope that by communicating about their endeavours and ideas, and structuring these in a framework of stepping stones, this research will contribute to making our cities more inclusive, communal and climate-resilient places for both people and wildlife.

APPENDIX 1: STRUCTURAL DIMENSIONS

Below we provide an overview of structural dimensions used in this research and their operationalisation (also see the Research Analysis Protocol.⁹ Figure A1 shows the analytical approach to study these dimensions for each of the regulatory, urban development and finance domains. The present Project Report provides an analysis of the full urban infrastructure regime by drawing across each of these three domains and all of the dimensions.

Figure A1. A conceptualisation of the urban infrastructure regime structure

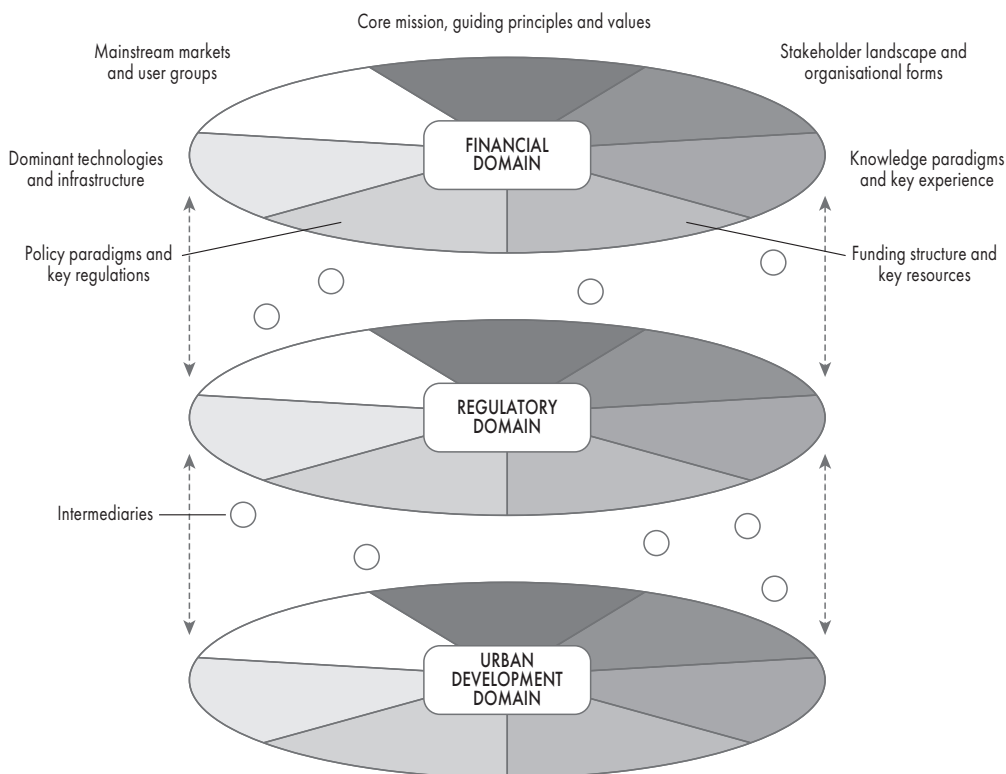


Figure A1. The analytical approach to studying the urban infrastructure regime, drawing upon findings from the regulatory, urban development and finance domains and underlying dimensions. The circles in between the three levels in the figure depict intermediaries active across different domains in this regime.

1. Core mission, guiding principles and values

We define this as the main sustainability targets and/or priorities articulated in the regulatory domain. The starting point for analysis will be (qualitative/quantitative) targets and priorities articulated by the national government and relevant ministries as well those from relevant public bodies advising the government and managing the natural environment (e.g. Natural England). The reporting on this dimension includes a description of the main rationale and focus in recent national strategies and their sustainable development priorities. We expect that the main data source is *desk study*. This dimension does not go into a detailed analysis of specific policies (which is part of 'policy paradigms and key regulations'). We expect to include relevant excerpts from strategic documents to highlight the country's sustainable development targets as well as the role these play in national development. We describe if the documents refer to 'nature-based solutions' or similar terms such as 'nature-based innovation', 'ecosystem-based adaptation' or 'green infrastructure' and whether and how these are explicitly linked to / framed in relation to sustainable development targets. *Interviews* and *placements* serve to find out more about the relative priority of sustainable development vis-à-vis competing interests such as the development of grey infrastructure including roads and housing, and how these priorities are shaping decision-making processes in the regulatory domain.

2. Stakeholder landscape and organisational forms

We refer to the stakeholder landscape as the roles and responsibilities (statutory duties) of relevant government departments and public bodies sponsored by government in shaping or challenging the sustainable development agenda, as well as the formal and informal rules that shape their interaction. The *desk study* will serve to get an initial overview of actors, partnerships and influential networks. *Interviews* and *placements* will serve to identify the roles of lobby organisations, key advocates (e.g., Al Gore for climate change) and/or key events (e.g., flooding events) pushing the political debate either in favour or against sustainable development, and the ways in which informal rules such as role expectations shape policy interactions regarding sustainable development. We also will explain the strategies used by advocates (e.g., campaigning, lobbying, experimenting) that are less effective in influencing the public debate. All three data collection methods serve to identify the extent to which decision-making powers have been delegated/devolved to lower (regional or local) levels, the role of citizens in decision-making and whether there is much variation between regions in sustainable development targets and actions as a result.

3. Knowledge paradigms and key expertise

We refer to knowledge paradigms and key expertise as the (expert) knowledge that is used to inform the development of legislation, policies and regulation, and the kinds of expertise (such as participatory skills or cost-benefit analysis) that shapes decision-making processes in the policy arena. The *desk study* may refer to particular studies and statistics that have informed the development of sustainable development targets and/or policies that are conflicting with this. The *interviews* and *placements* may provide insight into the complementary role of discourses and popular beliefs favouring certain knowledge perspectives over others, and explore explanations. In addition, they will shed light on who is providing what knowledge for developing sustainable development agendas. For example, what is the role of ecologists vis-à-vis construction companies in developing environmental assessment frameworks? Finally, this section also covers knowledge dissemination (what information is shared through which channels?) by government influencing understanding of sustainable development and/or sustainable behaviour of organisations and the general public.

4. Funding structure and key resources

We define funding structures and key resources as the instruments utilised by (different layers of) government to raise capital for the development, implementation and long-term net-worth of nature-based solutions and/or other sustainable development approaches, vis-à-vis investments and resources available for conventional urban development. These include direct government investment, supporting the trade of ecosystem products and/or services, grant schemes, favourable land purchase schemes, tax breaks etc. This also includes an analysis of how such resources are provided, i.e. on which actors the government is depending for regulating and supporting sustainable urban development. A *desk study* may reveal relevant instruments for resourcing NBS while *interviews* and *placements* are likely to help build an understanding of the effectiveness of these instruments, and gain insights in the challenges related to securing sufficient resources. It would be relevant to not only describe the types of instruments available, but also what kind of NBS (size & type) these promote, and if this varies between locations and landowner types (public or private).

5. Policy paradigms and key regulations

We refer to policy paradigms and key regulations as the key policies and regulations relevant to sustainable urban development. For the regulatory domain, this dimension is closely tied to the dimension of 'core mission, guiding principles and values'. The main difference is that whereas the 'core mission' dimension is mainly concerned with extracting sustainable development priorities and beliefs, this dimension is concerned with describing *if* and *how* these have been converted

into policies, planning/building regulations and legislation. The *desk study* and the report on ‘Nature-based solutions in European and national policy frameworks’ (D1.5) provide insight into relevant policy documents at EU and national level. These policy documents need to be listed along with relevant details on their role in driving sustainable development. This also applies to relevant planning and legal requirements. The *interviews* and *placements* serve to better understand the impact of policies and regulation on activities that are happening on the ground, and the ways in which these are enabling or constraining decision-making processes on sustainable urban development in the regulatory domain. It would be relevant to distinguish between different kinds (size & type) of NBS, different landowners and different locations.

6. Dominant technologies and infrastructures

‘Dominant technologies and infrastructures’ is a generic category related to technologies, material features and physical geographies that could influence the government’s decision-making on sustainable development. For the regulatory domain we expect this dimension to also be closely related to the ‘knowledge paradigm and key expertise’ dimension, as well as to other dimensions. For instance, particular dominant knowledge perspectives on sustainable development, such as neo-liberal market approaches, have both a knowledge paradigm component as well as a material component, embedded in the fundamental structure of tools and models used in decision-making processes, often the results of decades of developments. The existence of such models may provide material constraints or set particular conditions for the assessment of sustainable urban development. Highlighted aspects could vary from adopted assessment frameworks for sustainable urban development to the extent of established (non-)sustainable industries (e.g., transportation or fossil fuel production) in a country and the physical location of government departments influencing the degree to which their staff are exposed to certain sustainability challenges (e.g. flooding or heat stress). An initial overview of relevant information on technologies adopted by the government and/or infrastructures it is seeking to protect or promote could be extracted from the *document analysis*. *Interviews* and *placements* will contribute to the development of a more detailed understanding of how these aspects affect decision-making.

7. Mainstream markets and user groups

We refer to ‘mainstream markets and user groups’ as the perceived demand for sustainable development by users/citizens/customers, and the ways in which these perceptions shape decision-making processes in the regulatory domain. This includes an analysis of the perceived challenges and discourses in the policy arena regarding the organisation of markets, (gaps in) supply and demand, the engagement of private actors and the development of (new) markets. The *document analysis* will identify key beneficiaries of sustainable urban development and specifically NBS (e.g., communities, businesses, city administrators) and the ways in which perceptions of such beneficiaries and their ‘needs and demands’ shape decision-making processes regarding policies and regulations for sustainable urban development. Extracts from documents such as policy white papers and policy-analysis reports are expected to be relevant. *Interviews* and *placements* will provide insight into the effectiveness of current marketisation approaches and business models and explore if and why sustainable urban development, and in particular NBS types or user groups, are present or missed out.

APPENDIX 2: PLACEMENT REPORTING FORM

Appendix 2. Placement Reporting Form

PLACEMENT ORGANISATION	
Placement Organisation	
Date(s) of visit	
Placement Agreement (Agreed expectations and goals	
Main activities of researcher	
Researcher	

DATA ON ORGANISATION

[PROVIDE INFORMATION ON FUNCTION IN DOMAIN, GENERAL CHARACTERISTICS (SIZE)]

KEY OBSERVATIONS

[INSERT KEY OBSERVATIONS ON DAY-TO-DAY DECISION-MAKING – E.G. WHICH REGIME DIMENSIONS WERE MOST CLEARLY INFLUENTIAL AND IN WHAT WAYS.] Insert notes and narratives on observations from entry and exit talks as well. These talks can be used as interview for the case study. If that is the case, please treat these talks as regular interviews and use this space to provide your own observations on the organisation and impacts made (also see below)]

Impact (optional)

If your placement had impact, please use the table below to describe these. In addition, provide a brief narrative explaining the impact. Please include evidence of this impact, if available (e.g. copies of policy documents or meeting minutes showing influence on decision-making).

Which objectives has this output / activity contributed to, through which pathways? Tick those which apply.

	BUILDING CAPACITY	ENABLING UPTAKE	CULTURAL CHANGE
Impact Objective 1: Develop enhanced strategies, institutions, governance arrangements, business models and Citizen engagement in cities			
Impact Objective 2: Kick-start a collective learning process on NBS in cities			
Impact Objective 3: Develop the integrated evidence base needed to support the development of a green economy on NBS			
Impact Objective 4: Optimise policy, regulatory & administrative frameworks for the mainstreaming of NBS			
Impact Objective 5: Shift flows of public & private investment towards inclusion of NBS			

Narrative

APPENDIX 3: METHOD USED FOR IDENTIFYING STEPPING STONES

First, we identified stepping stones for the regulatory, urban development and finance domains separately – see overviews provided in previous Project Reports.¹⁰ This resulted in a total of 48 stepping stones (regulatory: N=21; urban development: N=11; finance: N=16). Second, this was clustered into a generic list of 20 stepping stones drawing from across the regulatory, urban development and finance domains in order to address overlaps between the recommended actions across the three different analyses. In order to achieve this, the three leading researchers (one for each domain) independently grouped the domain-specific stepping stones into broader clusters of related actions that could transcend domain boundaries. These clusters are not specific for the 7 cases but instead potentially transferable to other settings and hence interesting for a larger group of Member States. This exercise resulted in a ‘parent list’ of generic stepping stones that encompass actions to be taken in the regulatory, urban development and finance domains, in order to address particular categories of barriers or opportunities (rather than very specific, single ones found in each of the 7 cases). Third, the three researchers reconvened to discuss their groupings and discussed areas of con- and divergence. Following this, several versions of the stepping stones parent list were developed in an iterative way by the domain-leads together with the principal investigator of the NATURVATION project until agreement was reached. An overview of the final parent list is shown in Table 5. Table A1 below provides an overview of how the (clustered) stepping stones were constructed based on domain-specific stepping stones, which break down the stepping stone into sub-actions.

¹⁰The detailed findings corresponding to the regulatory, finance and urban development domains have been previously described in the three NATURVATION Project Reports on structural conditions for integrating NBS (regulatory/finance/urban development) that are available on the CORDIS portal of the European Commission (<https://cordis.europa.eu/project/id/730243/results>)

Table A1. Master list of stepping stones and their description.

Number	Stepping stone	Code	Underlying sub-actions
1	Provide a public mandate	UD1	Regulate NBS as a mandatory component of urban development
		F8	Regulate NBS as a mandatory component of real estate development (through tenders, policies, regulations)
		R12	Introduce mandatory urban greening measures, e.g. through regulation or modifying procurement and tendering procedures
		R17	EU or national-level policy strategies and instruments aimed at urban greening or sustainable urban development touching upon NBS
		R18	Experiment with new policy instruments targeting the urban development sector (e.g. Biotope Area Factors or Tradable Development Rights)
2	Regulate for No Net Loss	F9	Professionalise/harmonise no net loss / offsetting regulations and monitoring across Europe to increase effectiveness
		R12	Introduce mandatory urban greening measures through regulation (e.g. Biodiversity Net Gain)
3	Include in contractual requirements	UD11	Integrate NBS into existing infrastructure investments (planned or maintenance)
		UD10	Look for long-term thinking opportunities
		F10	Include urban NBS in the city as 'green' attached to 'grey' (buildings/infrastructure) for a lower land use opportunity cost
		F11	Integrate urban NBS into renovation and construction projects (infra/ real estate) to lower costs and draw on existing budgets
4	Align with strategic priorities	UD2	Frame NBS as a solution under related policy paradigms that are priorities
		F1	Position urban NBS as a mainstream CCA investment to access public and financial institution budgets
		R5	Build upon synergies between NBS and strategic priorities, e.g. circular economy, ecosystem services, healthy urbanisation and urban ecology
		R9	Seek to use instruments and powers provided by existing policy frameworks in fields of urban planning and environment in order to facilitate NBS development
		R17	EU or national-level policy strategies and instruments aimed at urban greening or sustainable urban development touching upon NBS
5	Create intermediaries	R1	More directorates or agencies working across scales and domains on sustainable development
		UD3	Create opportunities for capacity building related to coordination across silos
6	Generate partnerships	R4	Develop new strategic system-level partnerships (e.g. LNPs) to foster the green economy
		R10	Foster and nourish new partnerships between public, private and third sector organisations aimed at improving alignment of policy with nature-based innovation
		R6	Engage in alliance-building for lobbying, knowledge exchange & media outreach
		R2	Stipulate integrated ways of working as a requirement for external funding
		UD9	Integrate nature expertise into development processes early and incentivise collaborative design processes
7	Establish demonstration projects	UD6	Create shared learning and knowledge production opportunities (e.g. pilots)
		R16	Government acting as frontrunner by spearheading eco-district development and greening of own assets
		R7	Foster transdisciplinary research projects and other platforms providing knowledge sharing between cities and countries (e.g. TEEB project)
		R11	Support knowledge development on NBS benefits through local demonstration projects
8	Engage insurance sector	F6	Engage insurance sector as key stakeholder based on their multiple roles: expert, influencer, innovator, and partner
		F2	Public actors can engage the insurance sector as a key stakeholder of the risk reduction value of urban NBS

Table A1. Master list of stepping stones and their description.

Number	Stepping stone	Code	Underlying sub-actions
9	Facilitate community based action	R3	Improve active citizenship support structures (e.g. fixed municipal contact persons or social enterprise models)
		F7	Upscale community-based funding of NBS by using fintech (digital platforms); apply matchfunding between takeholders
		R21	Organise environmental awareness and education campaigns (e.g. garden competitions, BioBlitz events)
10	Facilitate community based action	R13	Provide indirect measures such as tax reform (e.g. land use tax, wastewater charges) and economic instruments supporting integrated approaches to sustainable development
		F1	Position urban NBS as a mainstream CCA investment to access public and financial institution budgets
		R2	Stipulate integrated ways of working as a requirement for external funding
11	Develop markets	UD4	Target stakeholders that value 'green' reputation and position NBS as a sustainability solution
		UD5	Align NBS with customer demand for urban quality
		R16	Government acting as frontrunner by spearheading eco-district development and greening of own assets
12	Build co-financing arrangements	R8	Develop innovative approaches for co-funding NBS development and maintenance (e.g., through Green Deal instrument)
		F5	Develop financial instruments for co-governance of urban NBS based on their multiple benefits, including both public and private actors
13	Work with investment cycles	F11	Integrate urban NBS into renovation and construction projects (infra/ real estate) to lower costs and draw on existing budgets
		UD11	Integrate NBS into existing infrastructure investments (planned or maintenance)
		F10	Include urban NBS in the city as 'green' attached to 'grey' (buildings/infrastructure) for a lower land use opportunity cost
14	Stimulate institutional investment for risk reduction	F4	Use TCFD recommendations to stimulate investment into urban NBS as a way to lower climate risks in investment portfolios
		F1	Position urban NBS as a mainstream CCA investment to access public and financial institution budgets
15	Target areas of low land value	F10	Include urban NBS in the city as 'green' attached to 'grey' (buildings/infrastructure) for a lower land use opportunity cost
16	Improve data & monitoring	F15	Upscale standardised indicators, evidence and funding of urban NBS using digital tools
		R20	Improve monitoring together with mapping and digitised data storage in pooled data portals and inventories
		UD7	Develop quantified data for NBS for key moments in the development process (particularly around costs), but also find ways to accommodate increased uncertainty
17	Advance valuation models	F3	Improve data/modelling of NBS impact to increase its valuation (in particular risk reduction), potentially affecting ratings
		UD7	Develop quantified data for NBS for key moments in the development process (particularly around costs), but also find ways to accommodate increased uncertainty
		F12	Increase investment into urban NBS by providing evidence-based monetisation of their non-financial benefits (SROI)
18	Grow practitioner expertise	UD9	Integrate nature expertise into development processes early and incentivise collaborative design processes
		R19	Develop practitioner guides providing integrating knowledge from the scientific and practice-based communities
		R14	Support ongoing research on the benefits of NBS, and investment in improved valuation metrics and tools for multifunctional solutions
19	Incorporate in green investment products	F16	Develop sustainable / impact investment products that allow institutional & retail investors to invest in urban NBS
		F13	Make sure urban NBS are clearly defined as a green investment (for real estate and infrastructure) in the EU Taxonomy
20	Promote certification schemes	UD8	Integrate NBS into existing sustainability tools (e.g. green building certification) and promote the use of new knowledge practices and tools that better recognise NBS benefits
		F14	Integrate urban NBS interventions as key criteria into sustainable certification schemes for real estate and infrastructure
		R15	Introduce more nature-based indicators into sustainable building certification schemes



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