

SCIENTIFIC OPINION PAPER // OCTOBER 2021

# Tackling the climate and biodiversity crises in Europe through Urban Greening Plans

Recommendations for avoiding the implementation gap

## Imprint

### Publisher

Umweltbundesamt  
Wörlitzer Platz 1  
06844 Dessau-Roßlau  
Tel: +49 340-2103-0  
Fax: +49 340-2103-2285  
[info@umweltbundesamt.de](mailto:info@umweltbundesamt.de)  
Internet: [www.umweltbundesamt.de](http://www.umweltbundesamt.de)

[f/umweltbundesamt.de](https://www.facebook.com/umweltbundesamt.de)

[t/umweltbundesamt](https://twitter.com/umweltbundesamt)

### Authors

Bettina Wilk  
ICLEI – Local Governments for Sustainability

Andreas Vetter, Alice Schröder  
German Environment Agency

### Reviewers

Inke Schauser  
German Environment Agency

Holger Robrecht, Barbara Anton, Julia Peleikis, Patrycja Dlugosz-Stroetges  
ICLEI – Local Governments for Sustainability

Publication as pdf:  
<http://www.umweltbundesamt.de/publikationen>

Dessau-Roßlau, October 2021

This work has been funded by the German Environment Agency (UBA) in the context of the Klimaresilienz in Europa project (FKZ 3719 48 104 0).

The consortium carrying out the project is led by adelphi and performed in collaboration with the Fraunhofer Institute for Intelligent Analysis and Information Systems (IAIS), the European Secretariat of ICLEI – Local Governments for Sustainability, the Leibniz Institute of Ecological Urban and Regional Development (IOER) and drift for transition.

SCIENTIFIC OPINION PAPER // October 2021

# **Tackling the climate and biodiversity crises in Europe through Urban Greening Plans**

Recommendations for avoiding the implementation gap

by

Bettina Wilk, ICLEI Europe, Brussels  
ICLEI Europe, Brussels

Andreas Vetter, Alice Schröder  
German Environment Agency, Dessau-Roßlau

On behalf of the German Environment Agency

## Executive Summary

The climate and biodiversity crises, which are interconnected and exacerbate each other, experience strong political momentum at European and global level. The global temperature and the frequency and intensity of extreme weather events is rising. Habitat and biodiversity loss are increasing. However, diverse and healthy ecosystems are the backbone of the livelihood of future generations and climate resilience. Thus, the protection of existing natural areas, the restoration of degraded habitats and the improvement of green spaces for enhanced biodiversity value and ecosystem services is key.

Nature-based solutions (NbS) have become pivotal as they simultaneously address climate adaptation, mitigation, resilience and biodiversity loss, next to multiple other challenges. With the majority of the world population residing in cities, urban action is important. In cities and towns, “urban green infrastructure” includes the whole network of systemic green interventions and NbS for the benefit of nature and human-beings. It fosters integrated approaches with other disciplines, such as housing, mobility, utilities and public health, as a way to balance the multitude of urban challenges and potential side effects. The availability of and equal access to urban green spaces for all population groups is needed. On the other hand, next to public urban green spaces also private ones need to be in focus to create impacts at scale.

To systematically bring nature back to cities, the EU Biodiversity Strategy calls upon cities with over 20,000 inhabitants to develop Urban Greening Plans (UGP) by the end of 2021. UGP present a unique opportunity for the systematic integration of urban green infrastructures in urban planning across Europe. However, whilst scientific evidence for the relevance and effectiveness of NbS for climate resilience, biodiversity gains, and other aforementioned areas is rapidly expanding, implementation is lagging behind. Thus, an exploration of those barriers with direct relevance to UGP formed the starting point for the recommendations of the authors presented in this paper. Most of them point to the need for enabling governance, regulatory and financing frameworks and guidance, accompanying such UGP, leading to five recommendations:

- (1) the development of an overarching *Urban Greening Strategy* to translate into *Urban Greening Plans* as operational plans,
- (2) a stakeholder participation strategy and a UGP narrative guideline for consistent messaging that enables buy-in,
- (3) prioritizing nature and biodiversity over competing land use in planning instruments and targets,
- (4) SMART indicators to support regular monitoring against established goals, and
- (5) business and investment models as well as financing mechanisms, that recognize the potential of co-benefits and revenue generation of urban greening actions.

# 1 The issue of a global climate and biodiversity crises

Biodiversity conservation and ecosystem restoration experience strong political momentum at European and global level. The EU Biodiversity Strategy for 2030<sup>1</sup>, the UN Decade of Ecosystem Restoration<sup>2</sup>, and the forthcoming Post-2020 global biodiversity framework<sup>3</sup>, which sets out an ambitious plan for broad-based action following a whole-of-government approach to bring about a transformation of society's relationship with biodiversity, build the multi-level policy framework for steering action across levels. Together with the new and ambitious EU Adaptation Strategy 2020<sup>4</sup> and the European Green Deal<sup>5</sup>, they have enabled broad recognition of a **combined climate and biodiversity crises that are interconnected and exacerbate each other**.

Global climate measurements show a continued temperature rise as well as an increase in the frequency and intensity of extreme weather events such as cloudbursts, heatwaves, and droughts [26, 27]. The resulting impacts of droughts, flooding and wildfires accelerate the destruction of ecosystems, impair the provision of ecosystem services and curb biodiversity loss [25, 26].

However, ecosystem services are of great importance: **diverse and healthy ecosystems are the backbone of the livelihood of future generations and climate resilience** through their capacity to absorb, buffer and recover from extreme weather events and long-term climate impacts. They serve as a valuable ally in the fight against climate change, as important carbon sink and through climate regulation [25]. Yet, we are experiencing habitat and biodiversity loss at an unprecedented rate. Global wildlife populations have fallen by 60 percent over the last four decades [52]. Despite the EU Nature Directives, which failed to achieve the objectives of the EU Biodiversity Strategy for 2020, biodiversity in the EU continues to decline and deteriorate due to land use changes, overexploitation, pollution, invasive alien species, and climate change [13, 25]. **Efforts should therefore focus on the protection of existing natural areas, the restoration of degraded habitats and the improvement of green spaces for enhanced biodiversity value and ecosystem services**.

**With the majority of the world population residing in cities, urban action is key.** As hotspots for land-use change due to urban expansion, cities are a main driver of biodiversity loss [25]. However, they can also serve as a refuge for species since they offer the required combination of nesting, resting and foraging habitats. In some cities and towns, biodiversity is even higher than in surrounding agriculturally dominated rural areas [7, 8, 51].

The ongoing COVID-19 pandemic has put a spotlight on the fundamental links between public and ecosystem health and the value of (urban) green spaces to physical and mental health. A growing body of research points to the beneficial effects that exposure to the natural world has on human mental and physical health [4, 22, 49]. Even more so, biodiverse environments with birds and a variety of plants. **As a result, nature-inclusive urban planning considerations have come to the fore more than ever, which focus on the human need for nature as a “must-have” and not only a “nice to have”**.

---

<sup>1</sup> [https://ec.europa.eu/environment/strategy/biodiversity-strategy-2030\\_en](https://ec.europa.eu/environment/strategy/biodiversity-strategy-2030_en)

<sup>2</sup> <https://www.decadeonrestoration.org/>

<sup>3</sup> <https://www.cbd.int/conferences/post2020>.

<sup>4</sup> [https://ec.europa.eu/clima/policies/adaptation/what\\_en](https://ec.europa.eu/clima/policies/adaptation/what_en)

<sup>5</sup> [https://ec.europa.eu/info/strategy/priorities-2019-2024/european-green-deal\\_en](https://ec.europa.eu/info/strategy/priorities-2019-2024/european-green-deal_en)

## 2 Urban Green Infrastructure as integrated, systemic solutions

In the face of increasing urbanisation, densification and climate change impacts, nature-based solutions (NbS) that simultaneously address climate adaptation, mitigation, resilience and biodiversity loss, next to multiple other challenges, have become pivotal in cities and towns. The European Commission defines them as solutions that are “inspired and supported by nature, which are cost-effective, simultaneously provide environmental, social and economic benefits, help build resilience. They must therefore benefit biodiversity and support the delivery of a range of ecosystem services<sup>6</sup>.” [15]. **Due to their manifold co-benefits, NbS are heralded as promising no-regret measures that can deliver on climate and biodiversity targets but also on societal challenges**, such as public health, quality of life, and social justice.

For successfully delivering on European and global policies and targets, NbS will have to create impacts at scale. There is a strong call for conceptualizing NbS as systemic interventions, i.e. an integral element to healthy and resilient ecosystems and adopting a multi-scale planning approach (urban, peri-urban, landscape). Such a systems approach puts forward the idea of integration with the urban technical and social infrastructure system [1, 35, 38]. Also, integration with the wider (peri-urban) green infrastructure has to be considered: a strategically planned and managed network of natural and semi-natural areas to deliver a wide range of ecosystem services, such as recreation, water purification or climate adaptation. **The authors opt for using the term “urban green infrastructure” (UGI) to consider the whole network of systemic green interventions and NbS for the benefit of nature and human-beings** (as opposed to single NbS interventions), emphasize interoperability with existing technical, social and environmental infrastructure and the need for integrated, biodiversity-inclusive urban planning. UGI brings together municipal stakeholders engaged in the “green sphere” (such as nature conservation and open space planning) [18]. It can also foster **integrated approaches with other disciplines, such as housing, mobility, utilities and public health, as a way to balance the multitude of urban challenges and potential side effects** [19, 42].

**To safeguard the long-term benefits of UGI for all of society, availability of and equal access to urban green spaces for all population groups for recreation is fundamental.** Socially deprived neighbourhoods often have fewer quality green spaces and are disadvantaged in accessibility of the latter, which can cause negative health effects [37, 41, 50]. Analysis and monitoring of such socio-spatial differences in availability and accessibility of urban green – i.e. “distributional injustice” [3] – should inform the development of targeted strategies and actions that ensure health benefits of urban green for all social groups.

**Creating impacts at scale will further require a focus on private urban green spaces (next to public ones)**, such as gardens and roofs, which comprise a large untapped potential with regards to enhancing biodiversity in cities and creating stepping stones in UGI [16]. In European core cities, on average 40 percent of the total surface area is urban green space, while publicly accessible urban green space only amounts to 2.45 percent of the total surface area [30]. The large share of private urban green space calls for public policies and planning approaches that address these spaces and include their owners. For instance, garden owners reporting on plant species richness can help to get a clearer picture of urban plant biodiversity [54].

---

<sup>6</sup> In line with criterion 3 of the IUCN Global Standard for NbS, stating that NbS should achieve a net gain of biodiversity and ecosystem integrity [28]. Measures should only be described as NbS if they provide both at the same time: contributions to human well-being and biological diversity [6].

### 3 Urban Greening Plans as unifying framework for climate-resilient, biodiversity-positive urban planning

NbS, as the fundamental elements of UGI, have been introduced into the EU policy agenda and identified as key action in several EU policies, such as the European Green Deal, the EU Biodiversity Strategy and the EU Adaptation Strategy [14].

This goes hand in hand with an **increasing recognition of the importance of cities and their local governments for achieving biodiversity and climate adaptation targets** at European (i.e. EU Biodiversity Strategy, EU Urban Agenda, EU Adaptation Strategy, EU Green Infrastructure Strategy) and international level (i.e. in the Post-2020 Global Biodiversity Framework, the concomitant Edinburgh process) [5, 9]. Since they are closest to the implementation of actions, they can steer the design and management of urban spaces towards UGI and enhancing urban ecosystems. They are equipped with pertinent mandates and regulatory powers to put land management regulation and development control in place [24].

**To systematically bring nature back to cities, the EU Biodiversity Strategy calls upon cities with over 20,000 inhabitants to develop Urban Greening Plans (UGP) by the end of 2021.**

These plans should include biodiversity-enhancing NbS, such as urban forests, parks, green roofs, or street trees, to achieve the target of planting 3 billion trees by 2030. They should further help to improve connections between green spaces, to eliminate the use of pesticides, to limit excessive mowing of urban green spaces and other biodiversity harmful practices. Such plans should also mobilise policy, regulatory and financial tools [16]. From a policy integration point of view, UGP are suitable instruments to reduce climate impacts in cities. The EU Adaptation Strategy outlines the importance of NbS including UGI in cities [17]. UGP can help to scale up NbS to UGI, addressing climate change, biodiversity issues and co-benefits to other urban challenges and goals, such as air pollution, environmentally friendly housing, social inclusion and sustainable mobility.

**UGP present a unique opportunity for the systematic integration of UGI in urban planning structures, policy and practices across Europe.** It is imperative that UGP are not seen as an additional top-down requirement but as a blueprint for systematic, integrated, nature- and biodiversity-positive urban planning with clear, long-term benefits for society at large, consistent across the European Union, which can be adopted independently of planning cultures. The roll-out of UGP across cities and towns in EU Member States also opens up (old) questions with regards to mainstreaming, implementation as well as a governance:

- What is the scope, format and character of such a plan?
- How can it be effectively integrated in the existing policy and instruments landscape across different contexts and planning systems?
- Who will have the overlooking mandate and what are the roles and responsibilities for their design, management, and implementation?
- How can its actions be financed in the long run?
- And most importantly, how can we make sure that these NGP are effective in reducing urban biodiversity loss and building urban climate resilience and thus increasing quality of life for different social groups?

## 4 Overcoming the implementation gap of integrated urban greening strategies and plans

UGI is in fact not a new field of action. Numerous European cities already have equivalents of UGP in place, are experienced in their integrated design and implementation (linking biodiversity, climate adaptation, mobility, housing, health issues and social justice), and know their success factors and bottlenecks. Such plans exist under different headings, such as green infrastructure plans, municipal landscape plans, green master plans, open space strategy and plans, local Biodiversity Strategy and Action Plans or climate adaptation plans.

The underlying mechanisms of such UGP, i.e. the incorporation of environmental issues and concerns in non-environmental sectors and policies, such as urban or sectoral planning, are well researched under the umbrella of environmental policy integration and mainstreaming [29, 33, 36, 39, 47]. Principles for UGI planning have been established and applied in planning policy and practices across European cities [10, 21, 31]. Further, steps towards UGI, from setting objectives and identifying suitable sites to choosing planning instruments, are outlined in detail in the recommendations for UGI [18] (see Annex I).

**Whilst scientific evidence for the relevance and effectiveness of NbS for climate resilience, biodiversity gains, and other aforementioned areas is rapidly expanding, implementation is lagging behind** [14]. Current plans and practices have either contributed to establish conditions for malfunctioning urban development or not yet managed to create sufficient outcomes at a scale and pace that effectively cut biodiversity loss and increase resilience at district and city level [5, 20]. This points to an implementation gap as a critical factor of success [23, 39, 40, 43, 44].

The reasons for this implementation gap – independent of the issue area that is mainstreamed, i.e. climate mitigation, adaptation, biodiversity – are well researched and confirmed by multiple case studies [2, 12, 45, 46, 47]. The main barriers are discerned into four categories, namely: political factors (such as political commitment, policy consistency, public awareness and support), organisational and institutional factors (such as expanded mandates/statutes, institutional routines, cooperation/coordination among departments, across policy levels with private actors), cognitive factors (such as perceived sense of urgency, problem awareness), and resources (knowledge & expertise, financial and human resources) [39]. Although policy discourses have changed, implementation barriers continue to persist.

Thus, an exploration of those barriers with direct relevance to UGP formed the starting point for the recommendations of the authors presented in this paper. In an expert workshop with policy makers, city representatives, researchers and practitioners organised as part of the project “climate resilience in Europe” in February 2021, the benefits of UGP complementing existing plans were confirmed and relevant barriers identified for UGP (see Annex II). Most of them refer to institutional/organisational and cognitive factors, and point to **the need for enabling governance, regulatory and financing frameworks and guidance, accompanying such UGP.**



## 5 Recommendations for requirements of Urban Greening Plans

The authors conclude that for the large-scale implementation of such UGP to be effective and in order to close the existing implementation gap, UGP must build on the bottlenecks and critical factors of success already identified in UGI planning and practices across European cities. From these, we derive the following recommendations, which we consider essential for the further conceptualisation and operationalisation of UGP.

- 1. UGP should manifest as part of an integrated, overarching city strategy, that tackles biodiversity loss, reduces the impacts of climate change and addresses the social dimensions of urban greening; it should be issued at high level (i.e. mayor), be action-oriented and perform as a comprehensive implementation plan with clear targets, timelines, and responsibilities**

A clear, visionary city strategy, namely an *Urban Greening Strategy* issued at mayoral level to garner political support, is the first step towards a UGP. As a guiding document, it outlines the strategic direction, priorities and goals, synthesizes and evaluates current green planning activities, identifies gaps as well key policies to guide sectoral plans and points out co-benefits to urban challenges and goals such as reducing biodiversity loss and the impacts of climate change as well as addressing the social dimensions of urban greening. It is a solid foundation for the long-term goal of mainstreaming urban greening into urban planning procedures and practices of all relevant sectors (i.e. infrastructure and housing, water management, public utilities).

The action-oriented *Urban Greening Plan* derived from this strategy contains the measures to accelerate urban greening. Timely and effective implementation of UGP hinges on a clear action plan with clearly described targets, actions necessary to deliver on these targets, a specified time horizon, defined responsibilities and financing options as well as an efficient monitoring mechanism. Due to its integral nature, a UGP shall outline a bundle of integrated, sectoral measures in response to several urban challenges such as biodiversity rehabilitation, protection and enhancement, climate adaptation, public health, social justice etc. UGP should also inspire cities to broaden their scope of action along issue areas not yet addressed in an integral manner.

- 2. UGP need to include a participation strategy for all relevant actors and should be accompanied by a communication- /narrative guideline to raise awareness about ecological and social benefits of NbS**

Stakeholder engagement and dialogue from early stages are key to increasing awareness, building ownership, acceptance and demand for urban greening [14]. Co-creation should therefore be engrained as a guiding principle in the design (i.e. problem definition, drafting of UGP), as well as in the planning, implementation and monitoring (i.e. via citizen science) of UGP, if they are to be implemented effectively. Activating multipliers and allies (both within and outside the municipality) is also important due to limited municipal resources and land ownership. In light of the EU Green Deal objective of “leaving no one behind”, special consideration should be given to vulnerable groups (i.e. elderly people, people with physical disabilities, mental health issues, migrants, socially deprived people, etc.), assessing their needs and potential impacts of urban greening actions to underpin social cohesion and equal opportunities.

Comprehensive guidance on co-creation approaches, steps and success stories, accessible for all interested parties should accompany UGP. It is imperative to base UGP on a consistent narrative of a nature- and biodiversity-inclusive urban development that reflects the values of its citizens

to engender a larger societal sustainable transformation. Any UGP guidance should thus be supplemented with a communication guideline that supports awareness raising on the benefits of healthy ecosystems and the risks of nature and biodiversity loss. Landscaping education and support for citizens on biodiversity and ecosystem-inclusive design, plant species composition and ecosystem water needs in the face of increasing temperatures could further underpin successful UGP. Hereby, showcase gardens and parks that promote climate-adapted landscape design and low-threshold consulting services can help raise awareness and spark citizen engagement.

### **3. UGP should ensure the prioritisation of nature and biodiversity over competing land use and single-sector objectives**

Due to high competition over land use in a city, green spaces and biodiversity often lose out against other sectoral interests, such as housing or transport. Both the protection of existing natural habitats and their restoration and extension is needed for the UGP, European and international targets to be met [53].

To achieve a higher degree of policy integration and, thus, implementation of UGP, we support to employ UN SDG 15.3 'land degradation neutrality' as a bottom line and benchmark and a call to a prioritisation of environmental and biodiversity objectives over sectoral ones, as overarching guiding framework [29, 36, 48]. Improved local, regional and national regulation and targets for ecosystem protection and enhancement and better integration of environmental aspects in building codes should be steered by higher level policy requirements. The forthcoming legally binding EU nature restoration targets [16] could serve as an impetus and even provide concrete benchmarks for formulating city-wide targets which are easy to communicate.

Existing planning instruments, such as codes for public and private green areas, regulations for blue-green-grey combinations in new building development, zoning or protected areas, should be reviewed to assess broader application and improved enforcement. Multifunctional use of space and the combination of grey and blue-green infrastructure should be adopted as a planning principle to reconcile competing interests [21, 34]. Blue-green infrastructure can improve and support the effectiveness of technical and social infrastructure by contributing to recreational functions, biodiversity and climate adaptation [18]. Green spaces attached to social facilities such as kindergartens, schools or hospitals can enhance the social facilities' objectives. Regarding rainwater retention or thermal regulation of buildings, a combination of grey and blue-green infrastructure has the potential to save costs. Sealed or built-on sites of grey infrastructure can be developed to form part of the blue-green infrastructure and thus have the potential to generate added value in terms of quality of life and biodiversity [18].

### **4. UGP should include measurable targets and require regular reporting against SMART indicators, consistent and harmonised with related international, European, and national targets**

An effective and efficient monitoring mechanism is imperative to make sure that UGP are consistently implemented, address all relevant issue areas, and offer room for adjustments in case targets are not sufficiently achieved. Key performance indicators to be established by the cities should be SMART and coherent with the targets of related policy instruments and commitments across governance levels, such as the post-2020 global biodiversity framework, the forthcoming nature restoration targets under the EU Biodiversity Strategy, or the Green City Accord. This is to align monitoring and reporting efforts to provide value in supporting and communicating existing green standards and benchmarking and limit additional burden.

To develop key performance indicators, cities can draw on a large repertoire of impact indicators for NbS composed by Horizon 2020 NbS projects for the European Commission<sup>7</sup> [11]. Performance indicators should further be developed in line with new accounting practices that integrate the multiple benefits of NbS. This can enable city departments and public utilities to justify co-financing biodiversity-enhancing urban greening projects (e.g. stormwater management projects through blue-green infrastructure).

**5. UGP should be linked to existing funding options (i.e. streamlined with other sector programmes at EU/national level) as well as innovative, multi-stakeholder business, investment models and financing mechanisms**

To be successful, UGP actions require sufficient and sustained financial resources, such as international and national funds, green bonds, public funding or grants, loans, private sector or market-based investments, or blended finance (combined funding sources). So far, they have been mainly financed by the public sector, grants and through philanthropy, leaving great potential untapped [32]. UGP should adequately address the underlying issues, by:

- a) Raising awareness for the outcompeting potential of urban greening actions regarding costs and benefits along their life cycle to reconcile perceptions of higher costs and lower effectiveness in comparison with conventional grey infrastructure;
- b) Linking with evidence and case studies on the long-term cost-effectiveness of UGI/NbS and the monetisation of UGI/NbS benefits<sup>8</sup> – one of the major barriers that prevents the creation of bankable UGI/NbS which attract private capital - and help identify revenue streams and cost savings generated;
- c) Providing best practices of tested business and investment models for urban greening at varying scales (district, landscape, region) and financing mechanisms, including supporting tools to increase the uptake and scalability of available green financial instruments suited for UGI/NbS;
- d) Providing information and guidance to city planners and decision makers on existing EU/national funding options and sector programmes to be tapped for UGP financing and improve their understanding of where resources are and how they can be accessed, based on the multi-functionality of UGI/NbS providing cross-sectoral benefits (i.e. adaptation finance, recovery funds).

---

<sup>7</sup> <https://op.europa.eu/en/publication-detail/-/publication/d7d496b5-ad4e-11eb-9767-01aa75ed71a1>; see also nature and biodiversity indicators of the Green City Accord at [https://ec.europa.eu/environment/green-city-accord/monitoring-framework\\_en](https://ec.europa.eu/environment/green-city-accord/monitoring-framework_en), the Singapore Index on Cities' Biodiversity at <https://www.nparks.gov.sg/biodiversity/urban-biodiversity/the-singapore-index-on-cities-biodiversity> and the IUCN Global Standard <https://www.iucn.org/theme/nature-based-solutions/resources/iucn-global-standard-nbs>

<sup>8</sup> The Horizon 2020 NbS Cluster Taskforce 3 on business, finance and governance models is undertaking relevant work in this field: <https://networknature.eu/networknature/nature-based-solutions-task-forces>

## References

- [1] Benedict, M. A.; McMahon, E. T. (2006): Green infrastructure: linking landscapes and communities. Island press.
- [2] Biesbroek, G.; Klostermann, J.; Termeer, C.; Kabat, P. (2013): On the nature of barriers to climate change adaptation. *Reg Environ Chang* 13(5):1119–1129. <https://doi.org/10.1007/s10113-013-0421-y>
- [3] Bolte, G.; Bunge, C.; Hornberg, C.; Köckler, H. (2018): Umweltgerechtigkeit als Ansatz zur Verringerung sozialer Ungleichheiten bei Umwelt und Gesundheit, *Bundesgesundheitsblatt*, 61 (6), 674-683.
- [4] Bowler, D., Buyung-Ali, L., Knight, T.; Pullin, A. S. (2010): A systematic review of evidence for the added benefits to health of exposure to natural environments. *BMC public health*, 10(1), 1-10.
- [5] Bulkeley H., Kok M.; Xie L. (2021): Realising the Urban Opportunity: Cities and Post-2020 Biodiversity Governance. PBL Netherlands Environmental Assessment Agency, The Hague.
- [6] Cohen-Shacham, E.; Walters, G.; Janzen, C.; Maginnis, S. (2016): Nature-based solutions to address global societal challenges (IUCN International Union for Conservation of Nature).
- [7] Connop, S.; Vandergert, P.; Eisenberg, B.; Collier, M.; Nash, C.; Clough, J.; Newport, D. (2016): Renaturing cities using a regionally-focused biodiversity-led multifunctional benefits approach to urban green infrastructure. *Environmental Science & Policy*. 62 (Aug.), pp. 99-111. <https://doi.org/10.1016/j.envsci.2016.01.013>
- [8] Connop, S.; Nash, C. (2018): Blandscaping that Erases Local Ecological Diversity. <https://www.thenatureofcities.com/2018/01/09/blandscaping-erases-local-ecological-diversity/>
- [9] Davis, M.; Gerdes, H.; Muehlmann, P.; Robrecht, H. (2014): Multilevel-governance of our natural capital: the contribution of regional and local authorities to the EU Biodiversity Strategy 2020 and the Aichi Biodiversity Targets (Part B: Recommendations). <https://doi.org/10.2863/10326>
- [10] Davies, C.; Laforteza, R. (2017): Urban green infrastructure in Europe: Is greenspace planning and policy compliant?. *Land use policy*, 69, 93-101.
- [11] Dumitru, A.; Wendling, L. (2021): Evaluating the impacts of nature-based solutions. Appendix of methods. European Commission, Brussels. [https://ec.europa.eu/info/news/evaluating-impact-nature-based-solutions-handbook-practitioners-2021-may-06\\_en](https://ec.europa.eu/info/news/evaluating-impact-nature-based-solutions-handbook-practitioners-2021-may-06_en)
- [12] Ekstrom, J.; Moser, S. (2014): Identifying and overcoming barriers in urban climate adaptation: case study findings from the San Francisco Bay Area, California, USA. *Urban Clim* 9:54–74. <https://doi.org/10.1016/j.uclim.2014.06.002>
- [13] EEA (2020): State of nature in the EU. Results from reporting under the nature directives 2013-2018, No. 10/2020, Luxembourg. <https://www.eea.europa.eu/publications/state-of-nature-in-the-eu-2020>
- [14] EEA (2021): Nature-based solutions in Europe: Policy, knowledge and practice for climate change adaptation and disaster risk reduction, Report No. 01/2021, Luxembourg. <https://www.eea.europa.eu/publications/nature-based-solutions-in-europe>
- [15] European Commission (2020a): The EU and nature-based solutions. <https://ec.europa.eu/research/environment/index.cfm?pg=nbs>
- [16] European Commission (2020b): Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions. EU Biodiversity Strategy for 2030. Bringing nature back into our lives. COM/2020/380 final. <https://eur-lex.europa.eu/legal-content/EN/TXT/?qid=1590574123338&uri=CELEX:52020DC0380>

- [17] European Commission (2021): Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions. Forging a climate-resilient Europe - the new EU Strategy on Adaptation to Climate Change. COM(2021) 82 final. <https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52021DC0082&from=EN>
- [18] Federal Agency for Nature Conservation (2017): Urban Green Infrastructure. A Foundation of attractive and sustainable cities. Pointers for municipal practice. Berlin. [https://www.bfn.de/fileadmin/BfN/planung/siedlung/Dokumente/UGI\\_Broschuere\\_Eng.pdf](https://www.bfn.de/fileadmin/BfN/planung/siedlung/Dokumente/UGI_Broschuere_Eng.pdf)
- [19] Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety (2018): White Paper “Green spaces in the city”. [https://www.bmi.bund.de/SharedDocs/downloads/DE/publikationen/themen/bauen/wohnen/weissbuch-stadtgruen-en.html? blob=publicationFile%26v%3D4](https://www.bmi.bund.de/SharedDocs/downloads/DE/publikationen/themen/bauen/wohnen/weissbuch-stadtgruen-en.html?blob=publicationFile%26v%3D4)
- [20] Garrard, G.; Williams, N.; Mata, L.; Thomas, J.; Bekessy, S. (2018): Biodiversity sensitive urban design. *Conservation Letters*, 11(2), e12411.
- [21] Hansen, R.; Pauleit, S. (2014): From multifunctionality to multiple ecosystem services? A conceptual framework for multifunctionality in green infrastructure planning for urban areas. *Ambio*, 43(4), 516-529.
- [22] Hartig, T.; Mitchell, R.; De Vries, S.; Frumkin, H. (2014): Nature and health. *Annual review of public health*, 35, 207-228.
- [23] Huttunen, S. (2015): Farming practices and experienced policy coherence in agri-environmental policies: The case of land clearing in Finland. *Journal of Environmental Policy and Planning*, 17 (6), 573–92.
- [24] ICLEI – Local Governments for Sustainability (2010): Local Action for Biodiversity Guidebook: Biodiversity Management for Local Governments. (M. T. Laros & F. E. Jones, Eds.).
- [25] IPBES (2019): Global assessment report on biodiversity and ecosystem services of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services. E. S. Brondizio, J. Settele, S. Díaz, and H. T. Ngo (editors). IPBES secretariat, Bonn, Germany.
- [26] IPCC (2019): Summary for Policymakers. In: IPCC Special Report on the Ocean and Cryosphere in a Changing Climate [H.-O. Pörtner, D.C. Roberts, V. Masson-Delmotte, P. Zhai, M. Tignor, E. Poloczanska, K. Mintenbeck, A. Alegría, M. Nicolai, A. Okem, J. Petzold, B. Rama, N.M. Weyer (eds.)].
- [27] IPCC (2021): Climate Change (2021): The Physical Science Basis. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change [Masson-Delmotte, V., P. Zhai, A. Pirani, S. L. Connors, C. Péan, S. Berger, N. Caud, Y. Chen, L. Goldfarb, M. I. Gomis, M. Huang, K. Leitzell, E. Lonnoy, J.B.R. Matthews, T. K. Maycock, T. Waterfield, O. Yelekçi, R. Yu and B. Zhou (eds.)]. Cambridge University Press. In Press.
- [28] IUCN (2020): IUCN Global Standard for Nature-based Solutions: a user-friendly framework for the verification, design and scaling up of NbS: first edition (IUCN, International Union for Conservation of Nature).
- [29] Lafferty, W; Hovden, E. (2003): Environmental policy integration: Towards an analytical framework. *Environmental Politics*, 12 (3), 1–22.
- [30] Maes, J.; Zulian, G.; Günther, S.; Thijssen, M.; Raynal, J. (2019): Enhancing resilience of urban ecosystems through green infrastructure (EnRoute). JRC Technical Reports. European Commission, Brussels.
- [31] Monteiro, R.; Ferreira, J.; Antunes, P. (2020): Green Infrastructure Planning Principles: An Integrated Literature Review. *Land*, 9(12), 525.
- [32] Mayor, B.; Toxopeus, H.; McQuaid, S.; Croci, E.; Lucchitta, B.; Reddy, S. E.; López Gunn, E. (2021): State of the Art and Latest Advances in Exploring Business Models for Nature-Based Solutions. *Sustainability*, 13(13), 7413.

- [33] Mullally, G.; Dunphy, N. (2015): State of play review of environmental policy integration literature. Dublin: National Economic and Social Council.
- [34] Naumann, S.; Davis, M.; Iwaszuk, E.; Freundt, M.; Mederake, L., (2020): Addressing climate change in cities – Policy instruments to promote urban nature-based solutions. Ecologic Institute, the Sendzimir Foundation: Berlin, Krakow.
- [35] Oke, C.; Bekessy, S.; Frantzeskaki, N.; Bush, J.; Fitzsimons, J.; Garrard, G.; Gawler, S. (2021): Cities should respond to the biodiversity extinction crisis. *npj Urban Sustainability*, 1(1), 1-4.
- [36] Persson, Å.; Runhaar, H.; Karlsson-Vinkhuyzen, S.; Mullally, G.; Russel, D.; Widmer, A. (2018): Editorial: Environmental policy integration: Taking stock of policy practice in different contexts. *Environmental Science and Policy*, 85, 113–15.
- [37] Rehling, J.; Bunge, C.; Waldhauer, J.; Conrad, A. (2021): Socioeconomic Differences in Walking Time of Children and Adolescents to Public Green Spaces in Urban Areas—Results of the German Environmental Survey (2014–2017). *Int J Environ Res Public Health* 18(5): 2326.
- [38] Rouse, D.; Bunster-Ossa, I.; (2013): Green infrastructure: a landscape approach (No. 571).
- [39] Runhaar, H.; Wilk, B.; Persson, Å.; Uittenbroek, C.; Wamsler, C. (2018): Mainstreaming climate adaptation: taking stock about “what works” from empirical research worldwide. *Regional environmental change*, 18(4), 1201-1210.
- [40] Runhaar, H.; Wilk, B.; Driessen, P.; Persson, A.; Mullally, G. (2020): Policy integration. In: Biermann, F., Kim, R. ed. *Architectures of the Earth System Governance. Institutional Complexity and Structural Transformation*. Cambridge University Press.
- [41] Schüle, S.; Hilz, L.; Dreger, S.; Bolte, G. (2019): Social Inequalities in Environmental Resources of Green and Blue Spaces: A Review of Evidence in the WHO European Region. *Int. J. Environ. Res. Public Health* 2019, 16(7), 1216.
- [42] Schubert, S.; Bunge, C.; Gellrich, A; von Schlippenbach, U.; Reißmann, D. (2019): [Interior development in urban neighborhoods: The Importance of environmental quality, health, and social compatibility]. UBA Background (in German). <https://www.umweltbundesamt.de/publikationen/innenentwicklung-in-staedtischen-quartieren-die>
- [43] Simeonova V.; van der Valk, A. (2010): The role of an area-oriented approach in achieving environmental policy integration in the Netherlands, and its applicability in Bulgaria. *European Planning Studies*, 18 (9), 1411–43.
- [44] Storbjörk S.; Lähteenmäki-Smith, K.; Hilding-Rydevik, T. (2009): Conflict or consensus: The challenge of integrating environmental sustainability into regional development programming. *European Journal of Spatial Development*, 34, 1–22.
- [45] Uittenbroek C. (2016): From policy document to implementation: organizational routines as possible barriers to mainstreaming climate adaptation. *J Environ Policy Plan* 18(2):161–176. <https://doi.org/10.1080/1523908X.2015.1065717>
- [46] Wamsler C. (2015): Mainstreaming ecosystem-based adaptation: transformation toward sustainability in urban governance and planning. *Ecol Soc* 20(2):30. <https://doi.org/10.5751/ES-07489-200230>
- [47] Wamsler C.; Pauleit S. (2016): Making headway in climate policy mainstreaming and ecosystem-based adaptation: two pioneering countries, different pathways, one goal. *Clim Chang* 137(1-2):71–87. <https://doi.org/10.1007/s10584-016-1660-y>
- [48] WBGU – Wissenschaftlicher Beirat der Bundesregierung Globale Umweltveränderungen (2020): *Landwende im Anthropozän: Von der Konkurrenz zur Integration. Zusammenfassung*. Berlin: WBGU.

[49] White, M.; Pahl, S.; Wheeler, B.; Depledge, M.; Fleming, L. (2017): Natural environments and subjective wellbeing: Different types of exposure are associated with different aspects of wellbeing. *Health & place*, 45, 77-84.

[50] WHO Regional Office for Europe (2017): Urban green space interventions and health: A review of impacts and effectiveness. Copenhagen. <https://www.euro.who.int/en/health-topics/environment-and-health/urban-health/publications/2017/urban-green-space-interventions-and-health-a-review-of-impacts-and-effectiveness.-full-report-2017>

[51] Wilk, B.; Rebollo, V.; Hanania, S. (2019): A guide for pollinator-friendly cities: How can spatial planners and land-use managers create favourable urban environments for pollinators? Guidance prepared by ICLEI Europe for the European Commission.

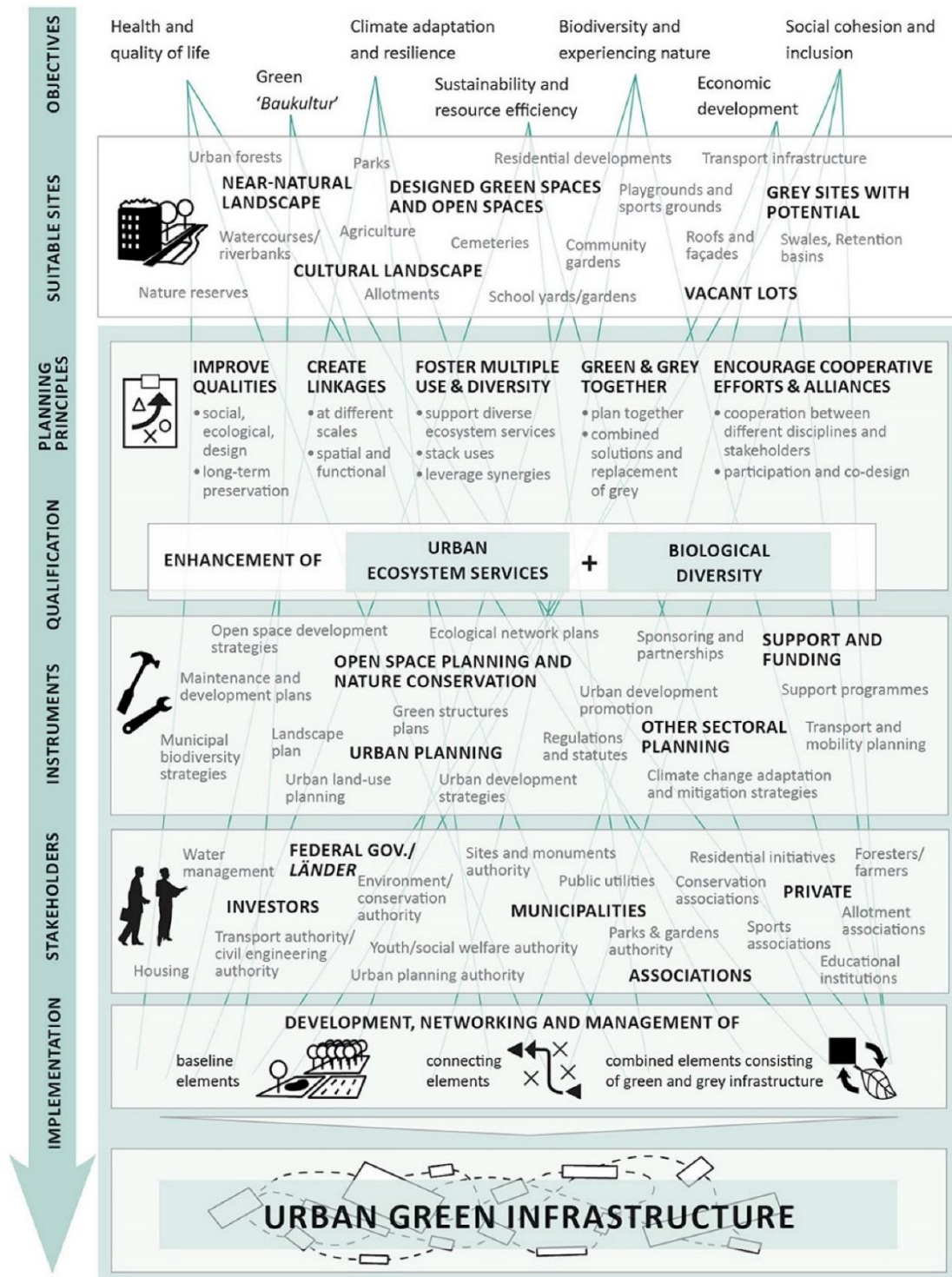
[52] WWF (2018): Living Planet Report - 2018: Aiming Higher. Grooten, M. and Almond, R.E.A.(Eds). WWF, Gland, Switzerland

[53] Xie, L.; Bulkeley, H. (2020): City for Biodiversity: The Roles of Nature-Based Solutions in European Cities, NATURVATION

[54] Young, C.; Frey, D.; Moretti, M.; Bauer, N. (2019): Research Note: Garden-owner reported habitat heterogeneity predicts plant species richness in urban gardens. *Landscape and Urban Planning*, 185, 222-22

# Annex I

**Figure 1: Steps towards urban green infrastructure**



Steps towards urban green infrastructure

Source: Federal Agency for Nature Conservation (2017): Urban Green Infrastructure. A Foundation of attractive and sustainable cities. Pointers for municipal practice. Berlin.



## Annex II

**Table 1: Main barriers identified for the implementation of integrated urban greening strategies according to factor categories**

Type of barrier	Barriers mentioned with regards to urban greening strategies
<p><b>Political factors</b> (i.e. political commitment, policy consistency, public awareness, political priorities etc.)</p>	<p>No prioritisation of NbS in land use decisions as a result of competing interests and high competition over space in urban areas, and urban densification in favour of housing and infrastructure development;</p> <p>Lack of involvement of citizens in decision making processes and co-design of NbS; need for better communication and information (communicable targets and commitments) to increase ownership, transparency and acceptance of solutions; need for shared responsibilities with local authorities (i.e. citizen science);</p>
<p><b>Organisational &amp; institutional factors</b> (i.e. expanded mandates/statutes, institutional routines, cooperation/coordination among departments, across policy levels with private actors)</p>	<p>Lack of binding long-term regulatory frameworks and legislation (such as the legally binding nature restoration targets) which require compliance across all government levels;</p> <p>Absence of a governance framework with clear responsibilities and mandates across EU, national, regional and local level to engender accountability, and with it, consistent execution of measures and transparency;</p> <p>Lack of coordinated decision-making at city level and collaboration across governance levels, including sub-national, regional, national and EU level, to co-develop mutually reinforcing objectives across scales; this is opposed to a landscape planning approach of connecting habitats and corridors required for large-scale climate resilience and urban biodiversity net gains;</p> <p>Due to the sectoral organisation of municipal administration, cross-cutting issues are not effectively addressed: responsibilities for nature conservation, urban (green space) planning, public health, etc. are divided up and have their own structures, goals, logics of acting; environmental departments often lack financial and human resources;</p> <p>Cost-effectiveness analysis does often not feature all positive effects of urban green, i.e. on public health, ecosystems, quality of life; this results in decisions favouring other land uses.</p>
<p><b>Cognitive factors</b> (i.e. such as perceived sense of urgency, problem awareness)</p>	<p>Perception of higher costs and lower effectiveness associated with NbS by city planners and decision makers which favours conventional grey infrastructure; need for raising awareness of negative implications and long-term costs in case of non-action across sectors;</p> <p>Need for narratives for the future reflecting values that implicitly integrate the biodiversity and climate agenda, involve citizens and can thus engender societal sustainable transformation.</p>
<p><b>Resources</b> (i.e. knowledge &amp; expertise, financial and human resources)</p>	<p>Lack of innovative, large scale financing solutions for NbS that include the private sector to supplement scarce public resources;</p> <p>Lack of availability and access to scientific evidence on interdependencies between ecosystems, resilience and climate change; need for tools assessing and illustrating NbS benefits, and guidance for UGP.</p>