

GreenEsteem

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Collaborative Knowledge Valorisation for Sustainable Nature-Based Solutions

Deliverable 2.1: NBS and CKV

Project factsheet

Acronym: **GreenEsteem**

Title: **Collaborative Knowledge Valorisation for Sustainable Nature-Based Solutions**

Coordinator: Adam Mickiewicz University (AMU)

Reference: 101217219

Type: HORIZON

Program: Horizon Europe

Start: 1st October 2025

Duration: 24 months

Website: https://www.greenesteem.eu

Consortium: Adam Mickiewicz University, Poland, (AMU), Coordinator

SYNYO GmbH, Austria (SYNYO)

Urban Policies Association, Bulgaria (TEAM SOFIA)

University of Architecture, Civil Engineering and Geodesy, Bulgaria (UACEG)

Klimabündnis Österreich, Austria (CAA)

Konin Municipality, Poland (KONIN)

Deliverable factsheet

Number: **D2.1**

Title: **NBS and CKV assessment report**

Lead beneficiary: UACEG

Work package: WP2

Task: **Tasks: T2.1, T2.2 and T2.3**

Dissemination level: Public

Submission date: 30.09.2026

Contributors: UACEG, AMU, SYNYO, CAA, TEAM SOFIA, KONIN

Document history:

Revision	Date	Main modification	Author
0.1	30/06/2026	First Draft	UACEG
0.2	31/07/2026	Content integration	GreenEsteem team
0.3	12/09/2026	Template transfer, legal review and local-practice synthesis	GreenEsteem team
1.0	Pending	Final version for submission	Consortium

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This project has received funding from the the Commission Agency under Grant Agreement No. 101217219.

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Abbreviations

Arup: Arup Group Limited, a British multinational professional services firm headquartered in London

BGI: Blue-green infrastructure

CAP: Common Agricultural policy (EU)

CCC: Climate City Contract (Sofia)

CIT: Corporate income tax

CKiS: Centre for Culture and Arts (konin)

CKV: Collaborative knowledge valorisation

CORDIS: Community Research and Development Information Service

CPI: City Partnership Initiative (Poland)

EBRD: European Bank for Reconstruction and Development

EEA: European Environmental Agency

EEA: European Economic Area

EFA: The Executive Forestry Agency (Bulgaria)

EIA: Environmental impact Assessment

ERDF: European Regional Development Fund

ESF+: European Social Fund

EU: European Union

IOŚ-PIB: Institute of Environmental Protection - National Research Institute (Poland)

IUCN: International Union for Conservation of Nature

JTF: Just Transition Fund

JTM: Just Transition Mechanism

KDK: Konin Cultural Centre

KPEiK: The National Energy and Climate Plan to 2030 with a perspective to 2040 (Poland),

KPI: Key Performance Indicators

KPOZP: Krajowy Plan Odbudowy Zasobów Przyrodniczych (National Nature Restoration Plan)

KSA: Krajowa Strategia Adaptacji do Zmian Klimatu (National Climate Adaptation Strategy)

KSRR 2030: The National Strategy for Regional Development 2030 (Poland)

KV: knowledge valorisation

NBS: Nature based solutions

MPA: Municipal climate adaptation plan

MAF: Ministry of Agriculture and Food

MoEW: Ministry of environment and waters (Bulgaria)

MRDPW: Ministry of Regional Development and Public Works

MS: member states

NGO: Non Governmental Organization

NZC: The Net Zero Cities (Sofia)

PDA: Plan Działań Adaptacyjnych (Adaptation Action Plan)

PIT: Personal income tax

QH: Quadrupel Helix

R&D: Research and Development

RBMP: River Basin Management Plans (Bulgaria)

RIEW: Regional Inspectorate for environment and water (Bulgaria)

SEA: Strategic Environmental Assessment

SECAP: Sustainable Energy and Climate Action Plan

SECAP: Sustainable Energy and Climate Action Plan (Sofia)

SO: Stolichna Obshtina (Sofia Municipality)

SRP2035: Strategy for Poland 2035

SuDS: (Sofia)

TPZ: Tree Protection Zones (Konin)

WB: The World bank

WP: Work package

Executive Summary

The GreenEsteem assessment examines how collaborative knowledge valorisation, participatory governance and cross-sectoral cooperation can support the planning, implementation and long-term management of urban Nature-Based Solutions (NBS). Its central premise is that the effectiveness and sustainability of NBS depend not only on ecological and technical design but also on the capacity of institutions, researchers, businesses and civil society to jointly generate, exchange and apply knowledge throughout the intervention lifecycle.

The assessment provides a comparative analysis of European and national policy frameworks, local planning and governance conditions in Poland and Bulgaria, and practical NBS implementation experiences in Konin and Sofia. It combines policy and regulatory reviews, comparative analysis of good practices, expert interviews, stakeholder mapping and initial local workshop findings. The research adopts the quadruple-helix approach, bringing together public authorities, academia, businesses and civil society, and examines collaborative knowledge valorisation as a mechanism connecting research evidence, local experience, institutional learning and practical implementation.

The findings establish an evidence base for GreenEsteem Living Labs, stakeholder capacity building, participatory co-design, local action plans and the development of transferable knowledge-sharing instruments.

Policy and institutional frameworks

The European policy framework increasingly recognises NBS as multifunctional instruments addressing biodiversity loss, climate adaptation, water management, environmental quality, public health and sustainable urban development. The EU Nature Restoration Regulation (2024/1991), particularly its provisions concerning urban ecosystems, strengthens the importance of measurable restoration outcomes, urban green-space protection and tree-canopy development. European research, environmental and territorial investment programmes provide complementary opportunities for experimentation, implementation and replication.

The comparative assessment identifies important differences between Poland and Bulgaria. Poland demonstrates a relatively stronger connection between national policy objectives and municipal implementation instruments, particularly through mandatory climate adaptation planning for cities with at least 20,000 inhabitants, technical guidance for blue-green infrastructure and requirements for monitoring and public participation. Bulgaria has an established regulatory framework for urban green systems and growing recognition of NBS within environmental and climate policies, supported by European and national investment programmes. However, implementation remains more fragmented across sectoral policies, administrative responsibilities and project-based financing.

At the local level, Konin has developed practical instruments for green-space management, stormwater retention, ecological restoration and climate adaptation, although NBS are often incorporated implicitly rather than through a dedicated strategic framework. Sofia demonstrates more explicit strategic recognition of NBS through its climate and integrated development policies, but faces difficulties translating these commitments into coordinated, financed and continuously maintained interventions.

In both countries and cities, the principal challenge is therefore not the absence of environmental objectives, but the insufficient integration of spatial planning, financing, technical standards, institutional responsibilities, stakeholder participation and long-term performance monitoring.

Good practices and knowledge valorisation

The assessment examines 74 NBS-related practices, comprising 40 selected international practices and 34 local practices from Poland and Bulgaria. The wider comparative analysis identifies different models of knowledge valorisation, demonstrating that effective knowledge transfer depends on the combination of stakeholder relationships, implementation mechanisms, digital tools, financing and opportunities for institutional learning.

The detailed local assessment includes 17 practices in Konin and 11 in Sofia, complemented by 15 expert interviews covering 16 stakeholders related to practices from both cities. These cases illustrate different approaches to NBS implementation and knowledge exchange.

Konin's practices are characterised by relatively strong municipal coordination, external financing and civic participation. Initiatives such as Green Urban Corridors, participatory-budget projects, community gardens and river-based regeneration demonstrate how municipal programmes can be complemented by smaller community-led interventions. Sofia presents a more diverse portfolio, including the URBiNAT Living Lab, Rivers of Sofia, the Green Ring, municipal greening programmes and community-based projects. These initiatives combine strategic planning, research, experimental approaches, civic mobilisation and private-sector involvement.

The comparison indicates that large municipal programmes are particularly important for institutional coordination, investment and technical implementation, while smaller civic initiatives contribute to experimentation, local ownership and social learning. Universities, NGOs, municipal organisations and community intermediaries play important roles in translating scientific, administrative and experiential knowledge into practical solutions.

Nevertheless, evidence of knowledge valorisation remains stronger for project activities, partnerships and visible outputs than for long-term ecological performance, institutional uptake and replication. Digital platforms are primarily used for communication and dissemination, while their potential for shared decision-making, monitoring and systematic knowledge reuse remains insufficiently developed.

Stakeholder cooperation and capacity building

Stakeholder mapping confirms the importance of collaborative governance throughout the NBS lifecycle. Konin benefits from active civic organisations, participatory budgeting, senior groups and established community networks, although private-sector engagement and structured cross-sectoral partnerships remain limited. Sofia possesses substantial academic, professional and institutional expertise, alongside active NGOs and civic initiatives, but cooperation is constrained by fragmented municipal responsibilities, political discontinuity and uneven stakeholder participation.

The expert interviews and initial Living Lab workshops identify common capacity-building needs in both cities. These concern participatory governance, co-creation methods, interdepartmental and cross-sectoral cooperation, practical NBS design, sustainable financing, digital communication, knowledge valorisation and long-term maintenance. Sofia additionally demonstrates a need for improved access to technical resources, clearer implementation procedures and stronger integration between municipal and district-level governance.

A central finding is that public participation should extend beyond information provision and consultation towards meaningful involvement in problem identification, design, implementation, monitoring and stewardship. This requires transparent responsibilities, accessible knowledge, sustained partnerships and mechanisms through which stakeholder contributions can influence decisions.

Conclusions and strategic directions

The assessment demonstrates that NBS implementation requires a transition from fragmented, project-oriented interventions towards integrated, collaborative and continuously evaluated urban development processes. Five priorities emerge from the comparative findings that identify the following needs:

- to strengthen institutional integration by connecting environmental and climate objectives with spatial planning, municipal investment programmes, technical design, procurement and maintenance responsibilities.
- to advance collaborative knowledge valorisation by establishing mechanisms through which scientific evidence, professional expertise and local knowledge can be jointly applied, documented and transferred into policy and practice.
- to develop sustainable financing and management models by linking initial investments with realistic lifecycle costs, clearly assigned responsibilities and long-term maintenance commitments.
- to improve monitoring and digital knowledge infrastructures by developing accessible, interoperable information resources and measurable indicators addressing biodiversity, water retention, urban cooling, accessibility, social inclusion and institutional performance.
- to build stakeholder capacities and durable partnerships by supporting practical training, inclusive co-creation, interdisciplinary collaboration and institutional learning through Living Labs and other participatory mechanisms.

For Konin, the strongest development pathway lies in integrating NBS with just transition, post-industrial regeneration, municipal green-space management and established community networks. For Sofia, priorities concern strengthening metropolitan governance, coordinating institutional responsibilities, improving technical and financial implementation capacity and ensuring equitable access to NBS benefits.

Implications for GreenEsteem implementation

The assessment provides a foundation for subsequent GreenEsteem activities, particularly establishing the Expert Support Group, developing participatory co-evaluation and co-design methods, and applying them through the Konin and Sofia Living Labs. Such instruments could support knowledge exchange among researchers, municipalities, businesses, and communities; reduce barriers to initiating NBS projects; and facilitate the adaptation and replication of successful approaches. It also highlights the need for a shared digital knowledge resource that integrates good practices, spatial information, implementation guidance, funding opportunities, stakeholder expertise, and monitoring results.

The overarching conclusion is that collaborative knowledge valorisation should be understood as an integral part of NBS governance rather than a separate dissemination activity. Its effectiveness depends on whether knowledge generated through research and practical experience leads to better decisions, stronger institutional cooperation and improved procedures, more inclusive participation and measurable long-term environmental and social benefits.

By connecting policy analysis, comparative good practices, stakeholder engagement and capacity building, GreenEsteem offers a framework to advance NBS from individual urban interventions towards a sustainable, evidence-informed and socially inclusive urban transformation.

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1.INTRODUCTION

GreenEsteem examines how participatory planning and collaborative knowledge valorisation can improve the design, implementation and long-term stewardship of urban nature-based solutions. Its central premise is that technically sound interventions deliver broader, more durable benefits when public authorities, researchers, businesses and civil society jointly define problems, combine evidence with lived experience, and remain involved throughout the solution lifecycle. The project tests this premise through living labs in Konin and Sofia, where partners will co-design and evaluate NBS and translate the resulting experience into action plans, training resources, policy recommendations and tools that can be reused in other European contexts (Figure 1.)

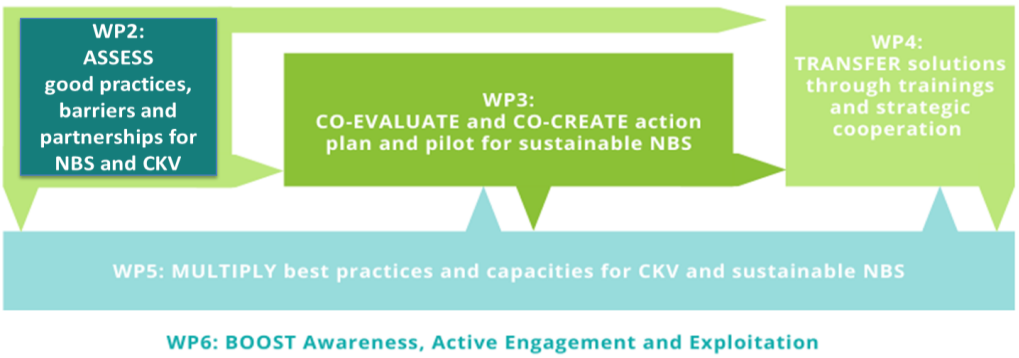


Figure 1. GreenEsteem work packages and the relationships between them. Source: Grant Agreement

Knowledge valorisation is understood broadly as the creation of social, environmental, policy and economic value from data, know-how and research results. This goes beyond commercialisation. It includes evidence-informed policy, open and responsible use of intellectual assets, citizen engagement, skills development and adapting knowledge to local needs. The EU guiding principles and their implementing codes provide the policy basis for this interpretation (Council of the European Union, 2022). Annex A explains the knowledge-valorisation framework, while Annex B relates it to quadruple- and quintuple-helix models of collaborative innovation.

Nature-based solutions are actions inspired and supported by ecological processes that address societal challenges while benefiting biodiversity and human well-being. In cities, they range from protecting and restoring ecosystems to managing green and blue infrastructure and creating hybrid solutions that combine ecological and engineered elements. Their value lies in multifunctionality, but this also makes them difficult to plan through sectoral institutions and single-purpose budgets.

The proposed conceptual framework (Figure 2) offers an integrated and systematic approach to investigating the planning, implementation, and evaluation of Nature-Based Solutions (NBS) within the built environment. It establishes relationships among the contextual conditions influencing NBS interventions, the stakeholder co-creation processes, and the resulting outcomes. The framework is structured around two interconnected dimensions: the NBS context and the NBS co-creation process, which together guide the development and assessment of investment and research projects.

The first dimension, NBS context, addresses identifying and selecting appropriate NBS types in response to global and local challenges, considering the characteristics of natural settings, the built environment, and relevant national, local, and international policy frameworks. It incorporates the spatial dimension (where?) and the temporal dimension (how long?), recognizing that NBS suitability and effectiveness depend on location-specific conditions and the time required for implementation and impact.

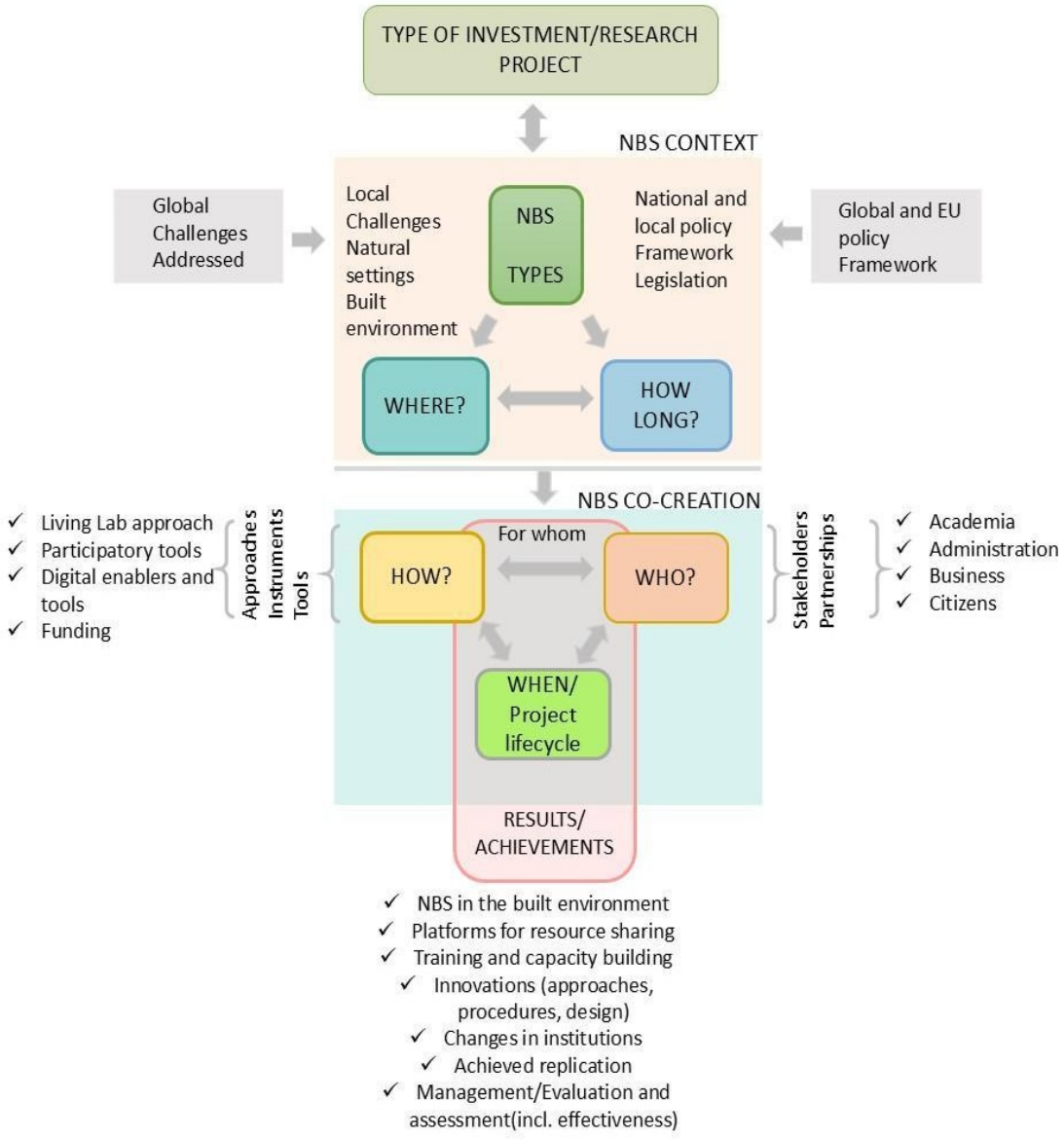


Figure 2. GreenEsteem Framework for evaluating NBS

The second dimension, NBS co-creation, focuses on the processes, actors, and instruments involved in developing and implementing NBS. It examines how interventions are designed and managed, who participates in decision-making, and when different activities occur throughout the project lifecycle. It places particular emphasis on stakeholder partnerships involving academia, public administration, businesses, and citizens, supported by participatory approaches, living laboratories, digital tools, and funding mechanisms.

Finally, the framework establishes a basis for assessing research results and practical achievements, including implemented NBS, resource-sharing platforms, institutional innovations, capacity building, and the replication of successful practices. By linking contextual factors, collaborative governance, and measurable outcomes, the framework supports comparative case-study research and the identification of enabling conditions, barriers, and opportunities for mainstreaming NBS in urban development. It also provides a methodological foundation for evaluating the effectiveness, transferability, and long-term sustainability of NBS interventions, particularly in complex urban territories. Annex C consolidates the NBS definitions, typologies, benefits, and key implementation gaps addressed further in GreenEsteem.

The analytical link between the two interconnected dimensions - the NBS context and the NBS co-creation process is the Collaborative Knowledge valorisation (CKV) for NBS. GreenEsteem therefore studies how knowledge is generated, negotiated, documented, shared and applied during problem definition, design, implementation, monitoring, stewardship and replication (Figure 3). It pays particular attention to who participates, which forms of knowledge count, how decisions are governed, what intellectual assets are created, and whether results influence policy or further practice. Annex 1D reviews the governance, co-creation and learning mechanisms that support this process.

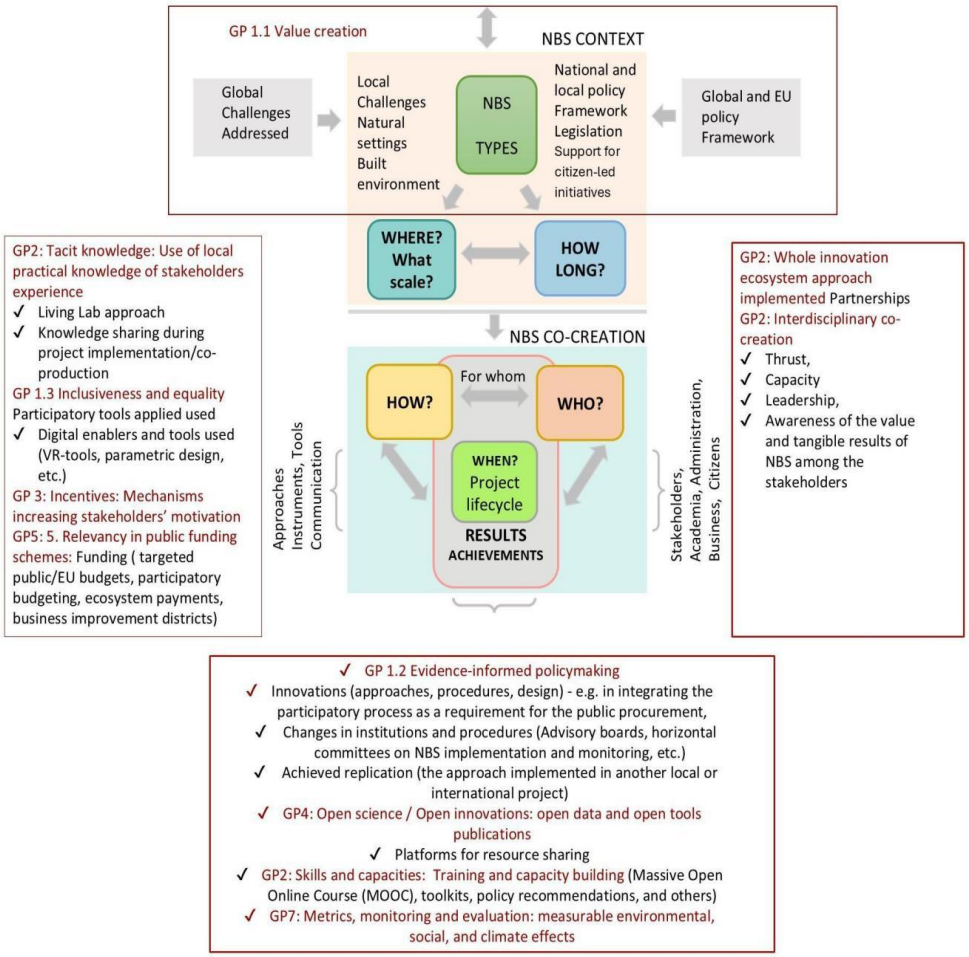


Figure 3. Framework for evaluating NBS against the principles for knowledge valorisation

2. POLICY AND PLANNING FRAMEWORKS

2.1. European policy framework for NBS and Knowledge Valorisation

2.1.1. NBS as a connective policy framework

The European Union does not regulate nature-based solutions (NBS) through one self-contained legal instrument. Instead, NBS operate as a connective framework across biodiversity restoration, climate adaptation, water and soil management, pollution prevention, public health, territorial cohesion and research and innovation. The Commission uses the concept for interventions inspired and supported by nature that address societal challenges while delivering environmental, social and economic benefits. This multifunctionality is NBS's principal added value, but it also creates a governance test: an intervention should

not be labelled nature-based merely because it contains vegetation. It should respond to a clearly defined problem, improve ecological functions and biodiversity, generate measurable co-benefits, and be planned for long-term management. EU research policy has progressively moved the concept from experimental urban projects toward systemic transformation, including water retention, ecosystem restoration, inclusive regeneration, health, climate neutrality and new governance and business models (European Commission, n.d.). The resulting framework is best understood as a policy portfolio in which binding ecological duties, strategic objectives, investment instruments and knowledge systems reinforce one another.

2.1.2. From strategic ambition to binding restoration duties

The European Green Deal and the EU Biodiversity Strategy for 2030 set the broader direction: protection alone is insufficient where ecosystems are degraded, fragmented, or unable to provide essential services. The Biodiversity Strategy connected ecosystem recovery with urban greening, ecological corridors and river restoration. It called for restoring at least 25,000 km of rivers to a free-flowing state and invited cities with at least 20,000 inhabitants to prepare ambitious urban greening plans (European Commission, 2020). Regulation (EU) 2024/1991 on nature restoration converts much of this restorative logic into a binding, Union-wide framework. Its overarching objective requires restoration measures to cover at least 20% of EU land and sea areas by 2030 and, by 2050, restore all ecosystems in need. Member States must prepare national restoration plans that quantify areas, select measures, consider integration with climate, water and other policies, identify financing needs and establish monitoring. For cities, this shifts urban nature from a discretionary amenity to a measurable national restoration obligation, while still leaving Member States and municipalities flexibility to select locally appropriate measures (European Parliament & Council of the European Union, 2024a).

2.1.3. Urban ecosystems under Article 8 of the Nature Restoration Regulation

Article 8 of the Nature Restoration Regulation provides the clearest legal anchor for urban NBS. By 31 December 2030, Member States must ensure no net loss in the total national area of urban green space and urban tree-canopy cover within the urban ecosystem areas defined under the Regulation, compared with 2024. From 1 January 2031, they must achieve an increasing trend in the total national area of urban green space, including green space integrated into buildings and infrastructure, measured every six years until a satisfactory level is reached. A corresponding increasing trend in tree-canopy cover is required in each urban ecosystem area. These targets are outcome-oriented: they do not prescribe a uniform project type, but they require reliable baselines, spatial delineation, periodic observation and measures capable of producing durable ecological gains. Parks, restored rivers and wetlands, green roofs and facades, street trees, permeable landscapes, rain gardens and ecological links may all contribute when they improve function rather than simply relocate or cosmetically replace green space. Municipal planning should therefore connect land-use protection, project pipelines, tree and habitat inventories, maintenance budgets and equity analysis to national restoration planning and reporting (European Parliament & Council of the European Union, 2024a).

2.1.4. Climate, water, soil and pollution integration

Sectoral policies reinforce the restoration framework by defining the problems NBS are expected to solve. The EU Adaptation Strategy promotes faster, smarter and more systemic adaptation and recognises nature-based approaches as long-term investments that can reduce climate and disaster risk while supporting biodiversity, mitigation and health (European Commission, 2021a). The Soil Strategy for 2030 adds the need to limit sealing, restore degraded soils and recover infiltration, water storage, carbon and biodiversity functions in urban land (European Commission, 2021b). The recast Urban Wastewater Treatment Directive strengthens integrated planning for stormwater and urban runoff and supports preventive and nature-based measures before additional collection or treatment infrastructure is built (European Parliament & Council of the European

Union, 2024b). The 2025 European Water Resilience Strategy further prioritises restoration of the water cycle and states that water management should give priority to NBS, while allowing hybrid combinations with engineered infrastructure where necessary (European Commission, 2025). Together these policies support a catchment-to-neighbourhood approach: upstream retention, floodplain recovery, permeable public space, soil restoration, urban cooling and pollution control should be designed as one interconnected system rather than as isolated sectoral projects.

2.1.5. Delivery through investment, experimentation and place-based policy

EU policy becomes operational through a layered funding and implementation landscape. Horizon Europe supports research, demonstration and assessment of NBS through Cluster 6 and the Missions on Adaptation to Climate Change, Climate-Neutral and Smart Cities, Restore our Ocean and Waters, and Soil. The Cities Mission uses co-created Climate City Contracts and investment plans, while the Adaptation Mission helps regions and communities test pathways to resilience. LIFE can support nature restoration, climate adaptation, integrated environmental strategies, and the replication of proven approaches. Cohesion Policy and the European Urban Initiative provide routes for integrated, place-based urban investment and capacity building; InvestEU, the European Investment Bank and national or regional programmes may complement these sources where project and eligibility conditions are met. This architecture should not be treated as a list of interchangeable grants. Research funding can reduce uncertainty and test innovation; technical assistance can build a viable pipeline; capital funds can deliver infrastructure; and municipal revenue must sustain operation and maintenance. Effective NBS programmes therefore combine projects into long-term portfolios, with clear ownership, lifecycle costs, measurable public value and a pathway from pilot to mainstream investment (European Commission, n.d.).

2.1.6. Knowledge valorisation as the bridge from evidence to implementation

The Council's guiding principles define knowledge valorisation as creating social and economic value by transforming data, know-how and research results into sustainable products, services, solutions and knowledge-based policies that benefit society. This is broader than commercialisation or technology transfer: it includes better public decisions, social innovation, professional practice, skills, standards, open tools and benefits that may not be monetised (Council of the European Union, 2022). This broader understanding matters for NBS because many of their most important results, avoided heat and flood damage, biodiversity recovery, improved health, social cohesion, and better public space, are distributed, long-term, and only partly captured through market revenue. Valorisation must therefore begin when a problem and partnership are framed, not after a research project ends. Municipalities, universities, utilities, businesses, communities, and funders should agree on intended users, decision points, evidence requirements, data and methods ownership, and the route by which results can enter plans, budgets, procurement specifications, maintenance practice, and regulation. In this sense, each NBS demonstration should be designed as both a place-based intervention and a reusable learning infrastructure.

2.1.7. Co-creation, citizen engagement and institutional learning

The EU codes of practice make collaboration a central mechanism of valorisation. The industry-academia code extends cooperation beyond contracted research or conventional intellectual-property transfer toward durable relationships based on shared interests, interdisciplinary teams, entrepreneurial capacity, staff mobility and recognition of diverse outputs, including evidence-informed policy and societal engagement (European Commission, 2024b). The citizen-engagement code similarly treats citizens, civil-society organisations, municipalities, cultural institutions and other groups as contributors to agenda setting, implementation, monitoring and interpretation, not merely as recipients of information. It recommends

sustained, inclusive participation so knowledge-based solutions align with societal needs and gain legitimacy and ownership (European Commission, 2024a). Applied to NBS, these principles support living labs, participatory mapping, co-design, citizen science, stewardship agreements and joint evaluation. They also require safeguards: representation must extend beyond already organised groups; local knowledge should be documented transparently; conflicts and distributional effects should be acknowledged; and feedback must show how participation affected decisions. Co-creation is therefore not an optional communication stage, but part of the evidence and governance needed for equitable and maintainable urban nature.

2.1.8. Quality, safeguards and durable public value

Stronger policy status for NBS also raises the quality threshold. Projects should demonstrate additional ecological function compared with a business-as-usual design and should not compensate for avoidable habitat loss, continued soil sealing or uncontrolled emissions. Planting choices, hydrological regimes, and management practices must suit local ecosystems and future climate conditions; otherwise, highly visible projects can fail due to drought, invasive species, insufficient soil volume, or maintenance gaps. Multi-benefit claims should also be tested for trade-offs. Dense vegetation may provide shade but impede ventilation in some street settings; restored water areas may create safety or vector concerns; and attractive green investment may contribute to displacement if housing and access effects are ignored. The relevant safeguard is not to avoid innovation, but to document alternatives, risks, affected groups, and mitigation measures throughout the project cycle. Long-term public value requires secure land status, realistic lifecycle budgets, accountable asset ownership, monitoring after the funding period and transparent reporting of both benefits and underperformance. These conditions align ecological restoration with the EU emphasis on effective evaluation, inclusive engagement and solutions that can be responsibly replicated rather than merely showcased (European Commission, 2021c, 2024a).

2.1.9. Evidence, standards and pathways to up-scale

Valorisation is complete only when credible learning changes routine decisions. The Commission's NBS evaluation guidance recommends a theory of change, context-sensitive indicators, and methods that can identify effectiveness, cost, and potential for replication or upscaling (European Commission, 2021c). For urban ecosystems, a common core should cover biodiversity and habitat condition, hydrology and water quality, canopy and cooling, soil function, carbon, health, accessibility, distributional equity, public acceptance, lifecycle cost and maintenance performance. Open, interoperable data make results reusable, while proportionate management of intellectual assets clarifies which datasets, designs, software, know-how, and methods can be shared or licensed. The Code of Practice on standardisation encourages research actors to translate validated knowledge into standards and technical specifications (European Commission, 2023a). For municipalities, this can mean standard details for tree pits and rain gardens, performance requirements for runoff or shade, outcome-based procurement, approved plant palettes, monitoring protocols and contract clauses for survival and maintenance. Networks such as NetworkNature can disseminate evidence, but local uptake still depends on institutional ownership. The European framework therefore leads directly to the local analysis that follows: local (municipal and city) plans, regulations, administrative capacity, data practices and socio-cultural conditions determine whether EU restoration objectives and research knowledge become durable, equitable NBS on the ground.

2.2. Comparative analysis of the national policy and planning frameworks in Poland and Bulgaria

The comparative analysis and assessment of the national and local policy and planning frameworks of Poland,and Bulgaria, and respectably Konin and Sofia, was condicted according to the Protocol for investigating factors and approaches that facilitate/hinder successful NBS implementation at local and national levels in Poland and Bulgaria.[1].

2.2.1. Review of the national policy and planning framework in Poland

National level - strategic documents

The Council of Ministers adopted the National Development Concept of Poland 2050 (KRK 2050) on 25 July 2025, which provides a long-term strategic context for developing nature-based solutions (NBS) in Poland. The document explicitly refers to nature-based solutions and blue-green infrastructure and links them with climate adaptation, quality of life and ecosystem services. It also points to river renaturation, wetland restoration, sustainable agriculture and integrated spatial planning. Importantly, the Concept treats the natural environment and public space - rather than blue-green infrastructure itself - as critical resources. KRK 2050 can therefore be regarded as an enabling strategic framework for NBS. However, it is a long-term foresight and diagnostic document: it does not itself define operational objectives or implementation actions. Translating its directions into practice depends on medium-term strategies, sectoral policies and regional and local planning instruments.

Strategy for Poland 2035 (SRP2035) and its 2026-2029 Action Plan contain several provisions highly relevant to NBS. As of 16 September 2026, the Council of Ministers has not adopted SRP2035; the version published by the Ministry of Funds and Regional Policy is the draft transmitted to the Council of Ministers on 10 April 2026. Priority 2.6, focused on environmental protection and climate adaptation, includes instruments under preparation such as the National Nature Restoration Plan (Krajowy Plan Odbudowy Zasobów Przyrodniczych - KPOZP), the National Climate Adaptation Strategy (Krajowa Strategia Adaptacji do Zmian Klimatu - KSA) and the Adaptation Action Plan (Plan Działań Adaptacyjnych - PDA). KPOZP was being actively prepared in 2026, while work on the KSA and PDA was formally underway. For urban areas, the draft SRP2035 provides entry points including blue-green infrastructure, rainwater retention, river renaturation, wetland protection, soil restoration, depaving, green roofs and walls, ventilation corridors and measures against urban heat islands. It also reflects the statutory obligation for cities with at least 20,000 inhabitants to prepare municipal climate adaptation plans and supports the protection of urban green areas.

The National Environmental Policy 2030 (PEP 2030), adopted by the Council of Ministers on 16 July 2019, is Poland's principal strategic document in the fields of environmental protection and water management. For NBS, its objectives on climate change adaptation, biodiversity conservation, sustainable water management, and stewardship of natural heritage resources are particularly relevant. The policy emphasizes protecting and restoring ecosystems and integrating environmental functions into socio-economic development processes. From an urban perspective, PEP 2030 provides a broad framework for developing NBS by promoting adaptation measures focused on natural water retention, green space protection, and resilience to climate impacts. Although the document does not establish a dedicated national NBS implementation system for

[1] Link to the protocol for comparative analysis and assessment of the national and local policy and planning frameworks in Poland and Bulgaria:

https://docs.google.com/document/d/1wLHKHb2v1kBSVh7MqlrvFZ0PXK7DtPPq/edit#heading=h.79brw8jhdj3z

cities, it provides a strategic rationale for investments in green infrastructure, river restoration, urban retention systems and biodiversity-enhancing interventions.

The National Urban Policy 2030 (KPM 2030), adopted by the Council of Ministers on 14 June 2022, is among the national policy documents most directly relevant to implementing NBS in urban environments. The policy identifies blue-green infrastructure (BGI) as an important tool for climate adaptation, quality of life and the green-city agenda. It highlights the integration of urban greenery, water systems, and spatial planning, and promotes stormwater retention, biologically active surfaces, urban parks, ecological corridors, green roofs, and other BGI components. The document also addresses urban resilience to heatwaves, droughts, and extreme rainfall as key areas of NBS application.

The National Strategy for Regional Development 2030 (KSRR 2030), adopted by the Council of Ministers on 17 September 2019, identifies climate change adaptation and the reduction of environmental risks as important development challenges. The strategy promotes territorially balanced and sustainable development and the resilience of regions and cities to climate-related impacts. Although NBS are not framed as a distinct policy category, the strategy supports regenerating degraded areas, improving environmental quality, protecting natural resources, and promoting climate-resilient development. It also provides a policy basis for integrating environmental objectives into regional development and for using regional development instruments and EU funds to support such measures.

National level - Sectoral Policies

The Program for the Conservation and Sustainable Use of Biodiversity, with the Action Plan for 2015-2020, approved by the Council of Ministers on 6 November 2015, is a sectoral policy document dedicated to biodiversity conservation in Poland, but its horizon has expired. It was based on the premise that biodiversity constitutes natural capital essential for social and economic development. The program emphasized maintaining ecosystem functions, protecting habitats, and integrating biodiversity considerations into wider development policies. From an NBS perspective, the most relevant elements are references to ecosystem services, ecological connectivity, protection of aquatic and terrestrial ecosystems, and reduction of pressures from infrastructure development. The program provides an ecological and policy justification for nature-based approaches in both urban and non-urban settings. A limitation is its relatively weak focus on urban environments and the implementation challenges identified in subsequent policy development.

The Strategic Adaptation Plan 2020 (SPA 2020), formally titled the Strategic Adaptation Plan for Sectors and Areas Sensitive to Climate Change to 2020 with a Perspective to 2030 and adopted by the Council of Ministers on 29 October 2013, provides an early national policy basis for measures now commonly associated with NBS. It identifies urban areas as vulnerable to heat, intense rainfall and drought-related water deficits and recommends, among other measures, increasing green and blue areas, protecting ventilation corridors, improving stormwater management, restoring degraded green areas and water bodies, developing small-scale urban retention and increasing the use of permeable surfaces. Beyond cities, the Plan supports non-technical flood protection, river renaturation, wetland protection and restoration, ecological connectivity, afforestation and reduced forest fragmentation. SPA 2020 predates the widespread use of NBS as an integrated policy concept in Poland, so its relevance to NBS is mainly implicit and dispersed across adaptation sectors. Its implementation horizon to 2020 has passed, although the document was adopted with a perspective to 2030 and remains an important historical reference for national adaptation policy.

The National Energy and Climate Plan to 2030 with a perspective to 2040 (KPEiK), adopted by the Council of Ministers on 8 June 2026, is Poland's current integrated energy and climate plan. Its relevance to NBS is primarily indirect. The Plan addresses climate policy and adaptation alongside decarbonisation and is linked with wider policy areas such as land use and forestry, climate-risk monitoring and resilience to drought and flooding. KPEiK is not an NBS strategy and does not use NBS as an integrating implementation category. Consequently, its contribution to scaling NBS depends mainly on coordination with environmental, water,

biodiversity, spatial-planning and municipal adaptation instruments rather than on a dedicated NBS implementation pathway within KPEiK itself.

National level - Operational documents/plans

The Program for Counteracting Water Scarcity 2023-2027 with a perspective to 2030, adopted by Council of Ministers Resolution No. 152 of 22 August 2023, provides a relevant policy and implementation framework for NBS even though it does not consistently use this term. Its main objective is to increase water retention through an integrated system of natural and artificial retention, sustainable water use, and public awareness. The Program includes actions for landscape, wetland, river, forest, agricultural and urban retention, which correspond closely to NBS logic. For urban areas, relevant measures include blue-green infrastructure, rainwater retention, permeable surfaces, rain gardens, green roofs, retention ponds and increasing biologically active areas. The Program combines planning, legal and economic instruments, prioritisation based on water deficits and retention needs, funding pathways and monitoring indicators. Its urban NBS potential nevertheless depends on effective local integration, project preparation, and monitoring of implementation.

National level - laws and regulations

Poland does not regulate NBS through a single act. The legal basis is distributed across environmental protection, spatial planning, nature conservation, water management, environmental assessment, revitalisation, local government and building regulation. Together, these instruments determine whether urban land can be protected or unsealed, whether water can be retained at source, how trees and habitats are managed, how residents participate in decision-making, and how measures are financed and monitored.
A major recent legal change is the Act of 27 November 2024 amending the Environmental Protection Law and certain other acts, which entered into force on 11 January 2025 (with a later entry into force for one provision). It introduced mandatory **municipal climate adaptation plans** (MPA) for cities with populations of at least 20,000. Article 18a requires each MPA to include, among other elements, climate-risk analysis; a concept for increasing green areas and tree cover; a concept for managing rainwater and snowmelt; spatial data; measurable objectives; an implementation schedule; responsible bodies; and public participation. Articles 18b and 18c provide for adoption by the municipal council, updates at least every six years, and monitoring reports every two years. The amendment also changed several related statutes, including spatial-planning, nature-conservation and environmental-assessment legislation, strengthening the legal links between climate adaptation and municipal planning. (Table 1)

Table 1. Legal instruments in Poland and their relevance to NBS planning, design and investment

Legal instrument	Relevant provisions	Relevance to NBS planning, design and investment
Environmental Protection Law	Arts. 3(9a), 14 and 18a-18d; Art. 403	Requires municipal climate adaptation plans in cities of at least 20,000 residents. Plans must include urban greening and tree-cover concepts, stormwater management, spatial data, quantified indicators, responsible bodies, public participation, biennial monitoring and six-year updates. Article 403 supports local environmental financing.
Spatial Planning and Development Act	Art. 1(2); regional spatial plans; municipal general and local plans; 2024 climate-	Requires spatial planning to account for environmental protection, water management, agricultural and forest land, landscape, and reduced climate vulnerability. General and local plans can protect connected green-blue networks, biologically active land and retention areas, while the 2024 adaptation reform strengthens consistency with municipal climate adaptation plans.

	adaptation amendments	
Nature Conservation Act	Arts. 2, 5, 78 and 83-90	Defines nature conservation broadly, recognises green areas and tree stands, and places duties on municipal authorities concerning their establishment and maintenance. Article 78, as amended in 2024, strengthens protection for existing native vegetation, ecological functions, and biologically active surfaces. Articles 83-90 regulate tree and shrub removal, replacement planting and fees, affecting the design, delivery and maintenance of urban greening.
Water Law	Arts. 165-166, 184-185 and 315-316	Provides the statutory framework for flood-risk management, drought prevention and water-management planning. These provisions create the planning context for retention, floodplain and wetland measures, river renaturation and hybrid green-grey approaches. The Act also provides for coordination among authorities and other water-management stakeholders.
Environmental Information and Assessment Act	Arts. 21 and 25; Arts. 39-55 and 59-71 (especially Arts. 62 and 66)	Provides access to environmental information, public participation, strategic environmental assessment and project-level environmental impact assessment. The 2024 adaptation amendment added municipal climate adaptation plans and monitoring reports to public registers and strengthened consideration of climate vulnerability and adaptation in project assessment.
Revitalisation Act	Arts. 2, 5-7, 11 and 15	Creates an integrated, area-based municipal process for degraded areas. Diagnosis, stakeholder participation, the Revitalisation Committee and the municipal revitalisation programme can combine public-space renewal, ecosystem restoration and social objectives, provided ecological functions are specified rather than inferred from the green appearance of a project.
Municipal Self-Government Act	Arts. 5a and 7	Assigns municipalities responsibilities for spatial order, environmental and nature protection, water management, public greenery and municipal facilities. Consultation and civic-budget mechanisms allow residents to propose and prioritise local green and blue interventions.
Forest Act	Arts. 7, 13, 14 and 19	Requires sustainable forest management, protection, regeneration and planning. It supports the management of municipal and peri-urban forests as biodiversity areas, cooling assets and ecological connections, although urban NBS objectives must be integrated into the relevant forest management instruments.
Technical conditions for buildings	Regulation of 12 April 2002, including §§ 39-40	Translates planning and building rules into site-design requirements concerning biologically active surfaces and recreational areas. These provisions establish minimum design baselines for specified development plots and play/recreation areas; local plans and project briefs can require higher ecological performance and better-connected green infrastructure.

The framework is the strongest when these instruments are used as sequence. Climate and water plans establish risks and objectives; spatial plans secure land and development parameters; nature and environmental-assessment law protect ecological values and enable public scrutiny; municipal and revitalisation procedures organise participation and funding; and technical rules shape delivery at site level.

The remaining weakness is practical integration. No act automatically requires every urban investment to prefer NBS over conventional infrastructure, quantify ecosystem-service gains, secure long-term stewardship or apply a common performance standard. Municipal procurement, project appraisal and monitoring must supply those links.

National level - National standards, catalogues and guidelines

The analysed document **Blue-Green Infrastructure for Climate Change Mitigation in Cities: Technical Catalogue** (Iwaszuk et al., 2019) identifies blue-green infrastructure as a form of NBS and presents it as a practical alternative or complement to grey infrastructure in cities. It links BGI/NBS to stormwater retention, cooling, carbon sequestration, improved air quality, biodiversity support, and urban liveability. Its key contribution is translating the NBS concept into implementable urban measures, including retention ponds, bioretention basins, bioswales, infiltration trenches, rain gardens, green roofs, green walls, permeable surfaces, and structural soils. For individual solutions, the catalogue discusses technical requirements, spatial conditions, costs, maintenance and implementation constraints. Its practical relevance has been reinforced by later Polish tools, including Poznań's "Retention Standards" adopted in 2024, which promote retention of rainwater at source and the use of blue-green infrastructure, Wrocław's catalogues and standards for sustainable stormwater management and streets with green-blue infrastructure, and broader national resources such as the "Catalogue of Good Adaptation Practices" published by the Institute of Environmental Protection - National Research Institute (IOŚ-PIB).

Additional Polish resources include the Institute of Urban and Regional Development's Small-Scale Blue-Green Infrastructure (2022), the Bydgoszcz green-blue infrastructure catalogue (Adamowski et al., 2017), Kalisz's catalogue of green-blue infrastructure solutions, and the Aquanet Retencja catalogue series on stormwater management. Together, these publications illustrate the gradual operationalisation of blue-green infrastructure and NBS in Polish urban practice. They should be treated as technical and practice-oriented guidance rather than binding national standards.

Overall, these technical catalogues and guidelines provide a useful practical basis for NBS design and implementation, but they do not by themselves constitute a complete or legally binding national implementation framework. Effective delivery still depends on binding planning rules, financing mechanisms, monitoring indicators, procurement and maintenance arrangements, and integration with local spatial planning, road design and stormwater policies.

2.2.2. Review of the national policy and planning framework in Bulgaria

National level - strategic documents

The **National Environmental Strategy 2021-2030** following the BG Environmental Protection Act, explicitly mentions NBSs in Priority 1: Restoring natural capital. Sustainable communities and ecosystems, and more precisely:

- SO 1: Restoring and conserving biodiversity and the natural functions of ecosystems, with a particular focus on those with high biodiversity potential
- SO 3: Greening cities—restoring nature's presence in urban areas
- Priority 3: Mitigating climate change and adapting to climate change
- SO 2: Achieving a climate-resilient society adapted to the inevitable impacts of climate change

The **National Climate Change Adaptation Strategy and Action Pla**n (elaborated by WB and MoEW) following the EU Climate Law 2021/1119, implicitly related to NBSs via (critical) Natural capital (red lines), natural resources, natural stock.

The **National Restoration Plan** (elaborated by the Ministry of Environment and Waters (MoEW) together with the Ministry of Agriculture and Food (MAF), the Ministry of Regional Development and Public Works

(MRDPW), and the Executive Forestry Agency (EFA)) with a drafting deadline of 1 September 2026 for all MS following the EU Nature Restoration Regulation 2024/1991, is the first publicly available one at the dedicated EU reporting portal with specific requirements for addressing NBSs as follows:

- 4.2.4 Consideration of the potential of restoration measures to minimise climate change impacts on nature, to prevent or mitigate the effects of natural disasters and to support adaptation (Art.15(3)(t)(ii)): Describe how the planned restoration measures contribute to climate resilience, disaster risk reduction and ecosystem-based adaptation. MS may consider including, for example, the role of nature-based solutions …
- 4.2.5 Consideration of synergies with national adaptation strategies or plans and national disaster risk assessment reports (Art. 15(3)(t)(iii)): Describe the synergies between the NRP and existing national adaptation strategies or plans, e.g., National Recovery and Resilience Plans. Identify common objectives between the restoration plan, adaptation strategies, and disaster risk reduction plans, such as ecosystem-based approaches and nature-based solutions for climate resilience.

The national draft addresses urban ecosystems under Art. 8 and provides measures functionally equivalent to NBS. Thirteen measures target Article 8: five are ongoing and eight are planned. The main intervention groups include:

- restoration or creation of parks, gardens, pocket parks, green squares, school grounds and accessible public spaces;
- green roofs and walls, street trees, linear greenery, protective belts, hedges and tree/shrub planting;
- removal or replacement of impermeable surfaces, restoration of soil functions and remediation of degraded urban land;
- restoration of urban riverside vegetation, green buffers, wetlands and natural water-management functions;
- biodiversity-sensitive planting using native or climate-suitable non-invasive species;
- enabling instruments such as planning standards for greening and permeability, protection of green corridors, municipal land acquisition, compensatory planting and GIS-based monitoring.

These interventions substantively correspond to NBS even when the term is not used explicitly. Irrigation systems, land acquisition and regulatory instruments are better understood as supporting or enabling measures in the draft plan rather than NBS themselves. Reported benefits include improved water retention and quality, lower flood and erosion risk, reduced dust pollution, climate resilience, recreation and biodiversity. Nevertheless, all 13 Article 8 measures lack quantified individual areas and geospatial delineation. The financial tables do not identify Article 8 financing. Climate and socioeconomic benefits remain unquantified. The Article 13 tables do not allocate additional trees. Public consultation on the first plan version is upcoming. These gaps limit our ability to fully evaluate this significant NBS implementation plan.

While the strategic documents above establish the overarching vision for environmental restoration and climate resilience, the following sectoral policies translate these goals into specific mandates for various societal bodies, from energy to public health, among others. Yet none is specific about urban NBSs, as those solutions are better received outside urban areas.

National and subnational (regional) level - sectoral policies

According to the Council of Ministers' Public Consultation Portal and the sectoral divisions of the strategic documents, several of them can be implicitly associated with NBS opportunities, though not directly related to as indicated in Table 2.

Table 2. Strategic documents in Bulgaria with relevance to NBS planning, design and investment

Sector	Document	Explicit/ Implicit
13. Environment	Strategy for Biodiversity in the Republic of Bulgaria 2022–2030 (Draft)	Explicitly
	National Program for the Protection, Sustainable Use, and Restoration of Soil Functions 2020–2030	Explicitly
	National Strategy for Water Sector Management and Development 2012-2037	Implicitly
	River Basin Management Plans and Flood Risk Management Plans for the water basin districts (Danube, Eastern and Western Aegean, Black Sea) 2022-2027	Explicitly
	Updated National Program for Air Pollution Control 2020–2030	Implicitly
06. Energy and Climate	Long-Term Strategy for Climate Change Mitigation by 2050 of the Republic of Bulgaria	Implicitly
	Integrated Energy and Climate Plan of the Republic of Bulgaria 2021–2030	Implicitly
	National Strategy for Adaptation to Climate Change and Action Plan until 2030	Explicitly
07. Health Care	National Health Strategy 2030	Implicitly
	National Strategy for the Mental Health of Citizens of the Republic of Bulgaria 2021–2030	Implicitly
08. Agriculture, Fisheries, Forestry, and Hunting	National Action Plan to Contribute to the Achievement of the Goals of the "Farm to Fork" Strategy by 2030	Implicitly
17. Regional Development	Effective amendment of the National Concept for Spatial Development 2012-2025 from 2019 and Draft National Concept for Regional and Spatial Development 2026–2040 from 2026	Implicitly
	Integrated Territorial Strategies for the Development of Level 2 Regions 2021-2027	Implicitly

National level - operational documents/plans

National Recovery and Resilience Plan 2020-2026:

Pillar 2: „Green Bulgaria“ is focused on sustainable management of natural resources. The policy area covers biodiversity, planned reforms and investment, integration of the ecosystem approach, and implementation of nature-based solutions to protect Natura 2000 protected areas. The following activities are planned: providing up-to-date information on the state of ecosystems, ecosystem services, and green infrastructure on the territory of the Natura 2000 network; determining specific objectives and protection measures for Natura 2000 protected areas; and involving stakeholders in the decision-making process. The total planned resource is BGN 38.0 million with an implementation period of 2021-2025.

Operational Program „Environment“ 2021-2027:

Priority 3: Biodiversity, Specific objective “Improving the protection and conservation of nature, biodiversity, and eco-friendly infrastructure, including in urban areas, and reducing all forms of pollution.” The measures are related to the development of the Natura 2000 network: Developing specific objectives for the protected areas of the Natura 2000 network and supporting the development and management of ecosystem services

and the assessment of the condition of green infrastructure elements - Demonstrating nature-based solutions for restoring ecosystems that contribute to climate action and ensuring the connectivity of the Natura 2000 network: BG16FFPR002-3.... - Implementation of measures under the National Framework for Priority Actions for NATURA 2000; BG16FFPR002-3.023 - Integration of the ecosystem approach and application of nature-based solutions in the conservation of protected areas within the Natura 2000 network

Priority 4: Risk and Climate Change, Specific objective "Promoting adaptation to climate change, disaster risk prevention, and resilience, taking into account ecosystem-based approaches." provides measures for flood and drought risk prevention and management (priority given to environmentally friendly measures): BG16FFPR002-4.006 - Nature-based measures for flood risk prevention and management - Flood risk prevention and management through the implementation of environmentally friendly "green" measures.

Priority 5: Air, Specific objective: "Improving the protection and conservation of nature, biodiversity, and green infrastructure, including in urban areas, and reducing all forms of pollution." Provides measures to address secondary particulate matter – green infrastructure in urban environments: BG16FFPR002-5.003/4 - Green Measures in Urban Environments (Completed). Improving air quality through measures to address secondary particulate matter – green infrastructure in urban environments.

Operational Program „Development of the Regions" 2021-2027, Integrated Urban Development and Integrated Territorial Investments:

- BG16FFPR003-1.001 - Support for Integrated Urban Development in the 10 Urban Municipalities – Key Growth Centers
- BG16FFPR003-2.001 - CONCEPTS FOR INTEGRATED TERRITORIAL INVESTMENTS (ITI) (Completed)BG16FFPR003-2.002 - Support for integrated urban development in 40 urban municipalities (Completed)
- BG16FFPR003-2.003 - CONCEPTS FOR INTEGRATED TERRITORIAL INVESTMENTS (ITI) - 2 (Completed)

These operational investment mechanisms support various NBS opportunities within spatial planning and environmental protection, although in reality these are restricted by limited capacity in applied research, not well elaborated urban design, landscape, technical, and legal solutions, as well as missing own co-funding capacity and well-structured partnerships at the local level that can fulfil funding gaps and ensure continuity of more complex projects and interventions.

National level - general and specific national laws and regulations

Table 3. Legal instruments in Bulgaria and their relevance to NBS planning, design, co-creation, maintenance and investment

Legislative Act	Specific Articles / Ordinances	Role in NBS Planning, Design, & Investment
Spatial Development Act	Art. 8 (specific designations defined by the detailed urban design plans related to ones for landscaped areas and landscaped connections between them and nature conservation areas, for decorative water systems (cascades, navigation channels, etc.)); Art. 10 (special territorial order and preventive order of protection); Art. 62 & 62a (Green systems and their protection); Art. 108 (Detailed urban design plans and their content such as plans (schemes) for park development and public works)	Planning: Defines the "Green System" as a mandatory element of urban structure. Regulates land-use changes to "parks and gardens," protecting them from construction.
Ordinance No. 7 (Spatial Planning Norms)	Art. 7, 11, 30-32 (Definition, elements and norms for public green areas in urban territories); Art. 19-21, 24-26, 28-29, 33, 38, 40-41, 44 (Minimum green area % (landscaping coefficients) for different functions); Art. 94 (Planting rules in properties)	Design: Sets mandatory percentages for "minimum greenery" (coefficient of landscaping).

Ordinance No. 8 (Content of Spatial Plans)	Art. 21 (general structure including territories for landscaping and special landscaped areas, territories for networks and facilities of the technical infrastructure, watercourses and areas, territories with other or mixed use, territories for active implementation of landscape planning measures, including territories for preventive planning protection, territories with probable spread of foreseeable natural disasters and the necessary preventive measures and method of planning and protection, coastal protection measures and coastal parks and gardens (for cities and settlements of national importance)); Art. 23 (requirement for the green system scheme as part of the general spatial development plan); Art. 50 (Plans for regulating and developing greening territories, with additional works included in the information sources, data from the register of greened areas and mapped vegetation, and in the graphic materials, the functional zoning of the territory, the compositional solution of the vegetation, water terrains, etc.)	Planning & Design: Specifies the requirement for volume and content of the general spatial development plans and the detailed urban design plans and their layouts, including those with designations for green areas, as well as water and other technical infrastructure.
Water Act	Art. 146m (Flood Risk Management Plans, accounting for and including promotion of sustainable land-use practices, improving water retention, and implementing controlled flooding in certain areas in the event of a flood); Art. 156n (Programs of measures for the protection and restoration of water bodies, additional measures, E.G. 7. restoration and creation of wetlands; 13. restoration or reconstruction projects; 14. artificial recharge of groundwater) 157 (River Basin Management, review of measures, additional measures)	Planning and funding: Mandates Flood Risk Management Plans (FRMPs) and River Basin Management Plans (RBMPs). "Green measures" are additional but are starting to be prioritised in the management plans, still on paper.
Environmental Protection Act	Art. 2. E.G. 9 (Financial mechanisms for environmental management among other aims of the environmental policy); Art. 61 (National Trustee Ecology Fund's mandate and financing framework, its principal function to implement environmental projects and activities supporting national and municipal strategies and programmes, alongside complementary operations necessary for their delivery. The Council of Ministers may provide state-owned property for its use and management, while borrowing from commercial banks or other financial institutions requires explicit government approval. Funding may originate from statutory environmental fees, targeted state-budget allocations, donations, interest and investment income, revenues from environmental services, and fines imposed under a broad range of environmental laws)	Funding: Establishes the mechanism for financing environmental projects via national and EU funds. Potential national financing mechanism(s) for nature-based solutions, ecosystem restoration, green-blue infrastructure and related municipal environmental projects, where these contribute to approved national or local strategies and programmes.
Regional Development Act	Art. 19 (defines the Regional Development Council as the principal body for coordinating integrated territorial development at NUTS 2 level. The Council discusses and approves the regional integrated territorial development strategy and manages, coordinates, monitors and controls its implementation. It participates in selecting integrated territorial investment concepts supported by EU funds, other European and national financing sources, and financial instruments. The Council also provides consultation during the preparation of municipal integrated development plans and considers broader matters affecting regional development)	Funding and partnership: An institutional framework for coordinating NBS, green-blue infrastructure, and ecosystem-restoration measures across municipalities, incorporated into integrated territorial investments, aligned with regional priorities, and linked to appropriate European and national funding.
Biodiversity Act	Art. 30 (Spatial and regional plans, among other plans, must comply with the protection regimes and measures applying to protected areas, and they must also maintain ecological connectivity by conserving landscape elements that facilitate species migration, distribution and genetic exchange, e.g. rivers and riparian vegetation, wetlands, floodplains, grasslands, field boundaries,	Planning: Encourages the creation of "bio-corridors" connecting protected areas via biodiversity-rich landscape elements and provisioning of these within spatial planning.

	shelterbelts, lowland forests, mountain connections, dunes, rock formations and the seacoast)	

A patchwork of technical standards and catalogues guides the implementation of these laws, providing specific metrics and design criteria for soil, water, and landscape management. Again, most of these are not that well suited to the more complex urban environments, limited space, and contested public land in cities and a combinatorially appropriate scaled approach (S, M, L, XL in urban design). Because of gaps in the land value capture system, many solutions are initially limited by the enormous funding needed for expropriation, difficulty reaching consensus in decision-making bodies, and public misunderstanding. Co-creation and maintenance are relatively weak points in legislation: while consultation processes and construction responsibilities usually exist, deeper, longer-term engagement with both the process and the substance is vague and left to local government bodies.

National level - national standards, catalogues and guidelines

Except for the national standards for **Good Agricultural and Environmental Condition** under the EU CAP Strategic Plans Regulation (2021/2115), there are no other urban ecosystem- or environment-related standards, aside from the legislative thresholds for minimum green area % (landscaping coefficients) in Ordinance No. 7 described above.

There is a **National Catalogue of Flood Risk Management Measures** that includes measures explicitly and implicitly related to NBS practices:

- Design and implementation of activities related to the construction, reconstruction, repair, and/or rehabilitation of nature-based infrastructure and green solutions for flood risk prevention and management, as well as grey infrastructure measures for flood protection, including construction and installation works, supervision, and other activities related to the implementation of the works
- Restoration of riverbeds
- Activities to protect riverbanks and riverbeds from erosion, including biological reinforcement
- Retention of water volumes (retention) in the main channel or floodplain
- Construction, rehabilitation of protective walls or dikes, or upgrading of existing protective walls or dikes with green infrastructure elements
- Nature-based water retention elements
- Construction, rehabilitation of protective walls or dikes, or upgrading of existing protective walls or dikes with green infrastructure elements
- Nature-based water retention elements
- Construction of small hydraulic structures
- Construction/excavation of a relief (bypass) channel
- Construction/reconstruction of elements of sustainable drainage systems in populated areas, including drainage channels

2.2.3. Comparative analysis

Comparative analysis framework. To conduct the comparative analysis, two synthesised policy and governance matrices were extracted from the inventory and review (see Sections 2.2.1 & 2.2.3). They provide comparable data on status; explicit/implicit NBS address; the decision-making body responsible for elaboration, approval, and implementation; and knowledge and public-participation inputs for each policy and planning instrument. (Appendix F) Two additional matrices synthesize the main findings on financing, maintenance, monitoring, challenges, and opportunities (Table 4 and Table 5).

Policy and governance context. Poland and Bulgaria recognize nature-based solutions (NBS) as instruments for biodiversity conservation, climate adaptation, water management and sustainable urban development. In both countries, NBS are embedded across multiple policy sectors rather than governed through a single comprehensive national NBS framework. However, the two countries differ in how far they translate strategic objectives into operational requirements, institutional responsibilities, and mechanisms for ensuring public participation. Poland demonstrates a comparatively stronger connection between the strategic policy documents and the implementation of NBS at the local level. The National Development Concept 2050 explicitly recognizes NBS, Blue-green infrastructure (BGI), ecosystem services, river renaturation, and wetland restoration. Further, the Polish National Urban Policy 2030 incorporates BGI into urban development priorities, while the Programme for Counteracting Water Scarcity 2023–2027 identifies measures such as rain gardens, green roofs, ponds and permeable surfaces. Other environmental, biodiversity and climate policies contribute indirectly by supporting ecological connectivity, retention and ecosystem protection. Bulgaria recognises NBS through environmental, climate, biodiversity and territorial development policies. The National Environmental Strategy 2021–2030 explicitly links NBS to natural-capital restoration, urban greening and climate resilience, while the National Climate Change Adaptation Strategy and Action Plan to 2030 provides a sectoral framework for ecosystem-based adaptation. The draft National Restoration Plan introduces additional opportunities concerning urban ecosystems. Nevertheless, the operationalisation of these objectives remains distributed among sectoral programmes, environmental regulations and spatial planning instruments. Both countries have adopted strategies, legislative instruments, draft policies and programmes with implementation periods that have already expired. These categories should not be treated as equivalent evidence of current policy commitments. In particular, draft documents demonstrate policy direction but do not establish binding implementation obligations.

Regulatory frameworks and operational instruments. The most significant difference lies in the relationship between countries' national strategic priorities and their planning obligations. In Poland, the 2025 amendments to the Environmental Protection Law introduce mandatory municipal climate adaptation plans for cities with at least 20,000 inhabitants. These plans require climate-risk analysis, measurable objectives, implementation arrangements and attention to urban greenery, tree cover and rainwater management. Therefore, a relatively direct pathway exists from national adaptation objectives to municipal planning and monitoring. Spatial planning, nature conservation, water management and revitalisation legislation provide complementary instruments, while technical catalogues and municipal standards support practical BGI design. Bulgaria has an established statutory framework for protecting and planning urban green systems through the Spatial Development Act and Ordinances No. 7 and No. 8. These instruments regulate green areas, development parameters, spatial plan documentation and related planning procedures. The Biological Diversity Act establishes complementary provisions for protected areas, ecological networks and Natura 2000 conservation. However, these instruments primarily regulate land use, vegetation protection, and biodiversity conservation, rather than prescribing NBS design integration or ensuring measurable ecosystem-service performance. Environmental Impact Assessment (EIA) and Strategic Environmental Assessment (SEA) provide additional regulatory entry points in Bulgaria, allowing environmental considerations, mitigation measures, and monitoring requirements to influence investment projects and spatial plans. Their effectiveness for NBS depends on whether environmental decisions incorporate ecosystem-based measures and subsequently implement them. In short, the Polish framework appears more developed in terms of mandatory municipal climate change adaptation planning, while the Bulgarian one relies predominantly on existing spatial, environmental and biodiversity regulation to enable NBS implementation.

Governance, knowledge inputs and implementation capacity. Both countries operate through multi-level governance arrangements involving national ministries, regional institutions, municipalities and other implementing organisations. In Poland, the Council of Ministers adopts the principal national strategies, while municipalities assume increasingly defined responsibilities for climate adaptation, spatial planning and urban

regeneration. The explicit focus on municipal climate adaptation planning is an important institutional link between climate-risk knowledge, spatial interventions and implementation monitoring. In Bulgaria, the Ministry of Environment and Water (MoEW) and the Ministry of Regional Development and Public Works (MRDPW) share responsibilities. MoEW coordinates environmental, biodiversity and climate-related instruments, while MRDPW manages spatial and regional development policy. Programme Environment 2021–2027 and Programme Development of the Regions 2021–2027 provide important financial and organisational mechanisms for translating policy objectives into projects. Regional Development Councils, municipalities, and project stakeholders contribute to implementing the concept of integrated territorial investments. Both frameworks draw upon scientific and technical knowledge, including biodiversity inventories, ecosystem assessments, climate vulnerability studies, spatial data and environmental monitoring. Poland's technical BGI catalogues and municipal standards provide an additional practical bridge between knowledge and design. In Bulgaria, it is relied on statutory planning information, environmental assessment and programme-level evidence, and fewer dedicated national technical standards for integrated urban NBS are identified.

Public participation and knowledge integration. Public participation is recognised in both countries, although its institutionalisation varies by instrument. Poland's municipal climate adaptation planning requirements explicitly provide for public participation and access to planning and monitoring documentation. Revitalisation procedures offer additional opportunities for stakeholder consultation and involvement in local regeneration. In Bulgaria, participation is particularly well established in statutory planning and environmental assessment procedures. The Spatial Development Act provides for public hearings on spatial plans, while EIA and SEA require institutional consultations, public access to documentation, written submissions, and public discussion under specified conditions. Biodiversity legislation also provides opportunities for NGO representation and consultation on conservation measures. Strategic documents, including the climate adaptation and biodiversity strategies, have undergone public consultation during preparation. Nevertheless, formal consultation should not be equated with continuous co-creation. The comparative matrices provide stronger evidence of opportunities to comment on proposed policies and projects than of institutionalised citizen participation in NBS design, implementation, maintenance and long-term evaluation. This limitation is evident in both countries, although the specific legal and administrative mechanisms differ.

Table 4. Regulatory frameworks and operational instruments: Delivery and performance matrix on national level. Poland

Poland: delivery and performance matrix				
Financing	**Maintenance**	**Monitoring**	**Challenges**	**Opportunities**
National, regional and EU programmes, local environmental and water-management instruments, and participatory budgeting offer potential financing pathways. However, dedicated NBS allocations and project-level commitments are generally unspecified. Technical catalogues provide cost guidance but no direct funding.	Municipalities have statutory responsibilities for urban greenery and tree management. Adaptation plans identify responsible bodies, while technical guidance addresses maintenance. Nevertheless, asset-specific stewardship, recurrent budgets and long-term responsibilities often depend on local arrangements.	Municipal climate adaptation plans require measurable objectives, reporting every two years and updates at least every six years. Environmental assessments and programme indicators provide additional oversight, but a unified framework measuring ecological, hydrological and social NBS outcomes is not established.	Fragmented sectoral responsibilities, uneven local implementation capacity and uncertain financing limit delivery. Statutory planning and minimum green-area requirements do not guarantee ecosystem performance, while voluntary technical guidance is not consistently embedded in planning, procurement or maintenance. Draft and expired instruments also affect policy continuity.	Link national strategies to funded municipal projects, spatial plans and investment schedules. Integrate restoration, retention and climate adaptation measures; strengthen ecosystem-service indicators; secure long-term stewardship; and translate technical guidance into binding local specifications, procurement criteria and monitoring requirements.

Table 5. Regulatory frameworks and operational instruments: Delivery and performance matrix on national level. Bulgaria

Bulgaria: delivery and performance matrix				
Financing	**Maintenance**	**Monitoring**	**Challenges**	**Opportunities**
Environmental and regional development programmes, integrated territorial investments (ITIs), national and EU funds, and the National Trust EcoFund provide potential financing pathways for biodiversity, flood management and urban greening. However, dedicated NBS allocations, project-level budgets and long-term financing commitments are frequently unspecified. Land acquisition can entail substantial additional costs.	Asset-level maintenance responsibilities, recurrent budgets and long-term stewardship arrangements are generally insufficiently defined. Continuity depends heavily on municipalities and local partnerships. Technical guidance includes rehabilita-tion measures, but does not consistently establish funded operational responsibilities or participatory maintenance.	Environmental assessments, GIS-based information, biodiversity data, regional strategy monitoring and river basin planning provide monitoring foundations. Green-area percentages offer regulatory compliance measures, but integrated indicators for ecological, hydrological, climate and social NBS performance remain limited or unspecified.	Strategic recognition is weakly connected to spatially defined, costed and measurable interventions. Fragmented responsibilities, limited municipal capacity and co-financing, weak partnerships, land constraints and insufficient technical standards hinder implementation. Several measures remain at the planning stage, while draft or expired instruments complicate continuity.	Develop costed, spatially targeted NBS programm with clear responsibilitie and performance indicators. Combine funding sources and strengthen intermunicip cooperation. Secure green-blue networks, integrate ecosystem assessments and stakeholder knowledge, and establish funded maintenance and monitoring. Supplement quantitative greening standards with biodiversity, permeabilit and water-management requirements.

The two matrices reveal five principal findings. First, both countries have potential financing mechanisms but lack consistently identified, dedicated NBS allocations. Poland benefits from municipal environmental and adaptation instruments, whereas Bulgaria relies substantially on sectoral programmes, ITIs and project-based funding. Second, both countries still fail to secure long-term maintenance. Poland has clearer statutory municipal responsibilities for green infrastructure (inc. NBS), while Bulgaria's arrangements depend more strongly on individual projects, local authorities and bottom-up initiatives. Third, Poland has a comparatively more structured monitoring framework through mandatory municipal climate adaptation plans. Bulgaria has environmental and spatial monitoring instruments, but it has less clearly established integrated NBS performance indicators. Neither country has a comprehensive national system for evaluating NBS outcomes. Fourth, both countries face fragmentation between strategic objectives and practical implementation. In Poland, a major challenge is translating existing legal and technical instruments into funded, performance-oriented projects. In Bulgaria, additional difficulties include limited implementation capacity, land availability, coordination, and limited operational instruments for some policies. Finally, Poland and Bulgaria could strengthen NBS delivery by integrating financing, spatial planning, ecosystem-service payments and indicators, maintenance, and stakeholder engagement. Poland's opportunities center on improving the implementation of existing instruments, while Bulgaria's cluster around establishing more coherent, value-added and measurable delivery arrangements.

Poland appears to have a more developed regulatory and municipal monitoring foundation for NBS implementation, while Bulgaria has several potentially complementary financing and planning instruments that require stronger operational integration. In both countries, the principal challenge is moving from strategic recognition and green-space provision towards funded, maintained, and measurable ecosystem-based interventions.

Comparative implementation gaps and potential directions for improvement

The following table moves from the documented findings to analytical proposals and potential directions for meeting the implementation challenges. (Table 6)

Table 6. Implementation challenges and gaps identified in Poland and Bulgaria

	Gaps Identified		
Implementation challenge	**Poland**	**Bulgaria**	**Potential direction for improvement**
Policy integration	Coordination needed between adaptation, spatial planning, water management and investment instruments.	NBS objectives distributed across environmental, spatial, regional and sectoral policies.	Establish integrated municipal NBS planning frameworks that connect ecological, climatic, spatial, and social objectives.
Operationalisation	Strategic and legal provisions do not automatically translate into NBS-preferred investment decisions.	Funding opportunities are constrained by insufficient technical and project-development capacity.	Introduce NBS appraisal requirements and practical implementation pathways within municipal investment processes.
Technical guidance	Existing catalogues are not universally binding or integrated into all planning procedures.	Limited comprehensive technical guidance for multifunctional urban NBS.	Develop adaptable urban NBS design standards, technical catalogues and model project briefs.
Monitoring	Municipal adaptation monitoring exists, but common NBS performance criteria remain incomplete.	Quantified spatial targets, geospatial delineation and impact assessment are insufficiently developed	Establish measurable indicators for ecosystem services, climate adaptation, accessibility, biodiversity and maintenance performance.
Co-creation	Formal participation mechanisms do not necessarily ensure continuous stakeholder involvement.	Long-term engagement and co-creation are weakly formalised.	Integrate Living Labs, stakeholder partnerships and co-design processes into planning, implementation and evaluation.
Financing and maintenance	Long-term maintenance and stewardship are not automatically secured.	Co-financing, land acquisition, partnership continuity and maintenance create implementation barriers.	Connect capital investment to long-term maintenance budgets, stewardship arrangements and cross-sector partnerships.
Knowledge transfer	Local technical innovations require wider institutional uptake.	Applied research and practical capacity for urban NBS design need strengthening.	Create transnational learning networks, demonstration projects, and mechanisms to adapt tested solutions to local conditions.

2.2.4. Conclusions

The comparative analysis of the national policy and planning frameworks in Poland and Bulgaria indicates shared strategic commitments to environmental protection, biodiversity conservation, climate adaptation and ecosystem restoration. Nevertheless, institutional and operational mechanisms for implementing NBS in urban environments differ.

In Poland, the framework shows increasingly explicit integration of NBS and blue-green infrastructure into national urban policy documents, municipal climate adaptation planning, and practical design guidance. A key distinction is the introduction of mandatory municipal climate adaptation plans for cities with at least 20,000 inhabitants, which must include measurable objectives, public participation, monitoring, and periodic updates. A growing body of technical catalogues and locally developed standards further supports the translation of strategic objectives into urban design and investment practices. Nevertheless, coordination across policy sectors, consistent assessment of ecosystem-service benefits, procurement practices, and long-term maintenance remain challenges.

In Bulgaria, NBS are increasingly recognised in environmental and climate strategies, the recently developed national restoration framework and EU-supported operational programmes. Although the legislative basis for the protection and planning of urban green systems, including statutory greenery requirements, is well established at the national level, the translation of these provisions into multifunctional urban NBS remains constrained by fragmented sectoral responsibilities, insufficient integrated technical guidance, limited municipal project-development and co-financing capacity, and weakly institutionalised mechanisms for co-creation, monitoring and long-term maintenance. The draft National Restoration Plan offers an important opportunity to strengthen urban ecosystem restoration, but it must address the identified shortcomings in spatial quantification, financing, and impact assessment.

The comparative analysis suggests that both countries' major challenge is not the absence of NBS-related policy objectives, but developing coherent implementation frameworks that connect strategic commitments with spatial planning, technical design, financing, participatory governance, and measurable long-term outcomes.

The Polish experience offers potentially transferable approaches to municipal climate adaptation planning, technical guidance, and integrating blue-green infrastructure into urban policy. The Bulgarian experience outlines the importance of linking statutory green-system protection and available investment instruments with stronger local implementation capacity, collaborative governance and context-sensitive design approaches.

For both countries, advancing NBS implementation requires shifting from predominantly sectoral, project-based interventions to integrated, multifunctional, and continuously evaluated urban transformation processes. Such a transition depends on stronger institutional coordination, capacity building, knowledge exchange and mechanisms that sustain ecological and social benefits beyond the projects' individual investment cycles.

The conclusions are drawn on information available and accessible for the researchers from the consortium. However, three important issues must be taken into consideration. First, the two national frameworks are not entirely symmetrical in coverage. The Polish section provides greater detail on municipal climate adaptation obligations and technical guidance, while the Bulgarian section contains more extensive discussion of EU funding programmes and implementation barriers. The comparison therefore reflects the evidence presented rather than a complete inventory of Poland's and Bulgaria's national arrangements. Second, the source should clearly distinguish adopted, draft, and expired-horizon documents. For example, the source identifies Poland's Strategy for Poland 2035 as a draft, and Bulgaria's National Restoration Plan as a draft with unresolved implementation details. These cannot be treated as fully up-to-date operational policy frameworks. Third, the analysis compares policy and implementation conditions, not demonstrated NBS outcomes. Establishing which instruments deliver greater ecological, social or economic benefits would require additional evidence from municipal projects, budgets, performance monitoring and post-implementation evaluations.

2.3. Comparative analysis of the strategic and planning documents, regulations, and guidelines at local level – Konin and Sofia

2.3.1. Review of the strategic and planning documents, regulations, and guidelines at local level Konin

Local level: Strategic documents, incl. the masterplan of the municipality

Konin Development Strategy 2020–2030 (updated in 2022) provides solid, albeit indirect, foundations for implementing nature-based solutions. Although the document does not explicitly use the term NBS, it includes numerous provisions fully consistent with this approach. These include developing urban green spaces, managing and retaining stormwater, protecting biodiversity, renaturing degraded and post-industrial areas, and using the Warta River valley and lakes for climate, recreational, and health-related functions.

Particularly relevant are the measures under the "Greenery in the City" pillar (one of three main pillars of the development vision), the spatial policy prioritizing renaturation over new greenfield development, and projects planned within strategic intervention areas, especially Pociejewo Island, envisioned as an "ecological living room" of the city (potential area for implementing NBS projects). The strategy integrates environmental objectives with quality of life, public health, and social participation, which aligns well with contemporary understandings of NBS. It also provides implementation mechanisms, including clearly defined strategic areas, indicators, governance arrangements, and diversified funding sources.

To fully unlock NBS's potential, the strategy could be strengthened by adding an explicit NBS definition, systematically linking them to climate change adaptation, and developing more detailed operational and design standards.

Konin: Green City of Energy (2022) includes numerous provisions that support implementing nature-based solutions, although it does not explicitly use the term. Key elements include references to "harmony with nature," the use of natural assets (river, lakes, green valley of the Warta River), and climate change adaptation. The document highlights the need to protect water resources, improve air quality, develop urban green spaces, and limit interference with hydrological systems. It also emphasizes stormwater management, revitalizing degraded areas, and creating recreational spaces based on natural resources. The strategy promotes a systemic approach that integrates environmental, social, and economic aspects—for example, through public participation, the development of green entrepreneurship, and the incorporation of ecosystem-based solutions into spatial planning and transport. The document provides a supportive strategic framework for the development of NBS, particularly at the level of values and general directions. However, it lacks operational detail—specific tools, indicators, and dedicated NBS programs. Thus, while it provides a solid foundation, it needs further specification and translation into implementation projects to fully realize the potential of nature-based solutions in Konin's development.

Study of Conditions and Directions of Spatial Development of the City of Konin (updated in 2022) contains numerous provisions that indirectly and functionally correspond to the concept of nature-based solutions. Key provisions include strong protection of the Warta River valley as an ecological corridor and retention zone; preservation and enhancement of urban green areas; protection of wetlands, oxbow lakes, and small water bodies; reclamation of post-industrial sites; and restrictions on development in environmentally valuable areas. The document promotes solutions that rely on natural processes to regulate water management, microclimate, and the urban landscape. At the same time, it does not explicitly reference NBS, ecosystem services, or climate change adaptation in a strategic sense. Therefore, the Study provides a solid spatial and environmental framework for implementing NBS, but it does not constitute an independent strategy for their

development. This potential can be fully realized only through operationalization in municipal climate strategies, revitalization programs, and plans for green and blue infrastructure.

Local level: Sectoral Policies and policy documents

The Climate Change Adaptation Plan for the City of Konin (2020) makes extensive use of a nature-based solutions approach, even though it does not explicitly or consistently use the term NBS. The document strongly promotes green and blue infrastructure, including green roofs and walls, rain gardens, flower meadows, pocket parks, permeable surfaces, and small-scale water retention systems (see Chapter 6). These measures are embedded in the city's strategic objectives, which focus on mitigating the urban heat island effect, reducing vulnerability to droughts and pluvial flooding, and improving residents' quality of life. The plan integrates nature-based interventions with spatial planning, water management, and urban green-space policy, and it identifies concrete funding sources, implementation schedules, and monitoring indicators. As a result, **the document constitutes a functional framework for implementing NBS in Konin**. Its main shortcoming is that it does not explicitly frame these measures under a unified NBS concept. Nonetheless, in practice, the city clearly recognizes nature-based solutions as a key pillar of its climate adaptation strategy.

Sustainable Urban Mobility Plan for Konin (2020) can be considered an enabling framework for Nature-Based Solutions, but not an implementation framework. In the analysed document, references to NBS are mainly indirect and dispersed; however, they are present in several key areas:

Strategic and environmental objectives

The document identifies protecting the natural environment and mitigating transport-related nuisances as one of its main objectives. It emphasises the need to reduce emissions, improve quality of life, and increase the share of walking and cycling.

Environmental responsibility and protection of green areas

The text explicitly states the need to care for air quality, reduce noise, and protect green areas in spatial management.

Shaping urban space

The concept of a compact city is promoted, limiting transport pressure and supporting improvements in the quality of the natural environment. This implies the potential implementation of green streets and solutions based on retention, shade, and microclimate regulation (although not named explicitly).

Public spaces and quality of life

The plan highlights the need to develop "aesthetic and user-friendly public spaces," including transforming parking spaces into mini-parks (PARK(ing) Day).

A systemic approach to mobility and the environment

The plan assumes integration of transport, spatial planning, and environmental protection. This is a key prerequisite for NBSs, which require an intersectoral approach.

The Environmental Protection Program for the City of Konin for 2017-2020 with a perspective for 2021-2024 (2017) contains numerous actions aligned with NBS, such as urban greenery, water retention, and ecological corridors, but these actions are dispersed. The programme establishes basic institutional and planning frameworks that can be used to implement NBS. Its key potential lies in its linkage to spatial planning and its consideration of climate change adaptation. The document's main limitation is its lack of a strategic approach to NBS as an integrated system. Provisions that, although not explicitly using the term NBS, are consistent with its logic include:

- ✓ **Urban greenery and ecological infrastructure:** maintenance, care, and development of urban green areas; revitalization of parks (e.g., the pond in Chopin Park); creation of "green infrastructure" (street greenery, buffer/insulating vegetation); a programme for the protection of old trees and new plantings.
- ✓ **Ecological coherence and ecosystem protection:** protection and restoration of ecological corridors; afforestation and increasing forest area; counteracting the fragmentation of natural spaces.
- ✓ **Water management and retention:** increasing water retention and investments in retention; flood protection and drought mitigation measures; use of spatial planning tools (floodplain areas).
- ✓ **Adaptation to climate change:** references to the adaptation strategy (SPA 2020) and the need for adaptation measures; identification of key challenges: droughts, floods, and heatwaves.
- ✓ **Spatial planning as an implementation tool:** limiting urbanization of areas with high natural value; incorporating environmental provisions into local spatial development plans.

Smart City Plan for Konin (2022) includes relevant provisions that enable the implementation of nature-based solutions; however, it does not establish a coherent or explicitly defined strategy in this area. The most significant reference appears in the climate change adaptation task (Task 20), which explicitly highlights the use of nature-based solutions and the development of blue-green infrastructure. The document identifies key climate challenges—such as droughts, floods, and urban heat islands—providing a strong rationale for applying NBS.

Additionally, provisions on climate-responsive urban planning and the 15-minute city indirectly support green infrastructure development and reduce environmental pressures. A key strength is the vision of the city as a sustainable system based on harmony between people and nature, along with data monitoring and management tools that support NBS planning and evaluation.

At the same time, the document reveals significant gaps: no dedicated NBS strategy, insufficient specification of concrete measures (e.g., rain gardens, green roofs), undefined indicators, and fragmented provisions. The predominance of a technology-oriented (smart) approach limits the potential for systematic implementation of nature-based solutions.

In conclusion, the document shows strong potential to support NBS and may serve as a foundational framework; however, it needs further specification, integration, and operationalization to guide implementation in practice.

The Low-Emission Economy Plan for Konin for 2021–2024 (2021) does not explicitly reference nature-based solutions. The document focuses primarily on technological and infrastructure measures such as building retrofitting, renewable energy sources, modernization of heating systems, and low-emission transport. At the same time, related documents—particularly the Air Protection Programme for the Wielkopolska Zone and the Spatial Development Plan of the Wielkopolska Voivodeship—include provisions that are characteristic of the NBS approach, such as the development of green infrastructure, the protection and expansion of green areas, the safeguarding of ecological corridors, and the improvement of the urban microclimate.

Konin has considerable natural potential (the Warta River valley, Natura 2000 sites, floodplain areas) that could support nature-based solutions for both emission reduction and climate change adaptation. However, the current Low-Emission Economy Plan provides only indirect and insufficient frameworks for developing NBS. Fully implementing this approach would require clearly integrating NBS into the city's policy objectives, actions, indicators, and financial instruments.

The Municipal Regeneration Programme of the City of Konin until 2030 (2023) includes numerous provisions that directly or indirectly correspond to the nature-based solutions approach. Particularly relevant are activities related to developing urban green spaces (parks, squares, green courtyards) and blue-green

infrastructure, managing riverside areas along the Warta River, mitigating urban heat island effects, and integrating green areas with social and recreational functions. Projects such as the renovation of Chopin Park, greening of housing estates, and the development of the Warta riverside boulevards fit well within the NBS concept as solutions based on natural processes that simultaneously deliver social benefits.

Although the document does not explicitly use NBS terminology and does not define clear ecological objectives (e.g. regarding biodiversity), its structure – linking spatial planning, social participation, and environmental actions – can support an institutional framework for implementing this approach in Konin. Strengthening the programme with explicit ecosystem-based goals and the monitoring of environmental outcomes would allow the city to fully realize the potential of nature-based solutions in its future development.

Local level: Integrated policy documents

"Green Space" Program - sustainable development of urban space (2023) was divided into analytical and design sections. The analytical section included an assessment of the existing greenery, an analysis of planning documents, and an assessment of green areas. The study also analyzed protected areas (scope and form of protection) and natural connections, and conducted a hydrographic analysis alongside an analysis of paved (sealed) areas. The design portion of the "Green Space" Program was presented as a master plan—a study that combined urban and architectural scales. The master plan contains general provisions for larger areas, including the entire city. It defines not only the greenery layout but also recommendations, operational principles, phasing, and priorities for implementing changes. The programme includes numerous elements typical of NBS, including green and blue-green infrastructure, retention and hydro-ecological solutions, renaturalization and natural succession, and ecological corridors and ecological networks. The document does not use the term “nature-based solutions”; the approach is implied but not named. However, the document has high implementation potential for NBS because it includes concrete solutions, integrates them with urban policy, and identifies priority areas.

Local level: Operational documents

Standards for the care of urban space (2023) practically implement the principles of nature-based solutions in Konin, although without using this term, and create a solid technical, organizational, and spatial framework for the implementation of NBS. It covers key types of NBS: conservation, retention, adaptation, biodiversity, and social. The provisions of this document can be directly used as the basis for a local NBS strategy once they are appropriately "named" and linked to climate and health goals. Key areas of the document supporting the implementation of NBS:

Protection and strengthening of existing natural capital (NBS of the “protect & restore” type)

This document addresses protecting trees and other forms of greenery during the investment process, the obligation to designate Tree Protection Zones (TPZ), strict protection of root systems, the use of trenchless technologies, and solutions that minimize soil disturbance.

Urban Surface Retention System (SPRiM) and water infiltration

The document includes recommendations on: infiltrating stormwater into root zones, reducing green areas relative to paved surfaces, using permeable pavements, and limiting stormwater runoff during drought.

Extensive forms of greenery and increasing biodiversity

The document consistently promotes: flower meadows as an alternative to lawns, reduced mowing and leaf raking, leaving biomass and creating microhabitats, and supporting native and non-invasive vegetation.

Green adaptation to drought and climate change

Section 4.6 focuses on principles for action during droughts, preventive measures (retention, mulching, reduced mowing), soil moisture monitoring, and adjusting green-space maintenance regimes under extreme conditions.

Social component and governance (NBS as a process)

The document also considers the social dimension, including establishing community gardens, running information campaigns on changes in green-space maintenance practices, and involving non-governmental organizations and residents. Technical documents often overlook this aspect, yet it is crucial for effective NBS (social acceptance and shared responsibility).

Local level: Local standards and guidelines

GUIDE Green and Blue Infrastructure in Urban Adaptation to Climate Change (2024) provides a comprehensive catalog of solutions that meet the definition of NBS, but it does not explicitly use the concept of nature-based solutions. The actions described can provide a solid framework for further developing NBS in Konin, both operationally and strategically. Identification of provisions corresponding to the NBS approach:

- ✓ **General strategic framework aligned with NBS.** Key elements include:
  - Strategic linkage with climate change adaptation, increasing urban resilience, and improving residents' quality of life.
  - References to municipal documents (Climate Change Adaptation Plan, the "Green Space" Programme, Standards for the Care of Urban Space), which serve as formal, institutional frameworks for the implementation of nature-based solutions.
- ✓ **Green and blue infrastructure as the core of NBS.** The solutions described in the guide can be directly classified as NBS (according to EU and IUCN classifications):
  - Stormwater retention and management: rain gardens, infiltration basins, dry streams, stormwater capture systems.
  - Urban green infrastructure: pocket parks, green courtyards, green corridors connecting larger ecological nodes, multilayer plantings, flower meadows, reduced mowing.
  - Green roofs and living walls: improvement of the microclimate, mitigation of the urban heat island effect, water retention, biodiversity enhancement, improvement of air quality.
- ✓ **Social dimension of NBS.** The guide repeatedly emphasizes the health and recreational functions of greenery, the importance of neighbourhood micro-spaces, parklets, and meeting places, as well as the role of educational elements (RED BOX, information boards).

2.3.2. Review of the strategic and planning documents, regulations, and guidelines at local level in Sofia

Local level: Strategic documents, including the masterplan of the municipality

Municipal Council initiative - Vision for Sofia: Long-term strategy for the development of Sofia and the suburban areas until 2050 and actions (approved 2020). The long-term strategy to 2050 establishes a shared framework for Sofia and its suburban territories and is intended to guide the General Spatial Development Plan and subsequent sectoral strategies. Its nature-based solutions (NBS) content centres on protecting biodiversity and natural capital, retaining the green wedges that connect Vitosha with the urban area, reducing soil sealing, and using environmental data in planning. The action programme translates these directions into restoration and protection of natural riverbeds, recreational routes along rivers, new or restored wetlands and a phased plan for completing the green wedges. It also calls for rainwater harvesting for irrigation and non-potable uses, rehabilitation of degraded land, and requirements or incentives for green roofs. Together, these measures combine ecological connectivity, flood management, cooling and access to green space, although

implementation depends on resolving land-ownership and cadastral constraints (Sofia Municipality, 2020a, pp. 59–61; Sofia Municipality, 2020b, pp. 240–244).

General Spatial Development Plan 2010–2030 and its amendment. The Plan is Sofia's principal statutory spatial framework. The ongoing comprehensive amendment, accompanied by a Strategic Environmental Assessment and appropriate assessments, offers the main route to translate the Vision's blue-green ambitions into binding land-use rules. Under the Spatial Development and Construction Act of Sofia Municipality, spatial development must support sustainable development and improvement of the municipality; the General Plan and its rules are public, and amendments must safeguard the green-system structure and existing green areas (Spatial Development and Construction Act of Sofia Municipality, 2007, Arts. 2, 3 and 5; Supplementary Provision § 7). For NBS, the amendment should therefore secure green wedges, river corridors, parks and inter-block spaces; limit additional sealing; identify land needed for connectivity and water retention; and coordinate implementation, expropriation, financing and monitoring. The environmental assessments are important safeguards for biodiversity, Natura 2000 connectivity and cumulative climate risks. Ongoing (from 2014) preparation of a more comprehensive amendment of the **General Spatial Development Plan 2010 – 2030 and its partial amendments and the Strategic Environmental Assessment altogether with assessment of compatibility with the national ecological network** is pressingly needed as the temporal horizon of the plan is close to be reached while previously aimed changes in the plan were stalled by the political turmoil at national and local level in the past 5 years.

Local level: Sectoral Policies and policy documents

The Municipal Council of Sofia has approved a wide spectrum of sectoral policies and documents, but none relate to NBS implementation. Some synergies may be sought with the **Sustainable Urban Mobility Plan,** which incorporates measures related to cycling and pedestrian infrastructure (re)development and additional provision, including green recreational corridors. The Vision also envisaged a Water strategy to be elaborated, but no such document is available for public consultation. Water-sensitive planning is addressed indirectly through river restoration, rainwater reuse and flood-risk measures in the Vision, SECAP and Green City Action Plan. Green infrastructure's status is similar, as there is no dedicated sectoral plan for its recovery and development.

Local level: Integrated policy documents

The **Plan for Integrated Development of Stolichna Obshtina 2021-2027 (developed under the requirements of the** Law for Regional Development) is an operational document that serves as the primary tool for planning and implementing local investments, specifically targeting the improvement of urban ecology and social infrastructure. It outlines concrete NBS projects, focusing on co-creating multifunctional green spaces that serve both climate adaptation and community recreation needs. Strategic Goal 1 seeks sustainable territorial development and connectivity through ecological, intelligent, and economically sound solutions. Priority 1, 'Sofia Municipality – sustainable, green and adaptive', and Specific Objective 1 call for a cleaner, healthier, and more diverse living environment that integrates natural capital into planning. The diagnostic basis highlights unequal access to green space, development pressure, flood exposure, aging street trees and the absence of complete green-system and tree-register data. It consequently treats NBS as responses to heat, pollution and climate risk, rather than as isolated landscaping. Relevant implementation directions include protecting biodiversity, improving green and blue infrastructure, restoring degraded or underused areas, strengthening green links and embedding ecosystem services in investment decisions. The Plan also serves as a vehicle for territorial investment and EU financing, so project selection and monitoring should explicitly identify NBS outputs and benefits (Sofiaplan, 2021, pp. 6–9).

Local level: Operational documents

The Net Zero Cities (NZC) - Climate City Contract (CCC) 2024-2030 explicitly outlines the city's commitment to climate neutrality, placing a heavy emphasis on carbon sequestration through urban forestry and greening. It promotes innovative NBS design to offset emissions and identifies partnership models to fund large-scale ecological transitions. Sofia's Climate City Contract raises the city's 2030 ambition to an 81% reduction in greenhouse-gas emissions from the 2018 baseline. Its investment logic recognises green infrastructure and NBS—including urban forests, parks, community gardens, green roofs and wetlands—as part of the climate-neutrality portfolio. These interventions can provide carbon sequestration, cooling, stormwater retention, biodiversity, and health benefits, but the Contract also shows they must connect to investment pipelines, municipal climate budgeting, and measurable outcomes. For urban ecosystems, the priority is therefore not only new planting, but long-term protection, irrigation, maintenance, survival monitoring and equitable distribution in neighbourhoods with the greatest heat and green-space deficits (Sofia Municipality, 2024).

As a member of the Covenant of Mayors, Sofia has developed the **Sustainable Energy and Climate Action Plan (SECAP) 2021-2030,** which was recently revised. This plan integrates climate adaptation with energy efficiency and highlights the role of green roofs and walls in reducing urban heat island effects. It provides a framework for implementing ecosystem-based adaptation measures to protect city infrastructure from extreme weather events. The updated SECAP integrates NBS into both mitigation and adaptation and aligns its mitigation pathway with the Climate City Contract's 81% reduction target. It includes 19 mitigation and 29 adaptation measures, along with goals for lower final-energy use, additional renewable generation, monitoring, and public participation. Strategic Objective 3 is an adaptive city supported by legal and institutional capacity, stakeholder engagement, NBS and improved preparedness (Sofia Municipality, 2026a, pp. 43–44, 227–228). Annex 4 makes this operational through measures to assess ecosystem services and incorporate them into spatial planning (A.3.5); study flash-flood and landslide risk (A.3.8); prepare an irrigation-support plan for trees and green areas (A.3.11); catalogue climate-suitable plant species (A.3.12); install blue-green cooling arches and targeted 'blue-green acupuncture' (A.4.3); and use landscape measures that accelerate tree growth (A.4.4). The indicative budgets include BGN 2.6 million for ecosystem-service integration, BGN 5 million for blue-green cooling interventions and BGN 14.3 million for tree-growth measures (Sofia Municipality, 2026b).

Under the Law on Environmental Protection (which transposes several EU environmental directives), the **Environment Protection Program and Action Plan 2022-2027** is still being implemented. The program is set to expire soon, and there is no draft of the next document yet. Its NBS-relevant actions include creating or restoring grassed areas at dust-generating sites, expanding street vegetation, forming green belts along roads, improving vegetation around business and industrial sites, and maintaining grass, shrubs and trees to reduce wind erosion and resuspended dust. These measures connect air quality with soil protection, biodiversity and neighbourhood amenity. Spatial targeting, native and climate-resilient species, survival and canopy indicators, and explicit links to the green-system register and SECAP adaptation monitoring would strengthen their value (Sofia Municipality, 2022).

In line with the Directive on ambient air quality and cleaner air for Europe and the transposed national Law on Clean Air, a Comprehensive Program for Improving the Quality of Atmospheric Air of Sofia Municipality for the Period 2021 – 2026 is under implementation, additionally supported by the Municipal Ordinance on Low Emission Zones for cars and domestic heating with years of introduction of regulations (referred as "Program for Air quality"). The Programme's primary objective is to reduce pollutant concentrations and achieve statutory air-quality standards, mainly through controls on domestic heating, transport and other emission sources. Urban greening, controlling dusty open surfaces, roadside planting, and better maintenance can provide supporting benefits by limiting resuspension, shading streets, and improving microclimates. These measures should be framed carefully - vegetation complements rather than replaces emissions reduction, and species placement and maintenance should avoid obstructing ventilation or increasing allergenic exposure. Linking air-quality monitoring with canopy, surface-sealing, and heat data would make NBS contributions clearer (Sofia Municipality, 2021a). The program includes a long list of measures that need clearer definition

in terms of green infrastructure's contribution to reducing PM and other pollutants, e.g., through dry deposition and capture, airflow modification and ventilation, reduced resuspension, and temperature reduction.

Developed in collaboration with the EBRD and ARUP and as part of the Green Cities initiative, the Green City Action Plan 2020-2023-2027, with a vision and goals to 2035, sets a strategic vision for 2035 focused on sustainable water management and air quality. Its strategic objectives include improving and expanding green space, integrating green infrastructure, and increasing resilience to surface-water and climate risks. It promotes investments in "blue-green" infrastructure, such as permeable surfaces and restored urban waterways, to manage stormwater and enhance local biodiversity. Particularly relevant actions are improvement of inter-block areas (H.01), pocket parks in dense neighbourhoods (H.04), reuse of brownfield land (U.02), climate-risk and flood modeling (BG.01), protection and expansion of green corridors (BG.02), and improved surface-water management (BG.03). These measures promote restoration of riverbeds and ecosystems, better access to green space and multifunctional corridors. Annual monitoring was envisaged, creating a basis for tracking delivery and coordinating the Plan with the Programme for Sofia, SECAP and capital programme (European Bank for Reconstruction and Development, Arup, & Sofia Municipality, 2020).

Local level: General and specific regulations

The unique legal act (adopted at national level, but implemented by Sofia Municipality) **Spatial Development and Construction Act of Sofia Municipality** regulates the development regimes and procedures in Sofia Municipality and although its provisions for green and blue infrastructure are relatively well elaborated, though a little bit outdated as concepts defined more than 25 years ago, the implementation mechanisms in place are not complete and that affects disproportionately the green and blue infrastructure, especially after key decision by the Constitutional court about the temporal aspects of expropriation. Nevertheless, Articles 2 and 3 link the General Plan to sustainable municipal development and binding planning rules; Article 5 requires public access to the Plan and related amendments. Its provisions and supplementary rules protect the structure of the green system and require the public to maintain relevant information. For NBS, the Act matters most when statutory plans designate green areas, river corridors, and ecological links, because designation can control incompatible development and enable acquisition and investment. Persistent practical issues concern fragmented ownership, expropriation, outdated detailed plans and the gap between mapped green-space status and implementation (Spatial Development and Construction Act of Sofia Municipality, 2007).

The **Sofia Municipality Urban Environment Ordinance** regulates the physical appearance and functional design of urban surfaces, focusing on mitigating runoff through sustainable drainage. It sets specific design criteria for public spaces that encourage natural materials and vegetation to manage the urban microclimate. The requirements are partial and still developing, covering only part of the city. Articles 1 and 3 establish its scope and the role of the standards, while Article 5 requires urban components to be maintained in good technical and aesthetic condition and to remain accessible. Article 14 requires projects for new or reconstructed streets, squares, and green areas to demonstrate compliance; the landscape component must address pavements, trees, shrubs, flowers, and garden elements. This provides an operational entry point for permeable surfaces, shade, rainwater retention and SuDS, provided that the annexes and project-review practice set measurable performance requirements (Sofia Municipal Council, 2020, Arts. 1, 3, 5 and 14).

The **Ordinance on the Development, Management and Protection of the Green System** sets specific legal requirements for designing and maintaining all green areas within the municipality. It sets technical standards for landscaping and further ensures that NBS are integrated into the long-term maintenance schedules of public urban spaces and into the design of single or more complex investment projects. It is the municipality's most direct regulatory instrument for urban vegetation. Article 1 covers planning, construction, sustainable

maintenance, conservation and development of the green system regardless of ownership, and recognises ecological, recreational, aesthetic and protective functions. Articles 3 and 4 address annual maintenance intensity, municipal coordination, the public vegetation register and expert advice. These provisions can support NBS throughout their life cycle—from site designation and design to planting, protection, replacement and maintenance. Effective delivery depends on an up-to-date inventory, transparent permits and compensatory planting, stable maintenance funding, climate-suitable species, and monitoring of canopy cover, condition, and survival rather than planting numbers alone (Sofia Municipal Council, 2017).

The **Ordinance on the Procedure for Holding Public Consultations** details participation and consultation opportunities that provide greater transparency in the capital city than elsewhere in the country. For NBS, early consultation can incorporate local knowledge about flooding, heat, biodiversity, access, and maintenance, while publishing proposals and responses improves transparency and can reduce conflict over land use and tree management.

The Ordinance on the terms and conditions for providing data and issuing reports on the decisions of the general development plan of Sofia Municipality provides the technical conditions and procedural steps for access to information about the planning provisions, and in this regard the capital city has more advanced access to urban environmental information for the general public and the owners and investors as primary stakeholders in the development process. By governing access to spatial-planning data and official reports, the Ordinance supports accountability for green-system designations. Open, interoperable data on land use, trees, sealing, water, ownership and project status would also enable public oversight and consistent monitoring of municipal NBS targets.

Local level: Local standards and guidelines

The **Sofia Municipality Urban Environment Ordinance** goes together with Annexes which can be considered urban design and construction standards. Some focus on improving the climate and environmental performance of public works, especially through the **Standard for pavements in pedestrian areas of the Sofia Municipality**. Appendix 8 is the Sofia Street Pavement Standard. Their relevance to NBS lies in choices about surface materials, planting zones, accessibility, street furniture, and the relationship between trees, utilities, and drainage. Future revisions could define minimum soil volumes, permeability, runoff retention, shade and tree-protection criteria, turning general blue-green intentions into verifiable project requirements (Sofia Municipality, n.d.). The Sofia Municipality developed another standard for street landscaping at a preliminary stage, without any graphic attachments, and has not yet approved it. Completing it would help standardise tree pits, soil, species selection, irrigation, utility clearances and maintenance responsibilities across street projects.

2.3.3. Comparative analysis between the strategic and planning documents, regulations, and guidelines at local level in Konin and Sofia

Based on the review of municipal strategic, planning, regulatory, and operational documents (Sections 2.3.1 & 2.3.2), two matrices compare the institutional and policy instruments supporting Nature-Based Solutions (NBS) in Konin and Sofia. The matrices distinguish between explicitly recognised NBS measures and measures that implicitly support NBS through green-blue infrastructure, climate adaptation, ecological restoration, and management of the urban environment.

The matrices reveal two distinct but complementary approaches to the institutionalisation of NBS. Konin demonstrates relatively strong operational integration of NBS principles, particularly through its Climate Change Adaptation Plan, Green Space Programme and technical standards for urban-space maintenance. However, most instruments incorporate NBS implicitly and do not establish a unified conceptual or institutional framework.(Appendix F3)

Sofia demonstrates more explicit recognition of NBS in climate and integrated development policies, particularly through the SECAP, Climate City Contract and Plan for Integrated Development. Its comparatively extensive regulatory and administrative framework creates implementation opportunities, although fragmented responsibilities and the incomplete translation of strategic objectives into binding spatial and technical requirements remain challenges. (Appendix F4)

In both cities, knowledge inputs come primarily from environmental assessments, spatial planning, climate-risk analysis, and technical expertise. Public participation is recognised across several instruments, but evidence of systematic co-creation and shared decision-making in NBS implementation remains limited. The comparison suggests that Konin prioritizes connecting existing operational practices through an explicit NBS governance framework, while Sofia prioritizes translating strategic NBS commitments into coordinated, enforceable, and participatory implementation mechanisms.

This presented hereafter thematic comparison of Konin (Table 7) and Sofia (Table 8) focused on actual financing, maintenance, and monitoring arrangements, as well as the main barriers and opportunities for NBS implementation. It also distinguishes existing arrangements from potential improvements.

Table 7. Konin: Delivery and performance matrix

Konin: Delivery and performance matrix				
Financing	**Maintenance**	**Monitoring**	**Barriers**	**Opportunities**
● External funding experience, diversified strategic funding ● Sources and identified climate adaptation financing. ● Dedicated NBS funding mechanisms are not specified.	Established technical standards for tree protection, stormwater infiltration, biodiversity-friendly management, reduced mowing and drought adaptation.	● Strategic and climate adaptation indicators, ● Greenery assessments and soil moisture monitoring. ● No integrated NBS monitoring system is identified.	● Absence of an explicit NBS framework; fragmented sectoral measures; ● Limited NBS-specific indicators and operational coordination.	● Integrate existing green-space standards and climate adaptation measures into a coherent NBS programme; ● Connect ecological restoration with post-industrial regeneration and just transition.

Table 8. Sofia: Delivery and performance matrix

Sofia: Delivery and performance matrix				
Financing	**Maintenance**	**Monitoring**	**Barriers**	**Opportunities**
● Municipal and EU investment frameworks are available ● Climate investment partnerships and indicative budgets for selected NBS-related adaptation measures are available. ● Long-term maintenance financing remains a concern.	● Regulatory requirements for green-space protection and maintenance are available; ● Responsibilities are distributed across municipal structures. ● Stronger tree survival, irrigation, and life-cycle management are needed.	● Climate and environmental monitoring, vegetation registers, and environmental assessments exist as frameworks ● Incomplete inventories and insufficient integration of NBS performance indicators.	● Fragmented institutional responsibilities, ● Land ownership and expropriation constraints, ● Delayed spatial planning updates ● Implementation gaps.	● Integrate NBS into binding planning regulations, ● Introduce climate investment programmes and coordinated monitoring; ● Strengthen ecosystem-service assessment and equitable green-space provision.

The matrices indicate that Konin has a comparatively well-developed set of technical and operational instruments for green-blue infrastructure management, particularly concerning urban vegetation, stormwater retention and biodiversity-friendly maintenance. However, financing and monitoring remain dispersed across sectoral policies, with limited explicit identification of NBS-specific funding and performance indicators. Sofia has more developed strategic investment and regulatory mechanisms, especially through the SECAP, Climate City Contract and integrated development planning. Nevertheless, implementation faces challenges from institutional fragmentation, land ownership issues, incomplete environmental inventories, and the need for stable, long-term maintenance financing.

For both cities, the main opportunity is to establish a more coherent NBS implementation and management cycle that links investment programming, maintenance responsibilities, environmental monitoring, and participatory governance. Such integration would support the transition from individual green infrastructure interventions to systematic, measurable, long-term nature-based urban development.

2.3.4. Conclusions

The comparative analysis of the municipal strategic, planning, regulatory and operational documents reveals different levels of institutionalisation and implementation capacity for Nature-Based Solutions (NBS) in Konin and Sofia. While both cities integrate NBS principles into urban development and environmental policies, they differ in their strategic recognition, operational instruments, financing arrangements, and governance structures.

Konin demonstrates stronger operational integration of NBS-related measures, particularly through climate adaptation planning, green-space management and technical maintenance standards. However, NBS are addressed largely implicitly, without a unified strategic framework, dedicated financing mechanisms, or comprehensive performance monitoring. Existing instruments provide a practical foundation for further development, especially by linking ecological restoration and green-blue infrastructure with post-industrial regeneration and just transition objectives.

Sofia shows a clearer strategic recognition of NBS, supported by climate policies, integrated development planning, and municipal regulations. The city benefits from established investment frameworks, including municipal and EU funding opportunities, and indicative budgets for selected adaptation measures. Nevertheless, fragmented institutional responsibilities, land ownership and expropriation issues, delayed spatial planning updates, and insufficient coordination between strategic objectives and operational delivery constrain implementation.

The delivery and performance matrices further highlight differences in financing, maintenance and monitoring. Konin has established technical standards for vegetation protection, stormwater infiltration and biodiversity-friendly maintenance, but lacks integrated NBS monitoring and dedicated funding arrangements. Sofia has broader regulatory and investment instruments, but incomplete environmental inventories, insufficiently integrated performance indicators, and uncertainties about long-term maintenance financing limit their effectiveness. In both cities, environmental assessments, spatial planning data and technical expertise provide important knowledge inputs, while public participation is recognised but not yet systematically integrated into NBS co-creation and decision-making.

Overall, the comparison identifies two complementary priorities: establishing an explicit, integrated NBS governance framework in Konin and strengthening the operational implementation of existing strategic commitments in Sofia. For both cities, improved coordination between financing, implementation,

maintenance, monitoring, and stakeholder participation is essential. This would facilitate a transition from fragmented green infrastructure interventions to coherent, measurable, and sustainable NBS implementation, contributing to urban climate resilience, ecological quality, and social inclusion.

2.4. Comparative analysis of the socio-cultural and institutional contexts in Konin and Sofia

2.4.1. Review of the socio-cultural and institutional context in Konin

Local level: Institutional context

The Konin City Cooperation Program with Non-Governmental Organizations (2025) does not reference NBS, climate change adaptation, or environmental and climate indicators. However, several specific objectives of the Programme are consistent with the philosophy of Nature-based Solutions (NBS), particularly in the context of transformation, adaptation, and improving the quality of the living environment. These mainly include: fostering social activity and local initiatives and strengthening responsibility for public space; creating conditions for cross-sectoral cooperation, including with scientific institutions. Another key element is supporting a just transition for Eastern Wielkopolska as a region affected by socio-economic changes resulting from the phase-out of lignite coal in the power generation and district heating sectors. The strongest foundations for NBS are set out in § 8 of the Programme:

- ✓ **Ecology and protection of natural heritage**

The Programme includes environmental education, engaging residents in pro-environmental activities, and the protection of animals and elements of urban nature.

- ✓ **Tourism, recreation, and sightseeing**

The scope includes, among other things, combining recreation, health, and nature conservation by maintaining and developing trails, cycling routes, walks, outdoor games, and educational activities in urban and natural spaces.

- ✓ **Revitalisation**

The document also provides for the implementation of activities resulting from the Municipal Revitalisation Programme until 2030.

- ✓ **Development of local communities and civic initiatives**

The Programme supports local initiatives, the diagnosis of needs in this area, and joint planning of activities.

Local level: Socio-cultural context

The Konin City Hall action plan to improve accessibility for people with special needs for 2025-2028 (2025) does not directly reference green spaces, ecosystems, or climate change adaptation. The plan takes a dominant technical and infrastructural approach, focusing on buildings rather than full-scale public spaces. However, the plan could indirectly provide a functional framework for developing NBS in Konin, serving as an integration platform rather than a strict NBS strategy. The "Accessible Urban Space" application, which maps urban infrastructure elements and facilitates movement for people with special needs, offers strong potential for synergistic NBS development while increasing accessibility. This tool could be expanded to include elements of green and blue infrastructure (parks, tree shades, water bodies) and to identify areas requiring climate adaptation.

Konin is a city with county rights (miasto na prawach powiatu) situated in central-western Poland, within the eastern part of the Greater Poland (Wielkopolska) Region. It serves as the subregion's primary administrative

and economic center. The city's urban fabric features a distinct spatial division between the historic southern quarter (the Old Town) and the northern quarter (New Konin), the latter shaped by modernist architecture and developed during the period of rapid post-war industrial expansion. The city's population is currently under 68,000 residents (compared to over 83,000 during its demographic peak at the turn of the 21st century).

The ecological, landscape, and hydrological spine of the city is the Warta River—the third longest river in Poland and a vital link within the regional water transport network known as the Great Loop of Wielkopolska (Wielka Pętla Wielkopolski (Development Strategy for the Wielkopolskie, 2020)).

Konin's location establishes it as a strategic multimodal logistics and transport hub on a European scale: Road Corridor: Direct access to the trans-European A2 Motorway (part of the TEN-T North Sea–Baltic Core Network Corridor), providing high-speed road connectivity along the Berlin – Poznań – Łódź – Warsaw axis; rail Corridor: Proximity to the international E20 Railway Trunk Line, ensuring efficient East–West freight and passenger transit (City of Konin, 2022).

Konin received its municipal charter at the end of the 13th century. A prominent testament to its long-standing heritage is the Konin Milestone from 1151—the oldest surviving Romanesque road marker in Central and Eastern Europe, originally erected to indicate the halfway point between the regional centers of Kalisz and Kruszwica. Over the centuries, the city functioned as a regional hub for craftsmanship, trade, and administration. In the second half of the 20th century, it underwent a profound metamorphosis into one of Poland's foremost centers for lignite (brown coal) mining, conventional thermal power generation, and aluminum smelting (Development Strategy for the Wielkopolskie…, 2020).

Social context

Konin faces structural depopulation and demographic shifts characteristic of European cities navigating deindustrialization:

- ✓ Selective Out-Migration and Brain Drain: The city experiences a persistent outflow of young, highly educated residents (aged 19–29) relocating to metropolitan academic and business centers (Poznań, Warsaw, Wrocław, Łódź). Because the local job market remains limited in specialized corporate services, IT, and creative industries, return rates among graduates are low. Consequently, the municipality faces a steady depletion of its most adaptable and innovative human capital (City of Konin, 2022).
- ✓ Aging Population: A shrinking pre-working and working-age population alongside a growing senior cohort has driven a steep increase in the demographic dependency ratio. This trend requires extensive, costly adaptation of municipal social, medical, and care services (City of Konin, 2022).
- ✓ Loss of Traditional Core Functions: The phase-out of lignite mining and workforce downsizing in heavy industry represent not only an economic loss, but also a shift away from a decades-old social identity grounded in industrial and mining traditions (City of Konin, 2022).
- ✓ Corporate-Welfare Legacy: Long-standing reliance on state-owned and privatized enterprises—which provided robust social safety nets and guaranteed lifetime employment—diminished the historical incentive for individuals to pursue self-employment or launch ventures (City of Konin, 2022).
- ✓ Entrepreneurship Gaps: Today, this legacy manifests in relatively low self-employment rates, risk aversion to launching commercial enterprises, and a modest tradition of B2B cooperation, networking, and cluster building among micro and small enterprises (City of Konin, 2022).

Cultural Context

Alongside these structural headwinds, Konin retains substantial cultural and institutional strengths:

- ✓ Cultural Traditions and Infrastructure: The city maintains a developed cultural infrastructure (notably the Konin Cultural Centre - KDK and the Centre for Culture and Arts - CKiS) and a recognized tradition in the

performing arts. The annual International Children's Song and Dance Festival is a flagship event and has run for over four decades as one of Europe's largest youth cultural exchange platforms (City of Konin, 2022).

- ✓ Active NGO Sector: Konin hosts an active network of NGOs, foundations, and associations. These bodies play an instrumental role in grassroots activation, senior inclusion, cultural animation, and shaping a renewed post-coal civic identity (Report on the condition, 2025).
- ✓ Public Participation: High community attendance and engagement in socio-cultural initiatives allow this sector to serve as an essential shock absorber for social tensions arising from industrial restructuring.

Institutional context

The intersection of structural energy transition and sustained demographic contraction exerts significant, measurable pressure on the city's fiscal architecture. As the local population declines and conventional heavy industrial plants scale down operations, the municipal budget experiences a direct contraction in own-source tax revenues, most notably from personal and corporate income tax shares (PIT and CIT) as well as industrial property taxes. At the same time, the local authority must maintain an extensive network of technical and social infrastructure—spanning primary schools, the municipal road network, and centralized district heating—originally engineered and built during the mid-to-late 20th century for an expanding city of nearly 100,000 residents. This mismatch increases per-capita fixed maintenance overheads, which in turn reduces the city's operating surplus and constrains its capacity to provide matching funds for large-scale capital investments (City of Konin, 2022).

To mitigate these internal fiscal limitations, the municipal administration and its subordinate units have developed sophisticated, specialized competencies in securing and deploying competitive external financing. As the core urban center of Eastern Wielkopolska, Konin serves as a primary hub for interventions supported by the European Union's Just Transition Mechanism (JTM) and the Just Transition Fund (JTF), deploying dedicated resources toward brownfield remediation, industrial diversification, and large-scale workforce reskilling initiatives (Churski, 2023). The municipality also demonstrates an established track record in absorbing European Cohesion Policy instruments (ERDF, ESF+), EEA and Norway Grants, and targeted national investment programs to finance comprehensive public transport fleet decarbonization, deep thermal retrofitting of public infrastructure, and urban blue-green climate adaptation systems. This strong funding absorption capacity is reinforced by active participation in inter-municipal partnerships, cross-border knowledge-exchange networks, and structured collaborations with research institutions, private-sector stakeholders, and international organizations aimed at accelerating sustainable urban transformation (Climate Neutrality Strategy…, 2021).

2.4.2. Review of the socio-cultural and institutional context in Sofia

Local level: Institutional context

Governance capacity and cross-sector coordination

Sofia Municipality combines political leadership and central administrative directorates with district administrations, municipal enterprises and external utility or service providers. This creates substantial implementation capacity, but NBS cut across spatial planning, environment, water, transport, public works, health, finance and district-level maintenance. The Vision for Sofia review found a generally clear relationship between municipal priorities and sectoral responsibilities, yet also called for a stronger chain linking the long-term vision, strategic objectives, annual administrative objectives, directorate targets and individual staff responsibilities. It recommended a unified performance index, periodic progress reporting and clearer ownership of strategic actions (Sofia Municipality, 2019a). For NBS, this means assigning a lead unit and a named co-owner for each measure, defining responsibilities throughout the project life cycle, and linking

capital delivery to maintenance, ecosystem-service, and equity indicators rather than reporting only expenditure or physical outputs.

Human resources, organisational learning and continuity

The municipal employee study, based on a focus group and a survey of 219 central and district-administration staff, depicts a qualified and generally satisfied workforce, but also a relatively closed administrative community and uneven communication across units. Although 83% of respondents found task deadlines clear and 73% reported clear responsibilities, only 22% received tasks from a single manager, while 26% received them from different managers. Staff identified needs for periodic legal training, clearer online descriptions of directorate responsibilities, more digital services, recruitment of younger employees and improved interaction with citizens and civil organisations (Sofia Municipality, 2019b). These findings remain relevant to multidisciplinary NBS programmes, which require continuity beyond electoral and funding cycles, shared technical vocabulary, joint procurement and monitoring skills, and institutional memory. The recent Bulgarian stakeholder study likewise identifies weak coordination and policy continuity, insufficient political support, limited finance and constrained institutional capacity as leading barriers to evidence-informed urban-environmental action (Kostadinov et al., 2026).

Data infrastructure, evaluation and adaptive management

The 2019 data audit identified 248 municipal datasets, of which 106 were described in detail. Only 30.7% were fully publicly accessible; three-quarters of published information was not reliably machine-readable, and only 13.9% of datasets supported access through an application programming interface. Scanned documents, paper workflows, duplication, and weak interoperability limited cross-system analysis (Sofia Municipality, 2019c). The Digital Transformation Strategy subsequently promoted data-supported smart growth and implementation governance developed with more than 100 public and private stakeholders (Sofia Municipality, 2020c). For urban ecosystems, the practical requirement is an interoperable evidence base that links land ownership and planning status to tree inventories, canopy, habitat, soil sealing, drainage, heat, air quality, demographic vulnerability, project costs, and maintenance records. Common identifiers, open metadata and neighborhood-scale dashboards would enable baseline assessment, transparent site selection, performance evaluation and adaptive management of NBS.

Participation, accountability and co-production

The Vision for Sofia assessment reviewed 81 consultations and observed eight events. It found that municipal practice focused mainly on informing and consultation: online access was limited, citizen-defined ‘hot topics’ rarely entered formal agendas, and feedback after consultations was often absent. The recommended response was a two-way model combining online and offline channels, targeted inclusion of diverse groups, machine-readable information, deliberative methods, co-creation and explicit reporting on how contributions influenced decisions (Sofia Municipality, 2019d). NBS can generate conflict over parking, land ownership, tree removal, safety, maintenance, or perceived gentrification; therefore, consultation should begin before a preferred design is fixed. Local residents, schools, businesses, disability organisations and maintenance teams should help define problems, compare alternatives and monitor outcomes. This shifts participation from formal acceptance toward shared stewardship and makes distributional trade-offs visible.

Financing, procurement and lifecycle responsibility

Institutional capacity also depends on whether implementation arrangements survive beyond the construction phase. Sofia can combine municipal capital and district budgets with European programmes and other climate or environmental finance, but short project cycles can separate design and delivery from the long-term costs of irrigation, replacement planting, sediment removal, biodiversity management and public-space care. Each NBS investment should therefore have a designated asset owner, an approved maintenance standard and a multi-year operating allocation before procurement begins. Lifecycle costing and performance-based specifications can reward functions such as stormwater retention, canopy survival, cooling, and habitat

quality rather than isolated physical elements. Budget tagging, public reporting of planned and actual maintenance, and clear risk allocation between municipal units, utilities and contractors would make implementation more durable. These arrangements respond directly to the documented barriers of fragmented coordination, limited finance, and weak policy continuity in Bulgarian urban-environmental governance (Kostadinov et al., 2026).

Much has changed since the Vision for Sofia studies, which offered some of the most in-depth looks at the institutional context. Many of these changes stem from political turmoil at the national and local levels over the last five years. Governance, along with human resources, is recovering after verbal "crossfires" in the municipal council and beyond, reaching the streets of Sofia around every significant investment. Open data is now a priority, but the pace of advancing new open datasets is slower than expected. Participation in the fast-paced absorption of EU and national funding with low-quality planning and design as victims of the political struggles stays relatively weak against the expression of the louder propagandist groups.

Local level: Socio-cultural context

Demographic concentration and changing needs

Sofia is Bulgaria's dominant population and employment centre. At the end of 2025, Sofia (stolitsa) district had 1,303,813 residents, or 20.3% of the national population, and was among the few districts recording annual growth. It also had the country's lowest share of people aged 65 and over (19.2%) and the most favourable demographic-replacement ratio, yet this still represents a large older population alongside children, commuters, students, internal migrants and newer international communities (National Statistical Institute, 2026). Such diversity creates different expectations of urban nature: accessible, shaded routes; quiet, restorative spaces; playgrounds; sports areas; community gardens; culturally meaningful landscapes; and safe river corridors. NBS planning should therefore avoid a uniform 'green amenity' model and use age, disability, income, tenure and mobility data to identify who can reach, use and help manage each intervention.

Quality of life, attachment and environmental dissatisfaction

The representative Vision for Sofia survey recorded strong urban attachment: 91% of respondents were satisfied with living in the capital. Respondents rated cultural and educational opportunities, commerce, and public transport especially positively, while public spaces and green areas attracted broad but more qualified satisfaction. Air quality, noise, cleanliness, street and building condition, living costs and safety were predominantly criticised. The study also identified spatially and financially constrained households whose limited ability to change dwelling increases reliance on public action in their neighbourhoods (Sofia Municipality, 2019e). More recent health-impact evidence confirms that environmental burdens are substantial and uneven: central higher-income areas and northern, north-eastern and north-western lower-income areas can all experience high exposure and health impacts, although the mixture of air pollution, noise, heat and insufficient greenery differs (Khomenko et al., 2025). Consequently, NBS priorities should be based on cumulative need and health equity, not land availability alone.

Trust, social cohesion and stewardship

The 2023 European city survey provides an important caution alongside Sofia's high place attachment: only 36% of respondents agreed that most people in the city could be trusted, compared with 61% in Burgas (European Commission, 2023, pp. 33–34). Low interpersonal trust can weaken collective action, increase opposition to unfamiliar interventions and complicate the shared use and care of public space. Nature-based projects can nevertheless become practical platforms for rebuilding trust when benefits are visible, decisions are transparent and local commitments are honoured. Small parks, restored river edges, rain gardens and shaded streets can support everyday encounters, recreation and intergenerational activity, but only when they are safe, inclusive and consistently maintained. Participatory monitoring, neighbourhood stewardship

agreements, micro-grants and feedback on complaints can transform NBS from a one-off construction project into a locally recognised public service.

Economic culture, creativity and just transition

Sofia's socio-cultural profile is shaped by concentrated knowledge-intensive employment, universities, research, information technology, business services, tourism, and creative and recreational industries. The inter-sector analysis identifies connections among these activities and public institutions, and explicitly includes landscaping, sport, recreation, health and knowledge creation among the city's relevant clusters (Sofia Municipality, 2019f). This ecosystem can support digital mapping, ecological design, citizen science, environmental education and new maintenance enterprises. At the same time, rising land values and unequal household resources can turn attractive green investments into exclusionary amenities. Municipal NBS programmes should therefore combine citywide flagship projects with distributed neighbourhood interventions, local employment and training, protection of affordable uses, universal accessibility and monitoring of displacement risks. Cultural programming and interpretation should recognise both Sofia's heritage landscapes and the practices of contemporary communities, making urban nature socially meaningful as well as ecologically functional.

Spatial diversity, accessibility and environmental justice

The municipality contains a historic centre, large housing estates, rapidly developing peripheral neighbourhoods, industrial zones and outlying settlements, so the meaning and usability of green infrastructure vary with urban form, tenure, mobility and access to services. The unequal and overlapping patterns of pollution, noise, heat and greenery identified at neighbourhood scale show why averages can conceal priority populations (Khomenko et al., 2025). Site selection should combine cumulative environmental exposure with walking access, age and disability, household resources and dependence on public space. Design should also anticipate unequal outcomes: improved greenery must not reduce affordable uses or displace vulnerable residents through escalating land values. Relevant monitoring extends beyond hectares or trees to shaded walking access, barrier-free routes, perceived safety, use by women, children and older people, participation from underserved areas and response times for maintenance complaints. In this way, NBS can support environmental justice and everyday belonging while responding to Sofia's changing demographic structure (National Statistical Institute, 2026).

2.4.3. Comparative analysis of the socio-econimic and institutional context of Konin and Sofia and their implications for the NBS implementation and management

The comparative analysis of Konin (Poland) and Sofia (Bulgaria) highlights the importance of local socioeconomic, demographic, institutional and governance conditions in shaping the planning, implementation and long-term sustainability of Nature-Based Solutions (NBS). Although the two cities differ significantly in their development trajectories, economic structures, and administrative capacities, they face common challenges related to inclusive participation, institutional coordination, accessibility, and integrating NBS into urban development policies. (Table 9)

Table 9. Comparative summary of the socio-economic and institutional context of Konin and Sofia and their implications for the NBS implementation and management

Comparative dimension	Konin	Sofia	Implications for NBS
Demographic characteristics and trends	Depopulation, selective out-migration of young graduates and population aging reduce human	Population concentration and growth coexist with a substantial older population and diverse groups, including	Konin should emphasize accessible, low-maintenance spaces and intergenerational benefits. Sofia should

	capital and increase service costs.	students, commuters and in-migrants from the countryside.	accommodate varied needs and target un-even access to urban nature.
Economic transition and identity	Lignite phase-out and industrial downsizing challenge employment, municipal revenue and a longstanding mining-industrial identity.	Knowledge-intensive services, universities, IT, tourism and creative industries offer innovation capacity, alongside rising land values and unequally distributed household resources.	Konin can link restoration to a just transition of the employment base and a renewed civic identity, while Sofia can mobilize innovation while protecting affordability and avoiding exclusionary green investment.
Institutional structure and coordination	Municipal administration and subordinate units demonstrate expertise in external funding and partnership experience. NBS-specific coordination arrangements are not detailed.	Extensive central, district, enterprise and utility structures provide capacity but fragment responsibilities across planning, environment, water, transport and maintenance.	Both need clear NBS project ownership. Sofia particularly needs cross-department coordination and multilevel governance; Konin needs to connect existing institutional strengths to explicit NBS responsibilities.
Human resources and organisa-tional continuity	Youth out-migration depletes potential innovative capacity, while specialized funding competencies remain an institutional strength.	Availability of qualified personnel but uneven communication and multiple reporting lines. More recent evidence highlights barriers to coordination, political support, and continuity.	Build multidisciplinary skills, retain institutional knowledge and establish responsibilities that survive electoral and funding cycles.
NGOs and civic partnerships	Active NGOs support senior inclusion, cultural activity and post-coal civic renewal. The 2025 cooperation programme enables ecology, recreation, revitalisation and scientific partnerships, without explicit NBS objectives.	Civic organisations and knowledge institutions offer collaboration potential, but their integration into decision-making is uneven and often limited.	Konin can introduce NBS objectives into existing NGO cooperation. Sofia can formalise collaborations with community, research and maintenance partners.
Participation and co-production	Strong engagement in socio-cultural initiatives; the NGO programme supports needs diagnosis and joint planning. Evidence of participation in NBS project decisions is limited.	As of 2019, the participatory process is focused on information and consultation, with weak feedback and limited uptake of citizen-defined issues. Later political conflict is described as an additional constraint.	In both cities, inclusive design and co-diagnosis are limited, while socio-cultural engagement and its revealed potentials should translate into project influence and stewardship.
Trust and social cohesion	Cultural institutions and civic organisations help absorb tensions associated with industrial restructuring. Compara-ble quantitative trust evidence is not supplied.	Strong place attachment coexists with low interpersonal trust: 36% agreed that most people could be trusted in the 2023 European city survey.	Visible benefits, transparent decisions and dependable maintenance can strengthen confidence. Sofia particularly needs credible feedback and locally accountable delivery.
Accessibility and inclusion	Accessibility Action Plan 2025–2028 is mainly building-focused. The “Accessible Urban Space” application could	Diverse ages, abilities, incomes, tenures and mobility patterns create different access requirements and	Integrate barrier-free routes, shade, rest areas and safe access into NBS design and

	incorporate parks, shade, water and climate-adaptation needs.	dependencies on public space.	monitoring; assess who can actually use each intervention.
Environmental and health priorities	The Warta River is a major ecological and hydrological asset. Aging and constrained municipal resources make accessible, health-supporting spaces even more important.	Pollution, noise, heat and insufficient greenery overlap unevenly across neighbourhoods; burdens affect both central and peripheral areas.	Konin can connect river restoration with recreation and health. Sofia should prioritise cumulative environmental exposure and health need rather than land availability alone.
Data and evidence infrastructure	The accessibility application provides an existing platform to integrate green-blue assets. A comprehensive NBS evidence system is not described.	The 2019 audit found limited public accessibility, machine readability and interoperability. Digital transformation and open data are priorities, but progress is described as slow.	Link ecological, spatial, demographic and maintenance data. Sofia needs interoperability across systems; Konin can expand existing tools while establishing relevant baselines.
Financing and fiscal capacity	Shrinking tax revenues and oversized inherited infrastructure constrain operating surpluses and investment matching funds. Strong absorption capacity spans JTF/JTM, cohesion funding, EEA/ Norway Grants and national programmes.	Municipal and district budgets can combine with European and climate/ environmental finance, but limited resources, political discontinuity and short project cycles constrain delivery.	Assess affordability across the full asset life cycle. External capital funding should be matched by realistic, sustained operating commitments.
Procurement and maintenance	High fixed infrastructure costs constrain recurrent spending. The text does not establish NBS-specific asset ownership or funded maintenance arrangements.	Construction and long-term care can become disconnected. Designated owners, maintenance standards, multi-year budgets and performance-based procurement are recommended.	Specify ownership, irrigation, replacement, ecological care and operating budgets before procurement. Monitor functioning assets rather than installation alone.
Culture, education and innovation	Established cultural centres, performing-arts traditions and youth festivals offer platforms for environmental education and civic mobilisation.	Universities, research, and the digital and creative sectors can support mapping, ecological design, citizen science, and maintenance enterprises.	Konin can embed NBS in cultural and community programming. Sofia can mobilise technical innovation alongside locally meaningful cultural interpretation.
Equity and distributional risks	Aging, limited mobility and fiscal pressure may restrict access to benefits; displacement risk is not directly assessed in the text.	Unequal exposure and rising land values increase the risk of exclusion, loss of affordable uses, and displacement following green investment.	Evaluate access and distribution alongside ecological gains. Sofia requires explicit safeguards for vulnerable residents and affordable neighbourhood uses.
Monitoring and accountability	The NGO programme lacks environmental /cli-mate indicators; accessibility mapping offers potential, but NBS outcome	Unified performance reporting, neighbourhood dashboards, equity indicators and maintenance reporting are proposed responses to identified gaps.	Track cooling, retention, habitat condition and vegetation survival alongside accessibility, participation, use and complaint resolution.

	monitoring is not documented.		
Principal barriers	Fiscal contraction, aging, youth out-migration, entrepreneurship gaps and limited explicit NBS framing in the institutional programs discussed.	Fragmented coordination, political instability, weak continuity, data limitations, shallow participation, low trust and life-cycle-funding gaps.	Institutional and social arrangements must accompany physical investment, as otherwise ecological benefits and public acceptance may be difficult to sustain.
Principal opportunities	Combine just-transition finance, NGO networks, cultural strengths and river-based regeneration to support inclusive environmental renewal.	Combine metropolitan expertise, climate finance, digital tools and neighbourhood co-production to deliver equitable, accountable NBS.	Konin's strongest possible pathway is integrating NBS within the just transition and community renewal process; while Sofia's is through coordinated metropolitan governance and active involvement of local governance and citizens

Demographic and economic characteristics represent important factors influencing NBS priorities. Konin is experiencing population decline, an aging population, and the outmigration of younger, qualified residents, alongside an economic transition tied to the lignite phase-out and industrial restructuring. These conditions suggest that NBS could support just transition objectives by driving urban regeneration, improving environmental quality, creating opportunities for community engagement, and strengthening local identity. In contrast, Sofia is characterised by population concentration, demographic diversity and a knowledge-intensive economy, accompanied by increasing development pressures and socioeconomic inequalities. Consequently, NBS interventions in Sofia should prioritise equitable access to urban green spaces, environmental justice and the needs of diverse population groups.

Institutional capacity and governance arrangements constitute another significant dimension of comparison. Konin demonstrates experience in accessing external funding and developing partnerships, although it has not clearly defined institutional responsibilities for NBS. Sofia benefits from a more extensive administrative and professional capacity, but the distribution of responsibilities across municipal departments, district administrations and utility organisations creates coordination challenges. In both cases, effective NBS implementation requires clearly defined institutional responsibilities, improved interdepartmental cooperation and mechanisms ensuring organisational continuity beyond individual projects and funding cycles.

The analysis also identifies considerable potential for stakeholder engagement and co-creation. Both cities have active civic organisations and established traditions of participation in cultural, social and community initiatives. However, these capacities available have not yet translated into meaningful participation in NBS planning, implementation, and management. In Konin, cooperation with NGOs and local institutions offers opportunities to connect ecological regeneration with social inclusion and post-industrial transformation. In Sofia, stronger integration of civic organisations, academic institutions and local communities into decision-making could help overcome fragmented participation and improve the responsiveness of NBS interventions to local needs. Trust, social cohesion, and accessibility emerge as cross-cutting conditions that influence the effectiveness and acceptance of NBS. While Konin benefits from established civic and cultural networks, Sofia faces particular challenges associated with relatively low interpersonal trust and uneven access to urban resources. Both cities therefore require transparent decision-making, visible environmental and social benefits, inclusive design approaches and clearly established long-term maintenance responsibilities.

Overall, the comparison shows that successful NBS implementation depends not only on environmental and technical suitability but also on local institutions' and communities' capacity to collaboratively plan, deliver,

and maintain interventions. For Konin, the main opportunity lies in integrating NBS into just transition and urban regeneration strategies, while Sofia's priorities focus on institutional coordination, equitable access, and participatory governance. These findings underline the need for context-sensitive NBS approaches that combine environmental objectives with social inclusion, institutional innovation and long-term territorial management.

2.4.4. Conclusions

Demographic and economic conditions shape different priorities for NBS development. Konin faces population decline, an aging population, youth outmigration, and economic restructuring associated with the phase-out of lignite-based industries. These processes create fiscal and social challenges, but also opportunities to integrate NBS into a just transition, post-industrial regeneration, and community renewal. The Warta River and surrounding natural assets provide considerable potential for ecological restoration, recreation and health-oriented interventions. In contrast, Sofia's growing, diverse population, knowledge-intensive economy, and increasing development pressures require NBS approaches that address environmental inequalities, urban heat, pollution, and uneven access to green spaces. Its academic, technological and creative sectors offer significant opportunities for innovation in NBS planning and management.

Institutional capacity and governance represent another important area of comparison. Konin benefits from experience in accessing external funding and establishing partnerships with civic organisations, although dedicated institutional responsibilities for NBS remain insufficiently defined. Sofia possesses more extensive administrative and professional resources, but responsibilities are fragmented across municipal departments, district administrations and utility organisations. Political discontinuity and insufficient coordination further constrain implementation. Both cities therefore need clearer institutional mandates, cross-sectoral cooperation, and mechanisms that ensure continuity beyond individual projects and funding cycles.

Stakeholder participation, trust and social inclusion are essential for the effectiveness and public acceptance of NBS. Konin's established NGO networks, cultural institutions, and community initiatives offer opportunities to integrate environmental objectives with social cohesion and local identity. Sofia benefits from active civic organisations, universities and research institutions, although their involvement in decision-making remains uneven. In both cities, participation is more developed in consultation and community activities than in systematic NBS co-creation, implementation and stewardship. Strengthening participatory governance, transparent decision-making and inclusive design would improve public ownership and the equitable distribution of environmental benefits.

Regarding financing, maintenance and monitoring, Konin has substantial experience with European and just-transition funding, but declining municipal revenues and high infrastructure costs constrain long-term financial capacity. Sofia has access to municipal, European and climate-related financing, although fragmented responsibilities and short project cycles create implementation and maintenance challenges. Both cities lack sufficiently integrated systems to monitor NBS performance and need stronger connections among environmental, spatial, demographic, and maintenance data. Long-term financing, clearly assigned responsibilities and measurable indicators for ecological performance, accessibility and social benefits are therefore essential.

Overall, the comparison identifies two complementary pathways for strengthening NBS implementation. Konin's principal opportunity lies in combining just-transition financing, river-based ecological restoration and established community networks to support inclusive post-industrial regeneration. Sofia's potential is associated with integrating metropolitan expertise, climate finance, digital technologies and neighbourhood participation within a more coordinated governance framework.

The findings demonstrate that successful NBS implementation depends not only on technical and environmental solutions but also on institutional capacity, financial sustainability, social inclusion and effective

territorial governance. In both cities, moving from individual interventions towards integrated, participatory and continuously monitored NBS programmes is essential for achieving lasting environmental, social and economic benefits.

3. EXISTING GOOD PRACTICES OF NBS KNOWLEDGE VALORISATION

3.1. Defining and comparative analysis good European, National and local level practices from Poland and Bulgaria

3.1.1. Aim and unit of analysis

The assessment identifies and compares practices in urban NBS implementation at European, national and local levels. For the purposes of the GreenEsteem project, **a practice is defined as an urban initiative in which one or more NBS have been implemented, or an activity whose principal purpose is to diffuse, exchange, apply or extend knowledge relevant to NBS and green urban development.** The unit may therefore be a site-based intervention, programme, platform, governance arrangement, training activity or policy-oriented process.

The study focuses on identifying different models of KV across international and local practices, in order to explore strategies for reaching different stakeholder groups, enabling different use of knowledge and utilizing and sharing it for capacity building and inhibiting behavioural change, increasing uptake and replicability, de-risking impact, and sustaining impact beyond the project's funding period. For this study, a "practice" is defined as an initiative in which a complex or single NBS has been implemented in urban areas located in any European country, or is actively dedicated to raising awareness, diffusion, exchange, and extension of knowledge.

3.1.2. Analysis of 74 practices: 40 derived from 224 international practices (included in 60 international projects) and 34 local practices from Konin and Sofia

The empirical assessment maps practices at European, national and local levels and compares their context, stakeholders, governance arrangements, NBS characteristics, knowledge-valorisation principles and digital enablers. It combines evidence from CORDIS, literature and partner experience with local mapping in Sofia and Konin. A staged screening process narrows the initial inventory to a balanced set for detailed analysis, including both mature and less-developed practices so that enabling conditions and barriers can be compared. Annex F sets out the research questions, coding framework, selection process and scoring formulas. Together, the annexes provide the conceptual and methodological basis for the subsequent comparative analysis without overloading the highlighted main issues in the text. The published paper introduced hereafter summarises the main methodological steps and key findings from the conducted primary analysis, starting from 224 international practices to selecting and analyzing 74 practices (40 derived from the 224 international + 34 local practices from Konin and Sofia).

Co-Creation of NBS Practices in Urban Areas: Towards A Holistic Approach to Knowledge Valorisation

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Accepted for publication in ARPHA Proceedings 12: **11th World Summit: Civil Engineering-Architecture-Urban Planning Congress (CAUSummit 2026), ed.** Isik Yilmaz, Marian Drusa, Gergana Antova, Georgia Cheirchanteri, Christina Mickrenska, published and available at: https://ap.pensoft.net/article/37130/

Abstract. Implementation of nature-based solutions (NBS) has emerged as an urgent agenda and priority within international interdisciplinary research in response to urban challenges as climate change, biodiversity loss, and social inequalities. Since the early 2010s NBS have been subjected to conceptualization from isolated green interventions to recognizing their multifunctionality and the necessity of integrating diverse stakeholder knowledge through co-creation and adaptive governance. However, controversial views exist on the balance between top-down institutional frameworks and bottom-up community-led initiatives, within the debates on the optimal pathways for fostering inclusive, legitimate, and sustainable NBS practices' governance. Underestimation of scalability and sustainability of NBS interventions is seen as factors that limit their transformative potential for urban regeneration and climate adaptation. The research aims to provide a holistic framework for knowledge valorisation of NBS practices in urban settings that respects the NBS type and its context, as well as the NBS co-creation in the course of its lifecycle. To test this framework, a systematic evaluation of 40 practices from the CORDIS database and 34 local NBS practices from Bulgaria and Poland was performed against the seven groups of knowledge valorisation principles, recommended by the Council of the European Union. By applyin cluster analysis, six clusters of KV practices were identified and analysed. Recommendations are formulated on the effectiveness of knowledge valorisation mechanisms and their combination thus heading for different pathways for knowledge sharing and learning within the governance networks.

Keywords: Nature-based solutions; knowledge valorisation; urban governance; EU-funded research projects; local NBS practices

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Published by CAUSummit and peer-reviewed under the responsibility of "World Summit: Civil Engineering-Architecture-Urban Planning Congress - CAUSummit-2026".

INTRODUCTION

Knowledge valorisation (KV) is nowadays still an under-tested policy landscape, where the persistent gap between research production and its effective use in society and industry is combined with regulatory, institutional, and resource barriers. KV as a domain has shifted from the field of narrow technology transfer towards a broader understanding of valorisation as encompassing commercialization, public engagement, and open science [1] and has been gaining prominence alongside the global and EU sustainable development agendas and the European research priorities [2], [3]. Although Europe produces 22,7 % of the global amount of high-quality scientific publications, converting this output into market innovation remains a persistent challenge [4], and regulatory and resource constraints continue to hinder replicability and up-scaling, while societal-impact metrics remain underdeveloped [5], [4] thus resulting in underused research potential [6]. Conceptually, KV integrates knowledge transfer, commercialization, and creation of social impact within an innovation ecosystem that includes universities, industry, governments, and civil society, and involves complementary pillars as intellectual property frameworks and open science [7], [8]. Yet the most serious gap in the literature is the absence of robust comparative empirical studies testing how valorisation policies actually perform, as current research largely describes policies rather than tests them [1], [4]. Standardized metrics for social, economic, and environmental impact remain underdeveloped, as assessments more often focus on commercialization outputs [2], [4], [6]. Public-private partnerships remain structurally fragile due to regulatory barriers, private-sector hesitancy and low motivation, and fragmented governance [9], [10]. Despite the EU initiatives for creating a database of sharing KV good practices, in many domains understanding the logics of demand-driven co-creation approaches to valorisation remains underdeveloped. This gap becomes especially evident when KV is analysed in domains like NBS practices, where co-creation is not incidental but constitutive of how the practice itself is being implemented.

Nature-based solutions are a research area and real-life practice where valorisation is significantly shaped by implementation context. Rooted in and evolving from ecosystem services and green infrastructure, NBS is considered an integrated, multifunctional paradigm since the mid-2010s [11], [12]. NBS research is driven by its potential to address environmental, social, and economic challenges across urban and rural contexts, and has gained strategic recognition at the global [2],[13] and EU scale [14]. Mainstreaming NBs requires coordinating stakeholders with divergent priorities [13] and overcoming short- and long-term misalignment, sectoral silos [15], weak governance support [16], knowledge gaps [17], funding obstacles [12], and limited municipal expertise [18]. These problems are not generic implementation problems ones, they are shaped by the NBS practice's scale, location, and the resources and capacities required to implement and manage it [19], [20]. In other words, the nature of the intervention for NBS practice implementation predetermines who needs to be involved, what tools and approaches to use to co-create it, and what value can plausibly be capitalized on afterward.

Stakeholder research collaboration is also evolving and shifting, from academia, business, and civil society operating separately toward shared responsibility, reflecting a broader public management transition from co-production to co-creation, in which citizens move from passive recipients to active participants, even under persistent power asymmetries [21]. This conceptualized interaction through the quadruple-helix collaboration models [22], [23] is operationalized through tools like living labs and co-design workshops [24], [25]. There, experimentation and feedback loops happen within adaptive governance models that help sustain NBS beyond initial project phases [25], [27], though tension between rigid formal structures and procedures and fluid co-production persists [28]. In this context, KV depends on communication platforms, decision-support tools, and combinations of scientific data, relational knowledge, and the negotiated mix of various fragmented shared experiences [29], and is closely tied to capacity building and continuous learning within governance networks [28], [30].

The existing platforms for NBS knowledge valorisation in EU-funded research organize the aspects of KV around discrete functional categories -stakeholders, data and knowledge, finance and business models, communicators, NBS education, and co-creation and governance [31]. In, addition to that, a platform for open data aiming to serve as a framework to support planning and evaluation of NBS projects was created [32]. In doing so, groups of stakeholders, mechanisms and tools, and outcomes are treated as separate categories, each addressed by its own valorisation principles in isolation. A large body of work focuses on who is involved, and dissemination and exploitation frameworks catalog how knowledge is spread, but without linking the tools supporting that process to the outcomes they actually provide. The EU impact assessment practice aggregates results (publications, policy citations, tools implemented) without explaining which combinations of actors and mechanisms generate them, or what kinds of knowledge and experience beyond the scientific ones are actually being disseminated. Meanwhile, locally funded NBS practices are rarely analysed through the KV lens at all. They are rarely compared against their EU-funded counterparts, despite the comparable ambitions and, in some cases, comparable impacts. This paper argues that these three dimensions – who, how, and results – are not independent classificational categories, but interacting sets of variables, whose combination determines both the type and scale of the knowledge valorisation outcome. The study focuses on identifying different models of KV across such practices, in order to explore strategies for reaching different stakeholder groups, enabling different use of knowledge and utilizing and sharing it for capacity building and inhibiting behavioural change, increasing uptake and replicability, de-risking impact, and sustaining impact beyond the project's funding period. For this study, a "practice" is defined as an initiative in which a complex or single NBS has been implemented in urban areas located in any European country, or is actively dedicated to raising awareness, diffusion, exchange, and extension of knowledge.

RESEARCH QUESTIONS AND RESEARCH METHODOLOGY

As part of the GreenEsteem Project [33], this study aims to perform a complex multicriteria assessment of the best practices in knowledge valorisation of NBS implementation and green urban development at local, national, and EU levels. To achieve this aim, the presented research strives to find answers of two research questions: RQ1: What types of interrelations between the actors and stakeholders (WHO), the means (HOW) and the added value and impact on local level (RESULTS)?, and RQ2: How the results of the complex assessment are linked to the type of NBS and the stages of its development?

Six steps in conducting the research activities were designed to systematically assess existing international, national and local practices from Bulgaria and Poland[2] (Fig. 1).

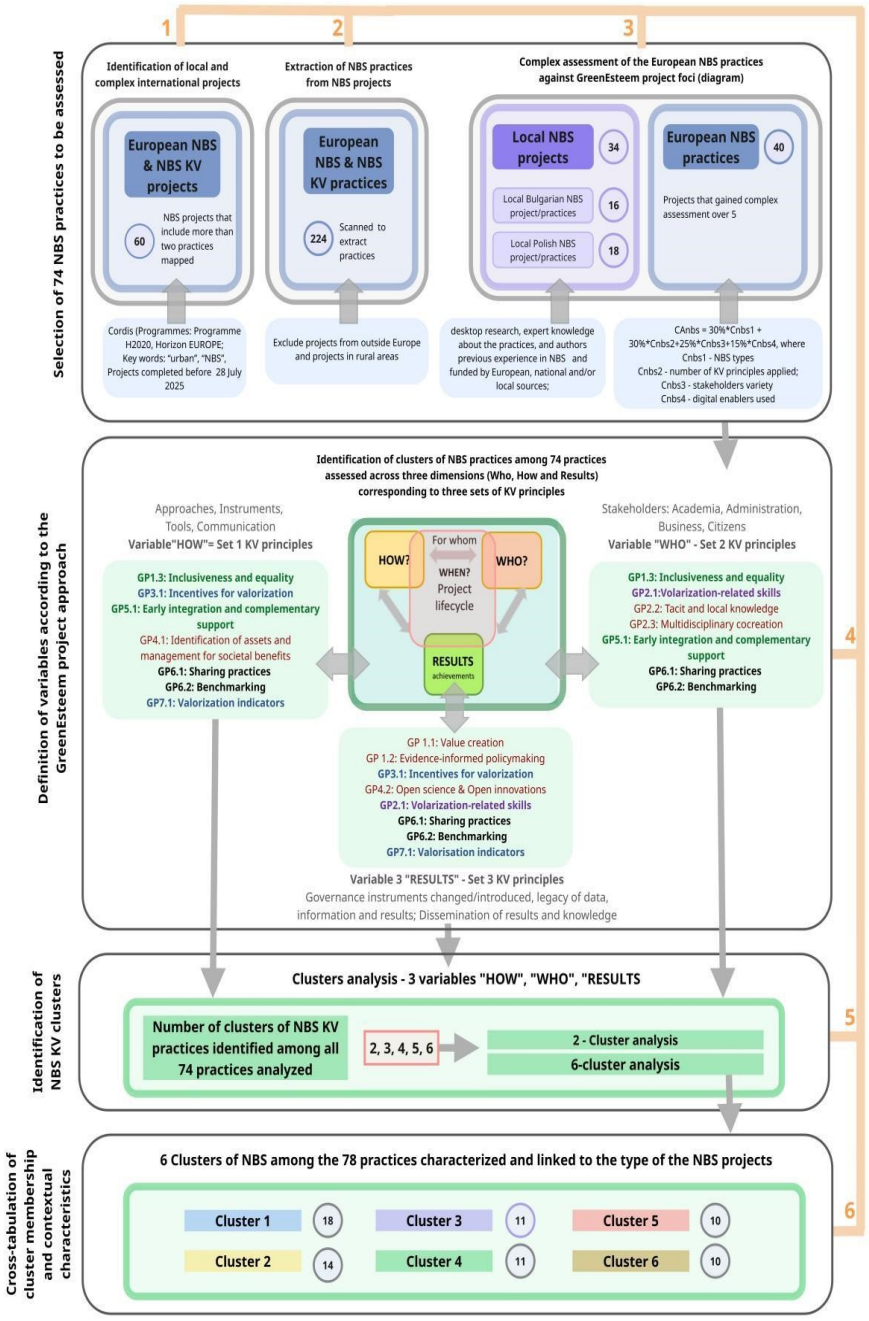


FIGURE 1. Research methodology

Step one: Identification of NBS practices within EU-funded projects. To identify international practices, a search was conducted in CORDIS [34] database (Programmes: Programme H2020, Horizon EUROPE) for projects completed before July 28th 2025 with keywords: 'urban', 'NBS'. Forty projects with more than two practices were mapped. The researchers provided information about 20 projects not discovered by the search engine based on their previous experience in EU-funded NBS projects. We have removed projects that are defined and characterized as KV projects.

[2] The described steps are referenced to Annex F where links to the detailed protocol, projects and practices database and their assessment are provided

Step two: Extraction of practices from the identified NBS projects. 224 practices extracted from the 60 international EU-funded projects were scanned, and practices from outside Europe and from rural areas were excluded. The created database, filled by scanning the project resumes and the titles of the deliverables available in the Cordis database, contained the following characteristics of the projects: type of NBS implemented According to the IUCN classification [35]; knowledge valorisation principles applied; stakeholders involved; and digital enablers used.

The Evaluation criteria for assessing knowledge valorisation principles was grounded and adapted for the NBS practice evaluation following the EU recommendations [36]: GP 1.1. Value creation (1. Knowledge valorisation in research and innovation policy; GP1.2. Evidence-informed policymaking (1. Knowledge valorisation in research and innovation policy, d); GP1.3. Inclusiveness and equity (1. Knowledge valorisation in research and innovation policy, e); GP2.1. Valorisation-related skills (2. Skills and capacities, a-b); GP2.2. Tacit and local knowledge (2. Skills and capacities, c); GP2.3. Multidisciplinary cocreation (2. Skills and capacities, d); GP3. Incentives for valorisation (3. System of incentives, a-c); GP4.1. Identification of assets and management for societal benefits (4. Intellectual asset management, a-c); GP.4.2. Open Science & Open Innovation (4. Intellectual asset management, d-e); GP5. Early integration and complementary support (5. Relevancy in public funding schemes, a-b); GP6.1. Sharing practices (6. Peer learning, a, c); GP6.2. Benchmarking (6. Peer learning, b); GP7. Valorisation indicators (7. Metrics, monitoring and evaluation, a-b). For each practice, a relevant choice is made from a drop-down menu, allowing for multiple choice from the criteria of the main CKV principles adopted for the purposes of the study.

The following types of digital enablers used during project implementation were offered as multiple-choice options via a drop-down menu: website, videos, social media, datasets, publications on digital platforms, digital tools, apps, podcasts, MOOCs, and other. As for the stakeholders involved, the following were offered to be chosen as multiple choice via a drop-down menu: research, business, citizen, public administration, NGO, other (health, educational, and cultural institutions; community associations, experts, other institutions).

To minimize subjectivity in steps two and three, researchers' triangulation was implemented - six different researchers worked independently on different datasets and assessment processes, and after that, the results were verified by two researchers. Step one and step two include providing evidence - links to the relevant deliverables published in the menu results of the projects' webpages in CORDIS data base portal.

Step three: Selection of local practices from Poland and Bulgaria and performing complex assessment of the European NBS practices against GreenEsteem project foci.

The Local NBS practices were mapped after observation of the local NBS initiatives in Konin and Sofia and big Bulgarian cities through researchers' expert knowledge, previous experience and desk top research. The local NBS projects counted 18 practices in Konin and 16 in Sofia. The number of local practices was refined to meet the research goals by excluding practices without co-creation of NBS (the latter are working on creation possibilities or building the framework for co-creation and implementation of NBS). The complex 4-factor assessment also assessed them.

The international practices to be evaluated are the 224 practices extracted in Step two. All local and international NBS practices were assessed using the complex assessment formula (CAnbs):

CAnbs = 30%*Cnbs1 + 30%*Cnbs2+25%*Cnbs3+15%*Cnbs4,

where the criteria are as follows: Cnbs1 - NBS types; Cnbs2 - number of Knowledge valorisation principles applied; Cnbs3 - number/types of stakeholders' variety; Cnbs4 - number/types of digital enablers used.

The final research database includes 40 international and 34 local practices focused on co-creating NBS. The international practices are selected based on a complex 4-factor assessment, with a minimum score of 5 (including scores equal to 5) (Table 1).

TABLE 1. Step three. Practices distribution by aggregated complex assessment and location

Location\Score	Score <=3	Score (3;4]	Score (4;5]	Score (5;6]	Score (6;7]	Score >7	Total
International practices	0	0	8	12	10	10	40
Local practices	11	18	5	0	0	0	34
Total	11	18	13	12	10	10	74

After that, the following additional characteristics were mapped for each practice to be assessed: project resume, period of implementation, funding source, final stage of NBS lifecycle achieved at the time of the

analysis (multiple choice from a drop-down menu: Analysis, Design, Construction, Management, Monitoring, Evaluation, Dissemination, Other); type of NBS implemented (T1. Complex NBS investment project implemented; T2. Single NBS investment project implemented; T3. Various single NBS investment projects implemented; T4. Demonstrator plan for complex NBS (not implemented); T5. Demonstrator technical NBS project (not implemented); T6. Business model for NBS implementation; T7. Model/ roadmap/ policy recommendation for governance of NBS, where the definitions are given by the researchers based on the scanned practices.

Step four: Definition of variables according to the GreenEsteem project approach. The **research framework of the complex multicriteria assessment of the three** main sets of KV principles represents the three research foci of the GreenEsteem project - subjects (WHO), the means (HOW) and the added value and impact at the local level (RESULTS). The assessment of each NBS practice against the "How" characteristics of NBS KV is performed for the following set of NBS KV Guiding Principles: GP1.3, GP3.1, GP5.1, GP4.1, GP6.1, GP6.2, GP7.1. The assessment of each NBS practice against the "Who" characteristics of NBS KV is performed for the following NBS KV Guiding Principles: GP1.3, GP2.1, GP2.2, GP2.3, GP5.1, GP6.1, GP6.2. The assessment of each NBS practice against the "results" characteristics of NBS KV is performed for the following set of the NBS KV Guiding Principles: GP 1.1, GP 1.2, GP3.1, GP4.2, GP2.1, GP6.1, GP6.2, GP7.1. The assessment used the Discrete Lines scoring [0:7]. To achieve a manageable number of variables across the HOW, WHO, and RESULTS dimensions, the specific knowledge valorisation activities linked to the tools implemented, stakeholders included, and impact provided were attributed to the corresponding 7 principles in total (13 with their subdivisions). Thus, despite the variables repeating across the three dimensions, they remain statistically independent. Thus, each practice was observed in terms of the applied principles for knowledge valorisation, referring to the tools and means implemented during the practice implementation; to stakeholder involvement during the co-creation process; and to the results both generated in the processes and used for the inner project's purpose, as well as spreading the knowledge about the final project's results and/or measuring the impact of the particular practice. No missing values were identified. To ensure equal weighting of the variables HOW, WHO, and RESULTS, data were standardised for use in cluster analysis.

Step five: Identification of NBS KV clusters. This step was executed for a pool of 74 practices (40 international and 34 local practices from Poland and Bulgaria) that were assessed across three dimensions (Who, How and Results), corresponding to three sets of KV principles (and considered the three main variables). Performing analysis to classify and group different objects in both the green infrastructure and NBS fields, and KV, is common practice. It is rare, but not unusual, to use statistical methods to do so [37], [38].

To analyse the pool of practices, the hybrid clustering strategy was applied [37],[39]. The strategy included data verification and standardisation, hierarchical clustering by Ward's method, computing the silhouette coefficient, and K-means clustering. Before starting the clustering process and in order to justify that the input data are suitable for grouping, missing values were checked, variable types were verified, and multicollinearity among clustering variables was assessed. The variables were standardised to avoid disproportionately influencing Euclidean-based distances [40].

After the data validation process was carried out and unusual value tests were performed, the data structure was explored, and the optimal number of clusters was determined by implementing hierarchical clustering. Hierarchical clustering was performed using Ward's method, measuring "Squared Euclidean distance" to be compatible with K-means clustering [41]. The dendrogram showed a meaningful structure within two groups, followed by other possibilities of 3, 4, and 6 groups. The Silhouette analysis, as a cluster validation measure [42], was performed to decide the final number of clusters, as indicated by the hierarchical clustering. The number of possible clusters is compared by their average silhouette coefficient (ASC). The K-means algorithm converged after four iterations.

Step six: Cross-tabulation of cluster membership and contextual characteristics. After determining the number and composition of the clusters, a post-clustering characterization was conducted. Each practice was cross-referenced with additional characteristics, including the type of NBS implemented, and with the knowledge valorisation dimensions HOW, WHO, and RESULTS, as well as the physical/material outcomes generated by the practice. This analysis enabled the identification of recurring associations among cluster membership, knowledge valorisation processes, actors, NBS types, and material outcomes, thereby providing an interpretive profile of each cluster. In the following section (Results and discussion), the results from the 2- and 6-cluster analyses are reported. For each of the six clusters from the 6-cluster analysis, the characteristics

are presented, their contextual characteristics, the types of NBS practices and stages of their development are discussed, and possible future strategies for the practices are suggested.

RESULTS AND DISCUSSIONS

The dendrogram resulting from the Hierarchical clustering performed using Ward's method showed a meaningful structure within two groups, followed by other possibilities of 3, 4, and 6 groups. The result shows that the two-cluster model achieved the highest average coefficient, indicating the strongest separation and cohesion. The number of clusters is inversely related to the average silhouette coefficient (ASC). When the number of clusters increases, the ASC decreases, which suggests that the quality of high-number clusters will be reduced (Table 2).

TABLE 2. Silhouette analysis.

Number of clusters	Average Silhouette coefficient	Interpretation
2	0.517	Good separation
3	0.436	Moderate separation
4	0.394	Moderate to weak separation
6	0.388	Weak separation

The two-cluster analysis. The hierarchical clustering indicated the existence of two major groups of practices, which was the reason to perform K-means clustering, where “k” was equal to 2, aiming to answer the question of the impact of location on the cluster’s affiliation. The average silhouette coefficient is 0.517, thus indicating a good cluster separation. Cluster 1 is more homogeneous, while Cluster 2 shows some heterogeneity due to greater variability in silhouette values. The K-means algorithm converged after four iterations, with no absence of further changes in the cluster centres (maximum absolute coordinate change = 0.000). Consequently, the two-cluster solution was considered stable. Although a small number of practices have lower silhouette coefficients, none are negative. This suggests that each practice is more similar to its assigned cluster than to the other cluster. Some practices are close to the boundary between the clusters, but most are very well embedded in the assigned clusters. To answer the question "Which variables contributed the most to the separation of these clusters?", from the ANOVA test we judge that the applied KV principles during the project process, both in terms of the tools in the creation and implementation of the NBS (FHOW=95), and in the stakeholder participation processes (FWHO=110) have an impact, but the most distinctive side of the clusters is formed by the variable related to RESULTS (FRESULTS=213) (Fig. 2).

Cluster centroid coordinates

ZHOW	ZWHO	ZREs	Cluster title
-0.619	-0.638	-0.709	NBS practices with a lower level of KV implementation
0.908	0.935	1.04	NBS practices with a higher level of KV implementation

K-means clustering – 2 clusters

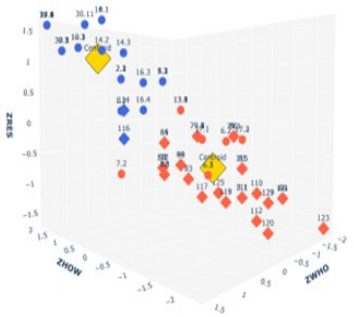


FIGURE 2. K-means clustering; Two-cluster analysis results

Cluster 1 NBS practices with a lower level of knowledge valorisation implementation. Practices identified in Cluster 1 exhibit below-average standardized scores across the HOW, WHO, and RESULTS dimensions. These practices demonstrate a comparatively lower degree of implementation of knowledge valorisation principles, including the application of knowledge valorisation instruments, stakeholder engagement, and the generation and utilisation of knowledge valorisation outcomes.

Cluster 2 NBS practices with a higher level of knowledge valorisation implementation. Practices identified in Cluster 2 exhibit above-average standardized scores across all three dimensions. These practices demonstrate a comparatively higher degree of implementation of knowledge valorisation principles, characterised by a broader application of knowledge valorisation instruments, greater stakeholder involvement, and more extensive generation, dissemination, and utilisation of knowledge valorisation results.

Although the 2-cluster silhouette coefficient is higher, statistically valid, and consistent, the result is not particularly informative. We chose to conduct the six clustering to provide much richer information for planners and policymakers. We assume that the six-cluster analysis maintains the statistical quality and lead us to answers of the research questions by analysing interpretable and practically useful 6 clusters.

The Six two-cluster analysis. In the case of the 6 clusters, EU-funded and locally-funded practices fall in different clusters. The clusters mix practices from large multi-partner EU-funded initiatives (URBiNAT, RECONECT, VARCITIES, Nature4Cities) with locally funded, often implemented by single-city or community-level practices (Sofia and Konin initiatives appear across nearly every cluster). Notably, locally funded practices appear across the full performance range — including in Cluster 3, the strongest cluster — rather than being confined to the weaker clusters. This is a meaningful empirical finding for the paper's stated aim of comparing EU-funded and locally funded practices: funding source does not appear to be a reliable predictor of valorisation strength, which pushes against an assumption that EU-level coordination is inherently what drives strong outcomes, and instead supports investigating the WHO/HOW combination as the more explanatory factor (Fig. 3). The 6-cluster analysis indicates that NBS type composition differs meaningfully by cluster, not just by intensity. The strongest clusters (1 and 3) are weighted toward complex investment projects and governance or business model outputs (T1, T6, T7); the weaker clusters are weighted toward single investment projects and non-implemented demonstrators (T2, T3, T4/T5). This indicates that valorisation strength is correlated with the complexity and institutional ambition of the underlying NBS practice, not merely with how well a given practice is documented or supported after the fact. That has a direct implication for the paper's design-versus-outcome argument: valorisation potential may be partly locked in by the type of NBS practice chosen at the outset (Fig. 3).

Cluster centroid coordinates

ZHOW	ZWHO	ZRES	Cluster title
-1.56	-1.38	-1.36	Limited Knowledge Valorisation
1.33	1.35	1.42	Comprehensive Knowledge Valorisation
-0.26	0.36	-0.62	Stakeholder-Driven Knowledge Valorisation
-0.89	-0.81	-0.75	Emerging Knowledge Valorisation
0.35	0.4	0.54	Balanced Knowledge Valorisation
0.08	-0.68	-0.29	Implementation-Oriented Knowledge Valorisation
-1.56	-1.38	-1.36	Limited Knowledge Valorisation

K-means clustering – 6 clusters

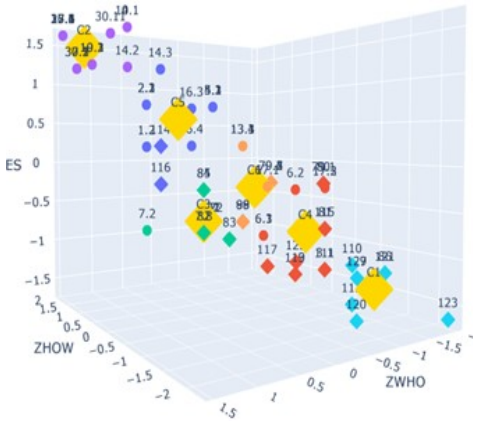


FIGURE 3. K-means clustering; six-cluster analysis results

The cross-tabulation of cluster membership and the contextual characteristics of the practices are visualized in Figure 4.

Cluster 1. Balanced Knowledge Valorisation (18 practices). This is the largest cluster and the one closest to the theoretical "ideal" combination: all three dimensions WHO, HOW, and RESULTS sit above average, with no single dimension dominating the others. Practices here span a wide variety of NBS types, from complex investment projects (T1) to implementation business models (T6) and governance roadmaps (T7), suggesting these initiatives are not only technically executed but also supported by the institutional and financial structures that sustain them. Practices from the EU-funded projects GROW GREEN, CLEVER Cities, and INTERLACE, alongside CLEARINGHOUSE and CONNECTING Nature, are part of this cluster. This cluster illustrates what happens when stakeholder engagement, methodological sophistication, and result generation reinforce one another, rather than one dimension compensating for the weaker prevalence of another. Given their demonstrated strengths, the practices in the cluster may replicate their KV models in the same context or test them in different geographical locations and contexts.

Cluster 2. Implementation-Oriented Knowledge Valorisation (14 practices). Here, implementation capacity overtakes stakeholder engagement, as HOW is close to the average, while WHO is comparatively low and RESULTS are slightly below the average. The NBS types are dominated by T7 (governance/policy roadmaps) and T2/T3 (single and multiple investment projects), indicating these practices are technically and procedurally developed but have not cultivated broad or diverse stakeholder involvement. Nature4Cities, REGREEN, and several Konin-based practices (Green Urban Corridors, Pociejewo Graduation Tower Park) funded after selection through citizens' budget programme and implemented by Konin municipality are included in this cluster. The cluster supports the argument that WHO and HOW must combine, rather than be sufficient on their own. Meaningful strategies for the practices in this cluster should focus on broadening the stakeholders involved in KV while capitalizing on the success of delivery mechanisms.

Cluster 3. Comprehensive Knowledge Velarization (11 practices). This is the strongest-performing cluster across all three dimensions and confirms the study's central thesis that WHO, HOW, and RESULTS interact rather than operate independently. NBS practices represent mostly complex investment projects (T1) and governance models (T7), with a business model (T6) also present. Typical practices in this cluster are characterized by high stakeholder diversity combined with exploitation-oriented mechanisms that produce macro-scale outcomes. Practices in the cluster include large, EU-funded, multi-partner initiatives lasting three to six years: URBiNAT healthy Corridors in Porto, Nantes and Sofia, CLEARINGHOUSE Gelsenkirchen, NetZeroCities, RECONECT, and VARCITIES. This cluster shows what combined strength across all three dimensions looks like, and suitable strategies for further KV may focus on demonstrating this combined strength, replicating the approaches undertaken, and testing them in different geographical, governance, and cultural contexts.

Cluster 4. Emerging Knowledge Valorisation (11 practices). In this cluster, all three variables score below average, but distinctly higher than those in Cluster 6. The practices in this cluster are still developing rather than structurally limited. The NBS types are concentrated in T2 and T3 (single and multiple investment projects), with T7 present but less prominent. Examples include UNALAB, REGREEN Aarhus, Citizens' Budget Sofia, and several locally funded Sofia and Konin initiatives (Urban Bird Havens, Edible Gardens of Learning, The New Forest of Sofia). The practices from Bulgaria are initiated, led, and implemented by civil society organizations (NGO-s and activists' operations at the national level), and although recognized, they have not yet generated the governance or business-model outputs seen in Clusters 1 and 3. They rely on external, usually limited, funding (municipal or grants from various sources) and focus on single or multiple NBS projects at different locations across the country. This cluster is analytically important for comparing EU-funded and locally funded practices, since it includes both, and suggests that practices in the cluster could plausibly shift to cluster 1 or 3 if the dynamics of the three variables change in the future. Therefore, the most relevant strategy for these practices is to focus on capacity building across all dimensions.

Cluster 5. Stakeholder-Driven Knowledge Valorisation (10 practices). The main feature of this cluster is stakeholder engagement: The WHO dimension is above average, HOW is close to average, and the RESULTS remain below average. Practices include SCORE, Darwale Community Garden, The Green Nook, and several community-oriented initiatives in Konin and Plovdiv (Bulgaria). The practices include investment projects (T3) and initiatives (T2). Mirroring cluster 2, cluster 5 suggests that broad or active stakeholder involvement does not always translate into stronger outcomes. Together, these two clusters strongly support the paper's

argument: neither dimension alone produces high scores without the other dimensions. This suggests that KV does not accumulate additively (more WHO + more HOW = proportionally more RESULTS), but multiplication and synergy are achieved by the interaction of the scores across the three dimensions - a shortfall in one dimension constrains what the others can produce, regardless of their own strength. A suitable future strategy to improve KV in this cluster is to focus on the mechanisms and tools (the HOW dimension) while capitalizing on strong stakeholder engagement.



FIGURE 4. Two-cluster and six-cluster analysis results and type of NBS implemented

Cluster 6. Limited Knowledge Valorisation (10 practices). The cluster scores are the lowest on all three dimensions and clearly represent the least developed NBS KV practices in the datasets. NBS types include a notable presence of T4 and T5—demonstrator plans and technical projects that were not implemented —

alongside single and multiple investment projects implemented by private-sector actors in Sofia (T2, T3), and one additional 40-year-old practice from Sofia: Zona B5 green roofs. Practices include OPERANDUM Dublin, several large-scale private development projects in Sofia (Garitage Park, BLD Building Difference), and non-implemented projects for large-scale green infrastructure development in Sofia (the Green Ring of Sofia and Manastirski livadi East park) and two small-scale practices - one integrated with a restaurant (The School) and one integrated in a private plot (a community garden). This dispersed pool of practices and fragmentation could inform the KV about barriers and stimulators for successful NBS implementation. The presence of planned but non-implemented NBS is a distinctive characteristic of this cluster. All these support the papers' theses that the scale, location, and the resources/capacities required for implementation and management predetermine valorisation outcomes. Therefore, implementation appears to be a gating condition rather than one input. Regardless of their original ambition and potential impacts, practices hindered at the planning stage are unlikely to generate the stakeholder engagement or governance output outlined in the stronger clusters. A plausible strategy for these practices, although diverse in their characteristics, may focus on two targets. First - to unblock the implementation itself before valorisation strategy to be meaningfully addressed at all, starting with the conversation around the barriers and facilitating factors that hinder NBS implementation at the local level. Second - involve the private sector in NBS KV. At present, representatives from this sector - real estate developers, entrepreneurs, construction companies, planning and design professionals, product manufacturers, and distributors are involved only in highly specialized forums and procedures for sustainable building certification, focusing only on the impact of NBS and seeing it as an integral part of the property commodification process. This involvement is necessary to go beyond the "business as usual" that gains motivation through corporate social responsibility, tapping NBS as a competitive advantage and incorporate them into real estate marketing strategies and PR. It also needs to meet the KV outputs from academia, wider professional communities, citizens, and end users. An additional KV topic on NBS maintenance could also be developed in light of shared responsibilities and the shift from co-production to co-creation.

CONCLUSION

This paper contributes to NBS practices' KV by proposing a comprehensive framework that integrates stakeholders, mechanisms, and outcomes as interacting composite variables. We test this framework using primary-source evidence from the EU platform for research and innovation, CORDIS, and published information on local practices in Bulgaria and Poland. By identifying and analyzing six clusters of NBS KV practices, we confirm that the framework can serve as a transferable analytical method for international comparison and diagnosis of NBS KV at the local level. In both cases, by treating the clusters as distinct starting conditions that require different intervention strategies, the framework can serve as an operational tool for developing NBS KV. This study's findings point to local NBS KV practices as an under-researched but analytically rich subject for future KV studies. Unlike the EU-funded projects, which benefit from the built-in coordination requirements, standardized reporting, and dedicated communication budgets, the local practices largely rely on the initiative of municipalities, NGOs, or private actors operating with limited and often short-term funding, and their valorisation strategies are correspondingly less systematized and fragmented. Yet this study shows that funding source alone does not predict valorisation outcomes — several locally funded practices perform comparably to, or better than some of the EU-funded ones, while others remain structurally limited by unresolved implementation barriers. Future research should therefore move beyond treating local practices as a residual comparison group to EU-funded projects, and instead investigate them as a distinct object of study in their own right: examining how informal, resource-constrained, and often civil-society-led valorisation pathways differ qualitatively — not just quantitatively — from EU-coordinated ones. Particular attention should be paid to the private sector's currently narrow involvement in local NBS valorisation, to the maintenance phase of the NBS lifecycle, and to longitudinal tracking of whether locally initiated practices do in fact migrate toward stronger valorisation profiles over time, and under what conditions.

ACKNOWLEDGEMENTS

This research is supported by the GreenEsteem project (Horizon Europe, contract No 101217219). The authors thank the consortium partners from Adam Mickiewicz University (Poznań), Konin municipality, and Team Sofia for their assistance and support with data collection and primary expert evaluation of selected practices.

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3.2. Good practices in knowledge valorisation, with particular focus on NBS implementation

3.2.1. Analysis of the national-level context enabling Knowledge Valorisation for NBS implementation in Poland

For this analysis, the national level is understood more broadly than activities undertaken directly by central government institutions. A practice may be implemented locally or regionally but is considered relevant at the national level when it is embedded in a national policy or funding framework, supported by national institutions or knowledge infrastructures, operates through networks extending beyond a single municipality, or generates approaches and knowledge that can be transferred and adapted across different territorial contexts. The national perspective therefore captures the enabling environment through which knowledge relevant to Nature-Based Solutions can move from policy and research into local planning and implementation (policy framework - institutions - funding - knowledge infrastructures - local implementation).

In Poland, an increasingly explicit policy focus on climate adaptation, urban resilience, and green-blue infrastructure shapes this enabling environment. The National Urban Policy 2030 (Krajowa Polityka Miejska 2030 – KPM 2030) recognises green-blue infrastructure as an important component of sustainable urban development and climate adaptation, linking environmental measures with quality of life and urban planning. The Environmental Policy of Poland 2030 (Polityka Ekologiczna Państwa 2030) similarly promotes adaptation measures including urban green areas, water retention and responses to urban heat.

This framework strengthened significantly after the introduction of a statutory system for Municipal Climate Change Adaptation Plans (MPAs) in January 2025. Cities with at least 20,000 inhabitants must now prepare an MPA based on climate data and risk and vulnerability assessments. The plans must include, among other elements, concepts for urban greening and rainwater management, implementation arrangements and monitoring. Public participation is also formally required. The system therefore creates a structured pathway to translate climate knowledge and evidence into local strategies and actions, and to monitor and update them.

National institutions provide both knowledge and implementation support. The Institute of Environmental Protection – National Research Institute (IOŚ-PIB) has developed the Klimada 2.0 knowledge base, which provides climate scenarios, adaptation knowledge and examples of adaptation measures, including green-blue infrastructure and Nature-Based Solutions. Importantly, from a Knowledge Valorisation perspective, the platform translates scientific and technical knowledge into information intended for public administration and other potential users.

National funding instruments complement the knowledge and policy framework and support implementation. The European Funds for Infrastructure, Climate and Environment 2021–2027 (FEnIKS) includes dedicated support for climate adaptation, green-blue infrastructure, rainwater management, and nature-based solutions. Calls administered through the National Fund for Environmental Protection and Water Management (NFOŚiGW) therefore provide an important mechanism connecting national and EU policy priorities with implementation by municipalities and other beneficiaries.

Taken together, these policy, institutional, knowledge and funding mechanisms create the national enabling environment for NBS implementation. However, their existence alone does not demonstrate effective Knowledge Valorisation. The key question is how actors actually exchange knowledge, translate it into decisions and implementation, adapt it to local conditions, and retain it for further use.

Selected good practices in Knowledge Valorisation supporting NBS implementation in Poland

The three good practices presented below were selected to illustrate complementary pathways through which different types of knowledge are valorised to support NBS implementation in Poland. They do not constitute an exhaustive review of Polish initiatives, but they represent three distinct, institutionally embedded mechanisms that connect knowledge to public decision-making and implementation. The first case shows how the Municipal Adaptation Plans framework translates scientific and expert knowledge into climate adaptation policy and local planning. The second illustrates how expert and municipal knowledge is exchanged through a national network and transformed into local action. The third shows how citizens' place-based and experiential knowledge can influence public decisions, funding allocation and the implementation of local interventions. Together, the cases capture top-down, network-based and bottom-up pathways of knowledge valorisation relevant to NBS.

Municipal Adaptation Plans (MAPs) as a national good practice in knowledge valorisation for climate adaptation and NBS implementation

One example of implementing European principles of knowledge valorization in climate policy and local development is Poland's regulations on Municipal Adaptation Plans (MAPs). These regulations are set out in the "Adaptation Handbook for Cities. 2023 Update" and in the Environmental Protection Law (EPL), particularly Article 18.

Even at the level of its underlying assumptions, the Handbook emphasizes that a Municipal Adaptation Plan (MAP) should be a knowledge-based document that draws on scientific research findings, reliable data, and the knowledge of residents and other stakeholders. Adaptation is presented as a participatory process requiring cooperation among public administration, scientific institutions, social organizations, businesses, and residents. This directly reflects the Recommendation (EU) 2022/2415 on co-creation between actors and the creation of societal value.

The Handbook also highlights the need to use scientific research findings in decision-making and public policy development. This is reflected in the requirement to base the city diagnosis on climatic, hydrological, social, and spatial data, as well as on environmental monitoring systems. The MAP preparation process includes analyzing historical data, climate change scenarios, and risk assessments, as well as identifying adaptation measures. Scientific knowledge is therefore translated into concrete recommendations and management actions to increase urban resilience. Article 18a of the EPL further requires municipal adaptation plans to be developed based on analyses of vulnerability, adaptive capacity, susceptibility, and climate risk.

An important aspect of knowledge valorization is developing competencies and fostering cooperation among different communities. The Handbook calls for establishing interdisciplinary adaptation teams comprising representatives from various municipal departments, experts, researchers, and external stakeholders. It also recommends involving climatologists, meteorologists, and climate risk management specialists. It also stresses the importance of educational and information activities for residents and other local stakeholders. These measures align with the EU recommendation's principles of capacity building and competence development. Article 18a of the EPL also requires public participation in preparing the plan and specifies how stakeholders and authorities involved in its development will participate. This creates a formal obligation to use scientific and expert knowledge in decision-making and to share it with stakeholders.

Another key component is monitoring outcomes. The Handbook dedicates a separate stage to monitoring and evaluating MAPs, while Article 18a of the EPL requires defining indicators and monitoring measures for both objectives and adaptation actions. Additionally, Article 18c of the EPL requires periodic monitoring and reporting on the implementation of adaptation plans. This institutionalises learning processes and the practical use of knowledge in public administration.

In summary, it can be concluded that the Adaptation Handbook for Cities and the provisions of the Environmental Protection Law, particularly Articles 18, 18a, 18b, and 18c, primarily implement the areas related to the use of knowledge in public policies, capacity and competence building, stakeholder participation, monitoring and evaluation of outcomes, as well as the dissemination of good practices and organizational learning. The requirement to develop municipal adaptation plans based on scientific analyses, climate data, and regular monitoring of adaptation measures aligns with principles that emphasize using research findings and expert knowledge in decision-making and public policy development.

The principles relating to multi-stakeholder cooperation within the knowledge ecosystem are also implemented. The Handbook assumes the involvement of public administration, the scientific community, social organizations, businesses, and residents in preparing MAPs, while Article 18a requires identifying the entities participating in the plan's preparation and how they are involved. This corresponds to the EU concept of co-creation and the engagement of knowledge users in its practical application.

The principles concerning monitoring, evaluation, and the use of performance indicators are also fully or substantially implemented. This follows from both the Handbook requirements and Articles 18a and 18c of the EPL, which provide for indicators, performance measures, periodic reporting, and updates to adaptation plans. These mechanisms are aligned with the EU-recommended system of continuous learning and improvement in knowledge valorisation processes.

At the same time, some principles of the Recommendation are reflected only indirectly or partially. This applies primarily to intellectual asset management, intellectual property protection, and using research results to create market innovations. Neither the Handbook nor the regulations governing MAPs contain provisions concerning intellectual property management, technology transfer, or the commercialization of research outcomes.

The principles governing incentive systems for researchers, innovators, and organizations engaged in knowledge valorisation are also underrepresented. The EU Recommendation encourages motivational mechanisms that support knowledge use and cross-sectoral cooperation, whereas the Handbook and the EPL focus mainly on planning and organizational obligations and do not establish specific instruments to encourage these activities.

Likewise, the framework does not directly reflect recommendations on intellectual asset management within Open Science, Open Innovation, or the use of standards and standardization as tools for knowledge valorisation. Regulations on municipal adaptation plans focus primarily on using knowledge in public policy and local governance, rather than on transferring knowledge to the economy or commercial exploitation.

The Green City Network as a national good practice in knowledge valorisation for NBS implementation

National context and objectives

The national strategic document National Urban Policy 2030 (NUP2030, 2022) recognizes challenges such as reducing the negative effects of climate change in cities, improving the quality of the urban environment, and enhancing the potential of green infrastructure and nature-based solutions. One strategic project linked to implementing the National Urban Policy is the City Partnership Initiative (CPI). The CPI was a flagship initiative of the Polish Ministry of Development Funds and Regional Policy carried out in cooperation with the World Bank (MFiPR, 2026b). The Ministry of Climate and Environment also supported the Green City Network's substantive work. Within the CPI, cities cooperate through thematic networks corresponding to their needs. One thematic network operating within the CPI in 2021–2023 was the Green City Network. Its institutional framework, coordination and expert support were organised at the national level, while the knowledge generated through municipal work was synthesised into recommendations addressed to national policymakers (World Bank, 2023).

The Green City Network provides an example of an initiative closely related to knowledge valorisation in the context of supporting the uptake of green infrastructure (GI) and nature-based solutions (NBS) at the

municipal level. Ten cities, differing considerably in population size, socioeconomic conditions and the characteristics of their urban green spaces, participated in the Green City Network. They were selected through an open national call organised by the Ministry of Development Funds and Regional Policy. The network included large, medium-sized, and small cities, broadening the range of practical experiences represented in the process and increasing the potential relevance of its results for different Polish municipalities. Its substantive work covered three main areas: green infrastructure planning, environmental aspects of urban regeneration and rehabilitation, and adaptation to climate change using GI or NBS. Each city addressed a challenge corresponding to its own context and developed a Municipal Action Plan (MAP) incorporating GI- or NBS-related actions.

Knowledge base and participating stakeholders

The value of the Green City Network as a knowledge valorisation practice lay primarily in transforming dispersed scientific, expert, administrative and practice-based knowledge into locally applicable solutions, municipal action plans and recommendations for national policy. Knowledge was not transferred through a simple, one-directional process in which experts provided cities with predefined solutions. Instead, the network combined several complementary forms of knowledge. Scientific and expert inputs addressed issues such as the multifunctionality of green infrastructure, ecosystem services, climate adaptation, and the potential role of NBS in addressing interconnected urban challenges. Representatives of ministries contributed knowledge of national policy, institutional and regulatory conditions. Municipal practitioners brought contextual and partly tacit knowledge concerning local problems, existing administrative procedures, organisational capacities, relevant local actors and practical experience.

The advisory process was designed to broaden understanding of GI as a system capable of delivering multiple ecosystem services and of NBS as interventions that may simultaneously produce environmental, social and economic benefits. Potential benefits that had not initially been recognised in some MAPs became more apparent during the work with cities, and the knowledge provided through the network was reflected in a more multidimensional approach to the proposed actions. The process thus went beyond communicating information about particular solutions: it supported a change in how urban problems and possible interventions were framed (World Bank, 2023).

Knowledge valorisation mechanisms

Knowledge valorisation was facilitated through a combination of workshops, field visits, online meetings, a study visit and individual advisory support. The Green City Network organised five three-day on-site workshops and four online workshops. Each city sent two delegates, creating a relatively stable group of about 20 municipal practitioners. Participants represented different fields of municipal administration, including strategic planning, climate adaptation, revitalisation, environmental protection, road and green-space maintenance, municipal management, promotion and fundraising. This composition reflected the cross-sectoral nature of GI and NBS implementation and brought different professional perspectives together within the same process. The workshops combined presentations of scientific concepts, municipal case studies, thematic expert contributions, group discussions, and exchanges concerning implementation problems (Zwierzchowska et al., 2026).

Preparing Municipal Action Plans was the main mechanism for translating knowledge into possible action. The MAPs functioned as city-specific roadmaps rather than uniform technical designs. A common template required cities to describe relevant challenges, objectives, and proposed solutions; implementation activities; stakeholder mapping and communication arrangements; human, technical, and financial resources; monitoring procedures; and project risks. World Bank experts provided guidance, but municipal teams prepared the plans and adapted them to each city's context and level of project maturity. Consequently, the MAPs varied in territorial scope and level of detail. Some focused on spatial interventions to protect, improve, or create GI and NBS, while others highlighted actions that support systemic management, cooperation, knowledge development, standards, or design guidelines (World Bank, 2023).

The CPI is followed up through annual CPI Alumni meetings held between 2023 and 2026 (MFiPR, 2026a). These three-day events bring together cities participating in the networks for network meetings, workshops, and ongoing knowledge exchange through both organized and informal interactions. They aim to further expand the knowledge developed and acquired through successive editions of the CPI, facilitate the exchange of good practices, and strengthen learning mechanisms. The meetings organized under the CPI Alumni programme provide an opportunity to engage in discussions with decision-makers at various levels of governance, representatives of relevant ministries, and cities participating in the CPI networks. Alumni events respond to calls to continue the learning process and maintain dialogue with the central administration, while also sustaining relationships established during the project. The CPI Alumni programme also serves to promote the broader idea of partnership-based cooperation and knowledge exchange, while contributing to the development of civil society.

Outputs and value created

The initiative produced value at three interconnected levels. At the municipal level, the cities developed structured plans that responded to locally defined challenges and strengthened their ability to identify, plan, and communicate GI- and NBS-related actions. At the network level, repeated interaction supported the creation of a community of urban practitioners and enabled cities to exchange experience. Importantly, this exchange concerned not only successful examples but also implementation difficulties, institutional constraints and approaches that had not produced the expected results. At the national level, recurring problems identified in the municipal work were aggregated into broader categories of legal, organisational, substantive and financial barriers. The Green Network then used its findings to develop an Improvement Plan and a Recommendation Bank of proposals for systemic changes and additional support measures. The process therefore created a two-way flow of knowledge: national institutions and experts supported local capacity development, while municipal experience generated evidence and recommendations relevant to national policy and funding frameworks (World Bank, 2023; Zwierzchowska et al., 2026).

Assessment against the EU guiding principles for knowledge valorisation

The practice can be assessed against the seven guiding principles established in Council Recommendation (EU) 2022/2415 (Council of the European Union, 2022). First, it supported knowledge valorisation in research and innovation policy by linking scientific and expert knowledge with the design of public policy and with the practical needs of local authorities. Second, it developed skills and capacities through workshops, advisory work, study visits, learning-by-doing and the preparation of MAPs, while recognising the practical and tacit knowledge of municipal staff. Third, participation in the Green Network can be seen as an incentive, giving city representatives access to experts, tailored advice, networking opportunities, study visits, and support for developing their own initiatives.

Fourth, the initiative generated and organised intellectual assets, understood broadly as plans, methods, recommendations, practical know-how and documented experience. The MAPs, Improvement Plan, Recommendation Bank and network methodology made knowledge more explicit and potentially reusable. Fifth, the network contributed to the relevance of public funding schemes by identifying financial barriers and formulating recommendations on funding needs and mechanisms that could better support integrated, long-term GI and NBS implementation. However, it did not provide a permanent funding scheme to implement all MAP measures (World Bank, 2023).

Sixth, peer learning was one of the initiative's strongest components. The stable network structure, repeated meetings, and exchange of both good practices and difficulties enabled knowledge to circulate horizontally between cities. The Green Network experience highlights city-to-city exchange as an important mechanism for transferring good practices and supporting municipalities facing similar challenges (Zwierzchowska et al., 2026). Seventh, the initiative incorporated some elements of metrics, monitoring and evaluation, particularly because the MAP template required monitoring arrangements and risk assessment (Zwierzchowska et al., 2026).

Participatory budgeting as a nationally institutionalised mechanism for citizen knowledge valorisation in NBS implementation

Participatory budgeting (PB; budżet obywatelski in Polish legislation) provides an example of a nationally institutionalised mechanism through which citizens' local and experiential knowledge can be translated into concrete public interventions. Its relevance to knowledge valorisation lies not primarily in the type of projects funded, but in the institutional pathway it creates between the identification of local needs, the formulation and prioritisation of solutions, the allocation of public resources and their subsequent implementation.

National framework and local adaptation

Participatory budgeting in Poland combines a common national legal framework with locally designed implementation procedures. At the municipal level, the Act of 8 March 1990 on Municipal Self-Government provides the legal basis, in particular Article 5a. The statutory framework for participatory budgeting was introduced by the Act of 11 January 2018 amending certain acts in order to increase citizens' participation in the process of electing, functioning, and controlling certain public bodies. This amendment added paragraphs 3–7 to Article 5a of the Act on Municipal Self-Government, defining participatory budgeting as a special form of public consultation and establishing the fundamental principles of its operation. The current consolidated text of the Act on Municipal Self-Government was promulgated in 2026 (Journal of Laws 2026, item 662).

Although legally classified as a form of consultation, participatory budgeting has stronger consequences than a purely advisory process. Residents decide annually, by direct vote, how to allocate a defined share of municipal spending. Projects selected through voting must be included in the municipal budget resolution, and the municipal council cannot remove them or substantially alter their scope. In cities with county rights, including Konin, participatory budgeting is mandatory, and its value must amount to at least 0.5% of municipal expenditure reported in the most recent budget implementation report.

The national legislation establishes the general institutional framework, while municipal councils determine detailed rules, including requirements for project submission, the required level of support for proposals, formal and technical verification, appeal procedures, voting methods and publication of results. Consequently, participatory budgeting does not produce one uniform model of implementation across Poland. Rather, it creates a nationally secured pathway that can be adapted to different local contexts.

This combination is particularly important from the perspective adopted in this report. The "national level" does not imply that a good practice must be implemented directly by the central government. In this case, its national character results from the statutory framework and its applicability across the country, while the actual mobilisation, combination and use of knowledge takes place primarily at the local level.

From citizens' knowledge to public intervention

From a knowledge valorisation perspective, the central feature of participatory budgeting is its capacity to make citizens' knowledge institutionally actionable. Residents identify problems and opportunities in their immediate surroundings, formulate project proposals and mobilise support around issues that they consider relevant to their neighbourhoods or cities. In this way, place-based knowledge – often tacit, experiential and difficult to capture through formal expert assessments – enters the public decision-making process.

During the assessment of proposals, this knowledge is subsequently confronted with other forms of knowledge. Municipal administrations verify projects for legal compliance, feasibility, technical requirements, estimated costs, and consistency with municipal responsibilities. Participatory budgeting therefore creates an interface between different knowledge holders: residents contribute knowledge of local needs and everyday use of space, while municipal administrations and experts contribute technical, regulatory and implementation knowledge.

Voting adds another stage by revealing collective preferences over a limited pool of public resources. Finally, including successful proposals in the municipal budget turns selected ideas into funded public interventions.

Thus, the knowledge valorisation mechanism can be expressed as: place-based knowledge and local needs - citizen proposals -administrative and expert verification - public prioritisation - allocation of public resources - implementation.

This characteristic also distinguishes participatory budgeting from the two other Polish practices analysed in this report. Whereas the Adaptation Handbook for Cities primarily supports translating scientific and expert knowledge into local adaptation planning, and the Green City Network facilitates the exchange and application of knowledge among municipalities and experts, participatory budgeting opens an institutional pathway for bottom-up knowledge generated by citizens and local communities.

At the same time, PB should not automatically be interpreted as full co-creation or co-design. The degree of deliberation and interaction between citizens, experts, and public authorities varies across municipalities. Its particular strength lies instead in creating a recurring, institutionally protected link between citizens' knowledge and preferences and the allocation of public resources.

Relevance to green infrastructure and NBS implementation

Polish legislation does not earmark participatory budgeting specifically for environmental projects or Nature-Based Solutions. Nevertheless, experience from Polish cities shows that the mechanism can provide an entry point for citizen-generated initiatives on green spaces, biodiversity, recreation, climate adaptation, and small-scale green infrastructure.

Some municipalities have gone further by creating dedicated "green" components within participatory budgeting or related participatory funding mechanisms. Lublin was the first Polish city to introduce a Green Civic Budget in 2017. Residents and local actors submitted 107 proposals, from which 24 projects worth more than PLN 2 million were selected. They included, among others, protection and improvement of existing greenery, street planting, flower meadows, parklets and improvements to public green spaces. Importantly, projects in the Lublin model were selected by an expert panel rather than by direct public voting, demonstrating that "green budgets" can represent a local adaptation of the broader participatory approach rather than a uniform form of statutory PB.

The same national mechanism also operates in Konin. Local experience demonstrates that projects selected through the Konin Participatory Budget may directly concern green public spaces. One example is Zielony Zakątek – strefa wypoczynku, aktywności i integracji, which included new planting and the development of a publicly accessible green recreational space.

These examples demonstrate the potential relevance of participatory budgeting for NBS implementation, but they also indicate an important limitation. Allocating funds to "green" projects does not, by itself, guarantee their environmental quality or compliance with NBS principles. As noted in the analysed literature (e.g. Janik, 2023; Martela, 2023), green-labeled projects can differ considerably in terms of ecological functionality and environmental benefits. Their assessment therefore needs to consider not only the presence of vegetation, but also the environmental functions and wider benefits provided by the intervention.

From a knowledge valorisation perspective, participatory budgeting is therefore relevant not because it constitutes a dedicated NBS policy instrument, but because it provides a stable, recurring and publicly funded mechanism through which citizens' knowledge can enter decision-making and be converted into locally implemented solutions. Its particular value for NBS lies in opening the implementation process to knowledge about everyday use of places, locally perceived environmental problems and community priorities that may otherwise remain insufficiently represented in formal planning processes.

At the same time, the case highlights areas in which the mechanism could be strengthened. Technical verification can restrict the range of admissible ideas, while voting may favour highly visible or popular projects rather than those with the highest environmental value. Another important limitation concerns participation

continuity after a project is selected. The national statutory framework gives residents a formal role in proposing and selecting projects but does not require continued involvement during design and implementation. Once selected and incorporated into the municipal budget, projects are generally transferred to the responsible municipal departments and implemented according to standard administrative, financial and procurement procedures. As a result, the place-based knowledge mobilised during project development may not be systematically retained or used when the intervention is translated into its final technical form. More broadly, the national statutory PB framework also does not systematically require post-implementation monitoring and learning. Connecting participatory budgeting more explicitly with continued community involvement, environmental expertise, NBS criteria and evaluation of implemented projects could therefore strengthen its role not only as a mechanism of public participation, but also as a more complete mechanism of knowledge valorisation for urban sustainability.

Cross-case findings, gaps and relevance for GreenEsteem

Comparing the three selected good practices reveals three complementary pathways through which knowledge can translate into decisions and actions that support NBS implementation in Poland. The Municipal Adaptation Plans framework represents a predominantly vertical pathway, in which scientific and expert knowledge is codified in national guidance and legal requirements and subsequently incorporated into local policy and planning. The Green City Network represents a horizontal, network-based pathway that enables municipalities and experts to exchange knowledge, learn from experience, and adapt solutions to local circumstances. Participatory budgeting introduces a bottom-up pathway, through which citizens' place-based and experiential knowledge can influence public decisions, the allocation of financial resources and the implementation of local interventions.

These pathways should not be regarded as successive stages of a single linear process. Each practice has a different institutional basis, involves different knowledge holders and uses a different mechanism to make knowledge actionable. In Municipal Adaptation Plans, this mechanism combines a national methodological framework, formal planning obligations, and local adaptation procedures. In the Green City Network, institutional coordination, peer exchange, and cooperation among municipalities provide this mechanism. In participatory budgeting, the decisive mechanism is the legally protected connection between citizens' proposals, collective prioritisation and the allocation of municipal funds. Together, the cases demonstrate that knowledge valorisation may proceed through regulation and planning, networked learning or participatory decision-making.

A central cross-case finding is that knowledge does not become valuable for NBS implementation merely because it is available. Practical use requires an institutional interface that connects knowledge holders with decision-making, financial resources, and implementation capacity. Guidance documents, legal procedures, professional networks, participatory mechanisms and public funding all perform this intermediary function. They enable knowledge to move beyond reports, consultations or informal exchanges and to influence plans, projects and expenditure.

Municipalities play a particularly important position within this process. In all three cases, they serve as the point where national frameworks, scientific expertise, professional experience, and citizens' knowledge converge. They interpret national guidance, participate in knowledge networks, verify the feasibility of proposed interventions, allocate resources and assume responsibility for implementation. The cases therefore confirm that national-level knowledge valorisation for NBS does not necessarily depend on direct implementation by central government. Its national significance may instead stem from frameworks and infrastructures that enable and shape locally implemented action across multiple territorial contexts.

The comparison also shows that transferability is based on the adaptation of mechanisms rather than the replication of individual solutions. The Adaptation Handbook provides a common methodological basis, but adaptation priorities and measures must respond to local climate risks and planning conditions. The Green City Network enables municipalities to learn from one another, but practices exchanged through the network

require adjustment to local institutional capacities and environmental challenges. Participatory budgeting provides a common statutory pathway, while local authorities determine its detailed procedures, funding levels, and project priorities. Consequently, the transferable elements of these practices are their underlying principles and mechanisms – methodological guidance, institutional networking, peer learning, citizen participation and binding links to public funding – rather than ready-made interventions.

Overall, the Polish cases demonstrate that knowledge valorisation for NBS is most effective when vertical policy support, horizontal institutional learning and bottom-up citizen participation reinforce one another. The main challenge is therefore not the absence of knowledge, but the fragmentation of the mechanisms that connect, assess, finance, implement, and sustain different forms of knowledge. GreenEsteem can respond to this challenge by using its Living Labs as spaces to integrate these knowledge pathways and turn them into context-sensitive, collectively supported, and implementable NBS actions.

3.2.2. National-level context enabling Knowledge Valorisation for NBS implementation in Bulgaria

In Bulgaria, national knowledge relevant to NBS moves through environmental and spatial strategies, sectoral plans, statutory procedures, municipal planning and project-based collaboration. The framework reviewed in section 2.2.2 creates several institutional interfaces through which ecological, technical and local knowledge can influence decisions, including environmental assessment, protected-area and biodiversity planning, water and flood-risk planning, regional development coordination and municipal investment. Its effectiveness depends on ministries, agencies, and municipalities' ability to share data, align funding, and translate national objectives into place-specific design and maintenance requirements.

3.2.3. Conclusions

Poland and Bulgaria offer multiple policy routes for NBS, but they differ in emphasis. Poland's mandatory municipal adaptation plans create a clearer national-to-local chain for climate risk, greening, stormwater, targets, and monitoring. Bulgaria's framework is broader, covering biodiversity, water, environmental protection, regional development, and spatial planning, but responsibility is more dispersed. In both countries, legal authority must connect to finance, practical guidance, public participation, and local implementation capacity before knowledge produces durable NBS outcomes.

3.3. Good practices in knowledge valorisation for local NBS implementation

This section synthesises the analysis of the 28 practice detail study and information forms, comprising 17 practices in Konin and 11 in Sofia (see Annex F.3). It examines how knowledge enters local decision-making, how it combines with finance and delivery capacity, and what evidence exists on implementation. The national and local assessment method is set out in Annex F.0., Annex F.1 and Annex F.2. where the wider 60+ practices selection and analysis are presented.

3.3.1. Practice portfolios and delivery models

Konin

Konin's portfolio is anchored in municipal delivery. Five documented components belong to the 2021-2024 Green Urban Corridors programme, which connected about 17 km of routes and a series of focal spaces through street planting, green roofs and walls, selective unsealing, permeable surfaces, rainwater retention, shade and educational elements. The programme linked municipal coordination with design support from

Wroclaw University of Environmental and Life Sciences and knowledge exchange through Polish and Norwegian green-infrastructure partners (City of Konin, n.d.; Rubaszek, 2024).

The remaining cases show how a larger municipal strategy can be complemented by smaller delivery mechanisms. The Konin Civic Budget supported an urban orchard, bird habitat, green-roof bus stops, pocket greenery, a school-adjacent green-energy square, a lakeside project, and the Warta River trail. Microgrants enabled NGO-led habitat and inclusive-garden activities, while the OXYGEN Stops introduced a public-private model with InPost. The Pociejewo Graduation Tower Park illustrates how Just Transition funding can combine land regeneration, urban greenery, health and recreation. Taken together, these cases show a practical progression from strategic planning to distributed, visible interventions. (Table 10)

Table 10. Konin: Illustrative NBS practices and knowledge valorisation mechanisms

Delivery model	Illustrative practices	Knowledge valorisation mechanism
Integrated municipal programme	Green Corridors, living courtyards, Sensory garden, Pocket parks and Dry creek garden	External programme finance, municipal coordination, academic design expertise and professional knowledge exchange
Civic-budget implementation	Urban orchard, Sparrow habitats, Green bus stops, Green Nook, Warta trail, Lakeside and school square	Residents formulate and vote on proposals; the municipality verifies, funds and implements selected projects
Civil-society and microgrant action	Urban Bird Havens; Wood, Earth and Us; Tree-distribution campaign	NGOs and local organisations mobilise volunteers, local knowledge and environmental education
Public-private and transition investment	OXYGEN Stops; Pociejewo Graduation Tower Park	Business resources or Just Transition funding complement municipal assets and delivery capacity

The Konin evidence is strongest on funding sources, implementing bodies, visible outputs and dissemination. It is weaker on quantified ecological performance, life-cycle maintenance costs, decision rights during co-design and the influence of participation after project selection. This limits comparison between highly visible civic projects and measures designed primarily for retention, biodiversity or cooling.

Sofia

Sofia's nine practices represent a more varied portfolio. URBiNAT uses a Living Lab and a Healthy Corridor framework to connect social housing neighbourhoods, co-creation and multifunctional NBS. Manastirski Livadi East Park and the Green Ring translate strategic spatial analysis into connected public-space concepts. Rivers of Sofia combines tactical placemaking, cultural programming and river awareness, while the New Forest of Sofia and the Green Sofia Programme use recurring municipal action to expand planting and neighbourhood greenery. The portfolio also includes a school vegetable garden, the privately developed Garitage Park and the historic green roofs of Zona B5. (Table 11)

This diversity broadens the knowledge sources used in implementation. Municipal enterprises contribute planning and spatial analysis; EU projects provide structured co-creation methods; NGOs and informal initiatives bring cultural and community knowledge; schools support practical environmental learning; and private developers contribute finance, landscape design and maintenance capacity. Nevertheless, the detailed forms vary in completeness. Evidence for URBiNAT, Manastirski Livadi, Rivers of Sofia, and the New Forest is comparatively rich, while several local practices still lack complete bibliographic and implementation records.

Table 11. Sofia: Illustrative NBS practices and knowledge valorisation mechanisms

Delivery model	Illustrative practices	Knowledge valorisation mechanism
Co-created and strategic corridors	URBiNAT, Manastirski Livadi East Park, Rivers of Sofia, Green Ring	Living Lab methods, spatial analysis, public events, tactical interventions and strategic network planning
Municipal greening programmes	New Forest of Sofia, Green Sofia Programme	Municipal funding, campaigns, donations and recurring neighbourhood implementation
Education and community practice	School vegetable garden	Experiential learning and stewardship through a school community [MC-3.3-02]
Private and legacy practice	Garitage Park, Zona B5 green roofs	Private development and maintenance capacity; long-term technical precedent, with uneven public documentation [MC-3.3-03]

3.3.2. Stakeholders and governance

In Konin, the municipality is the principal system integrator. It combines external finance, procurement, municipal land and infrastructure responsibilities with citizen-generated proposals. Civil-society organisations add mobilisation and specialist knowledge, and senior groups and parish communities can act as trusted local intermediaries. Research organisations are most visible in the larger Green Corridors programme. Business participation is emerging but remains concentrated in a small number of cases, so public-private learning has not yet become a routine delivery channel.

Sofia has a denser and more differentiated actor network. Sofia Municipality, district administrations and municipal enterprises provide planning authority and access to public space. Universities and project consortia contribute research and facilitation. NGOs, cultural organisations, schools, residents and volunteers activate sites and communicate local needs, while developers and sponsors provide resources in selected practices. This diversity creates more routes for knowledge exchange but also makes continuity harder to secure when a project depends on temporary funding, an informal coalition or a single champion.

Across both cities, participation is documented more often as consultation, volunteering, voting or event attendance than as shared authority over budgets, design trade-offs and maintenance. Future practice records should distinguish awareness raising, consultation, co-design, co-delivery and co-monitoring, and should identify which actor can approve or reject decisions at each stage.

3.3.3. Digital tools and knowledge-sharing channels

Web visibility supports dissemination but does not by itself demonstrate knowledge valorisation. Stronger evidence would show who used the information, whether it changed a plan or design, how feedback was resolved, and whether monitoring data informed maintenance or replication. A common digital record for GreenEsteem should therefore link each practice to its baseline, design choices, stakeholders, costs, outputs, ecological and social indicators, maintenance responsibilities and lessons learned. (Table12)

Table 12. Digital tools and knowlege-sharing channels identified in the practices from Konin and Sofia

City	Channels identified in the practice forms	Assessment
Konin	Municipal and project websites, social media, civic-budget portal, mapped guides, QR-linked educational elements, mobile city game and geosurvey tools	Good visibility of projects and funding; limited open performance data, reusable datasets and evidence of digital co-decision
Sofia	Municipal and project websites, SofiaPlan publications, Living Lab materials, social media, event communication and project platforms	Broader mix of planning, research and civic channels; uneven archiving and incomplete data on reach, feedback and later use

3.3.4 Expert Interviews Analysis

Scope and methodological notes

Fifteen interviews were conducted, covering 16 practices aimed at implementing nature-based solutions (NBS) in Sofia[3], Bulgaria, and Konin[4], Poland. The expert interviews aimed to examine stakeholders' roles and motivations; track assessments of NBS practice development and the tools used (including digital ones); identify barriers and enabling factors across process phases; and observe the application of knowledge valorisation principles[5]. The study focused on the local context—specifically national and local governance characteristics, readiness to adopt standards, the long-term sustainability of practices, and the potential for cross-sector partnerships. The researchers judgmentally selected interviewees from a variety of backgrounds based on their status as experienced members and/or participants in decision-making and operational implementation of NBS. Before subjected to content analysis, the scripts of conducted interviews in the period July-August 2026 were anonymised, coded and translated (Table 13).

Table 13. Coding of the Interviews

Code	Case study	Quadruple helix model representation	role for the practice development
1_KID92	Konin	NGO, citizen, local administration	initiator
2_KID79	Konin	researc/NGO	designer, implemented research and educational activities

[3] Link to the summary of the interviews: https://docs.google.com/spreadsheets/d/1Nc7rYFNK_JhU4qI5SGnCNo4ZoxiEqK-t/edit?gid=1832748238#gid=1832748238

[4] Link to the summary of the interviews: https://docs.google.com/spreadsheets/d/19fvevyQQ8Xyxhv4bN3z-MJkvfyEWalhj/edit?gid=1075139969#gid=1075139969

[5] Expert interview gidelines: https://docs.google.com/document/d/1w-Mw5wjdCOU8DqXO_WXnxfBFDQ6P9zgi/edit?usp=drive_link&ouid=113978012699755800632&rtpof=true&sd=true

Code	Case study	Quadruple helix model representation	role for the practice development
3_KID83	Konin	local administration	initiator, designer, responsible for the implementation, active user
4_KID86	Konin	local administration	project coordinator, manager
5_KID91	Konin	NGO	initiator
6_KID79,1	Konin	local administration	project coordinator
7_KID80	Konin	local administration	project member, responsible for the public relations and information dissemination
8_KID85	Konin	NGO	project coordinator
9_SID123	Sofia	practitioners	architect + landscape architect, designers and bearer of the idea
10_SID126	Sofia	Municipal planning enterprise	researcher, public relation
11_SID122	Sofia	NGO	project coordinator, designer, public relation
12_SID111	Sofia	NGO	designer, responsible for the implementation
12_SID117	Sofia	NGO	designer, responsible for the implementation
13_SID122	Sofia	Municipal planning enterprise	researcher sociologist, public relation
14_SID110	Sofia	NGO, active citizen	architect, bearer of the idea, project coordinator, designer, public relation

Summary of findings

In both countries, nature-based solutions (NBS) are typically implemented through a combination of municipal actions, professional expertise, and initiatives by local communities or non-governmental organizations. The most successful cases are those in which these actors' activities reinforce one another. Differences also emerge: the Polish cases presented are more firmly integrated into formal municipal programs, external funding schemes, participatory budgeting processes, and documented implementation mechanisms. Bulgaria shows greater case diversity: some are part of the municipality's urban management tasks; others are strongly community-oriented and experimental; while still others remain at the strategy, design, research, or advocacy stage, having never reached—or never likely to reach—physical implementation.

In both Sofia and Konin, interviewees pointed to a disconnect between the planning/design phases and long-term implementation or maintenance. In the Bulgarian context, this manifests primarily as administrative fragmentation, unstable funding, and a lack of continuity, whereas in the Polish context, the challenges relate

more to coordination, public procurement (including material substitutions), monitoring, and maintenance organization. In both countries, delays or lack of implementation, as well as maintenance difficulties, are described as highly demotivating for the stakeholders involved and as negatively affecting the process as a whole.

Stakeholder engagement matters in both countries. The Bulgarian cases place particular emphasis on mobilizing the local community, fostering communication between active agents (citizens, NGOs, businesses) and local authorities, building trust, and learning by doing. The Polish cases more frequently feature structured consultations, participatory budgeting, workshops, and municipality-led communication. On knowledge valorisation, Polish respondents report disseminating insights through study visits, integrating topics into educational curricula, defining guidelines, and facilitating the exchange of accumulated experience between cities. Bulgarian respondents identify local workshops and participation in expert networks as tools for professional exchange; social networks and Viber channels as means to disseminate information and expand the circle of like-minded individuals; and mapping, student projects, and practical demonstrations as effective methods for quickly capturing attention and fostering lasting interest and expertise in the planning and implementation of Nature-Based Solutions (NBS).

Given the significant efforts of the stakeholders involved, the resources invested, and the undeniable benefits of nature-based solutions, long-term sustainability is viewed as a key value in urban management—a perspective shared by both Polish and Bulgarian interviewees. It is argued that political or administrative changes and fragmentation can be overcome when nature-based solutions become institutionalised, gain public recognition, secure long-term funding, and are supported by a stable stakeholder network.

Stakeholders, roles, and motivations

The respondents discussed Bulgarian practices and efforts to represent a more diverse group of professional roles. They include representatives from municipal bodies—specifically those involved in urban planning and design—as well as architects, members of the research and academic communities, non-governmental organisations, local businesses, and community-oriented specialists. Several cases rely on a small core team that compensates for limited institutional or financial capacity with personal time and initiative.

Respondents describing practices in the field are more closely linked to local administration and non-governmental organisations, with several explicitly serving as coordinators, managers, or municipal project staff.

Motivation is similarly multifaceted in both countries. In Bulgaria, it often combines professional commitment with an attachment to the location—such as the rivers, public spaces, and greenery—and the community. In Poland, motivation more frequently blends local needs with specific program opportunities, available funding, climate adaptation, public space improvements, and the preservation of natural or historical assets. In both countries, funding can act as a powerful catalyst, but it does not, by itself, guarantee continuity.

Barriers and stimulating factors observed during the NBS practice phases

Respondents in both Bulgaria and Poland identify a fragmented, unsystematic administrative process as the most common cause of delays or the halting of such initiatives. Factors include lengthy public procurement timelines, excessive permit requirements, unclear responsibilities, poor coordination, or the loss of an active institutional champion. Funding is the second major structural issue, particularly when implementation or monitoring costs exceed the allocated project budget. Climate change and shifting local weather could hinder future and still-implemented NBSs.

The Bulgarian case studies highlight the significance of mutual distrust among active stakeholders, which also fosters a fear of change within the community. Respondents describe deep-seated suspicion of construction—

often associated with overdevelopment—along with fears about changes to familiar spaces and concerns about potentially poor-quality interventions. Small-scale physical prototypes and visible improvements help build trust.

In Poland, information deficits—such as stakeholders' lack of understanding, poor coordination, a lack of timely information, and inaccessible language—are reported during the key implementation phase. These issues delay and disrupt the project's pace and fail to overcome scepticism, sometimes even contributing to vandalism. During implementation, time is cited as a limiting factor. Issues also arise over who is responsible for providing support and conducting adequate monitoring.

The most significant favourable factors in both Sofia and Konin are linked to an active local community and committed, competent local government representatives or experts. The opportunity to use interdisciplinary expertise, combined with concrete examples demonstrating the potential of NBS, is viewed very positively. External and/or diversified funding is seen as a favourable way to avoid the disruptions associated with complying with the conditions of a single funding institution (typically programs initiated by local authorities). Factors stimulating these processes include education and knowledge exchange, such as specifically well-developed educational programs, site visits, on-site training, and participation in public academic and non-academic events. Emphasis is placed on the quality and value of the intervention area, where high quality and value favour the practice's successful execution. (Table14)

Table 14. Summary of the barriers and facilitating factors across the various phases of the NBS practice implementation in Bulgaria and Poland

Phase	Bulgaria–observed pattern	Poland – observed pattern	Comparative interpretation
Awareness / education	Strong in most cases; public events, student work, festivals, workshops and accessible communication are common.	Strong and often formalised through educational programmes, workshops and study visits.	Both recognise awareness as foundational; Poland is somewhat more programme-based, Bulgaria - more grassroots based and experimental.
Problem identification / data	Strong use of field observation, mapping, community knowledge and research, but systematic datasets are often missing.	Generally present; municipal information coordination and incomplete inventories are recurring issues.	Both value empirical/field knowledge, but both need better systematic data and coordination.
Planning	Often strategic and participatory, but vulnerable to institutional fragmentation and changing scope.	Usually linked to municipal planning, external funding, and formal coordination; inter-departmental coordination can be difficult.	Poland appears more institutionally embedded; Bulgaria shows more adaptive planning.
Design	Strong professional and experimental design capacity; temporary physical tests are valued.	Generally strong, with interdisciplinary expertise and consultation, but late changes and material substitutions can occur.	Design is a relative strength in both; the main issue is translating design into implementation.

Phase	Bulgaria–observed pattern	Poland – observed pattern	Comparative interpretation
Prototyping	Highly visible in temporary interventions and learning-by-doing cases.	Limited or absent in several cases; one case uses visualisations as a substitute.	Bulgaria has a stronger experimental/prototyping culture in the sample.
Implementation	Most problematic in strategic/large-scale cases; permits, municipal decisions, funding and continuity are critical.	Generally, more concrete, especially in funded municipal projects, but delays, procurement/material changes and coordination remain issues.	Polish cases show stronger implementation institutionalisation; Bulgaria shows greater discontinuity.
Monitoring	Often informal or under-resourced; lack of dedicated budget is a recurring concern.	Systematic monitoring is also limited; respondents explicitly identify this as a gap.	Monitoring is a shared weakness.
Maintenance	Frequently dependent on local people, project teams or uncertain future funding.	More often planned in project documentation, but long-term financing and maintenance responsibilities remain concerns.	Poland has somewhat clearer formal planning; both face the long-term maintenance challenge.
Use / benefits	Benefits become visible quickly when accessibility and quality improve; trust grows through actual use.	Positive public reception is reported in several completed cases, especially green spaces and bus shelters.	Both demonstrate that visible, tangible benefits strengthen acceptance.
Validation / governance	Strong variation by municipality; some cities provide clear channels; others are restrictive or slow.	Municipal authority and formal procedures are prominent; local political support is generally important.	Poland is more procedurally structured; Bulgaria - more context dependent.
Knowledge sharing	Expert networks, student work, mapping, social media/Viber and practical events.	Workshops, conferences, study visits, guidance materials and inter-city learning are prominent.	Both share practical knowledge; Polish cases show more formal documentation, Bulgarian cases more informal network diffusion.

Participation and decision-making process

Participation is built in, expected, and a significant component of the initiatives in both Sofia and Konin. However, the mechanisms through which this participation occurs differ notably. The Bulgarian initiatives rely on a growing cohort of local experts building knowledge and experience in NBS's field. This group includes representatives from academia and the non-governmental sector, local government experts, individual citizens, and members of grassroots initiative committees. Community mobilization is evident through informal networks and direct involvement in temporary interventions. Respondent feedback suggests that citizen engagement intensifies once people can see and utilise an actual intervention. Business interest is also

noteworthy, often driven by internal motivations rooted in personal values. In major projects like Sofia's "Green Ring," business investment reportedly stems from a desire to demonstrate social and environmental responsibility to the community and the city. The Polish cases more frequently combine community participation with formal municipal procedures, such as participatory budgeting, on-site consultations, social media engagement, and structured workshops. Experts and municipal officials drive implementation across all phases, while other stakeholder groups are involved in specific stages, particularly during needs assessment and consultation on proposed solutions. Individuals with a high level of awareness of the necessity and impact of NBS are strongly motivated.

A shared limitation in decision-making is observed. Residents and non-governmental organisations can influence the agenda, ideas, and consultation processes, while the final decision typically rests with the municipality or another official decision-making body. This hierarchy is particularly evident in Poland. In contrast, in Bulgaria, bottom-up initiatives exemplify the efforts, and often the civic pressure, that lead to the successful implementation of NBS practices, the execution of which is ultimately authorised by local authorities.

Innovations and Digital Tools

Some respondents view the Bulgarian practices themselves as innovations when compared to standard approaches to urban management and intervention. Furthermore, respondents note the implementation of innovations, such as temporary interventions to test ideas in real-world conditions and encouragement of student experiments. Testing various vertical greening approaches and combining them with other nature-based solutions (e.g., aquaponics, aquariums) also counts as an innovation. Creating a digital information environment that serves both to inform the public and to support evidence-based decision-making places most of these practices in the "innovative" category. Digital tools often facilitate communication and mobilization, including through social media groups, Viber networks, and interactive mapping.

In Poland, innovations are more frequently linked to municipal climate change adaptation programs, blue-green infrastructure, green roofs, "living" walls, water retention facilities, bus stops equipped with air-purifying systems, and combinations of various NBS within the urban environment. Respondents report applying organisational innovations (such as volunteer engagement and the restoration of local plant and tree species) as well as managerial innovations (such as shared responsibilities) in some of these practices. Practices that allow citizens to vote remotely demonstrate a strong innovative and digital character. Alongside direct personal contact, they use geoportals, videos, websites, and educational tools—such as games and a digital knowledge-sharing system accessible via QR code.

Respondents from both countries note that digital tools work best when they support an existing participatory or implementation process and cannot replace personal contact and engagement.

Awareness, acceptance and knowledge transfer

Both countries acknowledge that acceptance depends on context and does not occur automatically. People are more inclined to accept NBS when the intervention addresses an immediate local need and does not appear to compromise convenience, property rights, or established patterns of space usage. Acceptance is driven more by tangible benefits than by citizens' familiarity with the NBS concept itself. Young people and already active communities are frequently cited as being particularly receptive. Leaders and other individuals involved in these initiatives show a willingness to learn new knowledge and gain experience, including administrative procedures, and to overcome obstacles.

Knowledge transfer in Poland is considered effective at the local level; it is informal and delivered through on-site activities such as face-to-face conversations, workshops, games, competitions, local events, and

conferences, often tailored to diverse participant groups, including youth and older citizens. However, those responsible for implementing and maintaining these initiatives often lack time to attend conferences or other knowledge-exchange events. Examples from Poland place greater emphasis on structured educational content, study visits, conferences, guidelines, and experience exchange between cities. It is claimed that good examples have still inspired other local communities and neighbourhoods. However, barriers also persist, including differing stakeholder recognition, limited personnel, and financial constraints in further knowledge valorisation.

Examples from Bulgaria point to significant practical and media activity on NBS implementation, which has raised awareness among more people in recent years. At the same time, the need for a systematic approach and sustained effort in this field is highlighted, with a recommendation to communicate in accessible language that is nonetheless well grounded in professional expertise. A strong digital presence (websites, social media) and numerous public events, such as festivals featuring various activities, exhibitions, and placemaking initiatives, target a broader group of stakeholders. Meanwhile, broad interdisciplinary meetings and conferences (including non-academic ones) further develop and disseminate specialised knowledge among experts. To ensure increasingly well-prepared young professionals enter the field, the curriculum integrates topics drawn from case studies. A lack of awareness of Nature-Based Solutions (NBS) can also lead to scepticism, potentially causing sites where they are implemented to be perceived as neglected or poorly maintained.

Standards, policy, and institutionalisation

Respondents from both countries support clearer standards. The Bulgarian interviewees are particularly insistent on adopting NBS standards, incorporating them into the regulatory framework, and integrating them into municipal operational documents and Detailed spatial plans, emphasising the need to operationalise and standardise the entire process. However, they also highlight a risk: if a mandatory requirement is too broad, it may be interpreted narrowly or distorted, especially without practical guidelines and best-practice examples (e.g., flood risk management resulting in concrete river channels).

Polish respondents note that NBS are already integrated into local strategies but see value in adopting functional standards that cover the entire NBS lifecycle, including maintenance and monitoring.

A robust framework is needed to encompass planning, implementation, maintenance, monitoring, responsibilities, financing, and public participation.

The interviewees' assessment of acceptance by Quadruple Helix stakeholders is presented on Table 15.

Table 15. The interviewees' assessment of acceptance by Quadruple Helix stakeholders

Stakeholder group	Bulgaria – qualitative pattern	Poland – observed range	Cross-country reading	Caution
Business	Generally medium/conditional; acceptance depends on added cost and complexity.	Where scored, approximately 5; some respondents did not provide a score.	Business acceptance is conditional in both datasets.	Not all respondents supplied scores.
Citizens	No consistent overall score; acceptance depends strongly on how change is	Approximately 6–10 in the available Polish entries.	Citizens can be highly supportive when benefits	Context and project maturity matter.

	introduced and perceived.		are tangible and local.	
Urban-planning experts	Very high, around 9–10 where explicitly assessed.	Approximately 8 in the available Polish entries.	Expert acceptance is high in both samples.	Small, non-random samples.
Local government	Around 5 in the Bulgarian synthesis, strongly context-dependent.	Approximately 7–10 in available Polish entries.	Polish cases show somewhat stronger institutional acceptance in the supplied data.	Different wording/completeness of the two tables.

Long-term resilience and cross-sector partnerships

Stakeholders in Bulgaria are considering two possible approaches. One focuses on better integration between active NGOs, citizens, and local authorities, governed by clearly defined rules. There is also a recognised need for cross-sectoral integration among municipal departments, as well as integration across territorial levels, specifically between the municipal administration and its districts. The second approach emphasises maintaining an independent or cross-sectoral initiative that remains distanced from political parties and relies primarily on expert input. This would allow the practice to endure despite political changes.

Two other key factors include concluding formal agreements, particularly important for long-term projects, and creating conditions to replicate practices and share accumulated knowledge, including by turning strategic documents into practical tools for territorial management.

Interviewees from Poland note that implementing NBS will become increasingly necessary and valued, driven by both ongoing climate change and the tangible benefits citizens derive from them in their daily lives. This will both encourage civic engagement and provide a rationale for expert and political decisions. Another factor cited for long-term sustainability is integrating NBS into standard municipal planning practices, backed by secured, continuous funding. It is also noted that involving a broad range of stakeholders, not only in planning and design but also in maintenance, would help ensure resilience against the disruptions caused by political changes. This approach would succeed if a specific person were designated in charge, whether an institutional representative, an NGO member, or a volunteer citizen.

Regarding cross-sector partnerships, interviewees from both sides agree they are key to the long-term sustainability of implemented projects and to developing and scaling practices that incorporate NBS into urban environment management. A shared point of view concerns the need for a digital resource, such as a platform, to provide citizens and the NGO sector with both basic information (on best practices and funding opportunities) and specialised content (such as spatial data, interactive NBS-support resources, methodological and operational guidelines, and catalogues), as well as to clarify relevant implementation standards where they exist. Support for project management is also required, particularly for newly engaged active citizens and organisations, and this should be easily accessible via the same platform. Such a resource would consolidate accumulated academic and local knowledge and expertise, strengthen and expand the

stakeholder network, operationalise the process, help new participants assume various responsibilities, and reduce the transaction costs of launching NBS projects.

3.3.5. Conclusions: Transferable findings and evidence gaps

Four findings are transferable. First, municipalities need a stable mandate and budget interface to turn knowledge into approved projects. Second, large programmes and small civic initiatives perform different functions: integrated programmes create networks and technical standards, while small projects test ideas and build ownership. Third, intermediaries such as universities, NGOs, municipal enterprises and trusted community organisations help translate between technical, administrative and lived knowledge. Fourth, dissemination becomes durable valorisation only when lessons influence later planning, procurement, funding or stewardship.

The Annex F.3 forms also reveal a common evidence gap. Inputs and activities are recorded more consistently than outcomes. Future assessment should use a minimum set of comparable measures covering green-space area and connectivity, tree-canopy change, water retained or infiltrated, heat mitigation, biodiversity response, accessibility, participation quality, distributional effects, capital and maintenance cost, and institutional uptake. Where the local forms do not yet provide a source, the indexed blue markers below identify the required follow-up rather than presenting assumptions as findings.

4. KEY STAKEHOLDERS ON NATIONAL AND LOCAL LEVEL

4.1. Quadruple helix, co-creation and co-production of NBS

The synthesis of EU knowledge valorisation policies reveals an evolving conceptual framework that integrates technology transfer, knowledge transfer, and knowledge valorisation, highlighting a shift towards more systemic and inclusive innovation models. This evolution challenges traditional linear innovation theories by emphasizing multi-actor collaboration within Quadruple Helix ecosystems and the importance of reflexive governance to address complex societal challenges (Meoli &Grieco, 2025; Wiarda et al., 2024).

The literature confirms that the Quadruple and Quintuple Helix models extend the Triple Helix by incorporating civil society and environmental dimensions, embedding democracy and ecological sensitivity into innovation systems and supporting their conceptualization as socio-technical and socio-ecological systems (Carayannis et al., 2018; Carayannis et al., 2021; Carayannis & Campbell, 2017). Integrating and mode of knowledge production highlights a shift toward inclusive, participatory, and transdisciplinary innovation processes that challenge linear paradigms by emphasizing co-creation and reflexive governance (Peschke et al., 2023; Carayannis & Campbell, 2017). The conceptual relationship between the two models is best understood as nested, with the Quintuple Helix contextualizing the Quadruple within broader socio-ecological transitions, linking knowledge democracy with environmental stewardship (Kunwar & Ulak, 2024; Carayannis et al., 2021; Cai, 2022). Newer models, such as the Pentagonal Helix, further introduce foresight and anticipatory governance as temporal and strategic dimensions, emphasizing long-term alignment with sustainable development goals (Raxmatullayev, 2025). By contrast, while the Triple Helix remains central to core innovation dynamics, extended models offer complementary perspectives that better capture the complexity of contemporary ecosystems, supporting a pluralistic rather than prescriptive theoretical approach (Cai & Lattu, 2021; Cai, 2022). Across all frameworks, the recognition of civil society and the natural environment as active helices aligns innovation studies with broader societal challenges including climate change, social inclusion, and democratic governance (Yazıcı, 2023; Carayannis & Rakhmatullin, 2014).

The practical dimensions of the HELIX models are adding value for policymakers, as most of the research findings call for governance frameworks that institutionalize multi-stakeholder collaboration — including civil society and environmental actors — through instruments supporting co-governance, open science, and systemic decision-making (Meoli & Grieco,2025; Franc & Karadžija, 2019). Innovation intermediaries such as science and technology parks should expand their roles beyond knowledge transfer to actively support communities and sustainability initiatives, strengthening their capacity to orchestrate regional innovation systems (Dąbrowska, 2024; Shkarupeta & Babkin, 2024). New collaboration platforms — such as open labs and cultural innovation hubs — are needed to facilitate trust-building and co-creation among diverse stakeholders. Regional strategies also benefit from adopting these broader frameworks to embed community engagement and strengthen local innovation ecosystems' resilience (Grundel & Dahlström, 2016; Kim, 2025). Integrating digitalization and foresight capabilities offers practical pathways to accelerate technology commercialization and bridge innovation gaps, suggesting these should be prioritized in policy and practice (Loucanova et al., 2025; Raxmatullayev, 2025). Finally, universities emerge as pivotal knowledge mediators, with practical implications for institutional change toward sustainability-oriented education, research, and partnership development (Armas & Villegas, 2025).

NBS and stakeholders

Local climate actions are embedded within broader regional, national, and international governance arrangements for both mitigation (Allen et al., 2009; Sharpe et al., 2016) and adaptation (Amundsen et al., 2010; Van Well & Scherbenske, 2014), with local political and economic conditions identified as a key scale for driving climate policy (Fagiewicz et al., 2021; Lee & Koski, 2015). Climate change is increasingly perceptible at the local level, raising social awareness through both collective learning and direct personal experience of extreme weather events (Reyes-García et al., 2016; Torabi et al., 2016; Chingala et al., 2017), which in turn motivates communities to participate in developing targeted adaptation strategies (Picketts et al., 2013). Over the past decade, local and regional governments have shifted toward shared responsibility with academia, business, and civil society organizations (Ricart et al., 2019), a trend reflected in initiatives such as corporate social responsibility and cross-sector social partnerships (Fagiewicz et al., 2021; Barnett, 2019; Googins & Rochlin, 2000). Despite this progress, political weaknesses, conflicting socioeconomic and environmental priorities, and insufficient public engagement have often constrained joint mitigation and adaptation efforts (Adger et al., 2009; Withmarsh, 2011).

Co-creation and co-production of NBS

Public and private organisations are increasingly collaborating to address complex societal challenges — from climate change and unemployment to long-term illness — that cannot be resolved through evidence-based approaches alone and instead require networked, participatory solutions. This shift may represent a paradigm change in public management, driven by growing pressure on welfare systems and the inherently "wicked" nature of contemporary social problems. Central to this shift are co-production and co-creation. Co-production involves public and private actors jointly delivering already defined tasks, while co-creation goes further by collectively defining new policies or services before delivering them. In both cases, citizens move from passive recipients to active participants. While co-creation in the private sector focuses on improving the efficiency of goods and services through end-user input, the public sector positions citizens as integral contributors to social innovation (Vooberg, Bekkers, & Tummers, 2014).

While co-creation processes ideally rest on equal rights and positions among stakeholders (Chaudhary et al., 2018), in practice actors' influence and capacity differ significantly (Hein et al., 2017; Wang et al., 2020). Local governments hold decision-making authority, businesses control financing, NGOs and CSOs shape public opinion, and scientific institutions lend credibility to argumentation. Ackermann and Eden (2011) suggest prioritizing stakeholders best positioned to advance strategic goals, though competing interests among actors mean power asymmetries and social inequalities require careful attention throughout the co-creation process (Barnaud et al., 2018).

Addressing climate change in cities requires researchers, policymakers, practitioners, and other urban stakeholders to strengthen partnerships and produce knowledge collectively (Bai et al., 2018). This goes beyond monitoring local authorities to actively engaging diverse social groups in co-creating effective solutions (Kuenkel, 2019; Lam et al., 2019). Implementing complex climate actions requires coordinated, multi-level collaboration across stakeholder groups within a networked environment — an approach that aligns closely with the quadruple helix concept (Arnkil et al., 2010; Carayannis & Rakhmatullin, 2014; Carayannis et al., 2015). This framework integrates the distinct knowledge contributions of academia, business, local government, and civil society organisations, weaving them together to generate innovative solutions to shared challenges.

4.2. Typology of stakeholders – roles and responsibilities - explicitly and/or implicitly related to NBS, their funding, co-creation, maintenance and partnership

For the purpose of this mapping and analysis, the stakeholders were mapped according to the quadruple helix model classification, and their theoretical (Figure 4.) roles, responsibilities, and needed capacities were identified and related to NBS, their funding, co-creation, maintenance, and partnership. (Annex E)

Then their actual roles and responsibilities assigned by the Polish and Bulgarian legislation were identified, along with the mapping of the potential stakeholders to be involved in GreenESteem project initiatives.



Figure 4. Clusters of local stakeholders mapped

4.3. Roles and Potential for cooperation for NBS implementation in Sofia and Konin (according to the local context)

4.3.1. Roles and Potential for cooperation for NBS implementation in Konin

The stakeholder landscape in Konin is characterised by a strongly community-driven structure, with a high level of civic engagement and a prominent role of civil society actors. A distinctive feature of the Konin context is the exceptionally high activity of senior groups, which constitute one of the most engaged stakeholder

segments. Organisations representing older adults frequently initiate and support local initiatives, contributing to community mobilisation and continuity of actions. Their strong involvement is supported by factors such as time availability, well-developed social networks, and a strong attachment to the local environment, making them highly reliable partners in participatory processes. (Table 16)

Another important characteristic is their high level of civic participation, particularly evident in the Konin Participatory Budget. Residents actively propose and support local projects, including those related to environmental and spatial improvements, which indicates a well-established culture of bottom-up engagement and co-creation. This demonstrates that citizens in Konin are not only beneficiaries of nature-based solutions (NBS), but also active initiators and contributors to their implementation.

The stakeholder ecosystem is further strengthened by the significant presence and activity of non-governmental organisations (NGOs), which play a central role in initiating, coordinating, and implementing local actions. Their ability to mobilise communities and translate local needs into concrete initiatives makes them key actors in the implementation of NBS.

A specific and context-dependent feature of the Konin stakeholder landscape is the role of religious organisations, particularly parish communities. The example of the "Zielony Zakątek" ("Green Corner") initiative demonstrates that local parishes can act as trusted community hubs, supporting mobilisation, communication, and participation. Their strong local embeddedness and trust-based relationships enable them to effectively engage residents and contribute to the success of local initiatives.

Despite these strengths, the analysis also reveals several structural gaps. In particular, the private sector remains weakly engaged, and public–private partnerships in NBS implementation are noticeably lacking. While some small-scale and specialised actors are involved, the broader integration of business actors into the local ecosystem is limited. This indicates an underutilised potential for strengthening the economic and innovation dimensions of NBS implementation.

Overall, the Konin stakeholder landscape is socially embedded and participation-oriented, with strong civic and community-based engagement, but it still needs further development in cross-sectoral collaboration, particularly with private sector actors.

Table 16. Roles and Potential for cooperation for NBS implementation in Konin (according to the local context)

Stakeholders according to the local context	**Roles and Potential for cooperation for NBS implementation according to the local context in Konin**
Public sector Stakeholders	
Elected politicians: Mayor of Konin Deputy Mayors of Konin Konin City Council (councilors) Konin Youth City Council (youth councilors)	Elected politicians, including the Mayor of Konin and City Council members, play a key role in shaping the local governance context for Nature-Based Solutions. As democratically elected representatives, they are responsible for setting strategic priorities, allocating resources, and legitimising policy decisions. In the context of NBS implementation, their role is particularly important in: 1. integrating NBS into local strategies and policies, 2. supporting funding decisions, 3. and ensuring political support for innovative and participatory approaches. The analysis indicates that elected politicians in Konin have strong potential to support NBS implementation, given the city's active involvement in projects and the presence of engaged local stakeholders. However, this potential depends on increasing awareness of NBS

	benefits, strengthening evidence-based decision-making, and aligning NBS with broader political and development priorities.
Municipalities and local publicly owned institutions: Department of Strategic Management Department of Environmental Protection Department of Investment Department of Municipal Economy City Gardener Centre for Non-Governmental Organisations Department of Urban Planning and Architecture City Architect	Municipalities and local publicly owned institutions form the operational and administrative layer of local governance, translating strategic decisions into concrete actions. In the context of Konin, these administrative departments play a central role in the implementation of nature-based solutions (NBS), particularly in: planning and design of interventions, coordination across departments and stakeholders, execution of projects, and long-term maintenance of implemented solutions. Due to their direct involvement in project delivery and their position within local governance structures, municipalities and publicly owned institutions have a very high potential for cooperation in NBS implementation. They act as key intermediaries between political decision-makers, experts, and local communities. However, institutional fragmentation, limited resources, and procedural complexity may constrain their effectiveness. In addition, the implementation of NBS often requires interdisciplinary knowledge and new approaches that are not yet fully embedded in administrative practices. Strengthening capacities, improving interdepartmental coordination, and facilitating collaboration with external stakeholders (including NGOs, experts, and citizens) are therefore essential to fully realise their potential in supporting the implementation and scaling of NBS.
Public sector organization: Konin Senior Citizens Council; Public Benefit Activity Council; Konin Women's Council; Municipal Public Library; Konin Cultural Centre; Centre for Culture and Arts – Oskard Cultural Centre; Municipal Waste Management Plant; State Forests – Konin Forest District	Public sector organizations include publicly funded institutions operating at the local level that are not part of the core municipal administration but support the local system. In the context of Konin, these actors play a supporting role in the implementation of nature-based solutions (NBS), particularly in: facilitating local implementation activities, contributing to awareness-raising and environmental education, providing spaces for pilot actions and demonstration projects, and acting as intermediaries between local authorities and communities. Public sector organizations **have a moderate to high potential for cooperation,** especially in relation to engagement and dissemination of NBS practices. Their proximity to local communities makes them important actors in building acceptance and understanding of NBS. However, limited decision-making power, dependence on municipal structures, and restricted resources often constrain their role. As a result, their contribution is typically complementary rather than leading. Strengthening collaboration with these actors can significantly enhance the social dimension of NBS implementation and support the long-term sustainability of local initiatives.
Research and Academic Stakeholders	

Universities: Adam Mickiewicz University Poznań Wrocław University of Environmental and Life Sciences	Universities are a key stakeholder group in implementing nature-based solutions (NBS), particularly through research-driven and participatory approaches such as Living Labs. In Konin, universities play an especially important role because they are directly involved in NBS-related projects. Key actors include Adam Mickiewicz University, which is actively engaged in the GreenEsteem project, and Wrocław University of Environmental and Life Sciences, which has contributed through previous initiatives such as the Green Corridors project. Universities contribute to NBS implementation by: ● providing scientific knowledge and evidence, ● developing methodologies and analytical frameworks, ● facilitating participatory processes and co-evaluation activities, ● supporting knowledge valorisation, ● and bridging the gap between research and practice. In the GreenEsteem project, their role is particularly significant in designing and moderating co-evaluation workshops, as well as in translating stakeholder knowledge into actionable outputs such as action plans and training modules. Universities demonstrate a **very high potential for cooperation**, acting as key integrators of knowledge and facilitators of collaboration among stakeholders. Their involvement strengthens the evidence base of NBS implementation and supports the development of structured, scalable solutions. However, their effectiveness depends on maintaining strong links with local actors and ensuring that scientific knowledge is effectively translated into practical applications.
Research institutions	In Konin, research institutions are **not strongly represented at the local level**, and their involvement is mainly indirect or project-based.
R&D departments from private companies	In the Konin context, R&D departments from private companies are **not prominently represented in the analysed initiatives**, indicating a limited integration of innovation-driven private sector actors into local NBS implementation.
Private sector (for-profit businesses) Stakeholders	
Multinational and big companies (NBS recipients, investors); Company InPost	The private sector in the Konin context represents a diverse group of stakeholders, ranging from large multinational companies to small and micro-local businesses. The analysis of local projects indicates that private actors are involved in NBS-related activities to a limited extent, but their potential for engagement remains significant. Different categories of private sector actors can be identified: ● Multinational and large companies (e.g., InPost) primarily act as potential investors, recipients of NBS solutions, and actors with significant spatial and environmental footprints.
SMEs – specialized implicitly focused on NBS: State Forests – Konin Forest District	

SMEs – not implicitly focused on NBS: Company Omnilogy; LM.pl Portal Micro-Local business – (operation on site): Hortiflora" Gardens – Design, implementation and consultancy Justyna Szerechan-Orchowska – garden designer, educator	• SMEs specialized in NBS-related activities (e.g. forest management entities such as the Konin Forest District) contribute expert knowledge and play a key role in implementing nature-based approaches, particularly in ecosystem management. • SMEs not directly focused on NBS (e.g. technology companies or local media platforms such as Omnilogy or LM.pl) can support NBS indirectly through communication, technological solutions, and service provision. • Micro-local businesses (e.g. landscape design and gardening services) are directly involved in the practical implementation of NBS at the local scale, providing design, execution, and advisory services. Overall, the private sector shows moderate but largely untapped potential to cooperate in NBS implementation. While some actors are already engaged, particularly at the micro and specialised level, the involvement of larger companies and non-NBS-focused SMEs remains limited. Strengthening the role of the private sector requires the development of incentives, increased awareness of the economic and environmental benefits of NBS, and the creation of platforms for cross-sectoral collaboration. Better engagement of private actors could significantly help scale up NBS and ensure their long-term sustainability.
Civil society	
NGOs: **Local:** Akcja Konin Association; Centre for the Promotion and Development of Civic Initiatives PISOP; Rowerowy Konin (Cycling Konin) Association; Society for the Beautification of the City; Razem dla Łężyna (Together for Łężyn) Association; M-Lab Association; Konin Agglomeration Association; Konin University of the Third Age Association **Supra-local:** Polish Green Roofs Association; Gaja Club; "Podaj Dalej"; Foundation named after Dr Piotr Janaszek	Non-governmental organisations (NGOs) represent a highly active and influential group of stakeholders in the Konin context. The analysis of local initiatives shows that NGOs are frequently involved in initiating and co-implementing projects, particularly those related to community engagement, environmental awareness, and local development. These organisations play a central role in the implementation of nature-based solutions (NBS), especially in: initiating grassroots actions, co-organising and implementing local interventions, mobilising citizens and volunteers, facilitating communication between local authorities and communities, and promoting environmentally sustainable practices. NGOs act as key intermediaries between formal governance structures and local communities, bringing in local knowledge, experience, and social capital. Their strong engagement and practical experience make them essential actors in participatory approaches such as Living Labs. In the Konin context, NGOs demonstrate a **very high potential for cooperation** in NBS implementation (strong presence in projects, high motivation,experience in local activities, ability to mobilize the community). However, their impact is often constrained by limited decision-making power, dependence on external funding, and restricted institutional capacity. Strengthening collaboration with NGOs, as well as providing more stable support mechanisms and opportunities for co-creation, is therefore crucial for enhancing the effectiveness and sustainability of NBS initiatives.
Social enterprises	In the Konin context, social enterprises are **not strongly represented in the analysed projects**, indicating a potential gap in the local stakeholder ecosystem. Despite their limited current presence, social enterprises have a **moderate to high potential for future cooperation**, particularly in areas such as:

	delivering NBS-related services, supporting inclusive and community-based initiatives, and contributing to the development of green jobs. Strengthening the role of social enterprises would require targeted support mechanisms, increased visibility, and better integration into local governance and collaboration frameworks.
Voluntary organisations and associations, grassroots movements and collective initiatives; "Ogrodnicy Dobra" (Gardeners of Good) – informal social initiative	Voluntary organisations and grassroots initiatives represent an important group of stakeholders in the Konin context, characterised by bottom-up engagement and strong community involvement. These actors operate in informal or semi-formal structures and are involved in local environmental and social activities, including volunteer-based initiatives and community-led actions. Their role in the implementation of nature-based solutions (NBS) includes: initiating local actions, mobilising community members, supporting small-scale implementation activities, and raising awareness of environmental issues. These actors demonstrate a **very high potential for cooperation**, particularly in participatory approaches such as Living Labs, due to their flexibility, strong motivation, and close connection to local communities. However, their impact is often limited by the lack of formal structures, financial resources, and long-term organisational stability. Supporting these initiatives and linking them more closely with formal governance structures could significantly enhance the effectiveness and sustainability of NBS implementation.
Housing (Condominium) associations	Housing associations (condominiums) represent an important group of stakeholders in the implementation of NBS. These actors are responsible for managing residential buildings and adjacent semi-private spaces, such as courtyards and green areas. In the context of NBS, housing associations play a particularly important role in: selecting and enabling locations for implementation, participating in the co-design of interventions, supporting small-scale implementation, and ensuring long-term maintenance of solutions. Their involvement is especially relevant in place-based approaches, where local ownership and engagement are critical for success. In the Konin context, housing associations demonstrate a **high potential for cooperation**, particularly in relation to site selection and co-design processes. However, their engagement is currently limited and depends on increasing awareness, access to knowledge, and the availability of financial and organisational support mechanisms. Strengthening collaboration with housing associations can significantly contribute to scaling up NBS at the neighbourhood level and enhancing their long-term sustainability.

Individuals	In the Konin context,Individuals include residents who engage in activities such as proposing projects (e.g. through the participatory budget), participating in community initiatives, or contributing to local environmental actions. Their role in the implementation of nature-based solutions (NBS) includes: initiating ideas and proposals, participating in implementation activities, and acting as end-users of solutions. Individually, their influence on decision-making processes is limited; however, collectively they can have a significant impact on shaping local priorities and supporting NBS initiatives. Individuals demonstrate a **moderate potential for cooperation**, which can become high when supported through structured engagement mechanisms such as participatory processes, communication strategies, and community-based initiatives.
Groups and individuals with specificities: Konin University of the Third Age Association Senior Circle of the Association of Mining Engineers and Technicians (PAK–KWB Konin) Senior Club at the Konin Housing Cooperative	In the Konin context, a particularly important group within Groups and individuals with specificities category are senior citizens and organisations representing older adults. The analysis indicates that organisations focused on seniors are among the most active stakeholder groups in local initiatives. They play a significant role in community-based actions, often initiating and supporting local activities. During stakeholder engagement, it was even noted that *"without seniors, nothing happens in Konin"*, highlighting their central role in local social dynamics. Senior groups contribute to NBS implementation by: initiating and co-organising local activities, participating actively in community-based actions, supporting communication and outreach within neighbourhoods, and contributing to co-design processes. Their strong engagement can be attributed to several factors, including the availability of time, established social networks, and a high level of attachment to their local environment. As a result, they represent a highly reliable and motivated group of participants in participatory processes. In the Konin context, groups and individuals with specificities—particularly senior organisations—demonstrate a **high potential for cooperation**, especially in relation to community engagement, co-creation, and the long-term sustainability of NBS initiatives. Ensuring their inclusion through accessible and tailored participation mechanisms is essential for enhancing both the social relevance and inclusiveness of NBS implementation.
Champions	As part of the stakeholder mapping process, a group of local champions has been identified. These actors will be actively and closely engaged in the subsequent stages of the project, particularly within the co-evaluation workshops and the development of action plans. In the Konin context, champions include active members of local communities, NGO representatives, educators, practitioners, and individuals involved in grassroots initiatives. These actors operate across different sectors, connecting local authorities, civil society, and residents, and facilitating collaboration. Champions contribute to NBS implementation by: initiating innovative actions, mobilising local communities and volunteers,

	acting as intermediaries between stakeholders, and transferring knowledge and experience across projects. Their role is particularly important in participatory approaches such as Living Labs, where informal leadership and trust-based relationships are essential. Champions demonstrate a **very high potential for cooperation**, as they combine strong motivation, local knowledge, and the ability to act quickly and effectively. Their informal leadership and the trust-based relationships they create are essential for mobilising stakeholders and ensuring the effectiveness and sustainability of NBS implementation. However, their impact is often constrained by a lack of formal recognition, limited access to resources, and reliance on individual commitment.
Citizens, activists Community residents	Citizens and community residents are a key stakeholder group in the Konin context, serving as both beneficiaries and active contributors to local initiatives. The analysis of local projects indicates that residents are frequently engaged in community-based activities, including environmental actions, local revitalisation efforts, and volunteer initiatives. A particularly important aspect of citizen engagement in Konin is active participation in the **Koniński Budżet Obywatelski (Participatory Budget)**, where residents propose and support local projects. This mechanism demonstrates a relatively high level of civic involvement and provides a practical channel for bottom-up initiatives, including those related to nature-based solutions (NBS). Citizens contribute to NBS implementation primarily as: end-users of solutions, co-creators of local initiatives, providers of local knowledge, and participants in small-scale implementation activities. In the Konin context, citizens show strong **potential for cooperation**, particularly in participatory approaches such as Living Labs. Their engagement is essential for ensuring the relevance, acceptance, and long-term sustainability of NBS. However, their impact may be limited by limited technical knowledge, limited formal influence on decision-making, and dependence on structured participation mechanisms. Strengthening communication, providing accessible knowledge, and creating meaningful opportunities for co-creation are therefore key to fully leveraging their potential.
Other	
Religious organisation Parish Church of St. Thérèse of the Child Jesus”	Religious organisations, particularly local parish communities, represent a context-specific but potentially significant group of stakeholders in the implementation of nature-based solutions (NBS). In the Konin context, an important example is the Parish Church of St. Thérèse of the Child Jesus, which played a key role in the implementation of the “Zielony Zakątek” initiative. In Poland, especially in medium-sized cities and local neighbourhoods, parish communities often function as important social hubs. They are characterised by strong local embeddedness, high levels of trust, and well-established communication networks. As such, they can play a unique role in facilitating community engagement and supporting local initiatives. In the analysed case, the parish contributed to NBS implementation by: mobilising local residents to participate in activities, providing space for meetings and community gatherings,

	disseminating information about the project, and supporting the initiative through trust-based communication and advocacy. This example demonstrates that religious organisations can act as effective intermediaries between local initiatives and community members, particularly in contexts where trust and social cohesion are critical for success. Religious organisations in Konin therefore demonstrate a **high potential for cooperation**, especially in relation to community engagement, communication, and mobilisation. Their involvement can significantly enhance participation and social acceptance of NBS. However, their role is context-dependent and may vary depending on local conditions and the level of engagement of specific actors.

4.3.2. Roles and Potential for cooperation for NBS implementation in Sofia

The stakeholder landscape in Sofia is characterised by a diverse and relatively well-developed institutional, academic, professional, and civic ecosystem, with significant potential for cross-sectoral cooperation in the planning and implementation of nature-based solutions (NBS). A distinctive feature of the context in Sofia is the strong presence of municipal institutions, specialised municipal enterprises, universities, and research organisations, which provide substantial planning expertise, technical knowledge, and experience in urban development and environmental projects. However, the effectiveness of this institutional capacity is often constrained by administrative fragmentation, complex procedures, and insufficient coordination between municipal departments and other stakeholders. (Table 17)

An important characteristic of Sofia is the prominent role of academic and research institutions, particularly the University of Architecture, Civil Engineering and Geodesy, the University of Forestry, and the Bulgarian Academy of Sciences. These organisations contribute scientific knowledge, interdisciplinary expertise, and methodological support for NBS planning, implementation, and evaluation. Their involvement in European research projects and participatory initiatives, including Living Labs, creates favourable conditions for collaborative knowledge valorisation and the integration of scientific evidence into practical urban planning. Universities also have considerable potential to facilitate stakeholder dialogue, support co-creation processes, and translate research findings into actionable solutions.

The stakeholder ecosystem is further strengthened by the presence of active non-governmental organisations (NGOs), professional associations, and civic initiatives operating at municipal and neighbourhood levels. Organisations such as Rivers of Sofia, the Sofia Development Association, and other environmental and community-based groups play an important role in initiating local projects, mobilising volunteers, raising environmental awareness, and facilitating communication between public institutions and residents. Their experience in participatory initiatives and their ability to connect professional expertise with local needs make them valuable partners in NBS implementation. Nevertheless, their influence is often limited by dependence on external funding, restricted institutional capacity, and limited participation in formal decision-making.

Another distinctive feature of the Sofia context is the potential role of housing associations and local community groups in neighbourhood-scale NBS interventions. Housing associations can contribute to identifying suitable locations, participating in the co-design of green spaces, and supporting their long-term maintenance. Citizens also demonstrate an interest in local environmental improvements through community initiatives and participatory budgeting. Particular importance is attributed to senior citizens, school communities, and local champions, whose social networks, local knowledge, and trust-based relationships can facilitate community mobilisation and inclusive participation. However, limited access to technical information, insufficient organisational support, and the absence of stable participation mechanisms can restrict their involvement.

Despite these strengths, the analysis identifies several structural gaps in Sofia's stakeholder ecosystem. The private sector remains insufficiently integrated into NBS initiatives, although specialised landscape design companies, urban planning practices, and other businesses possess relevant expertise and investment potential. Public–private cooperation is not yet fully developed, while social enterprises remain underrepresented. At the same time, the relatively complex institutional structure of Sofia creates challenges for establishing clear responsibilities, maintaining continuity, and coordinating activities across administrative and sectoral boundaries.

Overall, the Sofia stakeholder landscape is institutionally and knowledge-intensive, with strong academic, professional, and civic capacities, but it requires more effective coordination and stronger mechanisms for sustained cross-sectoral collaboration. The main opportunity lies in connecting existing institutional expertise and civic initiatives through participatory governance, collaborative knowledge valorisation, and long-term partnerships, while strengthening private-sector engagement and the meaningful involvement of local communities in NBS planning, implementation, and management.

Table 17. Roles and Potential for cooperation for NBS implementation according to the local context in Sofia

Stakeholders according to the local context	**Roles and Potential for cooperation for NBS implementation according to the local context in Sofia**
Public sector Stakeholders	
Elected politicians: Deputy Mayor of Sofia Municipality Deputy Mayors of Krasna Polyana district Sofia City Council (councillors)	Elected politicians, including the Deputy Mayor of Sofia and City Council members, play a key role in shaping the local governance context for Nature-Based Solutions. As democratically elected representatives, they set strategic priorities, allocate resources, and legitimize policy decisions. In the context of NBS implementation, their role is particularly important in: integrating NBS into municipal strategies and policies, supporting funding decisions and lobbying for funding for NBS (the District Deputy Mayor), ensuring political support for innovative and participatory approaches, Initiating actions for improving the sectoral coordination and planning and design framework that enhances and stimulates NBS implementation, and making decisions on the municipality's participation in EU research and pilot actions, as well as knowledge and best practice sharing international activities. The analysis indicates that elected politicians in Sofia are key stakeholders to potentially support NBS implementation and NBS collaborative knowledge valorisation, due to the city's active involvement in NBS projects and programmes (such as Green Sofia, which is currently implemented, but also strategic ones such as the Green line project and the New Forest for Sofia. However, this potential depends on increasing awareness of NBS benefits, strengthening evidence-based decision-making, creating appropriate NBS planning and design framework, and aligning NBS with broader political and development priorities.

Municipality (Metropolitan) departments: Department of Environment; Department of Finances; Department of Urban planning and development; Department of Transport and mobility; City Chief architect; Department of culture and tourism; The Mayors' Cabinet; Including the Department for International relations; Krasna Polyana district departments; Department "Engineering Infrastructure, Planning , and Ecology"; Department "Territorial organization, Cadastre, Regulations and Construction Control"; Department "Financial-accounting activities"	Metropolitan and municipal departments carry out operational activities, representing the administrative layer of local governance responsible for translating strategic decisions into concrete actions. In the context of Sofia, these administrative departments play a central role in the implementation of nature-based solutions (NBS), particularly in: securing public land for NBS implementation, planning and design of interventions, coordination across departments and stakeholders, coordinating the development of new strategic and operational plans approval of NBS projects, implemented by representatives from the private sector organizing public procurements for the NBS projects' design and implementation, long-term maintenance of implemented solutions and arrangements for empowerment and transfer of use and maintenance rights. Because they are directly involved in project delivery and sit within local governance structures, the metropolitan and district administrations have strong potential to cooperate on NBS implementation. They act as key intermediaries between political decision-makers, experts, and local communities. However, institutional fragmentation, limited financial resources, a lack of incentives to motivate the private sector to implement NBS, and procedural complexity limit their effectiveness. In addition, implementing NBS requires interdisciplinary knowledge and new approaches that are not yet fully embedded in day-to-day administrative practices. This stakeholder group needs to develop technical and organizational capacity for NBS implementation through collaborative knowledge valorisation activities, to improve their communication capacities with a wider range of stakeholders (including NGOs, experts, activists, and citizens), to improve interdepartmental coordination, and to facilitate collaboration with stakeholders representing the private sector to fully realize their potential in supporting the implementation and scaling of NBS.
Municipal Companies Municipal Enterprise "Sofiaplan" Municipal Enterprise "Sofiaproekt" Municipal Enterprise "Parks and Urban Gardens" Municipal enterprise "Cemetery Parks" Municipal Enterprise "Management of Municipal land and forests"	The municipal enterprise carries out specialized studies and programs under the Framework Program for the Implementation of the General Development Plan (GDP), developing projects related to Sofia Municipality's urban development—including large-scale NBS—as outlined in the Municipal Development Plan. It conducts complex feasibility studies and design research within the GDP framework and monitors implementation of actions set out in the Regional Development Strategy and Municipal Development Plan. In this capacity, it is well positioned to act as a key mediator and evidence provider for decision-makers at both metropolitan and national levels. As a participant in elaborating and coordinating development plans with Sofia Municipality, and as a lead actor in conducting experimental studies, developing pilot projects, and producing methodological guidelines for new regulatory frameworks, the enterprise plays a central role in promoting and integrating NBS into planning practice. It also represents Sofia Municipality at expert level in international projects, programmes, and cooperative initiatives, and conducts marketing studies to attract investment to the city. This combination of roles — spanning research, planning, policy mediation, and international representation — positions this stakeholder as having significant potential to contribute to NBS knowledge dissemination and to champion innovative approaches for mainstreaming NBS into urban planning practice. This municipal enterprise specialises in the planning and designing transport, engineering, utility, and blue-green infrastructure. As such, it is well positioned to integrate NBS into large-scale linear city infrastructure. It represents a stakeholder with strong potential interest in upgrading its experts' technical knowledge and capacity in this domain. These municipal enterprises are

	primarily responsible for managing NBS and, more broadly, green infrastructure. Their potential interest as GreenEsteem stakeholders lies in NBS knowledge valorisation — and more specifically, in innovative NBS management practices and the engagement of diverse stakeholders in that process.
Municipal institutions and organizations: Public schools (2 secondary schools (N17 and N135) and 2 kindergarten (N48 and N130), Other schools and kindergartens that have already implemented different forms of urban agriculture and orchards, Local cultural centre in Krasna Polyana district	Public sector organizations include publicly funded institutions operating at the local level that are not part of the core municipal administration but support the local system. In the context of Sofia, these actors play a supporting role in the implementation of nature-based solutions (NBS), particularly in: facilitating local implementation activities, contributing to awareness-raising and environmental education, providing spaces for pilot actions and demonstration projects, but also being involved in maintenance, sometimes integrating the NBS implementation with the educational practices and acting as intermediaries between local authorities and communities. Public sector organizations **have moderate to high potential for cooperation, especially for engaging with and disseminating** NBS practices. Their proximity to local communities makes them important actors in building acceptance and understanding of NBS and in driving behavioural change. However, limited decision-making power, dependence on municipal structures, and restricted resources often constrain their role. As a result, their contribution is typically complementary in material terms but leading in long-term perspective in educational terms. Strengthening collaboration with these actors can significantly enhance the social dimension of NBS implementation and support the long-term sustainability of local initiatives.
Research and Academic Stakeholders	
Universities: University of Architecture, Civil Engineering and Geodesy University of Forestry in Sofia	Universities are a key stakeholder group in implementing nature-based solutions (NBS), particularly through research-driven and participatory approaches such as Living Labs. Universities contribute to NBS implementation by: providing scientific knowledge and evidence, developing methodologies and analytical frameworks, facilitating participatory processes and co-evaluation activities, supporting knowledge valorisation, and bridging the gap between research and practice. In the GreenEsteem project, their role is particularly significant in designing and moderating co-evaluation workshops, as well as in translating stakeholder knowledge into actionable outputs such as action plans and training modules. They act as key integrators of knowledge and facilitators of collaboration among stakeholders. Their involvement strengthens the evidence base of NBS implementation and supports the development of structured, scalable solutions. However, their effectiveness depends on maintaining strong links with local actors and ensuring that scientific knowledge is effectively translated into practical applications. In Sofia, UACEG plays an especially important role because the teams are directly involved in

	the GreenEsteem project and other similar NBS-related projects, such as Urbinat (2028-2024) and Aqualive (ongoing). Along with researchers from the Urban Planning Department, the Faculty of Hydraulic Engineering (specialized in water management), and the Faculty of Geodesy (specialized in soil management), they will exchange knowledge and support interdisciplinary dialogue across professional fields. Student involvement in the co-creation process will give landscape architecture, planning, architecture, and engineering students real-world experience by facilitating, assisting, and documenting the participatory process. This university has strong potential for cooperation, given its historical role in higher education and its contemporary expertise in research and teaching in forestry, landscape architecture, and ecology.
Research institutions Bulgarian Academy of Science, with its two Research divisions: Biodiversity, Bioresources and Ecology, and Climate Change, Hazards and Natural Resources	These two specialized research divisions operate at the national and international level and are known for their expertise in NBS implementation and NBS impact assessment. Because of their scientific expertise, they are potential stakeholders for knowledge exchange, providing education, evidence on NBS benefits, and support for policy briefs.
R&D departments from private companies	In the context of Sofia, R&D departments from private companies are **not prominently represented in the analysed initiatives**, indicating a limited integration of innovation-driven private sector actors into local NBS implementation.
Private Sector (for-profit businesses) Stakeholders	
Multinational and big companies (NBS recipients, investors); Jysk; Lidl	In the Sofia context, the private sector includes a diverse range of stakeholders, from large multinational companies to small and micro-local businesses. The analysis of local projects indicates that private actors engage in NBS-related activities to a limited extent, but their engagement potential remains significant. Different categories of private sector actors can be identified: Multinational and large companies (e.g. InPost) primarily act as potential investors, recipients of NBS solutions, and actors with significant spatial and environmental footprints. SMEs specialized in NBS-related activities (e.g. forest management entities such as the Konin Forest District) contribute expert knowledge and play a key role in the implementation of nature-based approaches, particularly in ecosystem management. SMEs not directly focused on NBS (e.g. technology companies, shipping companies, and furniture malls (USK) can support NBS indirectly through communication, technological solutions, and service provision.
SMEs – specialized implicitly focused on NBS: MR Green - landscape architecture office specialized in design and implementation of green/living walls; The green roofs - online site with specialized information on green roof design; Placemake - urban design studio	

SMEs – not implicitly focused on NBS: Private college - vocational training, options for distance learning (operating Krasna Polyana district, next to the selected site): "European Academy for Training and Development" (EATR) at Proper Development Ltd.	Micro-local businesses (e.g. landscape design and gardening services) are directly involved in the practical implementation of NBS at the local scale, providing design, execution, and advisory services. Overall, the private sector demonstrates a **moderate but largely untapped potential for cooperation** in NBS implementation. While some actors are already engaged, particularly at the micro and specialized level, larger companies and non-NBS-focused SMEs remain underrepresented. Strengthening the private sector's role requires developing incentives, increasing awareness of the economic and environmental benefits of NBS, and creating platforms for cross-sectoral collaboration. Enhanced engagement of private actors could significantly help scale up NBS and ensure their long-term sustainability.
Civil society	
NGOs: **Operation on National level:** Team Sofia ; National Eco Fund; National Association of the Municipalities in Bulgaria; Union of Bulgarian Urban Planners; Union of the Landscape Architects in Bulgaria; Bulgarian Association of the Decorative Nurseries; Union of Bulgarian Achitects; Bulgarian Water Association; Za Zemiata; Gorichka; Zaedno; Non Formal; **Operating on city level:** Sofia Development Association; Association “Rivers of Sofia”; The Collective; Gradoscope; **Operation on district/neighbourhood level:** Association of the Housing/Condominium associations in Zapaden park housing estate	Non-governmental organisations (NGOs) are a highly active and influential stakeholder group in the Konin context. Analysis of local initiatives shows that NGOs frequently initiate and co-implement projects, particularly those related to community engagement, environmental awareness, and local development. These organizations play a central role in the implementation of nature-based solutions (NBS), especially in: initiating grassroots actions, co-organising and implementing local interventions, mobilising citizens and volunteers, facilitating communication between local authorities and communities, lobbying for improvement of the NBS implementation framework, sharing know-how of NBS implementation and promoting environmentally sustainable practices. NGOs act as key intermediaries between formal governance structures and local communities, bringing in local knowledge, experience, and social capital. Their strong engagement and practical experience make them essential actors in participatory approaches such as Living Labs. In Sofia, NGOs show strong **potential for cooperation** in NBS implementation (strong project presence, high motivation, experience in local activities, and the ability to mobilize the community). However, limited decision-making power, dependence on external funding, and restricted institutional capacity often constrain their impact. Strengthening collaboration with NGOs, along with more stable support mechanisms and opportunities for co-creation, is therefore crucial to improving the effectiveness and sustainability of NBS initiatives.
Social enterprises	In Sofia, social enterprises are **underrepresented and associated with GreenEsteem, indicating** a potential gap in the local stakeholder ecosystem. Despite their limited current presence, social enterprises have a **moderate to high potential for future cooperation**, particularly in areas such as:

	delivering NBS-related services and NBS management supporting inclusive and community-based initiatives, and contributing to the development of green jobs. Strengthening the role of social enterprises would require targeted support mechanisms, increased visibility, and better integration into local governance and collaboration frameworks.
Housing (Condominium) associations	Housing associations (condominiums) represent an important group of stakeholders in the implementation of NBS. These actors manage multifamily residential buildings and the adjacent spaces in housing estates that, in most cases, are owned by the municipality. In the context of NBS, housing associations play a particularly important role in: selecting and enabling locations for implementation of small-scale NBS-related interventions, participating in the co-design of interventions, and ensuring long-term maintenance of NBS. Their involvement is especially relevant in place-based approaches, where local ownership and engagement are critical for success. In Sofia, housing associations show strong **potential for cooperation**, particularly in site selection and co-design processes. However, their engagement is sometimes limited by low knowledge levels, limited access to information, and a lack of financial and organizational support mechanisms. Strengthening collaboration with housing associations can significantly help scale up NBS at the neighborhood level and improve their long-term sustainability.
Individuals	In Sofia, individuals include residents who propose projects (e.g., through the participatory budget), oppose or participate in community initiatives, or contribute to local environmental actions. Their role in the implementation of nature-based solutions (NBS) includes: initiating ideas and proposals, participating in co-planning activities, participating in implementation activities, and acting as end-users of solutions. Individually, their influence on the decision-making processes is limited; however, groups significantly shape and support NBS. Individuals show **moderate potential for cooperation**, which can increase when supported by structured engagement mechanisms such as participatory processes, communication strategies, and community-based initiatives.
Groups and individuals with specificities: Club of the retired adults Pupils' Parliaments at schools	In Sofia, a particularly important group within the Groups and individuals with specificities category is senior citizens. Senior groups contribute to NBS implementation by: initiating and co-organising local activities, participating actively in community-based actions,

Roma communities in the neighbouring areas in Krasna Polyana district Mothers with prams/children	supporting communication and outreach within neighbourhoods, and contributing to co-design processes. Their strong engagement stems from several factors, including available time, expertise and wisdom, established social networks, and a strong attachment to their local environment. As a result, they represent a highly reliable and motivated stakeholder group in participatory processes.
Champions	As part of the stakeholder mapping process, a group of local champions was identified. These actors will be actively and closely engaged in the project's subsequent stages, particularly in the co-evaluation workshops and the placemaking process. In Sofia, champions include active community members, NGO representatives, educators, practitioners, activists, and individuals involved in grassroots initiatives. These actors operate across different sectors, connecting local authorities, civil society, and residents, and facilitating collaboration. Champions contribute to NBS implementation by: initiating innovative actions, mobilising local communities and volunteers, acting as intermediaries between stakeholders, and transferring knowledge and experience across projects. Their role is particularly important in participatory approaches such as Living Labs, where informal leadership and trust-based relationships are essential. Champions show strong **potential for cooperation**, combining strong motivation, local knowledge, and the ability to act quickly and effectively. Their informal leadership and the trust-based relationships are essential to mobilizing stakeholders and ensuring effective, sustainable NBS implementation. However, their impact is often constrained by a lack of formal recognition, limited access to resources, and reliance on individual commitment.
Citizens Community residents	Citizens and community residents represent a key stakeholder group in the Sofia context. They play a central role as both beneficiaries and active contributors to local initiatives. The analysis of local projects indicates that residents are frequently engaged in community-based activities, including environmental actions, local revitalisation efforts, and volunteer initiatives. A particularly important aspect of citizen engagement in Sofia is active participation in the **Citizens Budget (Participatory Budget) initiative**, where residents propose and support local projects. This mechanism demonstrates a relatively high level of civic involvement and provides a practical channel for bottom-up initiatives, including those related to nature-based solutions (NBS). Citizens contribute to NBS implementation primarily as: end-users of solutions, co-creators of local initiatives, providers of local knowledge, and participants in small-scale implementation activities. In Sofia, citizens show **moderate potential for cooperation**, particularly through participatory approaches such as Living Labs. Their engagement is essential for ensuring the relevance, acceptance, and long-term sustainability of NBS. However, their motivation is difficult to sustain, and a lack of technical knowledge, limited formal influence on decision-

	making processes, and dependence on structured participation mechanisms may compromise their impact. Strengthening communication, providing accessible knowledge, and creating meaningful opportunities for co-creation are therefore key to fully leveraging their potential.

4.4. Stakeholders training necessities - mapping - results from the first local workshops

4.4.1. Konin

The training needs identified during the co-evaluation workshops indicate that the key challenge in Konin is not a lack of engagement, but a lack of structured capacities for collaboration, communication, and long-term implementation. Stakeholders require practical, process-oriented skills to effectively plan, co-create, implement, and maintain nature-based solutions in a multi-stakeholder environment. Table 18 presents a synthetic overview of key training areas and target stakeholder groups.

Table 18. Stakeholders' training needs mapped in Konin. Source: Focus groups, first round

Stakeholders	Training area	Training necessities
Municipalities, NGOs, citizens, champions, public organisations	Participatory governance & communication	Strengthening skills in public dialogue, inclusive participation, and communication between administration and stakeholders; engaging diverse groups (youth, seniors, vulnerable groups)
Municipalities, universities, NGOs	Planning as a co-creation process	Developing iterative, inclusive planning approaches; integrating stakeholder input; using existing knowledge and evaluation results
Municipalities, NGOs, private sector, public organisations	Cross-sectoral collaboration	Building partnerships across sectors; improving interdepartmental cooperation; establishing long-term multi-stakeholder working structures
Municipalities, housing associations, NGOs, public organisations	Practical implementation of NBS	Developing hands-on skills for designing and implementing NBS; combining expert and local knowledge; working with real sites
Municipalities, private sector, NGOs	Financing and economic models	Understanding funding opportunities; developing sustainable financing models; exploring public–private cooperation
Municipalities, NGOs, citizens (especially youth)	Digital tools and communication	Using digital platforms for participation and communication; improving online engagement and knowledge exchange

Universities, municipalities, NGOs	Knowledge valorisation (KV)	Capturing and structuring knowledge from practice; translating experience into action; supporting Action Plan development and scaling
Municipalities, champions, NGOs	Leadership and organisational mindset	Strengthening proactive attitudes, local leadership, and institutional openness to innovation and collaboration

The identified training needs confirm that stakeholders in Konin require practical, collaborative competencies rather than theoretical knowledge. In particular, strengthening capacities in participatory governance, cross-sectoral cooperation, and long-term implementation is essential for the effective and sustainable deployment of NBS.

4.4.2. Sofia

The assessment of stakeholder training needs in Sofia identifies several interconnected priorities for strengthening capacities for the planning, implementation, and long-term management of Nature-Based Solutions (NBS). Particular emphasis is placed on participatory governance, inclusive communication, and co-creation methods that enable the meaningful involvement of diverse community groups and the integration of local knowledge into planning processes. Strengthening cross-sectoral collaboration, interdepartmental coordination, and long-term partnerships among municipal authorities, academic institutions, businesses, and civil society organisations is considered essential for overcoming institutional fragmentation. Additional training needs concern practical NBS design and implementation, sustainable funding mechanisms, cross-sectoral cooperation, and the effective use of digital tools for stakeholder engagement and knowledge exchange. Knowledge valorisation is identified as a cross-cutting priority that requires improved capacities to document and transfer practical experience, translate knowledge into actionable solutions, and support the development and scaling of local action plans. Specific attention is also given to improving access to technical information and resources in Bulgarian language. (Table 19)

Table 19. Stakeholders' training needs mapped in Sofia. Source: Focus groups, first round

Stakeholders	Training area	Training necessities
Municipalities, NGOs, citizens, champions, public organisations, citizens	Participatory governance & communication	Strengthening skills in public dialogue, inclusive participation, and communication between administration and stakeholders; engaging diverse groups (youth-children and pupils, seniors, vulnerable groups, families)
Municipalities, private sector, universities, NGOs	Planning as a co-creation process	Developing iterative, inclusive planning approaches; integrating stakeholder input; using existing knowledge and evaluation results
Municipalities, NGOs, private sector, public organisations, universities and research organizations	Cross-sectoral collaboration	Building partnerships across sectors; improving interdepartmental cooperation; establishing long-term multi-stakeholder working structures, exploring pathways for changing/filling gaps in legislative framework

Municipalities, housing associations, NGOs, public organisations	Practical implementation of NBS and balancing between technical/security, ecological, and social benefits of NBS	Developing hands-on skills for designing and implementing NBS; combining expert and local knowledge; working with real sites
Municipalities, private sector, NGOs	Financing and economic models for NBS co-creation and management	Understanding funding opportunities; developing sustainable financing models; exploring public–private cooperation
Municipalities, NGOs, citizens (especially youth), private sector	Digital tools and communication	Using digital platforms for participation and communication; improving online engagement and knowledge exchange
Universities, municipalities, NGOs, private sector	Knowledge valorisation (KV)	Capturing and structuring knowledge from practice; translating experience into action; supporting Action Plan development and scaling, Improving technical knowledge and access to different type of resources in Bulgarian language
Municipalities, champions, NGOs	Leadership and organisational mindset	Strengthening proactive attitudes, local leadership, and institutional openness to innovation and collaboration

Overall, the findings highlight the need for an integrated capacity-building approach that combines technical expertise with participatory competencies, institutional cooperation, and proactive leadership to support the sustainable and inclusive implementation of NBS in Sofia.

4.4.3. Conclusions: Stakeholder Training Needs for Nature-Based Solutions

The assessment identifies eight priority areas for capacity building among stakeholders involved in the planning, implementation, and management of Nature-Based Solutions (NBS). These training needs concern municipalities, public organisations, universities, research institutions, businesses, NGOs, and citizens, highlighting the importance of developing complementary competencies across different sectors.

A central priority is strengthening participatory governance and communication, particularly through inclusive public dialogue and the engagement of diverse social groups, including young people, older residents, families, and vulnerable communities. In close relation to this is the need to improve participatory planning and co-creation skills, to enable stakeholders to integrate local knowledge, to recognize and valorize stakeholders' contributions, and to provide integrated evaluation of the results. Cross-sectoral collaboration is another essential area that requires stronger institutional coordination, durable partnerships, and improved cooperation between municipal departments and external actors.

The assessment also emphasises the development of practical and technical competencies for NBS implementation, including the integration of ecological, social, and technical considerations in real-world projects. Training in funding mechanisms, sustainable economic models, and public–private cooperation is

needed to support long-term implementation and management. Digital literacy and communication skills are considered equally important for facilitating participation, knowledge exchange, and online engagement.

Finally, knowledge valorisation and organisational leadership emerge as cross-cutting priorities. Stakeholders need stronger capacities to document practical experience, translate knowledge into actionable solutions, support the development and scaling of action plans, and access technical resources. Strengthening proactive leadership, institutional openness, and a collaborative organisational culture is essential for sustaining innovation.

Overall, the findings indicate that effective NBS implementation requires an integrated capacity-building approach combining participatory, technical, financial, digital, and organisational competencies, supported by continuous cooperation among stakeholders.

5. Conclusions, roles and objectives in relation to other work packages

5.1. The role of WP2 in the GreenEsteem implementation process

Deliverable 2.1 represents the analytical foundation for the transition from assessment to collaborative action within GreenEsteem. It does not stop at documenting existing nature-based solutions (NBS), policy frameworks, and stakeholder relationships. More importantly, it identifies the conditions under which available knowledge can inform decisions, support cooperation and contribute to the sustainable implementation and management of NBS.

The combined findings from Tasks 2.1, 2.2 and 2.3 demonstrate the need to connect three complementary dimensions: the transferability of existing practices, the institutional and regulatory conditions for their implementation, and the capacities and relationships of the stakeholders involved. These dimensions provide a common reference for subsequent activities while recognising that Konin and Sofia require locally adapted approaches. (Figure 5)

The principal operational conclusion is that knowledge valorization should be assessed through its influence on decisions and implementation, rather than solely through the production and dissemination of information. Accordingly, subsequent work packages should examine whether research, public institutions, practitioners, and communities incorporate knowledge into local action plans, co-designed interventions, training activities, and longer-term cooperation arrangements.

WP2 therefore performs three interrelated functions within the project: establishing a shared evidence base, identifying implementation and capacity gaps, and providing criteria for evaluating the relevance and transferability of proposed solutions. Its findings are intended to inform subsequent activities, not predetermine the priorities or decisions of the Living Labs.

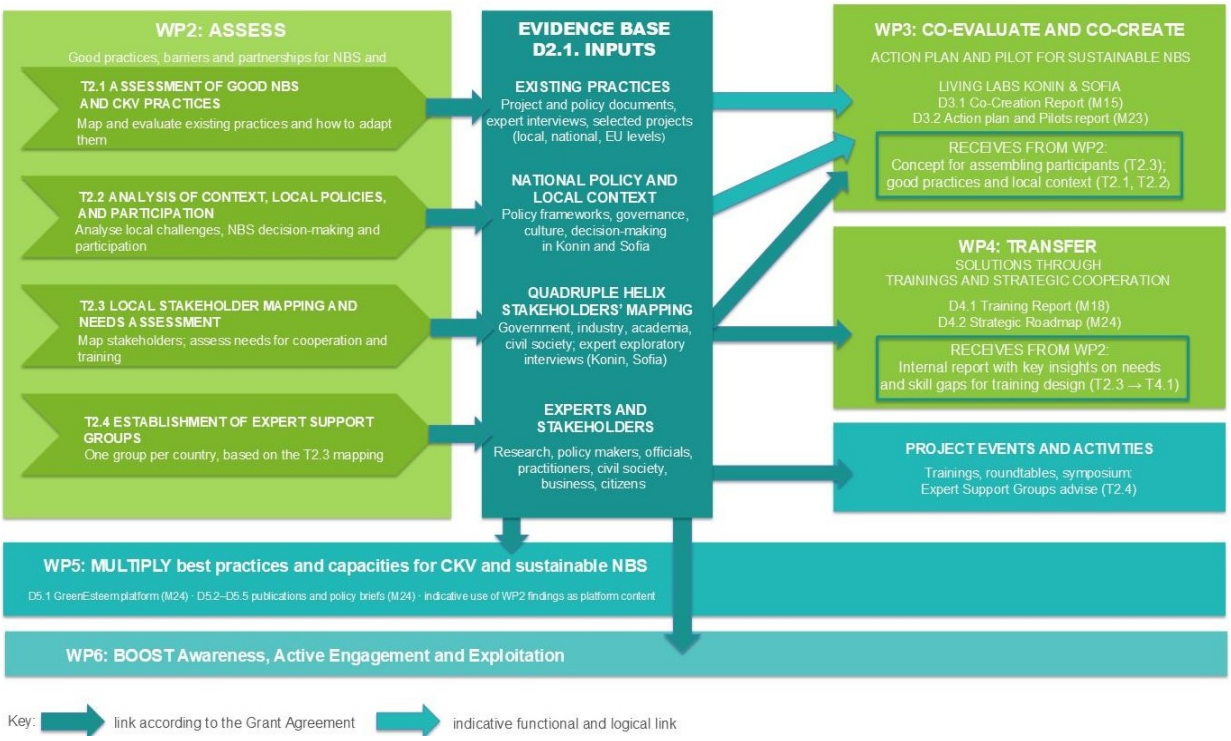


Figure 5. WP2 iInputs and relationships with the other GreenEsteem work pakages

5.2. From stakeholder assessment to expert support and co-creation: WP2–WP3

The stakeholder mapping and expert interviews provide the basis for establishing the Expert Support Groups under Task 2.4. They should connect complementary forms of expertise and address practical questions that desk research alone cannot resolve. These include the feasibility of proposed NBS, institutional responsibilities, financing and maintenance arrangements, and opportunities for cooperation between municipalities, researchers, businesses and civil society. The mapping also indicates that stakeholder participation should be organised according to actual responsibilities, available capacities and potential contributions, rather than representation alone. Expert Support Groups can help identify knowledge gaps, validate assessment findings and advise on locally appropriate implementation pathways. They should complement, rather than replace, the broader participatory processes developed through the Living Labs.

For WP3, the assessment provides a starting point for the design and application of co-evaluation and co-creation methods. The good-practice analysis identifies possible approaches and implementation models, while the policy and governance assessment clarifies the conditions that may enable or constrain their adaptation. Stakeholder mapping indicates which actors should be involved at different stages and where additional engagement is required.

The Konin and Sofia Living Labs will therefore play a complementary role: testing, contextualizing, and refining WP2's findings through interaction with local stakeholders. Co-evaluation should consider not only the technical and environmental qualities of NBS, but also decision-making arrangements, accessibility, participation, financial framework, management responsibilities and prospects for long-term continuity.

A particularly important objective is to distinguish transferable principles from context-dependent practices. Solutions that have proved effectiveness elsewhere cannot be assumed to be directly replicable. Adaptation should account for local governance structures, available resources, institutional capacities, and community priorities. The resulting co-creation reports, action plans, and pilot activities can show how the analytical findings translate into locally negotiated decisions.

5.3. Translating identified needs into capacity building and strategic cooperation: WP4

WP2 findings provide a basis for defining the content and target groups for WP4 training and strategic cooperation activities. The stakeholder assessment and initial workshops indicate that capacity-building needs extend beyond technical knowledge of NBS. They also concern participatory methods, institutional coordination, project development, financing, communication and long-term management.

WP4's main objective is therefore to translate these identified gaps into practical, stakeholder-specific learning opportunities. Training should respond to the different responsibilities of public authorities, researchers, practitioners, businesses and community organisations, while encouraging cooperation between them.

The comparison between Konin and Sofia suggests that a common training framework should allow for local differentiation. In Konin, particular attention could be given to strengthening cross-sectoral partnerships and involving businesses alongside established civic networks. In Sofia, priorities include improving coordination between municipal structures and districts, clarifying implementation procedures and strengthening cooperation between institutional and civic actors.

The WP4 training programme and strategic roadmap should build upon WP2 findings and incorporate lessons emerging from WP3. This connection would allow capacity building to address difficulties encountered during actual co-evaluation and co-creation, rather than relying exclusively on needs identified at the beginning of the project.

5.4. Knowledge transfer, multiplication and exploitation: WP5–WP6

WP2 also contributes to WP5 by identifying the knowledge resources, good practices and implementation experiences that can be adapted and shared beyond the two Living Labs. The assessment highlights the importance of making information accessible and practically usable, particularly concerning NBS typologies, institutional responsibilities, financing opportunities, stakeholder engagement and maintenance. The GreenEsteem knowledge-sharing platform and related publications can draw on the structured evidence generated through WP2, then enrich it with the results of WP3 and WP4. Their added value should lie in presenting knowledge in forms that support practical decisions, including comparative examples, methodological guidance and lessons concerning enabling conditions and implementation barriers. However, the assessment also identifies limitations in the available evidence, particularly regarding long-term ecological and social outcomes, lifecycle costs and institutional uptake. These limitations should remain visible in subsequent knowledge products. Distinguishing documented results from proposed approaches and anticipated benefits is essential for responsible knowledge valorisation.

For WP6, the findings offer a basis for communicating the project's relevance to different audiences and supporting the wider uptake of its results. Dissemination and exploitation activities should emphasise not only successful interventions but also the cooperation mechanisms, institutional arrangements and learning processes that make them possible.

In this respect, the relationship between WP2, WP5 and WP6 should extend beyond transferring report content. It should establish a process to transform research findings into accessible knowledge, practical guidance, and opportunities for reuse, with user feedback informing subsequent improvements.

5.5. Cross-work-package objectives and concluding remarks

Deliverable 2.1 contributes to the remaining work packages through four cross-cutting objectives. First, the project should maintain continuity between assessment, co-creation, training and knowledge dissemination.

Findings from WP2 should remain traceable in subsequent activities, while new evidence from the Living Labs should be used to refine initial assumptions. Second, the project should strengthen the connection between stakeholder participation and decision-making. The effectiveness of collaborative knowledge valorisation will depend on whether stakeholder contributions influence the selection, design, implementation and management of NBS. Third, subsequent activities should address the evidence gaps identified in the assessment. Particular attention should be given to documenting responsibilities, funding and maintenance arrangements, quality of participation, ecological and social performance, and institutional learning. A proportionate set of shared assessment criteria would improve comparability between the two Living Labs without overlooking local differences. Finally, the project should distinguish between replicating individual solutions and transferring implementation capacities. The wider value of GreenEsteem is revealed not only through the identification of suitable NBS, but also in developing transferable approaches to cooperation, knowledge integration, participatory decision-making and long-term stewardship.

Overall, WP2 establishes the analytical starting point for these activities. WP3 will test and apply its findings through local co-creation; WP4 will address the identified capacity needs; and WP5 and WP6 will support the wider transfer, communication and uptake of the resulting knowledge. WP1 provides the overarching project management and coordination framework.

The effectiveness of these relationships should be judged by the extent to which evidence and stakeholder knowledge contribute to actionable local solutions, stronger institutional cooperation and the capacity to sustain and adapt NBS beyond individual project activities.

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ANNEX A Knowledge valorisation and intellectual asset management

A1 Scope and Policy Basis

Knowledge valorisation converts research, data, expertise and other intellectual assets into benefits that can be used by society. The Council Recommendation on guiding principles for knowledge valorisation defines the concept more broadly than technology transfer: value may take the form of products and services, improved public policy, standards, professional practices, social innovation, cultural outcomes or environmental gains. It also places universities and firms within a wider ecosystem that includes public authorities, civil society, intermediaries and citizens (Council of the European Union, 2022).

This wider scope is especially relevant to NBS because many important outputs are not patentable products. They include spatial data, monitoring protocols, co-design methods, governance arrangements, maintenance knowledge, planning guidance and trusted relationships. The analytical task is therefore to follow how these assets move between actors and how they become embedded in decisions and routines.

A2 From Transfer to Responsible Value Creation

EU policy treats valorisation as a process that should begin when research and innovation activities are designed, rather than after results are produced. Funding arrangements should support stakeholder engagement, skills, uptake and scaling. Incentives should recognise diverse outputs and collaboration, while monitoring should capture social and environmental value alongside conventional commercial indicators. This orientation responds to a long-standing weakness in knowledge-transfer policy: instruments are often described in detail but evaluated mainly through patents, licences and spin-offs, leaving policy and societal impacts less visible (Kochenkova et al., 2016).

A3 Intellectual Assets, Open Science and Collaboration

The 2023 Code of Practice on intellectual assets recommends identifying assets early, clarifying ownership and access, and selecting protection or openness according to the intended route to impact (European Commission, 2023b). For GreenEsteem, the practical rule is “as open as possible and as closed as necessary.” Open data and reusable methods can accelerate learning, but personal data, community knowledge, confidential partner information and commercially sensitive material require proportionate safeguards.

Complementary EU codes address standardisation, citizen engagement and industry-academia co-creation. Together they emphasise accessible communication, acknowledgement of contributors, shared objectives, transparent roles, suitable agreements and continuity beyond a single project (European Commission, 2023a, 2024a, 2024b). These principles support the GreenEsteem assessment criteria presented in Annex E.

ANNEX B Collaborative Innovation and Helix Models

B1 Actors and Relationships

Helix models describe innovation as an interaction among social systems rather than a linear movement from research to application. The triple helix focuses on universities, industry and government. The quadruple helix adds civil society and the media- and culture-based public, making participation, public meaning and social acceptance part of innovation. The quintuple helix adds the natural environment as both a knowledge source and a criterion for sustainable development (Carayannis & Campbell, 2009; Carayannis et al., 2012).

Model	Primary actors	Use in GreenEsteem
Triple helix	Research, business and government	Explains institutional cooperation, resources and routes from research to implementation.
Quadruple helix	Triple helix plus civil society, communities, media and culture	Supports co-creation, democratic legitimacy, local knowledge and public communication.
Quintuple helix	Quadruple helix plus the natural environment	Connects innovation to ecosystem limits, biodiversity and socio-ecological value.

B2 Relevance to Place-based NBS

NBS depend on knowledge held by different actors. Municipalities control planning, procurement and maintenance; researchers contribute ecological and evaluative methods; firms provide design and delivery capacity; and residents contribute knowledge of everyday use, risk, access and care. The environment is not a passive setting because ecosystem condition, connectivity and capacity determine whether an intervention can deliver its intended functions. Regional applications of helix models show that actor roles and relationships vary with institutional history, resources and local economic structure (Grundel & Dahlström, 2016).

B3 Analytical cautions

The models are useful heuristics, not fixed organisational templates. Categories can conceal inequalities within “civil society,” differences between public bodies, and the role of intermediaries that translate between professional languages. Empirical studies should therefore identify actual organisations, resources, responsibilities and decision rights rather than infer collaboration from the presence of several actor categories. The distinction between quadruple and quintuple models should also follow the research question: a fourth helix is useful when citizen participation and public communication are central, while a fifth helix is useful when ecological systems have an explicit analytical role (Cai & Lattu, 2022).

ANNEX C Nature Based Solutions Definitions, Typologies, and Implementation Gaps

C1 Working definition

Nature-based solutions are actions that use or enhance ecological processes to address societal challenges and produce benefits for people and biodiversity. The IUCN definition stresses protection, sustainable management and restoration of natural or modified ecosystems, while the European Commission stresses innovation, cost-effectiveness, resilience and simultaneous environmental, social and economic benefits (Cohen-Shacham et al., 2016; European Commission, 2015). GreenEsteem uses the common core of these definitions: an intervention must respond to a defined societal challenge, work with nature, and generate ecological and human benefits.

C2 Typologies and Related Concepts

NBS is an umbrella concept that connects ecosystem protection and restoration, ecosystem-based management, green and blue infrastructure, ecological engineering and ecosystem-based adaptation. The typology proposed by Eggermont et al. (2015) ranges from minimal intervention in ecosystems, through management that improves multifunctionality, to the creation or substantial transformation of ecosystems. Urban classifications add location, scale, degree of engineering and the ecosystem services delivered (Castellar et al., 2021).

Type	Typical action	Urban examples
Protect	Maintain ecological integrity and prevent degradation	Protected habitats, river buffers, mature tree stands and ecological corridors
Manage	Improve the condition or multifunctionality of existing ecosystems	Urban forests, wetlands, parks, meadows, river restoration and soil management
Create or hybridise	Establish new ecosystems or combine ecological and technical elements	Rain gardens, bioswales, green roofs, constructed wetlands and floodable public spaces

C3 Benefits, Trade offs and Safeguards

Well-designed NBS can reduce heat and flood risk, regulate water, store carbon, support biodiversity, improve recreation and health, and strengthen social connection. Multifunctionality should not be assumed: benefits depend on site, design, maintenance, exposure and access. Trade-offs can arise through land competition, water demand, allergenic species, safety concerns, unequal access or green gentrification. Assessment should therefore consider baseline conditions, distributional effects, ecological integrity and alternatives, rather than counting the presence of greenery as proof of impact (Raymond et al., 2017; Seddon et al., 2020).

C4 Standards and Evaluation

The IUCN Global Standard provides eight criteria covering societal challenges, scale, biodiversity, economic feasibility, inclusive governance, trade-offs, adaptive management and mainstreaming. EU assessment frameworks similarly combine environmental, social and economic indicators and require stakeholder engagement across the intervention lifecycle (IUCN, 2020; Raymond et al., 2017). For GreenEsteem, this

means that evaluation must cover both physical performance and the institutional process that makes performance possible.

C5 Research and Implementation Gaps

These gaps explain why GreenEsteem evaluates context, stakeholders, governance, knowledge processes and outcomes together. Reviews consistently identify fragmented governance, limited capacity, uncertain evidence, finance constraints and insufficient attention to justice as interdependent barriers rather than isolated problems (Kabisch et al., 2016; Sarabi et al., 2019; European Environment Agency, 2021).

Gap	Implication for analysis
Evidence and monitoring	Baselines, indicators and time horizons often differ, limiting comparison and causal attribution.
Governance and policy integration	Responsibilities, budgets and rules remain divided across sectors and administrative levels.
Equity and participation	Benefits and burdens may be uneven, and participation can occur too late to affect core decisions.
Design and maintenance	Performance depends on context, stewardship and adaptation after construction.
Finance and valuation	Business cases may omit non-market benefits, opportunity costs and long-term maintenance.
Scaling and transfer	Replication without adaptation can overlook institutional, cultural and ecological differences.

ANNEX D Collaborative Knowledge Valorisation for Nature Based Solutions

D1 Collaboration as Part of Implementation

Urban NBS combine ecological functions with planning, infrastructure, public-space use and long-term maintenance. No single organisation holds all the knowledge or authority required. Collaborative knowledge valorisation describes how scientific, technical, administrative, commercial and experiential knowledge is brought together and converted into decisions, capabilities and reusable assets. It connects knowledge production with policy uptake, implementation and stewardship rather than treating dissemination as the final project stage.

D2 Governance and Co-creation

Research on urban NBS points to multi-level and adaptive governance: responsibilities are distributed, actors learn during implementation, and arrangements change in response to evidence and local conditions. Co-creation can take the form of living labs, workshops, participatory mapping, joint monitoring and community stewardship. Its quality depends on when actors are involved, what influence they have, whether power differences are addressed, and whether participation continues after construction (Frantzeskaki et al., 2019; Hölscher et al., 2024).

D3 From Knowledge Exchange to Value Creation

Mechanism	Potential value	Questions for assessment
Co-problem definition	Shared understanding and locally relevant objectives	Whose needs and evidence shaped the problem?
Co-design and prototyping	Context-sensitive design and greater legitimacy	Who influenced alternatives, trade-offs and final choices?
Monitoring and evaluation	Evidence for adaptation, accountability and policy	Are indicators credible, shared and used in decisions?
Documentation and platforms	Reusable data, methods and lessons	Are assets findable, accessible and responsibly managed?
Training and peer learning	Skills, organisational memory and replication capacity	Which capabilities remain after project funding ends?
Policy and standard uptake	Institutionalisation and scaling	Did results change plans, budgets, procedures or standards?

D4 Context and barriers

Collaboration is shaped by local political commitment, administrative capacity, procurement rules, social trust, land ownership, community readiness and environmental pressures. Comparative work shows that NBS may appear in plans while remaining weakly integrated across municipal departments and governance levels. Policy silos, short funding cycles and unclear stewardship can separate co-design from delivery and maintenance (Kauark-Fontes et al., 2023a; Wickenberg et al., 2021). Adaptive governance can address some of these

problems, but it requires stable coordination, learning routines and room to revise decisions (Kauark-Fontes et al., 2023b).

D5 GreenEsteem Interpretation

GreenEsteem treats collaborative knowledge valorisation as an observable chain. Actors contribute knowledge; governance arrangements determine how it enters decisions; project activities transform it into assets and capabilities; and uptake creates environmental, social, policy or economic value. The assessment therefore records both enabling conditions and points where knowledge is lost, excluded, inaccessible or disconnected from authority and resources.

ANNEX E Policy and governance matrices

E1 Poland: Policy and governance matrix

Poland: Policy and governance matrix						
Instrument	**Status**	**Operational actions/instruments**	**Explicit/implicit NBS**	**Decision-making body/Implementation**	**Knowledge inputs**	**Public-participation inputs**
National Development Concept 2050 (KRK 2050)	Adopted 25 06 2025	no	Explicit: NBS and blue-green infrastructure (BGI), ecosystem services, river renaturation and wetland restoration.	Adoption: Council of Ministers Implementation: depends on subsequent sectoral, regional and local instruments.	Long-term diagnosis; ecosystem-service considerations; integrated spatial planning.	n/a
Strategy for Poland 2035 and 2026–2029 Action Plan;	draft as of 16 09 2026	KPOZP, KSA and PDA under preparation.	Substantive NBS relevance: BGI, retention, repaving, green roofs and walls, soil restoration and ecological protection. Explicit NBS wording is not established for every instrument.	Adoption: Council of Ministers Implementation: n/a Draft published: Ministry of Funds and Regional Policy	Environmental and adaptation priorities; urban heat, water retention, soil and ecosystem considerations.	The strategy recognises municipal adaptation planning obligations, which include participation.
National Environmental Policy 2030; National Urban Policy 2030; National Strategy for Regional Development 2030	Adopted respectively in 2019, 2022 and 2019.	Strategic frameworks rather than a unified NBS delivery system.	Mixed: explicit BGI in urban policy; predominantly implicit NBS through adaptation, biodiversity, water management and regeneration in the other policies.	Council of Ministers adopted the policies. Delivery requires coordination across sectors, regions and municipalities.	Climate vulnerability, environmental quality, natural-resource protection and territorial development needs.	Local participation can operate through the municipal legal instruments
Biodiversity Programme 2015–2020; SPA 2020 with a perspective to	Biodiversity programme - expired horizon.	Contains Operational actions	Implicit/indirect: ecosystem functions, ecological connectivity, urban greening, retention, flood resilience and land-	Adoption: Council of Ministers Implementation: n/a	Habitat and ecosystem-function knowledge; sectoral climate vulnerability;	n/a

2030; KPEiK to 2030/2040	SPA – passed horizon 2020; perspectiv e-2030. KPEiK - adopted 08 06 2026.		use/forestry links. KPEiK is not an NBS strategy.		energy and climate analysis.	
Programme for Counteracting Water Scarcity 2023–2027,	22 08 2023;	operational combines planning, legal, economic and monitoring instruments.	Mainly implicit integrates natural and artificial retention; urban measures include rain gardens, green roofs, ponds and permeable surfaces.	Adoption: Council of Ministers Implementation; n/a	Water deficits and retention needs inform prioritisation; landscape, wetland, river, forest, agricultural and urban retention considered together.	Public awareness is an objective. Specific participation or co-design procedures: n/a
Environmental Protection Law and mandatory municipal climate adaptation plans (MPAs)	Amendme nt entered into force principally on 11 01 2025.	Operational MPAs required for cities with at least 20,000 inhabitants	Functionally explicit adaptation requirements; implicit NBS terminology: greening, tree cover and rainwater/snowmelt management are mandatory plan components.	MPA Adoption: Municipal council; MPA implementation: bodies and their responsibilities defined in the plan	Mandatory climate-risk analysis, spatial data, measurable objectives and implementation schedule.	Public participation required. MPAs and monitoring reports included in public registers.
Spatial Planning Act; Nature Conservation Act; Water Law; Environmental information and assessment legislation	In force	Statutory framework; adaptation amendments strengthen links between climate planning, spatial planning and assessment.	Predominantly implicit: land protection, ecological functions, tree conservation, Implicit: retention, wetlands, floodplains and climate-sensitive assessment.	Adoption: Implementation: Municipal authorities: green system management; Planning, water and environmental assessment authorities - exercise their respective powers.	Spatial and environmental evidence; ecological values; water-management planning; climate vulnerability in assessment.	Access to environmental information; participation through strategic environmental assessment
Revitalisation Act	In force	Statutory and regulatory instrument	Implicit: enable ecological regeneration, public greenery, municipal forests and biologically active	Adoption: Municipal authorities; Implementation: Municipal authorities Revitalisation	Regeneration diagnosis	Participation in revitalisation; municipal consultation and

		addressing regeneration	surfaces. Green appearance alone does not establish NBS performance.			civic-budget mechanisms. Committee supports stakeholder involvement.
Construction technical conditions	In force	Statutory and regulatory instrument addressing site design.	Implicit: enables ecological regeneration, public greenery, and biologically active surfaces. Green appearance alone does not establish NBS performance.	n/a	Site design requirements	n/a
Municipal Self-Government Act	In force	Statutory and regulatory instrument	Implicit: addresses municipal responsibilities on ecological regeneration and public greenery, municipal forests and biologically active surfaces.			n/a
Forest Act	In force	Statutory and regulatory instrument addressing forests management	Implicit: enables management of municipal forests and biologically active surfaces. Green appearance alone does not establish NBS performance.	n/a	forest-management planning	n/a
BGI technical catalogues and municipal guidance	Technical Catalogue published in 2019; Poznań Retention Standards - adopted in 2024.	Catalogue - identifies BGI as NBS	Explicit subsequent resources operationalise related measures.	Adoption: n/a Implementation: Guidance - authors and issuing organisations; Approval of local applications: municipalities.	Technical requirements, spatial suitability, costs, maintenance and constraints for individual solutions.	n/a
National Development Concept 2050 (KRK 2050)	Adopted 25 06 2025	no	Explicit: NBS and blue-green infrastructure (BGI), ecosystem services, river renaturation and wetland restoration.	Adoption: Council of Ministers Implementation: depends on subsequent sectoral, regional and local instruments.	Long-term diagnosis; ecosystem-service considerations; integrated spatial planning.	n/a

E2 Bulgaria: Policy and governance matrix

Bulgaria: policy and governance matrix						
Instrument	**Status**	**Operational actions/instruments**	**Explicit/implicit NBS**	**Decision-making body/Implementation**	**Knowledge inputs**	**Public-participation inputs**
National Environmental Strategy 2021–2030	In force	Strategic document	Explicit: NBS linked to natural-capital restoration, urban greening and climate resilience.	Adoption: Council of Mitisters The strategy and its action plan were subject to mandatory Strategic Environmental Assessment, including consultation and environmental monitoring requirements. Implementation: MoEW	Biodiversity, ecosystem functions, natural capital and climate resilience.	Government-led strategic preparation. Stakeholders involved: research community, environmental NGOs and sectoral organisations must participate in preparation and public discussion.
National Climate Change Adaptation Strategy and Action Plan to 2030	Prepared by the World Bank MoEW; adoption date: 2019	Strategic document with an action plan	Iimplicit relevance, but the strategy itself is considered sectoral and explicit.	Elaborated by: MoEW and WB; Adoption: Council of Ministers Implementation: MoEW Council of Ministers (decisions on institutional and financial arrangements); National Expert Council on Climate Change (Advisory support and coordination); National Coordination Council on Climate Change, Sectoral ministries and competent agencies; Municipalities and regional authorities	Natural capital, natural resources and climate-adaptation analysis.	Elaboration: Public consultation on the draft strategy, stakeholder workshops and engagement with public authorities, academia, NGOs and other interested parties; primarily institutional and stakeholder consultation mechanisms Implementation: Recognised, but not uniformly operationalised. No standard participation procedure for every measure. Lack of practical mechanisms for monitoring and evaluation

Draft National Restoration Plan—urban ecosystems under Article 8	Publicly available draft; Consultation on the first version - upcoming.	Operational Article 8 measures, comprising five ongoing and eight planned.	Mixed: NBS references in reporting requirements; urban measures are substantively equivalent to NBS even where terminology is absent.	Elaborated: MoEW with Ministry of Agriculture and Food, Ministry of Regional Development and Public Works, and Executive Forestry Agency. Approved by: European Commission	Restoration measures, adaptation synergies and GIS-based monitoring proposed. Individual areas, geospatial delineation and quantified benefits are missing.	Public consultation planned. Detailed co-creation and implementation-stage engagement: n/a.
Biodiversity Strategy 2022–2030	Draft as from 2022 not approved	Strategic Docu-ment	Mixed: biodiversity, soil and basin/flood plans classified as explicit; water-sector, air, energy, health, agriculture	Elaboration: MoEW Coordination: MoEW and competent biodiversity and nature conservation authorities. Aadoption: Council of Ministers Implementation: MoEW, relevant sectoral ministries, agencies and regional/local authorities, according to the final strategy and action plan.		Public consultation on the draft strategy; Written stakeholder submissions; Earlier consultation during preparation Strategic rationale for cross-sectoral stakeholder engagement established, but yet not demonstrated participatory decision-making mechanism
National Regional Spatial Concept 2026–2040	draft. Earlier Spatial Concept horizon ended in 2025.	Strategic Docu-ment	Mixed: biodiversity, soil and basin/flood plans classified as explicit; water-sector, air, energy, health, agriculture and regional	Elaboration: MRDPW National endorsement: Council of Ministers Formal approval: EC Implementation: MRDPW Integrated urban development: Eligible urban municipalities and their project partners, under the programme's selection and implementation procedures. Integrated Territorial Investments (ITIs): MRDPW coordinates the overall ITI approach;	Sectoral environmental, health, land-use and regional-development knowledge. Detailed urban NBS	Elaboration: consultation with relevant national, regional and local stakeholders. Council of Ministers' Public Consultation Portal is identified as a source

			strategies mainly implicit.	Regional Development Councils undertake regional coordination and participate in the pre-selection of ITI concepts; approved beneficiaries and partnerships implement individual projects.	methods: NS.	
National Recovery and Resilience Plan (NRRP)—Green Bulgaria/Natura 2000 measures	Plan labelled 2020–2026; identified activities had a planned implementation period of 2021–2025. Actual completion: NS.	Operational Document	Explicit: ecosystem approach and NBS for Natura 2000 protection.	Elaboration: Council of Ministers National endorsement- Council of Ministers EU assessment - European Commission Formal EU approval - Council of EU Implementation: coordination and monitoring - Administration of the Council of Ministers and Ministry of Finance; Financial management: Ministry of Finance; Implementation of individual measures - Designated ministries, agencies and other implementing bodies Implementation of Natura 2000 measures – MoEW	Updated information on ecosystem condition, ecosystem services and green infrastructure; protected-area objectives and conservation measures.	Stakeholder involvement in decision-making is expressly identified.
Programme Environment 2021–2027: biodiversity, flood-risk and urban-air measures	Programme and calls described. Urban green-measure calls labelled completed; completion of funded interventions is not established.	Operational Document	Explicit for biodiversity and flood-risk NBS; urban green infrastructure is functionally relevant, subject to ecological design.	Elaboration: MoEW (incl coordination of the draft with stakeholders) Adoption of the draft: Council of Ministers Formal EU approval: EC Implementation and management: MoEW Implementation of individual projects - beneficiaries, including competent public authorities, municipalities and other organisations Programme monitoring - Monitoring Committee, supported by the MA	Ecosystem-service and green-infrastructure assessment; flood/drought risk; particulate-matter reduction.	Call-specific consultation, co-design and public oversight:
Programme Development of the Regions 2021–2027; integrated urban development and ITIs	Supports ten growth-centre municipalities and forty urban municipalities; several calls labelled completed. Regional strategies cover 2021–2027.	Operational	Implicit/enabling: NBS can enter integrated urban and territorial investments.	Elaboration: MRDPW National coordination and endorsement: Council of Ministers, with MRDPW as the responsible ministry Formal approval: EC Implementation: MRDPW Coordination of the ITI approach - MRDPW Regional coordination and project pre-selection: Regional Development Councils	Territorial priorities, municipal integrated development plans and project concepts.	Regional councils provide consultation on municipal plans; partnerships are important. Resident-level co-creation: NS.

				Integrated urban development: the eligible urban municipalities, in cooperation with local stakeholders Implementation of individual ITI projects: the approved project beneficiaries and partnerships		
Spatial Development Act; Ordinances 7 and 8;	In force	Statutory and regulatory instruments	Implicit NBS. Explicit regulation of urban green systems, parks, gardens, vegetation and green space protection. Provides a statutory basis for green infrastructure and ecosystem-based interventions, but does not establish NBS as a separate planning category	Adoption/amendment: National Assembly. National policy and regulatory coordination: MRDPW Planning approval: Municipal councils, mayors or competent national authorities, depending on plan type and territorial scope. Implementation: Municipal administrations, chief architects, landowners, developers and competent control bodies.	Spatial plans, geodetic and engineering studies; green-system inventories; infrastructure data; green-system schemes; green area registers and mapped vegetation; landscape, water and natural hazard information.	Explicit, legally regulated participation in specified planning procedures. Public notification, access to draft plans, opportunities for objections and proposals, and public discussions where required. The form of participation depends on the type of plan and applicable procedure. Mainly consultative rather than continuous co-design.
Biodiversity Act	In force	Statutory and regulatory instruments	Implicit: green networks, protected land, vegetation, water areas and ecological corridors, enable NBS implementation.	Adoption/amendment: National Assembly. Policy coordination: MoEW, particularly the Minister of Environment and Water Implementation: MoEW, competent sectoral ministries and agencies, RIEWs, national park directorates and municipalities within their respective competences Advisory body: National Council of Biological Diversity	biodiversity inventories; Natura 2000 conservation objectives; ecological monitoring; expert assessments and spatial data sets	Explicit statutory participation in specified procedures; Sectoral authorities and NGOs take part in preparing national biodiver-sity strategy and planning instruments. The National Council of Biological Diversity includes scientific, institutional and NGO representatives. Draft of conservation objectives are published and opinions collec-ted. Limitations: Participa-tion is primarily

						consultative and advi-sory; the Act does not establish universal citizen co-design or co-mana-gement of biodiversity measures.
Environmental Protection Act and The Ordiance for EIA and SEA	In force	Statutory and regulatory instruments	Implicit: NBS related to some of the factors and components oft he built and natural environment	Screening and scoping:Investor/plan initiator notifies MoEW / RIEW Elaboration of the report: xperts/consultancy company Issue of decision: MoEW / RIEW Final project or plan approval: Competent permitting or authorising authority, plans – the Council of Ministers, a minister or a municipal council. Implementation/ensuring the environmental conditions: Investor / project operator. Authority or organisation responsible for implementing the plan/programme, Monitoring: MoEW / RIEW and other competent control authorities(projects); MoEW / RIEW supervise compliance with SEA conditions; the plan initiator prepares the required monitoring reports.		EIA: Public participation is explicitly regulated and mandatory for projects subject to a full EIA. Includes: early notification, access to environ-mental documentation, written comments and objections, and public discussion of the EIA report. Consultation outcomes must be considered in environ-mental decision-making. SEA: Public participation is explicitly regulated through consultation during the prepa-ration and environmental assessment of plans and pro-grammes. Access to draft docu-ments and the SEA report, tob e profided for min. 30-days for consultation, written stakehol-der submissions and public discussion.
Water Act; flood-risk catalogue; environmental /agricultural standards	Binding laws, a national flood-risk catalogue and agricultural standards.	The text identifies limited urban ecosyste m standard s beyond	Mixed: explicit nature-based measures in the flood catalogue; implicit restoration and retention provisions in	Water-planning authorities are not fully identified. National Trust EcoFund financing framework described; government approval required for borrowing.	Basin and flood-risk planning; technical flood measures; agricultural environmental requirements.	Detailed participation and stewardship procedures: the broader account identifies weak long-term engagement.

		landscaping thresholds.	water legislation; environmental financing is enabling.		Catalogue includes both nature-based and conventional structural measures.	

E3 Konin: Strategic and operational instruments supporting NBS implementation

Bulgaria: policy and governance matrix						
Instrument	**Status**	**Operational actions/instruments**	**Explicit/implicit NBS**	**Decision-making body/Implementation**	**Knowledge inputs**	**Public-participation inputs**
Konin Development Strategy 2020–2030	Strategic; updated 2022	Urban greenery, stormwater retention, post-industrial restoration, Pociejewo Island	Implicit	Municipal authorities; relevant implementing units	Spatial, environmental and socioeconomic analyses	Strategic participation and stakeholder engagement
Study of Conditions and Directions of Spatial Development	Spatial planning; updated 2022	Ecological corridors, Warta Valley protection, wetlands, land-use restrictions	Implicit	Municipal planning authorities	Land-use, hydrological and ecological data	Planning consultation mechanisms
Climate Change Adaptation Plan (2020)	Sectoral; adopted plan strong operational alignment	Rain gardens, green roofs, pocket parks, permeable surfaces, retention	Implicit;	Municipality; environmental and infrastructure units	Climate vulnerability, heat, flood and drought assessments	Not specified in the supplied review
Smart City Plan (2022)	Strategic/sectoral	Blue-green infrastructure, climate adaptation, environmental monitoring	Explicit	Municipal administration	Smart-city data, environmental monitoring	Not specified
Municipal Regeneration Programme until 2030 (2023)	Operational/regeneration	Parks, green courtyards, Warta riverfront, urban greening	Implicit	Municipality; regeneration stakeholders	Spatial and socioeconomic regeneration analyses	Social participation integrated into regeneration

"Green Space" Programme (2023)	Integrated masterplan high operational relevance	Ecological networks, retention, renaturalisation, phased greening	Implicit;	Municipality; urban planning and green-space management	Green inventories, hydrography, sealed surfaces, protected areas	Not specified
Standards for the Care of Urban Space (2023)	Operational standards	Tree protection, infiltration, biodiversity maintenance, drought adaptation	Implicit; directly applicable	Municipal green-space and maintenance units	Arboricultural, soil, water and maintenance knowledge	NGOs, residents, community gardens, information campaigns
Guide: Green and Blue Infrastructure (2024)	Technical guidance	Rain gardens, green roofs, pocket parks, green corridors, infiltration basins	Implicit	Municipal project designers and implementing units	Climate adaptation and technical design knowledge	Educational and neighbourhood-space provisions

E4 Sofia: Strategic and operational instruments supporting NBS implementation

Bulgaria: policy and governance matrix						
Instrument	**Status**	**Operational actions/instruments**	**Explicit/implicit NBS**	**Decision-making body/Implementation**	**Knowledge inputs**	**Public-participation inputs**
Vision for Sofia 2050 (2020)	Long-term strategic framework	Green wedges, river restoration, wetlands, rainwater harvesting, green roofs	Implicit	Sofia Municipal Council; municipal planning bodies	Environmental, spatial and biodiversity analyses	Shared vision and strategic consultation
General Spatial Development Plan 2010–2030	Statutory spatial plan; amendment ongoing	Green-system protection, ecological corridors, land-use regulation	Implicit	Sofia Municipal Council; planning administration	GIS, cadastral data, environmental assessments	Statutory public access and consultation
lan for Integrated Development 2021–2027	Integrated investment framework	Multifunctional green spaces, ecological restoration, green-blue connectivity	Explicit NBS project orientation	Sofia Municipality; municipal implementing bodies	Territorial diagnostics, environmental and socioeconomic data	Co-creation and community-oriented project development
Climate City Contract 2024–2030	Climate-neutrality investment framework	Urban forests, green roofs, wetlands, community gardens	Explicit	Municipality; climate and investment partners	Emissions inventories, climate and investment assessments	Stakeholder partnerships; specific procedures not detailed

Sustainable Energy and Climate Action Plan 2021–2030 (revised)	Climate mitigation/adaptation plan	Ecosystem-service assessment, blue-green cooling, tree irrigation, climate adaptation	Explicit	Municipality; relevant sectoral departments	Climate-risk assessments, ecosystem services, monitoring	Stakeholder engagement and public participation
Green City Action Plan 2020–2027	Strategic investment/action plan	Pocket parks, brownfield reuse, green corridors, surface-water management	Implicit; strong alignment	Municipality; EBRD-supported planning framework	Climate-risk modelling, environmental and infrastructure data	Not specified
Green System Ordinance (2017)	Binding municipal regulation	Green-space protection, vegetation registers, maintenance, replacement planting	Implicit	Municipal Council; green-system administration	Tree registers, vegetation inventories, expert assessments	Public information; participation mechanisms not detailed
Urban Environment Ordinance (2020) and standards	Binding design regulation/technical standards	Pavement design, street greenery, accessibility, potential drainage measures	Implicit	Municipal Council; design approval and implementation units	Technical standards, landscape and infrastructure information	Public consultation through applicable municipal procedures
Public Consultation Ordinance	Binding procedural regulation	Public consultations, disclosure of proposals and responses	NBS-enabling instrument	Municipality; relevant decision-making bodies	Public proposals, local knowledge, consultation records	Formal public consultations and feedback

ANNEX F NBS PRACTICES

F0. Protocols for 60+ Practices Analysis

File name: GreenEsteem_D2.1_Annex_3.1_60_Practices_Analysis_Protocols

Link to file in Collabto: https://docs.google.com/document/d/1bmcJVx8l3zxN0Yp21MNLa8363k7WGUDV/edit

F1. Complete database with the NBS practices

Link to excel file “GreenEsteem_D.2.1_Annex_60+practices analysis”in Collabto drive: https://docs.google.com/spreadsheets/d/1SfADr8xRd-Z6EkKj0Gf1UnpTroDEcw_ZUrN4uRQMomc/edit?gid=911056001#gid=911056001

Sheet 1.0_Cordis search

Alternative link to pdf file shared in Collabto:

File name: GreenEsteem_D.2.1_Annex_60+ practices analysis_CordisSearch:

Link: https://drive.google.com/file/d/1tDDI1NyYf34NjW7KnEUoFyL1jvK5N3fJ/view?usp=drive_link

Sheet 1.1_Projects’ general data + Assessment

Alternative link to pdf file shared in Collabto:

File name: GreenEsteem_D.2.1_Annex_60+ practices analysis - 1.1_Rrojects' General Info + Assessment

Link: https://drive.google.com/file/d/1S7oHlh5Fo206roGzUfn96wmak6bnKise/view?usp=drive_link,

Sheet 1.2_Practices General Info + Assessment

Alternative link to pdf file shared in Collabto:

File name: GreenEsteem_D.2.1_Annex_60+ practices analysis - 1.2_Practices General Info + Assessment

Link: https://drive.google.com/file/d/1RvikKTQ3Arc8nUIB3rqM1M5qvbRh6VNH/view?usp=drive_link

F2. 60+practices analysis: 74 NBS Practices comprising 40 international practices and 34 local practices.

Sheet 1.3_74_Practises_Assessment (Link to excel file “GreenEsteem_D.2.1_Annex_60+practices analysis”in Collabto drive: https://docs.google.com/spreadsheets/d/1SfADr8xRd-Z6EkKj0Gf1UnpTroDEcw_ZUrN4uRQMomc/edit?gid=911056001#gid=911056001)

Alternative link to pdf file shared in Collabto

File name: GreenEsteem_D.2.1_Annex_60+ practices analysis - 1.3_74_Practices_Analysis

(Link to excel file “GreenEsteem_D.2.1_Annex_60+practices analysis”I n Collabto drive: https://docs.google.com/spreadsheets/d/1SfADr8xRd-Z6EkKj0Gf1UnpTroDEcw_ZUrN4uRQMomc/edit?gid=911056001#gid=911056001)

https://drive.google.com/drive/u/0/folders/1eDmFHlcLIO_acle6cE4wmFUOXiAbej_x

F3. Detailed Forms for Local Practices (filled)

File name shared in Collabto: GreenEsteem_D2.1_Annex_3.3_Detailed_Forms_for_Local_Practices

Link: https://docs.google.com/document/d/1K0_rzxbrxw6xpVmqWC0wcQcBqFW6ispW/edit

ANNEX G Typology of stakeholders according to the quadruple helix model classification and their theoretical roles, responsibilities, and needed capacities

Public institutions are increasingly moving beyond their traditional administrative roles to strategically engage citizens, businesses, and organisations in the renewal and development of urban communities. Through participatory processes, municipalities find that more challenges can be addressed effectively, while simultaneously strengthening social cohesion, trust, and democratic accountability. The key shift is not simply that citizens are involved, but that public institutions now methodologically incorporate diverse actors across the full cycle of public tasks — from co-diagnosing and co-planning through to co-delivery and co-assessment.

This reflects a broader paradigm shift from New Public Management (NPM) to New Public Governance (NPG). NPM's market-oriented approach has failed to achieve satisfactory impact (OECD; Hood & Dixon), and growing demands for innovation, decentralisation, and citizen empowerment have made co-production and co-creation central to public service delivery. Under NPG, the public sector's role becomes one of coordination, facilitation, and network leadership — setting conditions and criteria while citizens and other actors actively participate in implementation.

This transition operates across three interconnected levels. Co-production involves individuals and communities continuously participating in the delivery of welfare services, effectively producing their own services in part. Co-management engages voluntary and third-sector organisations in service design and resource contribution. Co-governance enables citizens and private organisations to participate in policy planning and resource prioritization (Pestoff, 2012). Across all three, professionals shift from service deliverers to advisors, users gain greater responsibility, and public services are no longer delivered simply for citizens but with them.

GreenEsteem project assumes that, public sector organization strategically and methodologically coordinate and facilitate the engagement of other actors through co-participative processes.

Elected politicians exert a dual influence on NBS projects — acting as both enablers and potential obstacles depending on how they engage with the processes and stakeholders involved. Politicians can provide critical support by securing funding, elevating NBS as a political priority, and helping to overcome financial barriers (Dijck, 2022; Dijck & Steen, 2023). Their capacity to connect stakeholders and mediate conflicts can facilitate smoother collaboration and ensure alignment with broader societal goals. They also lend legitimacy to collaborative networks, supporting wider public and institutional acceptance of NBS within policy frameworks (Dijck, 2022; Dijck & Steen, 2023). At the same time, political involvement can introduce complications. Politicians may adjust project goals to align with political agendas, compromising neutrality and creating tension among stakeholders. Bureaucratic obstacles introduced through political processes can also slow implementation, which is particularly problematic where timely action is needed to address urgent environmental challenges (Dijck, 2022; Dijck & Steen, 2023). Politicians play an important role in developing policies that mainstream NBS into urban planning and cross-sectoral decision-making, helping to address regulatory barriers and facilitate institutional integration (Joseph & Megan, 2025; Schielen et al., 2025). They can also support the dissemination and application of NBS knowledge by championing initiatives that compile and share best practices across different contexts (Daniela, 2024; Diana et al., 2022). Effectively harnessing political support while managing its inherent risks requires strategic and thoughtful engagement with political actors throughout the NBS development and implementation process.

Municipalities and municipal institutions

Municipalities play a central role in integrating NBS into urban governance, acting as facilitators and

They are responsible for embedding NBS into urban planning and policy frameworks, aligning them with existing legal and ecological structures. Examples from Stockholm, where green spaces are planned to enhance ecosystem services, and Portugal, where municipal ecological structures incorporate NBS into planning law, illustrate this in practice (Brokking et al., 2021; Carvalho, 2024). Institutional and knowledge-related barriers remain common challenges, addressed in initiatives such as Nature4Cities through targeted training programmes (Nature4Cities, 2022), and through policy assessment tools that evaluate municipal readiness (Neumann & Hack, 2019). Securing funding is equally critical, with municipalities drawing on regional and international sources such as EU Missions and Horizon2020, while countries like Hungary are exploring reforms to mobilise public and private investment for climate adaptation through NBS (Laurence et al., 2024; Promoting nature-based solutions in municipalities..., 2023). Municipalities facilitate multi-stakeholder partnerships involving public and private actors, researchers, and citizens to advance NBS and enhance climate resilience (Ham & Klimmek, 2017; Laurence et al., 2024). Transdisciplinary collaboration between researchers and practitioners — as demonstrated by the Naturvation project — supports joint problem-framing and knowledge co-production, underpinned by adaptive governance and participatory institutional arrangements (Wickenberg, 2023; Sanusi & Sanusi, 2024). Municipalities also facilitate the exchange of best practices across global NBS implementations through community-of-practice approach and Urban Living Labs as valuable mechanisms for horizontal learning and innovation (Laurence et al., 2024). Despite their central role, municipalities face persistent challenges including institutional fragmentation, limited cross-sectoral coordination, and insufficient policy guidance. Addressing these requires regulatory reform, inclusive governance, and sustained political commitment to NBS as a strategic urban development priority.

Public sector organisations are central to the implementation of NBS and the valorisation of associated knowledge, leveraging regulatory and financial capabilities to overcome investment barriers, facilitate cross-sectoral collaboration, and mainstream NBS within broader sectoral and integrated policy frameworks. They shape the policy environment for NBS by integrating them into urban planning, agriculture, and infrastructure strategies, as reflected in frameworks such as the European Green Deal and the Sustainable Development Goals (Datola & Oppio, 2023). By recognising the economic value of ecosystem services, they can provide financial incentives that stimulate NBS investment, addressing the under-recognition of NBS value that currently limits funding flows (Blaettner et al., 2026). Public sector institutions' engagement is also critical in identifying and addressing the key barriers to NBS finance, providing targeted recommendations and support to enhance participation in NBS initiatives (Blaettner et al., 2026). Public sector organisations facilitate transdisciplinary collaboration by bringing together stakeholders from diverse sectors to build comprehensive business cases for NBS investment and develop natural assurance schemes (Pranto, 2023). They also play a vital role in capacity building and awareness raising, promoting cross-sectoral collaboration and robust monitoring frameworks essential for the long-term mainstreaming of NBS (Schielen et al., 2025). Additionally, they support the development of protocols for NBS design, implementation, and maintenance — particularly in specific contexts and landscape settings — providing decision-making tools for adaptive ecological management (A5.1 Report on Protocol..., 2024). Despite their central role, public sector organisations face persistent challenges including limited data on NBS effectiveness and fragmented governance structures. Addressing these barriers requires coordinated cross-sectoral efforts, the development of decision support systems, and continuous adaptation of public sector strategies to fully harness the potential of NBS within long-term sustainability frameworks (Schielen et al., 2025; Datola & Oppio, 2023).

Research and educational institutions act as catalysts for innovation, bridging theoretical research and practical application by bringing together researchers, practitioners, and community members to collaboratively address sustainability challenges through transdisciplinary collaboration. They have highlighted mechanisms that transform knowledge into economic and social value through co-creation, co-governance,

and collaborative innovation processes (Varvaris et al., 2024; Peschke et al., 2023; Shkarupeta & Babkin, 2024). Universities and research institutions are also recognized as central knowledge producers and mediators in innovation ecosystems (Deirmentzoglou et al., 2025; Bracht et al., 2024). Digitalization and eco-innovation have emerged as critical valorization pathways in recent studies, linking knowledge exchange to technological and environmental outcomes (Loucanova et al., 2025; Shkarupeta & Babkin, 2024).

Higher Educational Institutions (HEIs) extend beyond traditional teaching and research to engage in socio-economic problem-solving through co-creation and systemic thinking. Activities such as mutual learning, knowledge diffusion, and technology-based collaboration enable them to engage with society and strengthen partnerships with social actors, fostering social innovation (Kumari et al., 2019). Collaborative governance arrangements involving non-government actors are essential for NBS co-creation. European project case studies illustrate how clearly defined actor roles and structured approaches (derived throu action research by academic partners) — such as the seven-step pathway and decision-making matrix developed within the RECONECT project — facilitate effective stakeholder engagement throughout the co-creation process (Wilk et al., 2021; Diana & Christian, 2024). Transdisciplinary collaboration, requiring relational capacities, communicative skills, and joint reflection, is central to integrating research and practice in NBS implementation (Wickenberg, 2023). Urban Living Labs across Europe further demonstrate how municipal organisations with scientific partners engage stakeholders and shape the effectiveness of knowledge co-production and dissemination (Nina, 2023; Nina, 2024). In entrepreneurial contexts, educational institutions contribute to value co-creation by fostering flexible learning environments and supporting the development of entrepreneurial ecosystems, with particular relevance in developing country/city/neighbourhood settings (Badie et al., 2024). Key challenges for research and educational institutions include the absence of clear co-creation frameworks, persistent capacity building needs, and the difficulty of making co-creation principles accessible to diverse stakeholders (Diana & Christian, 2024). Rethinking traditional academic dissemination methods to reach broader audiences — and integrating co-dissemination as an integral part of knowledge co-creation — also remains an important consideration (Federica, 2024).

R&D departments from private companies

R&D departments in private companies are key drivers of NBS innovation, knowledge management, and strategic collaboration, playing a multifaceted role in integrating NBS into business operations.

These departments generate and implement innovative solutions that embed NBS into business practices. In the Brazilian electricity sector, for instance, mandatory R&D investment has led to the development of tools and strategies that address gaps in scientific, technological, and market knowledge, facilitating the adoption of NBS (Bin et al., 2015). Fourth-generation R&D management models further emphasise the internal and external creation and diffusion of knowledge as central to developing NBS that address environmental and societal challenges (Liyanage et al., 1999).

Knowledge Management

Effective knowledge management — encompassing knowledge sharing, codification, and collaboration — is closely linked to innovation performance and is critical for successful NBS implementation (Mardiah et al., 2025). Knowledge-intensive business services (KIBS) further support this by facilitating efficient knowledge exchange between actors within national innovation systems, enhancing the integration of NBS across sectors (Hertog & Bilderbeek, 2019).

Strategic Partnerships and Collaborations

R&D departments frequently engage in partnerships with universities, research centres, and other organisations to strengthen innovation capabilities and improve knowledge flows (Zhang & Zhou, 2020). Italian Science and Technology Parks provide an example of how public-private collaboration can facilitate innovation processes through R&D networking and agreements (Alessandro, n.d.).

Key challenges include difficulties in internalising the long-term benefits of NBS investment, financing constraints, and the need for cross-sectoral coordination (Conceicao & Finlay, 2021; Schielen et al., 2025). Mainstreaming NBS requires coordinated efforts across stakeholders, as illustrated by the ResiRiver initiative (Schielen et al., 2025). Internally, cultural resistance, insufficient incentives, and inadequate technological infrastructure also present barriers that require strong leadership commitment and the integration of knowledge management into core innovation strategies (Mardiah et al., 2025).

Private sector (Businesses) for-profit businesses

Private sector actors — particularly SMEs and social enterprises — are increasingly recognised as key partners in designing, implementing, and maintaining nature-based solutions (NBS) in urban contexts. As companies grow more aware that their futures depend on natural resources rather than man-made infrastructure alone, engaging them in participatory NBS processes can drive business practice changes and enhance the long-term sustainability of such initiatives (Ozment et al., 2015).

Company engagement with NBS can be understood through the Reasoned Action Approach (Fishbein & Ajzen, 2010), which unfolds across three phases. In the first, companies develop a positive attitude toward NBS by recognising their potential to generate corporate value alongside social impact — supporting projects financially or through access to funding, often as part of broader corporate social responsibility strategies. In the second phase, this translates into an actual willingness to pay for NBS, with companies contributing resources, facilities, or services to support implementation. In the third phase, companies become active participants in NBS governance networks, collaborating with other stakeholders to co-create solutions that deliver collective benefits to communities in which they often also have employees and business interests.

Since private sector decisions to engage with NBS are typically driven by a mix of business and personal motivations, approaches to securing their participation should be carefully tailored, presenting clear and compelling arguments for the tangible benefits their involvement can bring.

The private sector is vital in securing investment and infrastructure development. Not just through Public Private Partnerships but also through the facilities the private companies create and invest in NBS (tableX).

Table 20A.. Reasons for Involving Private Business in NBS CKV

Reasons for Involving Private Businesses in NBS CKV
They bring complementary insights and perspectives that enrich those of government, civil society, scientists, and local communities.
They offer market knowledge and management experience valuable to effective NBS implementation.
Their involvement helps make NBS delivery more cost-effective and sustainable over the long term.
They enable the integration of public, private, and civic goals within triple helix initiatives that serve multiple interests simultaneously.
They provide access to media channels that support broad dissemination across sectors, stakeholders, and communities.
They contribute technologies and sub-solutions essential to the development of NBS and healthy corridors.
They offer access to private space, buildings and installations that can become integral components of the NBS infrastructure.
They can provide suitable venues and facilities for hosting participatory processes.

They supply materials, advanced R&D capabilities, and design tools needed to visualise and deliver NBS solutions.

They bring access to capital for financing investments in NBS and associated ecosystem services.

They support the scalability of NBS and community participation, particularly where private infrastructure is required.

As described by Tsavdaridou and Metaxas (2015), private businesses may have different motives for taking part and contributing to co-creation of NBS, and therefore diverse of incentives for private businesses to engage in Green Urban regeneration are available and implemented selectively. (table XX)

Table 21A. Categories and examples of motives/incentives

Policy **3.** The company has an established CSR policy or commitment that drives engagement with socially and environmentally responsible initiatives. **4.** The company operates a foundation through which it channels financial or in-kind contributions to relevant projects. **5.** Internal policy allows employees to dedicate a set number of working hours per month to social or community activities. **6.** The company has adopted policies aimed at reducing waste, reclaiming products, and circulating materials within a circular economy framework.	**Innovation** **7.** The company is interested in developing and testing new solutions through NBS that could subsequently be scaled and applied in other urban contexts. **8.** Involvement offers an entry point into public-private innovation partnerships, with NBS serving as a platform for broader collaborative development. **9.** Participation provides access to technological infrastructure — such as telecommunications, drones, pipelines, and waste collection systems — that can enable the development of new NBS and healthy corridor solutions.
Economical **10.** Participation provides access to a significant customer base in the area. **11.** Involvement creates pathways to similar projects and assignments elsewhere. **12.** Engagement may lead to cost reductions in other future business areas. **13.** The company can contribute or leverage products and services directly relevant to the NBS. **14.** Discarded but still functional products or raw materials held by the company can be repurposed within the NBS. **15.** The company owns property or assets in the area that may be positively or negatively affected by the NBS, for instance through	**Reputation and image** **17.** Involvement provides access to customers, citizens, and potential employees in the area, strengthening the company's image and reputation among these key groups. **18.** The business owner or employer may have personal ties to the area and wish to demonstrate local commitment, sustaining their standing and influence within the community. **19.** Association with NBS initiatives offers valuable PR and marketing opportunities, generating broad positive coverage and enhancing the company's public profile. **Social Impact and Responsibility**

mitigation of climate-related risks such as flooding. **16.** The company is interested in investing in NBS-linked property or infrastructure as a source of future variable income that also benefits the local community.	**20.** Companies can contribute meaningfully to improving the communities and local environments in which they operate. **21.** Engagement with NBS offers an opportunity to develop and test innovative solutions with potential for wider urban application. **22.** Participation may serve as a form of compensation for negative environmental or social impacts generated by the company's own activities.

The specialized small and medium sized enterprises (SMEs) implicitly focused and specialized in NBS play a crucial role in the co-creation and sustainability of green systems, landscape architecture, and related fields. These enterprises are pivotal in integrating sustainable practices into their operations, thereby contributing to broader environmental and economic goals. SMEs in this sector face unique challenges and opportunities, which influence their ability to drive sustainable development.

SMEs are increasingly adopting and integrating green business practices such as waste reduction, water management, energy efficiency, and sustainable supply chain management. These practices not only reduce environmental footprints but also enhance operational efficiency and competitiveness (Omowole et al., 2024). The transition to a low carbon economy requires SMEs to develop environmental capabilities, including eco-innovation and access to green supply chains, which are essential for maintaining competitiveness and benefiting from green growth (Baranova, 2017). Collaboration with other organizations is vital for SMEs in overcoming sustainability challenges. Such cooperation with other SMEs can facilitate the sharing of resources and knowledge, promoting sustainability and contributing to the circular economy in practice (Suchek & Franco, 2023). Collaborative networks among SMEs can provide a backbone for urban product-service systems, enhancing sustainability through shared service packages and common service backbones (Lelah et al., 2012). Nature-based enterprises and Economic Activities, which offer products or services with nature as a core element, contribute significantly to sustainable economic activities. These enterprises engage in diverse activities such as ecosystem restoration and community engagement, which are crucial for the market development of NBS (Kooijman et al., 2021).

The design companies (architecture and landscape architecture), the engineering companies and the construction sector, benefits from twin green and digital innovations, which are essential for SMEs to improve business performance and align with the European Green Deal (Krogt et al., 2023).

Investment companies, through the voluntary sustainability Green Building certification (BREAM and LEEDS) also play an essential role in behavior and preference change in the supply and the demand side of the real estate market.

SMEs have the potential to build resilience at individual, organizational, and community levels through sustainability-oriented business practices. These practices are not only technical but also reflect deeper sustainable values shaped by organizational culture and behavior (DiBella et al., 2022). Sensory and regenerative design strategies can be applied by SMEs to create environments that are ecologically restorative and experientially engaging, thereby enhancing environmental performance and human well-being (Tonin et al., 2026).

Despite the potential benefits, SMEs face barriers such as financial constraints, limited access to sustainable technologies, and regulatory challenges. Policy support, financial incentives, and collaborative networks are crucial in facilitating the transition toward greener operations (Omowole et al., 2024) (Tonin et al., 2026). Effective policy measures and market development strategies are essential to recognize and support the value

created by nature-based enterprises, thus enabling wider adoption of NBS (Kooijman et al., 2021). With appropriate support and strategic collaboration, these enterprises can significantly contribute to ecological and social regeneration, positioning themselves as key players in the transition to a sustainable future.

SMEs – not implicitly focused on NBS (NBS recipients, investors)

Small and Medium-sized Enterprises (SMEs) contribute to the development of NbS through knowledge sharing, resource management, and investment in sustainable practices. SMEs play a significant role in disseminating and applying NBS-related knowledge, enhancing organisational learning and innovation both within and across sectors. Effective knowledge sharing leads to improved customer relations, creativity, and operational processes — all essential for successful NBS implementation (Anand et al., 2021). Knowledge management in SMEs is also closely linked to human resource development, fostering a culture of innovation and sustainable practice (Anand et al., 2021). SMEs draw on both tangible and intangible resources — including human expertise and organisational culture — to develop and implement net-zero and NBS practices. Their capacity to process and apply knowledge is critical for meeting sustainability targets, and the adoption of Industry 4.0 technologies can further enhance resource management and facilitate the integration of NBS into their operations (Sharma et al., 2024).

SMEs face a range of barriers to NBS engagement, including high costs, uncertain returns, and skill shortages. The absence of a unified NBS definition and difficulties in measuring environmental impact create further uncertainty, while excessive bureaucracy and inconsistent sustainability reporting requirements across regions add compliance burdens that disproportionately affect smaller organisations. (Report on stakeholders' motivations, needs..., 2025) Access to finance remains a the most significant challenge for SMEs seeking to invest in NBS projects, necessitating tailored support mechanisms. Blended finance approaches combining public and private funding are recommended to unlock NBS potential and attract SME investment, while sustainable business models such as public-private partnerships can provide clearer revenue streams and reduce financial risk (Andreas et al., 2024; Prospectus for Nature-Based Solutions, 2024).

Micro-Local business – (operation on site)

These businesses contribute local knowledge, foster community engagement, and support the implementation of NBS through their unique position within the community. Their involvement is essential for the successful integration of NBS into local contexts, as they provide insights and resources that are often overlooked in top-down approaches. They serve as valuable repositories of local knowledge, offering insights into community needs, preferences, and historical context that can meaningfully guide the design and implementation of NBS (Woo et al., 2019). They also act as neighbourhood navigators, helping to map the socio-cultural landscape and facilitating connections between residents, designers, and policymakers (Woo et al., 2019). The participation of micro-local businesses in co-creation processes is essential for tailoring NBS to specific local conditions and needs (Soini et al., 2023). Their involvement in participatory approaches such as Living Labs draw on their input to deepen stakeholder engagement and foster a sense of community ownership over NBS initiatives (Soini et al., 2023; Baldacchini et al., 2024). By integrating NBS into local economic activities, micro-local businesses contribute to the economic sustainability of such initiatives, potentially generating new business opportunities and strengthening local economic resilience (Daniela, 2024). Socially, their involvement supports community capacity-building and inclusivity by engaging diverse groups in NBS planning and implementation, thereby promoting cohesion and empowerment (Syafei et al., 2025). Through initiatives such as Open Microfactories, micro-local businesses can drive innovation and facilitate the transfer of NBS-related knowledge, experimenting with new technologies and practices that support sustainable development (Langhammer et al., 2024). Collaborations between academia and local businesses — such as the Off Campus Nolo project — further demonstrate how academic knowledge can be translated into effective community-level action, enhancing the quality and impact of NBS outcomes (Fassi & Vergani, 2024).

Civil society

NGOs and Social enterprises

Nonprofit organisations contribute to the co-production of welfare services by enabling collaborative conditions and encouraging co-management that extends beyond public sector actors alone, fostering resource sharing and collective responsibility (Larsson, 2023). Central to this process are continuous communication and feedback loops, which drive transformative change and ensure that NBS are not only scientifically robust but also socially and environmentally just (Nina, 2023). These perspective facilitate the co-creation process by delineating roles and responsibilities, ensuring that diverse perspectives are integrated into NBS design and implementation (Wilk et al., 2021).

Social enterprises are distinguished by their dual pursuit of economic and social value, with economic sustainability serving as a means rather than an end (Dees, 2003; Thomas, 2004). Understanding them fully requires moving beyond mainstream market economics toward a substantive conception of the economy — one rooted in Polanyi's recognition of multiple economic principles, including redistribution by states, reciprocity by communities, and household-based provisioning — alongside the European tradition of social economy research (Ferreira, 2018).

Compared to commercial enterprises, social enterprises typically face greater resource constraints, including limited access to external capital and skilled labour, which heightens their motivation to seek partnerships and external support for sustainable development. Despite these constraints, they are vital actors in participatory community processes, often reaching marginalised groups and minority communities that the public sector cannot access. They unlock community assets, build human capital, and act as key agents in converting living labs into communities of practice where new NBS can be tested (Ferreira, 2018). Social entrepreneurs typically live and work within the communities they serve, bringing deep local knowledge, creativity, and relational networks to address social and health challenges while mobilising community resources and fostering a sense of co-responsibility. Like voluntary organisations, they can inform, plan, and support the implementation of public health and social policies. Their commitment to ethical trading also makes them valuable partners for exploring alternative financing models for public health prevention, particularly given growing constraints on public budgets (Dees, 2003; Thomas, 2004).

To fully realise this potential, social enterprises require visible contracting opportunities and greater flexibility in public sector procurement, making strong partnerships between voluntary, community, and social enterprise actors essential to meaningful participatory processes.

Table 22A. Principles for participatory action of social enterprises and set of criteria for defining the social enterprise. Source: Report A Map of Social Enterprises and Their Eco-Systems in Europe,4 sponsored by the Directorate-General for Employment,Social

Principles for participatory action of social enterprises
It must pursue an explicit and primary social aim: a social aim is one that benefits society;
It must have limits on distribution of profits and/or assets: the purpose of such limits is to prioritise the social aim over profit making;
It must be independent i.e. organisational autonomy from the State and other traditional for-profit organisations; and,
It must have inclusive governance i.e. characterised by participatory and/or democratic decision-making processes.
A set of criteria for organisations to meet in order to be classified as social enterprises were also identified, following from the knowledge generated by European researchers

Primacy of the individual and the social object over capital,

Free and voluntary membership,

Democratic control by its affiliates (except foundations which have no associate members),

Combining the interests of affiliates / users and / or the general interest,

Defense and application of the principles of solidarity and responsibility,

Autonomy of management and independence in relation to the public powers,

Most surpluses are for the achievement of objectives in favor of sustainable development and the provision of services of interest to members and / or the general interest. (European Economic and Social Committee, 2007)

Co-creating and co-evaluating NBS to deliver social and quality-of-life benefits — including for the most vulnerable — inevitably carries public sector risks. However, living lab spaces that engage relevant community groups provide an environment where new ideas can be designed, tested, and assessed, ultimately strengthening the future evidence base. Social enterprises are well positioned to operate in this space between the state and the private sector, where experimentation through co-creation and co-production is more feasible. This approach ensures citizens remain actively involved throughout the innovation process, with the dual benefit of producing solutions that genuinely respond to identified social needs and fostering a sense of community ownership over new services, products, and facilities.

Voluntary organisations, grassroots movements, and collective initiatives are key contributors to the co-production and knowledge valorisation of NBS. By integrating diverse knowledge systems and fostering community engagement, they help bridge the gap between scientific research and practical implementation, ensuring that NBS are both contextually relevant and socially inclusive. Voluntary organisations play an important role in advancing research and disseminating knowledge, often working alongside scientists and practitioners to address complex challenges through innovative programmes (Epstein, 2010). They frequently act as intermediaries between researchers and the public, facilitating communication that is essential for effective knowledge transfer and the practical implementation of NBS (Nina, 2023). Grassroots movements are particularly valuable in adapting NBS to local contexts, especially in informal settlements and housing areas where socio-spatial complexities require solutions grounded in community knowledge. By integrating local expertise with technical know-how, they empower communities to shape their own environments, as demonstrated by initiatives such as the RISE programme in Indonesia (Moschonas et al., 2025). These movements also increasingly leverage digital mobilisation and platform-based activism as tools for co-producing knowledge and participating in NBS governance (Kazanskaia, 2025). National Consultation Groups (NCGs)as specific voluntary formation acting at supra-neighbourhood level often serve as platforms for diverse national and subnational actors to provide feedback and suggestions on making co-produced knowledge actionable across different socio-political contexts in Europe(Katriina et al., 2025) (Katriina et al., 2025). They help define actionable knowledge characteristics, such as being evidence-based, easy to communicate, and capable of enhancing planning, policy, and financing(Katriina et al., 2025).

Voluntary organisations and associations play a vital role in urban societies, delivering leisure, welfare, and special interest services on both a long-term and ad-hoc basis. In the context of developing and sustaining NBS through co-participatory processes, they present a distinctive mix of benefits and challenges (Table 23A).

Table 23A. Involving volunteer organisations in NBS co-creation: Benefits and challenges

Benefits	Challenges
• Many citizen groups with specific characteristics as age, gender, ethnicity, disability, or migration status are already organised into associations supported by voluntary organisations, providing ready-made channels for reaching and engaging diverse communities in participatory processes. • Working through associations and voluntary organisations makes it possible to involve large numbers of participants when needed, enhancing the scale and representativeness of co-creation processes. • These organisations are frequently led and staffed by capable individuals with the skills and networks to effectively mobilise and facilitate participatory activities. • Associations and voluntary organisations are embedded in broader networks that also include businesses and other civic bodies, offering opportunities to draw additional relevant actors into participatory processes where appropriate.	• Voluntary organisations and associations operate according to their own strategies, priorities, and policies, meaning that meaningful collaboration will require alignment and consensus on goals between these organisations and other participants in the process. • Since these organisations already provide benefits and value to their members through existing activities, any additional co-participatory engagement will need to offer clear added value to motivate volunteers and members to invest further time and effort. • Members and volunteers already dedicate a significant portion of their spare time to their organisations' activities, so securing additional commitment will depend on either offering substantial new benefits or ensuring that participatory activities meaningfully overlap with and complement their existing engagements.

Voluntary organisations and associations are essential to co-participatory processes for developing and sustaining healthy corridors in cities. However, achieving sustainable outcomes requires the creation of shared visions between these organisations, their members, and other actors involved in the process.

Beyond formally organised groups, grassroots movements and collective initiatives contribute to community life in a variety of ways. Some engage through "participation by irruption" — self-organised actions such as protests, space occupations, petitions, blogs, and flyer distribution — while others pursue what Holston and Sandercock (1998) describe as "insurgent practices": community kitchens, shared allotment gardens, self-organised cultural activities, community patrols, and other horizontal forms of neighbourhood solidarity aimed at improving daily life and local services. Even within top-down institutional frameworks, less formalised but valuable forms of outreach exist, such as on-the-spot surveys, neighbourhood walks, and direct dialogue between civil servants or construction workers and local residents.

As a result, GreenEsteem mapping local participatory culture therefore needs to encompass informal agents and movements that are open, flexible, and dynamic, in order to understand how and where to engage people outside institutional structures. This includes social institutions that foster community bonds and socialisation — such as churches, religious groups, neighbourhood networks, and public services — as well as informal gatherings that arise organically from daily life, such as caretakers meeting at playgrounds, parents connecting through school communities, cycling and walking groups, and gym communities. Political party members and other role-based social groups equally form part of this broader participatory landscape.

By connecting residents with urban planners and local authorities, **housing (condominium) associations** ensure that community needs are embedded in NBS projects, fostering a sense of ownership and shared

responsibility (Bernardi et al., 2018; Czischke, 2018). They also coordinate the pooling of shared resources, securing funding and leveraging partnerships with local governments and private actors to support sustainable initiatives (Bernardi et al., 2018; Veer & Schuiling, 2005). Through innovative governance models such as the "City as a Commons" framework, they experiment with new forms of housing and urban regeneration that can catalyse broader sustainability transitions (Bernardi et al., 2018; Hal & Femenias, 2009). Housing associations contribute to knowledge valorisation by capturing, storing, and disseminating sustainability-related knowledge to support the planning and execution of housing projects (Leblanc et al., 2015). Organisational learning processes — including the analysis of defect data — help improve construction practices and modes for public space management and build a stronger collective knowledge base over time (Hopkin et al., 2018). Collaboration with local governments, residents, and private partners further enables access to the expertise and resources needed for effective NBS implementation (Czischke, 2018). Despite their significant potential, housing associations face challenges including complex governance structures, funding constraints, and the need to balance diverse stakeholder interests. Integrating local knowledge with expert insights requires effective communication and collaboration among all parties involved (Santoro et al., n.d.; Priemus, 2005). Nevertheless, their capacity to drive sustainable urban transformation remains considerable, particularly in contexts where innovative governance models and strong community partnerships are in place.

Local champions play a pivotal role in mainstreaming NBS within urban governance by advocating for their benefits and integrating them into policy and planning frameworks. Drawing on examples such as Melbourne's urban forest strategies, they help reshape institutions and build pathways for sustainability transitions, while also fostering collaborative mindsets and sustaining long-term commitment to overcome implementation barriers (Adams et al., 2024). Champions facilitate the integration of local and indigenous knowledge into NBS planning, ensuring solutions are tailored to specific community needs and environmental conditions (Yu & Mu, 2023). Through participatory engagement — such as the Group Model Building approach applied in Brindisi, Italy — they help disseminate knowledge, build consensus, and enhance social justice and liveability in urban areas (Santoro et al., 2024). Local champions contribute to capacity building by organising training and educational programmes that raise awareness of NBS benefits and help overcome knowledge-related barriers at neighbourhood, municipal, regional, and national levels (Nature4Cities, 2022). They also support the development of decision support systems and evaluation frameworks that guide effective NBS design and implementation in line with urban sustainability goals (Datola & Oppio, 2023). Champions facilitate multi-stakeholder collaboration by aligning diverse interests and fostering partnerships between government agencies, community groups, and private sector actors (Vries et al., 2024). This collaborative approach enables adaptive management and the institutional embedding of NBS through the sharing of resources, knowledge, and expertise across sectors (Vries et al., 2024).

Citizens

Four distinct role types can be identified among citizens participating in co-creative processes: the interacting role, the group-oriented role, the task-oriented role, and the production role, each requiring different levels of commitment, skills, and immersion (Barcellini, Prost & Cerf, 2015).

The interacting role encompasses participation in discussions, meetings, workshops, and digital platforms, and is relevant across all phases of the NBS lifecycle. During co-diagnosis, it involves expressing needs, observations, and aspirations; during co-selection, formulating problems and articulating reasoning behind choices; during co-design, proposing criteria and responding to outline proposals; during co-implementation, active participation in delivery activities and maintanance; and during co-monitoring, contributing observations and reflections. To ensure representativeness, this role should be carried out by and with a diverse group that gives voice to all community members.

The group-oriented role focuses on coordinating others, supporting fellow participants, and contributing to decision-making across all five phases. Those who take on this role are typically well-networked within the

community, possess strong motivational skills, and often already hold coordinating functions within formal or informal organisations. They are able to connect the goals of the co-creative process with their broader daily activities and aspirations, making them instrumental in mobilising citizens and setting the conditions for effective participatory engagement throughout the entire process.

The task-oriented role involves transferring knowledge from users and participants into the design process, with individuals contributing specific expertise at each phase. During co-diagnosis, this includes gathering, recording, and communicating citizen observations and survey responses, as well as promoting participation opportunities. During co-selection, it involves disseminating and explaining NBS options and their trade-offs. During co-design, it encompasses facilitating the process, making materials available, and helping communicate design options. During co-implementation, it includes sustaining and maintaining the NBS and communicating its use and results. Finally, during co-monitoring and evaluation, it involves gathering and recording citizen feedback and change suggestions.

The production role concerns the tangible creation of designs, prototypes, and installations that can be tested, discussed, and evaluated. During co-diagnosis, this might involve producing visual materials or photos and videos of the area. During co-selection, it includes producing scaled or tailored NBS representations and tools such as billboards to support the selection process. During co-design, it encompasses developing prototypes, digital reproductions, and business models. During co-implementation, it involves physical maintenance, harvesting outputs, and producing events or artworks associated with the NBS. During co-monitoring, it includes developing displays, software tools, and documentation of citizen experiences.

In terms of skills, the interacting role requires no specific competences, while the remaining three roles each demand particular capabilities. The group-oriented role calls for motivational and facilitation skills and access to community networks. The task-oriented role requires strong communication, administrative, and technical skills alongside relevant subject expertise. The production role demands creative and technical abilities such as illustration, 3D design, prototype building, and digital content production.

Beyond the formal roles outlined above, it is essential to recognise that every individual brings valuable knowledge rooted in their own lived experiences. Cultural and local knowledge should therefore serve as a foundational assumption in the design of participatory solutions, including recognition of diverse rationalities in residential construction, spatial organisation, and the management of locally available resources (Lucas dos Santos, 2018). By creating platforms that genuinely value all voices, participation becomes a shared process of responsibility among all involved. The role categories described are not rigid or closed frameworks but rather practical guides for organising collaborative work in an inclusive and flexible manner.

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