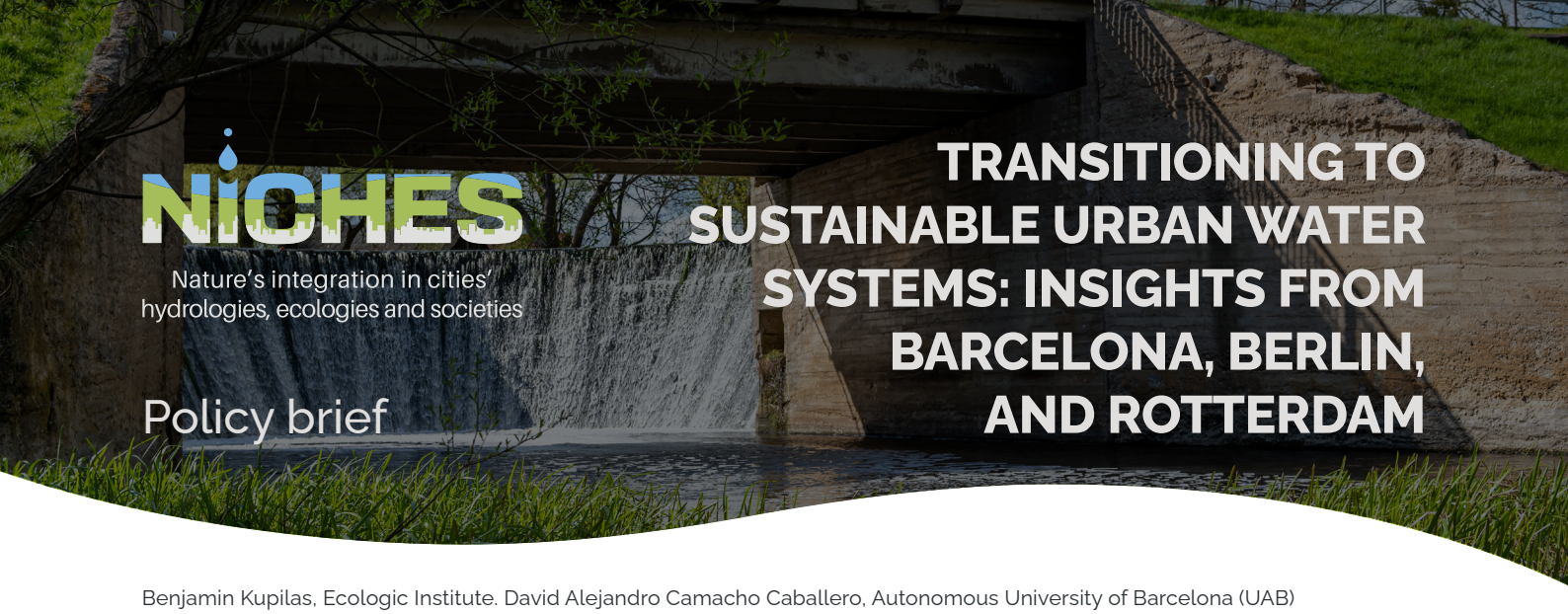

NICHES

Nature's integration in cities' hydrologies, ecologies and societies

Policy brief

TRANSITIONING TO SUSTAINABLE URBAN WATER SYSTEMS: INSIGHTS FROM BARCELONA, BERLIN, AND ROTTERDAM

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KEY MESSAGES

- Nature-Based Solutions (NBS) offer viable, multifunctional alternatives to conventional grey infrastructure by enhancing ecological resilience, social equity, and technical adaptability.
- Despite growing recognition of NBS, implementation is often hindered by fragmented governance, lack of funding, outdated infrastructure, and limited stakeholder engagement.
- While Barcelona, Berlin, and Rotterdam aspire towards comparable sustainable urban water futures, each city follows a distinct path, tailoring its strategies and priorities to local contexts and values. This illustrates that there is no one-size-fits-all solution.
- Transition pathways towards integrated urban water management must embrace participatory governance, cross-sector collaboration, and integrated planning to build resilient, just, and adaptive urban water futures.
- Implementing urban NBS is expected to support urban resilience to climate change while actively supporting the EU biodiversity targets for 2030 and the EU Nature Restoration Regulation by contributing to efforts to halt biodiversity loss.

THE CHALLENGE

Urban areas face compounding water management crises driven by urbanization and ecosystem degradation. Urban water systems are under increasing pressure from climate-induced stressors such as flooding, drought, and combined sewer overflows (CSOs).

Traditional engineering approaches centered around grey infrastructure are ill-equipped to respond to this complexity. NBS, such as green roofs, bioswales, and restored waterways, offer ecosystem-based benefits but often remain insufficiently integrated into urban planning and policy (https://doi.org/10.5751/ES-14182-280225).

Three European cities—Rotterdam, Berlin, and Barcelona—exemplify both the potential and the obstacles of this transformation. Each city grapples with unique technical, ecological, and social challenges, yet shares common barriers in governance and the systemic integration of NBS.

THE APPROACH

This policy brief builds on participatory workshops and systemic assessments conducted in the NICHES project. Using the Socio-Ecological-Technical Systems (SETS) and Three Horizons framework, researchers and stakeholders co-produced pathways for transitioning towards NBS-led water governance (REF).

The SETS framework offers a multidimensional perspective for analyzing the interconnections between human activities, ecological systems, technological infrastructure, and governance mechanisms in urban water management. By emphasizing the co-dependence of technical, ecological, and social components, SETS supports the identification of NBS that are context-sensitive and multifunctional. Particularly in dense urban settings such as those studied in Rotterdam, Berlin, and Barcelona, the framework highlights that institutional arrangements and participatory governance are just as critical for the success and longevity of NBS as their technical performance.

Complementing this, the Three Horizons framework provides a dynamic roadmap for transformation. It distinguishes between current practices (Horizon 1), emerging innovations and enablers (Horizon 2), and long-term systemic visions (Horizon 3). This structure guided the co-production of transition pathways in each city, allowing stakeholders to explore how experimental NBS initiatives today can evolve into resilient, equitable water governance regimes in the future.

Multiple workshops held in the three cities engaged diverse actors—including municipal authorities, utilities, civil society, and academia—along all three horizons. These sessions aimed to identify present challenges, transition innovations, and long-term visions. Results reveal a consistent need for cross-sector collaboration, integrated planning, and context-specific technical solutions.

TRANSITION PATHWAYS: INSIGHTS FROM THREE MAJOR CITIES

Barcelona

Horizon 1: Despite active citizen platforms, institutional fragmentation limits effective stormwater management and results in uneven NBS uptake and high surface sealing; fragmented habitats weaken ecological performance; outdated infrastructure is found across the city.

Horizons 2–3: Focus on circular water systems, digital tools, and harmonized technical standards for NBS underpin resileint infrastructure; inclusive governance drives equitable NBS adoption; ecological goals center on embedding green corridors.

Key Need: Harmonize planning and elevate ecological connectivity through multifunctional spaces.

Berlin

Horizon 1: Fragmented institutional responsibilities and weak coordination hinder integrated planning; ecological degradation is driven by CSOs and surface sealing; inflexible infrastructure combined with enforcement gaps limits system's adaptability.

Horizons 2–3: Participatory platforms, legal clarity, and collaborative governance foster social engagement; ecological goals prioritize biodiversity corridors and unsealing of impervious surfaces; digital monitoring and sustainable materials drive resilient system.

Key Need: Institutional reform and systemic coordination to scale decentralized NBS.

Rotterdam

Horizon 1: Reliance on outdated grey infrastructure hampers adaptability and resilience to extreme weather events; low public awareness limits public involvement; insufficient green space negatively impacts urban biodiversity.

Horizon 2: Emphasis on regulatory reform and rainwater taxation can align urban policy with climate goals; material and infrastructure innovations support ecological resilience; participatory education and collaborative platforms foster public engagement.

Key Need: Integrate ecological thinking into robust water infrastructure planning.

CROSS-CITY INSIGHTS

Social	Governance remains fragmented, with limited participation across cities. Transition requires co-produced, transparent, and inclusive decision-making frameworks, supported by capacity building and public education.
Ecological	Urban ecosystems often remain disconnected, limiting biodiversity and ecological function. Restoring ecological connectivity through blue-green infrastructure and unsealing surfaces is critical for ecological resilience.
Technical	Outdated infrastructure hampers adaptation. Investment in decentralized, flexible, digitally supported systems and sustainable material innovations is vital.

POLICY IMPLICATIONS AND RECOMMENDATIONS

The transition pathways co-developed across Rotterdam, Berlin, and Barcelona offer valuable insights into overcoming persistent challenges in urban water governance. Drawing from these city-specific experiences, the following recommendations aim to strengthen institutional frameworks, foster inclusive participation, and maximize the multifunctional benefits of Nature-Based Solutions for climate-resilient urban water management.

- **Institutional Integration:** Align water governance with climate, land use, and biodiversity strategies across administrative levels.
- **Participatory Planning:** Institutionalize co-creation through advisory councils, participatory budgeting, and digital platforms.
- **Incentivize Innovation:** Support NBS pilots with dedicated funding, tax benefits, and clear technical standards.
- **Ecological Restoration:** Prioritize unsealing surfaces, habitat connectivity, and the multifunctionality of green spaces.
- **Digital Monitoring:** Advance smart infrastructure to enable real-time, adaptive stormwater management.

The transition towards NBS-led water governance is not only a technical challenge—it is a societal and institutional one. As cities continue to confront climate uncertainty, the pathways identified through NICHES provide a blueprint for resilience. Investing in inclusive, adaptive, and ecological urban systems today will ensure equitable and sustainable water futures tomorrow.

PROJECT OBJECTIVES AND METHODOLOGY

The NICHES project explores the potential of NBS to address the growing challenges posed by heavy rainfall events that overload combined sewage systems, leading to contamination and aquatic biodiversity decline. The project seeks to develop sustainable, resilient solutions to manage stormwater and mitigate the negative impacts of CSO on aquatic ecosystems. The project employs a SETS approach to co-create knowledge on restorative NBS and assess their ecological, social, and economic impacts.

Key objectives of NICHES include:

- Co-creating knowledge on restorative NBS to prevent stormwater run-off;
- Analysing the ecological, social, and economic impacts of CSO events and evaluating the mitigation potential of NBS;
- Developing an integrated framework to assess trade-offs and synergies between urban needs and NBS implementation;
- Co-creating pathways for integrating NBS into existing policy frameworks.

These objectives are achieved using various methods and tools, such as targeted stakeholder interviews and workshops, literature review, policy content analysis, the Diagnostic Water Governance Tool, scenario analysis and mapping, among others. This holistic approach employing both qualitative and quantitative methods from various disciplines allows to comprehensively address the complex issue of effective NBS implementation for stormwater management in a transforming urban setting.

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PROJECT IDENTITY

PROJECT NAME

Nature's **I**ntegration in **C**ities' **H**ydrologies, **E**cologies and **S**ocieties

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CONSORTIUM

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April 2022 – March 2025 (36 months)

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