National Urban Research & Extension Center

Building Resilient Cities: The Role of Nature-Based Solutions in Urban Planning

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About NUREC

The National Urban Research and Extension Center (NUREC) is a collaborative membership-based nationwide organization for land grant universities that facilitates the co-creation and application of knowledge; enabling urban communities to improve the health and wellbeing of all residents, achieve equitable economic growth, and steward their natural environments. NUREC bridges the gap between community and research by applying the unparalleled power and reach of the land-grant university system, rooted in Extension's community-centered approach to address our nation's urban challenges.

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Introduction

Nature-based solutions (NbS) have the potential to achieve mutual benefits for people and nature by reducing CO2 emissions, creating green jobs, unlocking approximately 10 trillion USD of business opportunities, and lowering biodiversity loss by 50% (International Institute for Sustainable Development, 2021). One key aspect of NbS is their ability to address urban challenges holistically, offering nature-integrated solutions that provide layered ecosystem services and human health benefits while addressing environmental issues and supporting urban growth. There is a need to begin mainstreaming NbS in urban planning policy with a goal of implementing long-term climate resilience by involving local communities in participatory approaches.

NbS can be divided into three primary categories: **restorative solutions,** which prioritize restoring degraded ecosystems, **adaptive solutions,** which integrate NbS into existing infrastructure, and **transformative solutions,** which aim to implement changes in policy to mainstream NbS (Welden et al., 2021). Additionally, Sowińska-Świerkosz & García (2022) describe NbS as initiatives that are influenced and powered by nature, address or solve societal problems, provide numerous services/benefits, are highly effective and economically beneficial, and are context-specific.

Nature-based Solutions (Nbs) are natural processes, developed or modified, to address human-based environmental issues (e.g., managing storm water runoff with rain gardens)

Ecosystem Services are benefits to humans that are derived from natural systems (e.g., using trees to shade homes and reduce indoor temperatures to replace or reduce the use of air conditioning)

To realize the full transformative potential of NbS, there is a need to recognize their multi-functionality, economic benefits, and need for scalability. We posit that by integrating NbS into existing infrastructure, enhancing collaboration, fostering public-private partnerships, and engaging communities, NbS can produce transformative policy changes. Furthermore, the accompanying Sankey diagram (Figure 1, interactive Sankey diagram available online https://public.flourish.studio/visualisation/19906715/) provides a visual of the interconnected benefits of NbS and how ecosystem services can be amplified to maximize them. The Sankey diagram can serve as a decision-making tool for practitioners and policy makers to identify and/or justify interventions that span multiple sectors. Additionally, the diagram aids in linking the benefits for diverse stakeholders (water management, transportation, health, biodiversity, etc.) and the need for involving communities and multiple sectors in their planning.

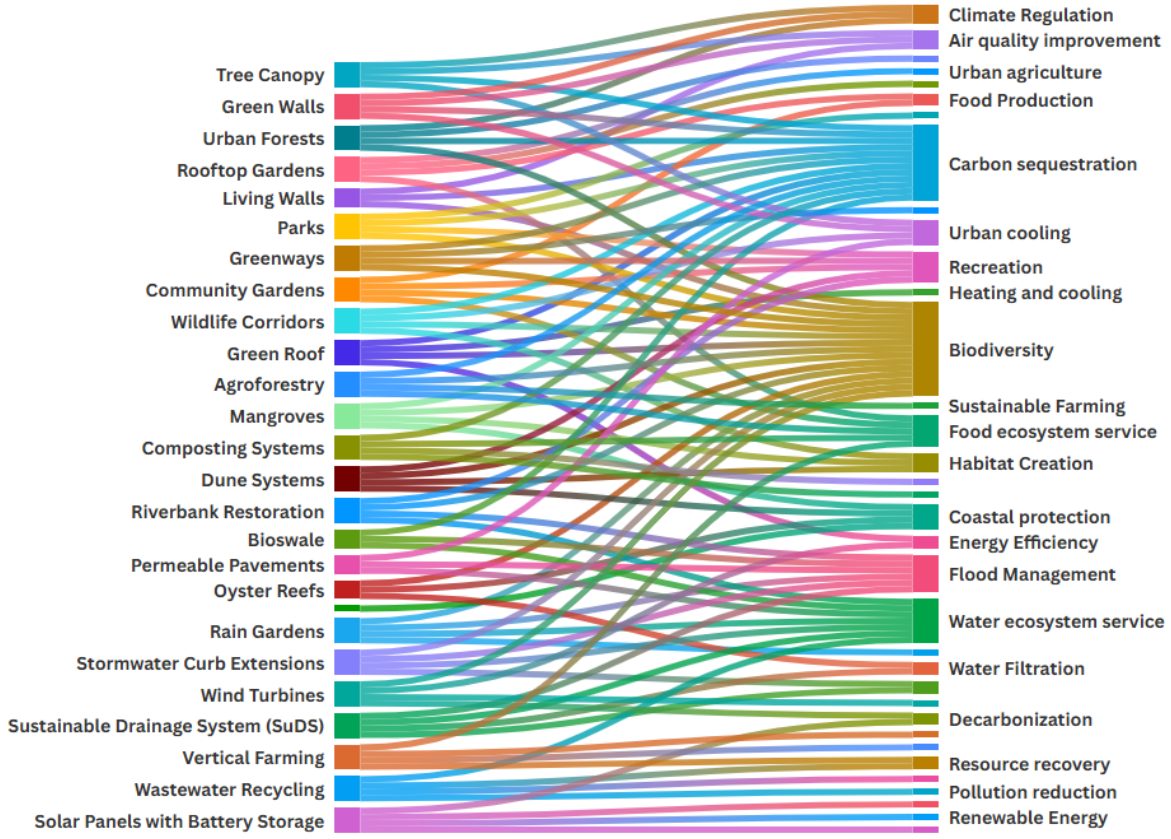

Figure 1. Sankey diagram of potential nature-based solutions (left side) and ecological benefits provide (right side). Interactive diagram available here: https://public.flourish.studio/visualisation/19906715/. *Diagram developed by E. Blondell using Flourish template.*

NbS are increasingly relevant to urban planning as cities face the various consequences of a changing climate (floods, heatwaves, storms, droughts, etc). Urbanization is projected to escalate (68% of the world's population will be living in urban areas by 2050), and these issues will intensify, threatening food security, human health and well-being, and economic security (World Bank, n.d.). Whereas traditional grey infrastructure only supports one concern at a time (i.e., roads or water systems), we can harness the mutual benefits of NbS into a pathway towards sustainable and green growth. Nature-based solutions provide an array of ecosystem services and are cost effective alternatives to gray infrastructure. In fact, NbS could mitigate over 11,000 Tg CO2e per year at a cost of less than $100 per ton, with over 4,000 Tg CO2e mitigated for less than $10 per ton. This would more than offset the approximate 7,000 Tg CO2e of yearly emissions from the global transport sector, all while preserving food security and biodiversity (Griscom et. al., 2017). For example, Philadelphia's city-wide Green City, Clean Waters program is projected to save the city $8 billion over a twenty-five-year implementation period, compared to the traditional gray infrastructure required by the U.S. EPA in an agreement created to control the city's stormwater. By investing in NbS, we can address climate challenges while fostering resilience and sustainability.

Moreover, environmental challenges that accompany growing cities disproportionately impact disadvantaged and marginalized communities. Since NbS engages multiple stakeholders, disenfranchised citizens can be involved in their realization. This approach would create stewardship for locations co-created and vetted through and with the community (Hunter, 2011). Successfully implementing NbS also encourages an institutional approach, prioritizing inclusivity and advancing equity and justice throughout the planning cycle, ensuring that the benefits of these solutions are shared fairly across all demographics.

Place-Based Approaches and NbS

Urban areas function as interconnected socio-ecological systems where human and environmental needs must be balanced for best results. NbS must address both ecological functions and human needs. According to Morgan et al. (2024), place-based approaches like the Guided Transformation (GT) framework can guide communities in navigating these complex systems by integrating ecological and social perspectives. Utilizing these practices ensures that NbS are designed not only to enhance ecological resilience but also to meet the diverse needs of urban populations, fostering sustainable and inclusive growth.

The GT framework is guided by the following principles:

- Inclusive decision-making by involving diverse stakeholders at different scales to ensure all perspectives are considered.
- The co-creation of a shared goal for the future, based on the values and aspirations of the community to ensure alignment with local priorities.
- Embracing change and uncertainty by implementing interventions that are dynamic and can adjust to the evolving nature of socio-ecological systems.
- Promoting capacity building and contributing to long-term ecological and social resilience.

To illustrate the effectiveness of place-based approaches, landscape architecture firm SCAPE designed an 11-acre estate in the Hudson Valley drawing inspiration from the region's natural landscapes. By integrating contemporary art into the property, reorganizing circulation, enhancing existing natural features, and restoring local grassland ecosystems, the project creates a space that simultaneously respects and protects the local environment while fostering meaningful human interaction with nature.

Similarly, Biohabitats uses a place-based approach to ecological restoration, conservation planning, and regenerative design which integrates NbS to strengthen urban resilience. Their projects focus on restoring degraded ecosystems, enhancing water management systems through stormwater conveyance, and developing landscapes that function as part of the surrounding natural environment. By prioritizing local ecological contexts and cultural contexts, Biohabitats ensures its solutions are adapted to the distinct needs of each site, reinforcing the multi-functionality of NbS. Their work demonstrates how cities can embrace nature to address environmental challenges while fostering social and ecological well-being.

NbS can support local job creation by fostering workforce development in installation, operation, and long-term maintenance, possibly more than gray infrastructure, which favors larger businesses. Practically, these interventions can involve training programs that equip residents with competencies and knowledge in ecological restoration, native species planting, hydrological monitoring, or community stewardship. Local governments can partner with NGOs, community centers, or local schools to establish certificates, apprenticeships, and service contracts for tasks such as bioswale upkeep, tree canopy management, or rain garden installation (NatureScot, 2025). By enabling the training and employment of a hyper-local workforce, NbS can contribute to economic opportunities within communities while reinforcing ecological resilience (Raymond et al., 2017). Additionally, place-based solutions that address local concerns are more likely to succeed, tailored as they are to the specific environmental and social needs of the area, which ensures long-term sustainability and community support. To explain, place-based NbS draws on local ecological knowledge, responds to locally identified environmental and social needs, and builds community ownership through participatory planning, co-management, and stewardship. By collaborating with local authorities, community organizations and residents, socio-economic co-benefits are enhanced alongside ecological resilience (Cabling et al., 2024). NbS projects can mitigate unemployment (Boyle and Kuhl, 2021), increase incomes by targeting new markets, and support climate resilient livelihood opportunities.

For example, as shown in Figure 1, implementing a nature-based solution such as a rooftop garden on an office or apartment building can provide a range of benefits. Ecologically, it supports urban agriculture, local food production, and biodiversity by providing a habitat for pollinators. Socially, rooftop gardens can foster community engagement, educational programming, and improved mental well-being through access to green space. From an economic perspective, it can reduce energy costs through insulation and provide local job opportunities in garden maintenance and food production. As a place-based intervention, rooftop gardens can respond to specific local needs such as food insecurity or lack of green space, while contributing to wider urban sustainability goals.

Current State of Nature-Based Solutions and Place-based Approaches

Nature-based solutions have recently appeared within the purview of urban sustainability discussions as a viable alternative to traditional infrastructure approaches. Cities, design firms, community groups, and private developers are embedding NbS into their projects' design parameters and implementation strategies to address a range of phenomena: climate adaptation, stormwater management, biodiversity loss, and urban heat (Seddon et al., 2023, Orta-Ortiz & Susana, 2022, Albert et al., 2017, Hayes et al., 2022). When implemented correctly, these interventions offer multiple returns or co-benefits for added economic, social, and environmental value (Brundtland, 1987). Addressing each pillar of sustainability: environmental, social, and economic (Reames & Wright, 2021), NbS have demonstrated the capacity to attract both private and public investors (Biasin et al., 2024).

During the last decade, cities and others utilizing NbS have engaged in post-occupancy evaluations for NbS projects, focusing on the performance of these interventions and the systems in which they work (LAF, 2025). Examples of NbS evaluations include but are not limited to: a metric to evaluate a green roof's seasonal stormwater retention, a restored wetland's biodiversity gains, or demonstrations of the social and health benefits of tree-lined streets. These evaluations and assessments demonstrate how each intervention contributes to the overall system's performance once they are implemented or retrofitted to a site (LAF, 2025). Organizations such as the Landscape Architecture Foundation's Case Study Inventory (LAF CSI) program provide a robust framework and toolkit for such evaluations and performance standardization (LAF, 2025). LAF's CSI program operationalizes a shared set of performance indicators across environmental, social, and economic dimensions, providing an open-access and transferable platform and inventory for projects to be analyzed across a range of geographies and project scales.

Within the current state of NbS, there are many advances to analyze conditions, performance, and the municipal or regional network performance of these solutions, but more research is needed. The fields of design and planning require large scale meta-analyses and consistent evaluation units to compare outcomes and evaluations across different socio-political contexts, scales, and eco-regional climates. Variations in measurement, project grain and extent, and lack of consistent units make project comparison difficult or irreplicable. Expanding participation and defining specific measurable units in programs such as LAF's CSI, United Nations Sustainable Development Goals (UN SDGs), and the U.S. Green Building Council (USGBC) LEED and SITES program (USGBC, 2025) could encourage agency participation and elicit standardization across approaches.

Place-based design and planning approaches offer an additional layer of complexity and value to NbS. Strategies that address specific community needs encourage local stakeholder buy-in to solutions as well as commitment to stewardship of those same system interventions, thus enabling long-term management and sustainability (Ferguson et al., 2017; Kliskey et al., 2023). One such example would be designing urban greening programs to align with a municipality's urban forest or legacy tree program, with the intent of addressing neighborhood-level heat vulnerability. This type of program ensures that residents feel connected to their communities and the natural systems in which they live.

Funding agencies such as the U.S. National Science Foundation (NSF) are also signaling a shift towards 'use-defined' research (i.e. projects shaped by co-production of the needs of people and organizations that ultimately utilize the interventions). Recent NSF programs such as the Technology Translation Partnership (TTP) and Confronting Hazards, Impacts, and Risks for a Resilient Planet (CHIRRP) emphasize this concept while incentivizing research for place-based, stakeholder-driven infrastructure interventions. Both programs seek to align models and frameworks with on-the-ground testbed initiatives. NbS networks and system meta-analyses can provide viable options for proof-of-concept comparisons and exemplary projects.

In summary, NbS and place-based solutions, in conjunction with one another, are on the rise within policy and funding support. However, strengthening the evidence to support their efficacy through performance evaluation is a critical part of this discussion. Longitudinal analyses, meta-analyses of overall system performance, and shared frameworks for evaluation will ensure NbS design and planning success answer to regional and community needs. Bringing performance metric programs into planning and policy will be key to ensure NbS principles and overall objectives match the needs of communities and the places they inhabit.

Multi-functionality

Another advantage of NbS over gray infrastructure is its ability to provide multiple benefits simultaneously while addressing economic, environmental, and social challenges. For example, Figure 1 demonstrates how urban forests can regulate climate, support biodiversity, and encourage carbon sequestration.

Copenhagen's Climate-Resilient Parks offer several examples of the multi-functionality of NbS systems in action. Remiseparken Park, for instance, was built as an inclusive green space at the center of a public housing development. The park features playgrounds, farm animals, kitchen gardens, and provides protection against cloudbursts. Additionally, Remiseparken includes a retention basin that supports biodiversity and collects and filters stormwater along a 2,000 cubic meter trench. The park has won two awards and is visited by an estimated 80,000 people annually.

Similarly, Grønningen-Bispeparken Park was designed with water management in mind. The park features a 3,000 cubic meter trench and retention basins to store stormwater, 18 bioswales that treat and filter stormwater, and several areas where residents can enjoy the surrounding natural environment (UNI Editorial, 2025). Moreover, the park was designed through the collaboration of a variety of stakeholders. Residents were able to attend meetings to have their voices heard by project architects and experts in fields such as water management, concrete work, fire safety, and traffic planning.

These examples highlight the co-benefits of NbS (i.e., supporting social-ecological connectivity in local communities). While the parks provide critical ecosystem services like improving air quality, supporting biodiversity, and managing stormwater, they also serve as a functional outdoor space for the community that provides long-term environmental, social and cultural advantages. The different areas in the parks – such as the kitchen gardens, playgrounds, and spaces for social events – all contribute to residents' health and improved climate resilience.

Additionally, the parks encourage residents to engage with nature, promoting environmental education and fostering stronger connections between residents and their surrounding ecosystems. These inclusive spaces can improve the physical and mental health of local community members and develop environmental stewardship over their local environment, leading to long-term environmental, social, and cultural sustainability.

Co-production

Co-production is a collaborative governance model that advances policy transformation in urban governance through promoting ongoing engagement, empowerment, and co-stewardship. A people-centered approach, it can be executed and defined in various ways, but consistently requires a nuanced, context-specific strategy that brings together local governments, technical experts, charities/NGOs, community groups, and researchers, from design through implementation. This set of practices easily integrates localized nature-based solutions into policy creation at the community level.

Co-production also has the capacity to spur use-inspired research to build community and/or stakeholder stewardship, support and buy-in into the adoption of NbS, thereby shortening the lag-time or acceptability process of public acceptance (Ferguson et al., 2017).

In addition, co-production of knowledge within a community (i.e., an empowering form of community-engaged research), has the capacity to demonstrate, communicate and provide training for community members, both in the context of practical application and in the enactment of transdisciplinary science (Norstrom et al., 2020). All such learning and experience on the part of citizens advances the implementation of NbS across time.

Mitlin (2008) emphasizes the political aspects of co-production by arguing that, “attention must be given to co-production as a political process that citizens engage with to secure changes in their relations with government and state agencies, in addition to improvements in basic services.” Similarly, Hickey and Mohan’s (2005) framework highlights that co-production must be part of a political venture that questions power relations and confronts structures of oppression, both of which are often revealed through community enactment of NbS. These perspectives highlight the transformative potential of co-production when it is used not only in service delivery but also to reshape governance.

Complementing these critical perspectives, the International Association for Public Participation (IAP2) provides a practical framework for understanding the gradations of co-production through their Spectrum of Public Participation. The Spectrum outlines five increasing levels of public involvement in decision-making: inform, consult, involve, collaborate, and empower. Each level reflects a deeper commitment to stakeholder engagement from simply informing the public to empowering the public to final decision-making power. The spectrum explains the public's role at each stage and the corresponding promise made by decision-makers, ranging from providing the public with information to implementing what they decide. This framework helps institutions plan effective co-production initiatives by clarifying the role of the public at each stage and the corresponding responsibilities of decision-makers, to support transparent community engagement strategies (Figure 2).

These frameworks are illustrated in an example from Hölscher et al., (2024) in Poznań, Poland. Here, a co-produced project aimed to create green classrooms and open gardens in kindergartens to enhance urban sustainability, promote environmental education, and foster community engagement. The project involved multiple stakeholders, including Poznań’s Department of Education, parents, NGOs, and teachers. Workshops and consultations encouraged these groups to contribute their ideas, while carefully designed activities allowed children to share that input as well. This example demonstrates how co-production can be mobilized across different levels of public participation to generate inclusive, place-based NbS tailored to local needs and values.

Green Gentrification

Significant disparities already exist in the distribution of and access to greenspace, specifically in relation to race and income. In the US, various studies (Anguelovski et al., 2022; Loukaitou-Sideris & Mukhija, 2020) have acknowledged inequalities based on race and socio-economic status regarding park provision. Ethnic minorities and lower socioeconomic communities have access to fewer acres of parks, fewer acres of

park per person, and lower park quality, maintenance, and safety compared to more privileged individuals. These discrepancies are often reflected in the geographical division between inner cities and suburbs. As a result, marginalized groups experience lower public health outcomes, both physical and mental, than their economically advantaged neighbors (i.e. Baltimore, New York City, Denver; Rigolon, 2016).

However, the introduction of green infrastructure, such as greenways or parks, can trigger green gentrification by increasing property values and attracting wealthier residents, which often leads to the displacement of lower-income communities. This phenomenon has been documented globally; countries include the US, Spain, Belgium, and South Korea (Jelks et al., 2021). Green gentrification often undermines its intended purpose of improving health equity for existing residents. Addressing this goal requires a justice-based approach focused on sharing the health, economic, and social benefits of green infrastructure with all residents, particularly lower-income households.

Studies have found that green spaces in gentrifying neighborhoods are normally planned to cater to the tastes and needs of wealthier White newcomers, rather than those of long-term, low-income residents of color. Thus, a co-production approach where marginalized residents can take part in the planning and design of NbS from the inception of the project can reduce instances of green gentrification. To illustrate, Mullenbach et al. (2019) found that community engagement in park design in Philadelphia was associated with community ownership of renovated parks and seen as an important part of the social fabric of the neighborhood. Similarly in Los Angeles, park promoters were used to increase community engagement in park programming and planning in underprivileged neighborhoods (Loukaitou-Sideris & Mukhija, 2020). The promoters were successful in increasing access for marginalized individuals in the planning and programming of culturally relevant events by State Parks in a trusting environment.

When residents are involved in meaningful, early, and regular engagement in urban greening projects, their voices can be heard in crucial planning aspects such as cultural preferences, everyday needs, and cost of services.

Levels of Community Involvement, Impact, Trust, and Communication Flow

Outreach	Consult	Involve	Collaborate	Shared Leadership
Entities aware of each other	Entities share information	Entities cooperate	Entities work together closely	Entities in bi-directional relationship
Unidirectional comm flow	Comm. Focused on answering questions(s)	Comm flows both ways to ask and answer	Comm flows both ways to ask and answer	Final decision – making is at community level
Provides information to community	Gets information/ feedback from community	Involves more participation with community on parts of project	Partnerships for each aspect of the project – from development to solution	Strong, fully integrated partnerships
Outcome: Builds comm channels, shares new knowledge	Outcome: Develops a relationship between entities	Outcome: Establishes a cooperative partnership.	Outcome: Trusted partnership	Outcome: Broad impacts, strong trust

Figure 2. Levels of community engagement and core features of each used in developing community-engaged research. Modified by J. Padowski from International Association for Public Participation in NIH Publication 11-7782. Used with permission

Discussion

Opportunities for National Urban Extension

The National Urban Extension Leaders (NUEL) presented a strategic analysis of urban Extension opportunities in The National Framework for Urban Extension (NUEL Steering Committee (NUEL et al., 2015)).

Extension has many opportunities to embrace and advance NbS; the examples below are arranged by four common themes that emerged in the literature on the unique aspects of urban Extension:

- **Positioning**: How Extension is positioned at the national, state, regional, and city levels
- **Programs**: How Extension addresses the multitude of issues and priorities in the city
- **Personnel**: How Extension attracts, develops, retains, and structures competent talent
- **Partnerships**: How Extension collaborates to leverage resources for collective impact

Positioning

Nature-based solutions provide a wealth of positioning opportunities for urban Extension, including:

- Providing the research-based expertise needed to develop and implement specific projects, which involves positioning Extension as the conduit or front-door to the University for local communities.
- Serving in a convening role for the co-production of projects, thereby demonstrating how Extension can also serve to support multiple organizations and knowledge systems to spur collaboration.
- Conducting existing programs or developing new ones that support or complement NbS.
- Evaluating or assessing direct benefits of NbS or of targeted co-benefits (e.g. human health, community development, etc). This work could include partnering with the Landscape Architecture Foundation in their Case Study Inventory program.

Programs

There are several existing programs that connect with NbS practices (left side of Figure 1), such as Master Gardeners and several natural resource-based programs. There is also an expanded opportunity to connect these activities to core health and nutrition programs (e.g. community gardens with EFNEP programs) as well as newer programs in development around food as medicine.

Additionally, Extension can develop training modules around the skills necessary for various NbS program and partner with the Extension Foundation's Campus or Catalog to offer workforce development programs to support local jobs and economic development associated with NbS. Such programming could support the training of a local workforce to help design, install, and maintain NbS projects, thus countering some gentrification concerns.

Extension can also develop and host programs that focus on citizen input (e.g., hosting community forums to build support for NbS in various projects). The University of Florida/Institute for Food and Agriculture's Community Voices, Informed Choices (CIVIC) program is one example of such an Extension program.

Personnel

Nature-based solutions also provide opportunities to connect with 'traditional' Extension personnel approaches and expertise – e.g. community development and natural resource educators who develop programming related to a content area, or identifying university-based expertise to support community decision-making around NbS issues on purpose, design, implementation, evaluation, and impact.

In addition, Extension could innovate in the creation of new leadership roles for its personnel, where they could act as conveners / co-producers focused on developing NbS space for community engagement.

Partnerships

Many of the positioning and program opportunities discussed above can help foster partnerships associated with NbS. Programs that support capacity-building, policy advocacy, and technical guidance will bring new partnerships to Extension. This would include working with local municipalities to integrate NbS into urban planning frameworks and / or developing public-private partnerships with the same goal. Extension could also partner with organizations or campus-based faculty to develop and support local knowledge-sharing platforms around NbS. One such example would be the University of Missouri's Center for Applied Research and Engagement Systems (CARES) community hubs.

Additional opportunities for Extension related to green infrastructure can be found in NUREC's Leading Edge Dialogue Series (PDF), specifically in their publication on green infrastructure (PDF).

Conclusion

Nature-based Solutions (NbS) offer a transformative path for creating resilient, equitable, and sustainable cities. As the evidence demonstrates, these interventions extend well beyond environmental management, linking ecological restoration with social well-being, economic vitality, and community identity. By embedding NbS within the fabric of urban planning and policy, cities can simultaneously address climate adaptation, biodiversity loss, and public health challenges while cultivating inclusive and participatory governance. The place-based frameworks outlined throughout this paper underscore that when communities, researchers, and policymakers collaborate, NbS become more than infrastructure — they become shared systems of care.

Advancing NbS depends on continued refinement of performance evaluation and large-scale comparative studies to ensure that their long-term impacts are both measurable and replicable. Equally important is a justice-centered design process that recognizes the risks of green gentrification and ensures that benefits are equitably distributed. Co-production models, emphasizing shared leadership and community expertise, provide a practical and ethical framework for integrating marginalized voices into NbS planning from inception through stewardship. Such approaches foster trust, build capacity, and secure the local commitment necessary for enduring success.

For Extension, NbS present a timely opportunity to align mission, method, and impact. Positioned at the intersection of research and community engagement, Extension can convene cross-sector partnerships, translate science into policy, and guide implementation through locally relevant programming. Strengthening personnel expertise in design, evaluation, and facilitation, expanding programs that link environmental and human health, and fostering partnerships across municipal, academic, and private sectors together form the scaffolding for sustained progress.

As climate pressures intensify and urban populations continue to grow, the integration of NbS into planning and policy is no longer optional — it is essential. Through collaborative research, co-produced knowledge, and community-centered implementation, Extension and its partners can help realize the full transformative potential of NbS: cities and regions that not only adapt to change but thrive within it, sustaining both people and the planet for generations to come.

References:

Albert, C., Spangenberg, J. H., & Schröter, B. (2017). Nature-based solutions: criteria. *Nature*, *543*(7645), 315–315. https://doi.org/10.1038/543315b

Anguelovski, I., Connolly, J. J. T., Cole, H., Garcia-Lamarca, M., Triguero-Mas, M., Baró, F., Martin, N., Conesa, D., Shokry, G., Del Pulgar, C. P., Ramos, L. A., Matheney, A., Gallez, E., Oscilowicz, E., Máñez, J. L., Sarzo, B., Beltrán, M. A., & Minaya, J. M. (2022). Green gentrification in European and North American cities. *Nature Communications*, *13*(1), 3816. https://doi.org/10.1038/s41467-022-31572-1

Biasin, A., Toxopeus, H., Pettenella, D., Polzin, F., & Masiero, M. (2024). "Financing urban Nature-based Solutions (NBS): A literature review from the perspective of funders." *Nature-Based Solutions*, *6*, 100195. https://doi.org/10.1016/j.nbsj.2024.100195

Boyle A and Kuhl L. "Nature-based Solutions are Job and Livelihood Solutions" Policy Brief. School of Public Policy and Urban Affairs, Northeastern University and United Nations Development Programme, April 2021. Available at: https://cssh.northeastern.edu/policyschool/wp-content/uploads/sites/2/2021/05/Northeastern-Jobs-and-Livelihoods-brief.pdf

Brundtland, G. (1987). Report of the World Commission on Environment and Development: Our Common Future. United Nations General Assembly document A/42/427.

Cabling, L. P. B., Dubrawski, K. L., Acker, M., & Brill, G. (2024). Harnessing community science to support implementation and success of Nature-Based solutions. *Sustainability*, *16*(23), 10415. https://doi.org/10.3390/su162310415

Ferguson, L., Chan, S., Santelmann, M., & Tilt, B. (2017). Exploring participant motivations and expectations in a researcher-stakeholder engagement process: Willamette Water 2100. *Landscape and Urban Planning*, *157*, 447–456. https://doi.org/10.1016/j.landurbplan.2016.08.014

Griscom, B.W., J. Adams, P.W. Ellis, R.A. Houghton, G. Lomax, D.A. Miteva, W.H. Schlesinger, D. Shoch, J.V. Siikamäki, P. Smith, P. Woodbury, C. Zganjar, A. Blackman, J. Campari, R.T. Conant, C. Delgado, P. Elias, T. Gopalakrishna, M.R. Hamsik, M. Herrero, J. Kiesecker, E. Landis, L. Laestadius, S.M. Leavitt, S. Minnemeyer, S. Polasky, P. Potapov, F.E. Putz, J. Sanderman, M. Silvius, E. Wollenberg, & J. Fargione, (2017) Natural climate solutions, Proc. Natl. Acad. Sci. U.S.A. 114 (44) 11645-11650, https://doi.org/10.1073/pnas.1710465114.

Hayes, A., Jandaghian, Z., Lacasse, M., Gaur, A., Lu, H., Laouadi, A., Ge, H., & Wang, L. (2022). Nature-Based Solutions (NBSs) to Mitigate Urban Heat Island (UHI) Effects in Canadian Cities. *Buildings*, *12*(7), 925. https://doi.org/10.3390/buildings12070925

Hickey, S., & Mohan, G. (2005). Relocating Participation within a Radical Politics of Development. *Development and Change*, *36*(2), 237–262. https://doi.org/10.1111/j.0012-155x.2005.00410.x

Hölscher, K., Frantzeskaki, N., Kindlon, D., Collier, M. J., Dick, G., Dziubała, A., Lodder, M., Osipiuk, A., Quartier, M., Schepers, S., Van De Sijpe, K., & Van Der Have, C. (2023). Embedding co-production of nature-based solutions in urban governance: Emerging co-production capacities in three European cities. *Environmental Science & Policy*, *152*, 103652. https://doi.org/10.1016/j.envsci.2023.103652

Hunter, M. R. (2011). Impact of ecological disturbance on awareness of urban nature and sense of environmental stewardship in residential neighborhoods. Landscape and Urban Planning, 101(2), 131–138. https://doi.org/10.1016/j.landurbplan.2011.02.005

International Institute for Sustainable Development. (2021). Nature-Based solutions as a catalyst for achieving mutual benefits for people, nature, and climate: lessons learned from China and globally. https://www.iisd.org/events/nbs-as-catalyst-for-achieving-mutual-benefits-for-people-nature-and-climate

Jelks, N. O., Jennings, V., & Rigolon, A. (2021). Green Gentrification and Health: A scoping review. *International Journal of Environmental Research and Public Health*, *18*(3), 907. https://doi.org/10.3390/ijerph18030907

Kliskey, A. “Anaru,” Williams, P., Trammell, E. J., Cronan, D., Griffith, D., Alessa, L., Lammers, R., Haro-Martí, M. E. de, & Oxarango-Ingram, J. (2023). Building trust, building futures: Knowledge co-production as relationship, design, and process in transdisciplinary science. *Frontiers in Environmental Science*, *11*, 1007105. https://doi.org/10.3389/fenvs.2023.1007105

Landscape Architecture Foundation. (2025). *Landscape Performance Series*. https://www.landscapeperformance.org/

Loukaitou-Sideris, A., & Mukhija, V. (2020). Promotores for Parks? The potential of a public health model to improve outreach and community engagement in park planning. *Leisure Sciences*, *45*(3), 281–303. https://doi.org/10.1080/01490400.2020.1817202

Mitlin, D. (2008). With and beyond the state — co-production as a route to political influence, power and transformation for grassroots organizations. *Environment and Urbanization*, *20*(2), 339–360. https://doi.org/10.1177/0956247808096117

Morgan, M., A. J. Webster, J. C. Padowski, R. R. Morrison, C. G. Flint, K. Simmons-Potter, K. Chief, B. Litson, B. Neztsosie, V. Karanikola, M. Kacira, R. R. Rushforth, J. Boll, and M. B. Stone. (2024). Guided transformations for communities facing social and ecological change. Ecology and Society 29(4):20. https://doi.org/10.5751/ES-15448-290420

Mullenbach, L. E., Baker, B. L., & Mowen, A. J. (2021). Does public support of urban park development stem from gentrification beliefs and attitudes? *Landscape and Urban Planning*, *211*, 104097. https://doi.org/10.1016/j.landurbplan.2021.104097

NatureScot. (2025). Business Plan 2025/26: Year four of a a nature rich future for all. https://www.nature.scot/sites/default/files/2025-04/naturescot-business-plan-2025-2026-accessible-edition_1.pdf.

Norström, A. V., Cvitanovic, C., Löf, M. F., West, S., Wyborn, C., Balvanera, P., Bednarek, A. T., Bennett, E. M., Biggs, R., de Bremond, A., Campbell, B. M., Canadell, J. G., Carpenter, S. R., Folke, C., Fulton, E. A., Gaffney, O., Gelcich, S., Jouffray, J.-B., Leach, M., … Österblom, H. (2020). Principles for knowledge co-production in sustainability research. *Nature Sustainability*, *3*(3), 182–190. https://doi.org/10.1038/s41893-019-0448-2

Orta-Ortiz, M. S., & Geneletti, D. (2022). What variables matter when designing nature-based solutions for stormwater management? A review of impacts on ecosystem services. *Environmental Impact Assessment Review*, *95*, 106802. https://doi.org/10.1016/j.eiar.2022.106802

Raymond, C. M., Stedman, R., & Frantzeskaki, N. (2023). The role of nature-based solutions and senses of place in enabling just city transitions. *Environmental Science & Policy*, *144*, 10–19. https://doi.org/10.1016/j.envsci.2023.02.021

Reames, T. G., & Wright, N. S. (2021). The Three E’s Revisited: How Do Community-Based Organizations Define Sustainable Communities and Their Role in Pursuit of? *Sustainability*, *13*(16), 8825. https://doi.org/10.3390/su13168825

Rigolon, A. (2016). A complex landscape of inequity in access to urban parks: A literature review. *Landscape and Urban Planning*, *153*, 160–169. https://doi.org/10.1016/j.landurbplan.2016.05.017

Seddon, N., Chausson, A., Berry, P., Girardin, C. A. J., Smith, A., & Turner, B. (2020). Understanding the value and limits of nature-based solutions to climate change and other global challenges. *Philosophical Transactions of the Royal Society B: Biological Sciences*, *375*(1794), 20190120. https://doi.org/10.1098/rstb.2019.0120

Sowińska-Świerkosz, B., & García, J. (2022). What are Nature-based solutions (NBS)? Setting core ideas for concept clarification. Nature-Based Solutions, 2, 100009. https://doi.org/10.1016/j.nbsj.2022.100009

U.S. Green Building Council. (2025). Sustainable SITES Initiative (SITES®). Green Business Certification Inc. (GBCI). https://www.sustainablesites.org/about

UNI Editorial. (2025, February 25). Grønningen-Bispeparken: a groundbreaking Nature-Based climate Park by SLA. UNI. https://uni.xyz/journal/grnningen-bispeparken-a-groundbreaking-n

Welden, E. A., Chausson, A., & Melanidis, M. S. (2021). Leveraging Nature-based Solutions for transformation: Reconnecting people and nature. *People and Nature*, *3*(5), 966–977. https://doi.org/10.1002/pan3.10212

World Bank. (n.d.). Urban Development. https://www.worldbank.org/en/topic/urbandevelopment/overview.

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