URBAN GREEN INFRASTRUCTURE

OPEN GREEN SPACES

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ADDRESSED HAZARDS

PROTECTED CRITICAL INFRASTRUCTURE

Examples of open green spaces in urban setting - grassy lawns, demonstrated here [a] Schenley Plaza, Pittsburgh, PA, USA (photo by S. Paudel); [b] native floral meadows, Schenley Park, Pittsburgh, PA, USA (photo by S. Paudel), [c] urban meadow dominated by Erigeron annuus in Jászság County, Hungary (photo by Dr. Ferenc Toth), and [d] xeriscape meadow at neighborhood yard in Sandy, Utah, USA (photo by Olivia Carril).

Source: Paudel, S., & States, S. L. (2023).
Image Credits: A & B: [S. Paudel, Paudel & States, 2023]; C: [Ferenc Toth, Paudel & States, 2023]; D: [Olivia Carrill, Paudel & States, 2023] Used with permission

What is it?

Greening of open spaces involves the incorporation of vegetation and natural elements into urban, peri-urban, and rural spaces to improve environmental quality, mitigate climate challenges, and enhance social well-being. It includes initiatives such as planting trees, building green walls or rooftop gardens, and developing parks and greenways to restore ecosystem functions.
This approach mitigates the effects of heat islands, enhances air quality, manages stormwater, and supports biodiversity. By creating green spaces, urban greening fosters a healthier and more livable environment for urban communities.
(Georgi & Dimitriou, 2010; Paudel & States, 2023; Veitch et al., 2013)

Challenges this NbS addresses

Open green spaces help mitigate multiple hazards by preventing, reducing, or recovering from their impacts:

- **Heatwaves –** reduction (provides shading and cooling effects, mitigating urban heat islands)
- **Flooding –** prevention/reduction (absorbs and retains rainwater, reducing runoff and urban flooding risk)
- **Air Pollution –** reduction (absorbs pollutants, improves air quality)
- **Biodiversity loss –** recovery (enhances habitat creation and ecological connectivity)
- **Social Well-Being Challenges –** reduction (provides recreational areas, improves mental health and social cohesion)

Primary functions and key services

- **Heat mitigation:** reduces urban and rural heat island effects through shading and evaporative cooling; support **urban infrastructure**, agricultural land, amongst others.
- **Stormwater management:** captures and filters rainwater to reduce urban flooding.; support risks mitigation of **roads, grey water infrastructure**, amongst others.
- **Air quality improvement:** absorbs pollutants and increases oxygen levels (Georgi & Dimitriou, 2010; Veitch et al., 2013).
- **Biodiversity enhancement:** by creating habitats for urban wildlife and pollinators.
- **Recreational and social benefits:** provides recreational areas and improves mental well-being for residents.
(Georgi & Dimitriou, 2010)

Infrastructure protection – Open green spaces protect critical infrastructure such as roads, drainage systems, and buildings from environmental degradation caused by excessive heat, flooding, and erosion. (Georgi & Dimitriou, 2010; Veitch et al., 2013)

Climatological hazards:
- Limited mitigation of wildfire risk through increased moisture retention and reduced temperature effects.
- Moderate mitigation of desertification by preventing soil degradation and increasing vegetation cover.

Meteorological hazards:
- Moderate mitigation of wind erosion by stabilising soils and providing windbreaks.

Hydrological hazards:
- Limited mitigation of fluvial floods by slowing runoff and enhancing infiltration.
- Moderate mitigation of surface runoff, stream bank and bed erosion, rill erosion, and urban drainage overflow through permeable surfaces and vegetative cover.

Site suitability, scale and coverage

Open green spaces are applicable in:

- Urban, peri-urban, and rural areas (Georgi & Dimitriou, 2010)
- Public parks, community gardens, and green corridors (Veitch et al., 2013).
- Residential and commercial developments (Georgi & Dimitriou, 2010).
- Areas facing high temperatures, air pollution, and urban flooding challenges (Paudel & States, 2023).

Ecosystem services

Beyond infrastructure protection, open green space NbS provides these ecosystem services:

- **Climate regulation:** reduces heat and enhances air quality (Georgi & Dimitriou, 2010; Paudel & States, 2023).
- **Water regulation:** improves stormwater management and water infiltration (Veitch et al., 2013).
- **Biodiversity support:** provides habitats for urban flora and fauna.
- **Cultural services:** creates recreational and aesthetic benefits.
- **Health improvement:** reduces stress and promotes physical activity in green spaces (Georgi & Dimitriou, 2010; Raza et al., 2024).
- **Carbon Sequestration:** CO_2 capture and storage in biomass and soil is significantly increased; especially when trees and shrubs are used.

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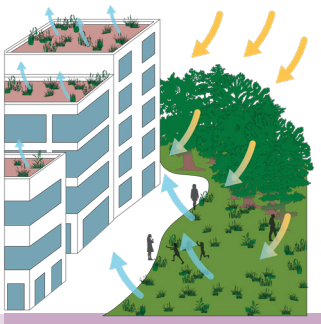
Cost-benefit profile

Costs of implementing open green spaces are influenced by factors such as location, scale, design complexity, and maintenance requirements.
In urban areas, the initial investment can be substantial due to land acquisition expenses, site preparation, and the integration of infrastructure like walkways and lighting.
Cost analyses of green infrastructure interventions for flood prevention consistently perform better than traditional grey infrastructure measures for flood prevention. A 2007 US EPA study found that 11 out of 12 green infrastructure projects had lower costs than equivalent grey stormwater infrastructure projects (such as underground canals) (US EPA, 2007).
In rural settings, establishing open green spaces may require lower upfront costs, primarily associated with land preparation and planting native vegetation. Maintenance costs include managing invasive species and ensuring ecological balance, to preserve the environmental benefits.
Investing in open green spaces provides long-term economic and social returns through improved environmental quality, reduced healthcare costs, and increased real estate value (Georgi & Dimitriou, 2010; Merk et al., 2012; Veitch et al., 2013).
Non-monetized benefits of green infrastructure include enhanced biodiversity and well-being (Kim and Song, 2019; Lovell and Taylor, 2013; Paudel & States, 2023).
In semi-arid urban areas there are some barriers for open green spaces implementation mainly associated with water needed for irrigation (Okour and Shaweesh, 2024).

Environmental impacts (EU taxonomy)

- ☑ **Climate change mitigation**
- ☑ **Climate change adaptation**
- ☐ **Sustainable use and protection of water and marine resources**
- ☑ **Transition to a circular economy**
- ☑ **Pollution prevention and control**
- ☑ **Protection and restoration of biodiversity and ecosystems.**



Conceptual illustration for Open green spaces combined with green infrastructure, an urban NbS example.
Image Credit: [Alchemia-Nova Research and Innovation], [2025].

Main components

- **Tree canopy expansion:** Planting and maintaining urban/peri-urban trees to provide shade and reduce heat. (Georgi & Dimitriou, 2010)
- **Green walls and roofs:** Vegetation incorporated into building design for insulation and aesthetic value.
- **Urban parks and gardens:** Public green spaces offering recreation and ecosystem services. (Georgi & Dimitriou, 2010)
- **Permeable surfaces:** Use of green infrastructure to reduce surface runoff and improve water infiltration.
- **Ecological corridors:** Linking fragmented habitats to promote biodiversity in urban areas.

Discovery Green.
Image Credit: [Lance Childers, Courtesy Houston First], [2024]. Free to Use

Example of installation

- **Discovery Green**
- **Location:** Houston, Texas, USA
- **Implemented by:** Discovery Green Conservancy in partnership with the City of Houston and local philanthropic organisations
- **Description and results:** Discovery Green is a 12-acre urban park located in downtown Houston. Opened in 2008, the park transformed former parking lots into a vibrant green space featuring a lake, performance areas, playgrounds, dog runs, and public art installations. It serves as a hub for community events and recreational activities, enhancing urban life and promoting environmental sustainability.

  Since its opening, Discovery Green has hosted around 500 free events annually, attracting millions of visitors and providing significant economic development in the surrounding area.

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