URBAN GREEN INFRASTRUCTURE

URBAN FORESTS

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ADDRESSED HAZARDS

PROTECTED CRITICAL INFRASTRUCTURE

Bird's Eye View of Urban Park and City Skyline - Osaka, Japan.
Image Credit: [Eileen Gao], [n.d] Free to use.

▶▶ What is it?

An Urban Forest is a strategically designed network of trees and vegetation within urban and peri-urban areas, aimed at enhancing resilience against climate change and anthropogenic hazards. It provides multiple ecosystem services, including heat mitigation, air and water quality improvement, and carbon sequestration, while also offering technical functionalities that protect infrastructure from extreme weather events and environmental stressors (EEA, 2021, Tyrväinen et al., 2005).

Challenges this NbS addresses

- **Flooding:** prevention and reduction by managing runoff and storing excess water.
- **Heatwaves:** mitigation through increased vegetation and cooling effects.
- **Air Pollution:** reduction by trapping particulates and absorbing pollutants.
- **Biodiversity Loss:** recovery by providing habitats in urban areas.
- **Social Vulnerability:** addressed through improved access to green spaces, promoting well-being.

▼▼ Primary functions and key services

(Tyrväinen et al., 2005)

Urban forests protect critical infrastructure by providing natural climate regulation and buffering urban systems against environmental stress. Strategically planted trees and woody vegetation reduce heat stress on buildings and pavements, intercept rainfall to prevent stormwater overflow, and serve as windbreaks that reduce the impact of storms on built structures. They also stabilise soils, protect transport networks from erosion, and reduce energy demand by cooling urban microclimates. Additionally, urban forests provide shade for pedestrians, buffer noise pollution, and improve the aesthetic and recreational quality of public spaces—contributing to social cohesion, urban resilience, and quality of life.

- **Road and railway protection:** acts as a windbreak, prevents soil erosion, and reduces flooding impacts that could compromise transportation infrastructure.
- **Bridge and tunnel safeguarding:** enhances slope stability around critical structures, reducing landslide risks and mitigating erosion from extreme rainfall events.
- **Electric and hydroelectric infrastructure resilience:** shields power lines and substations from strong winds and extreme heat while stabilising soil near hydroelectric facilities to minimise sedimentation and landslide risks.
- **Urban and rural flood control:** absorbs excess stormwater, enhances infiltration, and reduces runoff velocity, decreasing pressure on drainage systems.
- **Wildfire risk reduction:** incorporates fire-resistant species and moisture-retentive ground cover to slow fire spread and protect built environments.

▼▼ Site suitability, scale and coverage

Urban forests are suitable across a wide range of urban settings—from city parks and street corridors to peri-urban green belts. Their implementation is most effective in areas with high impervious surface coverage, elevated temperatures, or vulnerable populations affected by poor air quality and heat. Urban forests can be developed at various scales: from small community greening projects to city-wide tree canopy initiatives. Success depends on available planting space, soil conditions, long-term maintenance capacity, and policy integration into spatial planning.

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.**

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Cost-benefit profile

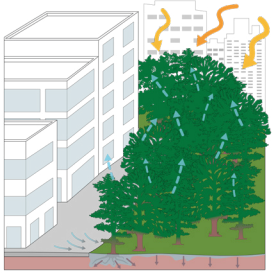
Urban forests involve a wide range of costs, including tree procurement, site preparation, planting, irrigation, inspections, pruning, storm clean-up, infrastructure damage repair, and eventual removal (Morgenroth, 2023; McPherson et al., 2005). Despite these expenditures, the economic return on investment is consistently positive. McPherson et al., (2005), reported: **Annual cost** of €12–€60 per tree, and **Annual benefit** of €29–€82 per tree. **BCR**: €1.26–€2.84 per €1 invested.

Studies reviewed in the Morgenroth (2023) report estimate that annual costs per tree typically range from NZD $68–$99 or (€38–€55), while annual benefits per tree range from NZD $110 to $490 or (€62–€274), depending on location, species, and services evaluated. Reported **benefit-to-cost ratios (BCRs)** ranged from **1.35 to 6.69**, with an average of **3.39**, meaning every dollar invested yields about **$3.39 (€1.90) in return**. Larger and longer-living tree species perform especially well, with large trees reaching a **BCR of 3.93**, nearly **three times higher than small trees** (BCR = 1.4). While costs are generally well-documented, many ecological and social benefits—such as mental health, biodiversity, and employment contributions—remain under-quantified, indicating that the reported benefit values are likely **conservative estimates** (Morgenroth, 2023).

Ecosystem services

(O'Brien et al., 2022; Endemy et al., 2017; McPherson et al., 2005)

- **Heat mitigation:** lowers urban temperatures through shading and evapotranspiration, reducing the urban heat island effect.
- **Wind and noise protection:** functions as a natural windbreak, reducing storm damage while also buffering noise pollution in urban environments.
- **Air and soil pollution control:** captures particulate matter, absorbs pollutants, and enhances soil remediation through phytoremediation.
- **Carbon sequestration and climate regulation:** CO_2 capture and storage in biomass and soil is significantly increased; especially when trees and shrubs are used.
- **Biodiversity support and habitat provision:** creates ecological corridors for urban wildlife, supporting pollinators and native species.
- **Water regulation:** manages stormwater and reduces urban flooding.
- **Pollination support:** enhances habitats for pollinators like bees and butterflies.
- **Improved public health:** reduces noise, improves air quality, and encourages physical activity.



Schematic of Urban Forest, NbS family Urban Green Infrastructure.
Image Credit: [Alchemia-Nova Research and Innovation], [2025].

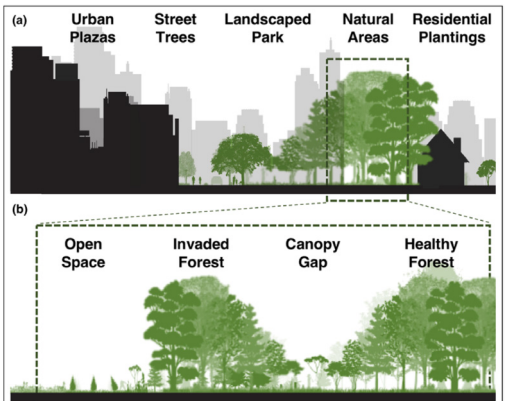
Main components

Vegetation Species & Spatial Composition: includes a mix of native and adapted tree species, shrubs, and ground cover arranged in dense clusters or corridors to optimise biodiversity, shade, and carbon absorption. Spatial planning considers tree height, canopy cover, and root expansion for maximising benefits.

- **Root Structure & Soil-Plant Interaction:** deep-rooted trees enhance water infiltration, stabilise slopes, and prevent soil erosion, while fibrous-rooted species improve soil aeration and organic matter content, promoting resilience against drought and stormwater runoff.
- **Man-Made Sloping Zones & Engineered Substrates:** includes green embankments, bioengineered slopes, and amended soils to support vegetation growth, manage water retention, and reduce structural vulnerability to erosion, landslides, or urban flooding.

Example of installation

- **Million Trees NYC (n.d)**
- **Implemented by:** New York City Department of Parks & Recreation and New York Restoration Project
- **Location:** New York City, USA
- **Description and results:** Launched in 2007, MillionTreesNYC aimed to plant and care for one million new trees across New York City within a decade. The initiative focused on increasing urban canopy cover, reducing air pollution, mitigating heat, and enhancing social cohesion in under-served communities. By 2015, over one million trees were planted in parks, streets, schools, and private lands. The program demonstrated measurable improvements in air quality, surface temperature reduction, and stormwater interception, alongside increased public engagement and environmental awareness. (Million Trees NYC, n.d)



Sketch of Urban forest. (a) The urban forest encompasses a wide range of greenspaces, from planted sites to natural areas and woodlands; (b) In temperate, forested regions (e.g., the northeastern US), urban forested natural areas can be categorised by forest condition to support targeted management approaches. Image Credit: [Max R. Piana, Harvard University Graduate School of Design], [2021], Used with permission;

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