URBAN GREEN INFRASTRUCTURE

# GREEN PAVERS

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NATURE-DEMO

ADDRESSED HAZARDS

PROTECTED CRITICAL INFRASTRUCTURE

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**Green paver.**
Image Credit: [Techno-bloc1], [2025]. Used with permission

## ▶▶ What is it?

**Green pavers** are a permeable paving solution designed to enhance urban resilience by integrating vegetation and soil within structured paving units. These systems consist of modular concrete or plastic grids filled with soil, grass, or gravel, allowing for water infiltration and natural drainage. By reducing stormwater runoff, minimising heat accumulation, and improving local microclimates, green pavers provide an effective nature-based solution for urban surfaces while maintaining load-bearing capacity for pedestrian and vehicular use. (Fini et al., 2017; Qamhia et al. 2024; Santhanam & Majumdar, 2020)

## Primary functions and key services

Green pavers contribute to infrastructure resilience by:

- **Reduction of urban heat effect -** infiltrated water is stored in the soil layer (temporary water storage). Vegetation ensures that a portion of water evaporates. In addition, green pavers reduce ground temperatures.
- **Surface runoff regulation -** infiltrated water is taken up by vegetation and stored in soil. Stormwater runoff is delayed and reduced.
- **Stormwater management -** infiltrates rainwater into the soil, delaying and reducing runoff pressure on drainage systems. (Fini et al., 2017; Santhanam & Majumdar, 2020)
- **Pollution control** - filters nutrients and sediments, improving urban water quality (Qamhia et al. 2024)

**Infrastructure protection –** reduces erosion and pressure on stormwater management systems.

### Climatological hazards:

- Limited mitigation of urban heat island effects through enhanced water retention and evapotranspiration.

### Meteorological hazards:

- Moderate mitigation of aeolian (wind-driven) erosion by stabilising urban surfaces

### Hydrological hazards:

- Limited mitigation of urban flash floods by reducing stormwater runoff.
- Moderate mitigation of surface runoff and urban drainage overflow through enhanced infiltration.

## Site suitability, scale and coverage

Green pavers are applicable in:

- Urban, peri-urban, and commercial developments
- Pedestrian pathways, driveways, parking lots, and plazas
- Areas prone to surface flooding and stormwater management challenges (Santhanam & Majumdar, 2020)

## Challenges this NbS addresses

Green pavers help mitigate multiple hazards by preventing, reducing, or recovering from their impacts:

- **Extreme heat –** reduction (stored water in soil helps cool surrounding areas, reducing ground temperatures)
- **Flooding –** prevention/reduction (facilitates water infiltration, reducing surface runoff and urban flooding risks)
- **Water Pollution –** reduction (filters pollutants from stormwater before reaching drainage systems) (Fini et al., 2017)
- **Drought –** prevention/reduction (enhances groundwater recharge and maintains soil moisture levels)

## Ecosystem services

- ▶ **Climate resilience:** microclimate improvement: contributes to urban cooling, lowers surface temperatures, reducing heat stress.
- ▶ **Water regulation:** nutrient and sediment filtration (Santhanam & Majumdar, 2020)
- ▶ **Support local biodiversity**
- ▶ **Aesthetic and cultural value**
- ▶ **Carbon Sequestration:** green pavers contribute to low but constructive $CO_2$ capture in soil and plant biomass

## 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

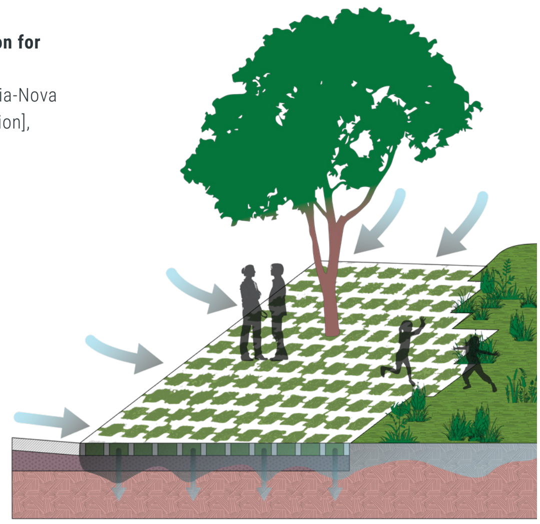
Greened pavers and permeable pavers provide a cost-effective, long-term solution for urban stormwater management and heat mitigation, despite higher initial costs (due to more soil excavation and implementation of different layers, compared to traditional asphalt) (Terhell et al., 2015). Installation costs, exceed conventional asphalt or concrete, but offer substantial economic benefits over time. Studies show that green infrastructure investments yield cost-benefits driven by lower stormwater fees, reduced maintenance, and extended pavement lifespan (Hao et al., 2022). The return on investment varies, with faster payback in areas with high stormwater charges or strict regulations but extending longer where incentives are lower. Over time, these pavers reduce urban heat effects, indirectly lowering energy costs. While the upfront investment can be 10–30% higher than traditional paving, lifecycle analyses indicate a net-positive return, making them a financially viable sustainable solution. Based on available data the installation costs vary depending on type and design complexity (Noel, 2024), the price ranges are:

- **Permeable Interlocking Concrete Pavers (PICP):** Approximately €75 to €130 per m².
- **Plastic Grid Pavers:** Around €30 to €100 per m².
- **Porous Concrete Pavers:** Approximately €80 to €160 per m².

Benefits:

- Green pavers reduce long-term maintenance costs associated with drainage systems by mitigating stormwater overload. (Fini et al., 2017; Qamhia et al., 2024)
- They provide additional social and environmental benefits such as improved urban cooling and aesthetic value. (Fini et al., 2017)

**Conceptual illustration for Green paver.**
Image credit: [Alchemia-Nova Research and Innovation], [2025].



## Main components

- **Concrete or plastic matrix –** grid-based structures that provide load-bearing capacity while allowing infiltration.
- **Vegetation and soil filling –** gaps filled with grass or gravel to support infiltration and greenery (Qamhia et al. 2024).
- **Drainage system integration –** can be designed to work with existing drainage infrastructure (Fini et al., 2017).
- **Green grids and vegetated pavers combination** (Beleri and Kotyal, 2024).

**Permeable pavement in Milan, Example of installation (IRIDRA, 2024)**
Image Credits: [IRIDRA], [2022], Used with permission

## Example of installation

- **Integrated Urban Plan Metropolitan Sponge City** (IRIDRA, 2024)
- **Location:** Metropolitan City of Milan, Lombardy Region, Italy
- **Implementation:** Client was Gruppo CAP
- **Description and results:** the project 'Integrated Urban CMM Sponge Plans' of the Metropolitan City of Milan, aims at relieving the sewerage network of several municipalities, in order to ensure the proper drainage of rainwater; in particular, IRIDRA designed 26 of the 90 planned interventions in 32 municipalities of the Metropolitan City of Milan. The project chose to propose unconventional solutions belonging to the 'Sustainable Urban Drainage Systems' (SuDS) or 'Nature-Based Solutions' (NbS) families. The solutions identified for the objectives set are solutions that allow easy insertion into the area of interest and the ability to offer multiple ecosystem services; among the proposed solutions are rain gardens, detention basins, drainage trenches, permeable pavements, vegetated ditches and infiltrating geocellular modules. The sum of the surface areas of the SuDS elements of all 26 interventions is 31,019 m², for a total of 6314 m³ of lamination volume.

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