



Nature-based solutions for managing climate risks

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*Preparing for Regional Climate Risks in Urban
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Editor: Hilja Kurkinen, City of Turku

Authors:

Stella Aaltonen, City of Turku

Hilja Kurkinen, City of Turku

Layout: KMG Turku

Cover photo: Minna Kivimäki

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Introduction

The aim of this publication is to provide an overview of different nature-based solutions that promote climate change adaptation and support biodiversity in urban environments. The publication aims to inspire the use and development of nature-based solutions. In addition to providing an overview, it assesses the impacts of each measure on the management of climate risks related to temperature, water and soil and on biodiversity, as well as provides an estimate of implementation and maintenance costs. The publication also proposes climate risk-specific indicators to support the monitoring of climate change adaptation and decision-making, while also supporting climate change adaptation in accordance with the EU Taxonomy.

The measures were developed as part of the Climate-Resilient Investment Projects (IKI) – Preparing for Regional Climate Risks in Urban Planning and Design project implemented by the City of Turku, the University of Turku and Turku University of Applied Sciences.

Nature-based solutions

Nature-based solutions (NBS) are solutions to societal challenges that rely on or are inspired by nature. They simultaneously provide ecological, social and economic benefits. Nature-based solutions can be used to manage climate risks, including the mitigation of urban flooding and the urban heat island effect, as well as to support and enhance biodiversity in urban environments.

Several urban planning tools have been developed to support the use of green solutions. For example, [the blue-green factor](#) can be used to assess the quantity and quality of vegetation and surfaces on a site, as well as their stormwater retention capacity. The 3-30-300 rule, in turn, guides the planning of new areas so that at least three trees are visible from every window, tree canopy cover is 30% and the nearest green space is within 300 metres.

It is important to remember that preserving existing nature is often more sustainable and beneficial for nature than creating new habitats. Existing ecosystems are more diverse and functionally mature. This is particularly evident in the case of mature trees, highlighting the importance of preserving them: shade from tree canopies provides protection during hot weather and improves air quality, while tree roots improve soil water permeability. Trees also play a key role in stormwater management: a single mature birch can absorb up to 500 litres of water per day.

Climate risks

Climate change is already effecting negatively on nature, people, society and the economy. Preparing for climate risks – by reducing the direct and indirect negative impacts of climate change while strengthening society's

climate resilience – is becoming increasingly important. A climate risk results from interactions between hazard (for example, urban flooding), exposure (for example, living in a flood-risk area) and vulnerability (for example, old age or low socioeconomic status).

As part of the IKI project, climate risk maps relating to temperature, water and soil have been produced for Turku and Southwest Finland. This collection of measures supports preparedness for the risk categories identified in the climate risk maps, such as prolonged heatwaves, cold spells, urban flooding, landslides and increasing coastal erosion. The climate risk maps are available in the [Lounaistieto map service](#).



Spreading bellflower and oxeye daisies. Photo: Niina Ruuska



Biodiversity refers to the diversity of life at all levels, from genetic diversity to species and ecosystem diversity. It encompasses all living organisms and the interactions between them that sustain ecosystem services and make life on Earth possible.



Herttuankulma residential area. Photo: Heikki Räisänen

EU Taxonomy

The EU Taxonomy is a classification system for sustainable finance that enables climate objectives to be examined from multiple perspectives and facilitates the use of green finance. The EU Taxonomy's climate and environmental sustainability objectives aim to mitigate and adapt to climate change, promote circular economy and prevent adverse impacts on nature and water bodies.

The assessment of technical criteria of climate change adaptation aims to promote the identification of climate risks that are material to an economic activity, the implementation of adaptation measures, and the monitoring and continuous improvement of their effectiveness. Climate risk and vulnerability assessments under the EU Taxonomy take into account the scale and life cycle of the activity. Climate risk assessments are based on the best available climate data and multiple future climate scenarios. These climate scenarios are often based on IPCC combinations of socioeconomic

pathways (SSPs) and climate projections based on representative concentration pathways (RCPs). The climate risk maps produced in the IKI project have been modelled using RCP/SSP scenarios.

The Taxonomy emphasises the use of nature-based solutions as well as blue infrastructure (water elements) and green infrastructure (vegetation-based solutions) in climate change adaptation. The use of nature-based solutions in urban planning therefore also supports climate change adaptation in accordance with the EU Taxonomy.

The climate risks defined in the EU Taxonomy are presented in the accompanying table. The same climate risks have been modelled in the climate risk maps produced in the IKI project (see previous paragraph).

Classification of climate related hazards relevant to the activity ([EU Taxonomy](#))

Chronic			
Temperature-related	Wind-related	Water-related	Solid mass-related
Changing temperature (air, fresh water, marine water)	Changing wind patterns	Changing precipitation patterns and types (rain, hail, snow or ice)	Coastal erosion
Heat stress		Precipitation and/or hydrological variability	Soil degradation
Temperature variability		Ocean acidification	Soil erosion
Thawing permafrost		Saline intrusion	Solifluction
		Sea level rise	
		Water stress	

Acute			
Temperature-related	Wind-related	Water-related	Solid mass-related
Heat wave	Cyclone, hurricane, typhoon	Drought	Avalanche
Cold wave/frost/freeze	Storm (including blizzards, dust and sandstorms)	Heavy precipitation (rain, hail, snow or ice)	Landslide
Wildfire	Tornado	Flood (coastal, fluvial, pluvial, groundwater)	Subsidence
		Glacial lake outburst	

Climate risk indicators

The climate risk indicators have been developed to reflect the temperature-, water- and soil-related climate risks examined in the IKI project. Some of the indicators can also be linked directly to the nature-based solutions presented in this publication. The indicators are intended to provide inspiration rather than constitute a comprehensive list for monitoring climate change adaptation. The list includes outcome indicators and performance indicators for each climate risk. The indicators were developed drawing on Julia Tuomimaa's (2020; 2024) research on temperature-related indicators, international sources, and the expertise of the project consortium and the City of Turku.

Temperature

The temperature-related indicators concern the management of heat risks, taking into account exposure, vulnerability and progress in implementing measures.

OUTCOME INDICATOR:

- › Proportion (%) of the population or employees exposed to high temperatures in risk areas.

PERFORMANCE INDICATORS:

- › Tree canopy cover (%) in risk areas.
- › Area of green spaces, green walls and green roofs, and other vegetation-covered areas relative to the impermeable surface area in the neighbourhood (m, m² or %).

The outcome indicator reflects the proportion of residents and workers exposed to heat in risk areas. A vulnerability perspective can also be incorporated into the indicator, for example by monitoring the number of older residents in the risk area. The performance indicators reflect measures aimed at reducing heat risks. Tree canopy cover provides significant shade, helping to mitigate the urban heat island effect and protect against heat risks. Green spaces and vegetated surfaces have a significant beneficial effect on surface temperatures, particularly in areas with impermeable surfaces.



Filtration dam in a ditch. Photo: Minna Kivimäki

Flooding and heavy rainfall

OUTCOME INDICATOR:

- › Number or area of buildings/transport routes exposed to flooding (number or m²).

PERFORMANCE INDICATORS:

- › Volume of stormwater retained (m³) in the catchment area.
- › Proportion of permeable surfaces (incl. structural layers required for water management) (%).

The outcome indicator reflects the adequacy of adaptation measures for managing flooding in relation to buildings and transport routes. For the performance indicators, the volume of stormwater retained and the proportion of permeable surfaces represent key practical means of managing flooding in the built environment.

Soil

An outcome indicator could not be defined for soil. Instead of an outcome indicator, the experts formulated the following objective: The stability of erosion-prone slopes remains at a safe level even during exceptional rainfall and other weather conditions.

PERFORMANCE INDICATORS:

- › Proportion of vegetation cover (%) in erosion-prone areas.
- › Coverage of protective structures (slope protection, embankments, bioretention) (%)

The performance indicators were selected based on the soil-binding properties of vegetation cover and the ability of protective structures to prevent and mitigate erosion.

Nature-based solutions for managing climate risks

The measures compiled here serve as a catalogue of ideas illustrating nature-based solutions. The publication presents 23 nature-based solutions for minimising temperature-, water- and soil-related climate risks and enhancing biodiversity. In addition to the impacts presented for each measure, nature-based solutions also have beneficial effects on carbon sequestration, recreation, well-being and health.

The measures have been compiled from several sources, including the Union of Baltic Cities, World Bank Group and World Health Organization, and the publication presents measures suited to the conditions in South-west Finland. Each measure has been assessed in terms of its impacts on temperature-, water- and soil-related climate risks and biodiversity, as well as its implementation and maintenance costs. The cost estimates are indicative, and actual costs will always depend on the scale of implementation. The impacts and costs of the nature-based solutions were assessed by experts from the City of Turku, the University of Turku and Turku University of Applied Sciences in spring 2026.

It is important to note that nature-based solutions always need to be tailored to the specific site, taking into account its needs and objectives as well as the constraints and opportunities presented by the environment. The impacts of the measures on biodiversity and climate risk mitigation depend on the size of the area and the details of implementation, such as the use of local plant species.

Some of the measures presented in this publication are large-scale and need to be taken into account as early as the zoning phase. The measures are presented from the largest to the smallest scale. It is also important to note that preserving existing nature is usually more sustainable and beneficial for nature than creating new habitats.

The following scales have been used in the assessments:

Impact of the measure on the management of temperature-, water- and soil-related climate risks and on biodiversity

0 = No impact

1 = Low positive impact

2 = Moderate positive impact

3 = Significant positive impact

The cost assessment covers both implementation and maintenance costs.

Implementation costs:

1 = Low cost, less than €10,000

2 = Moderate cost, €10,000–€100,000

3 = High cost, more than €100,000

Maintenance costs:

1 = Low maintenance cost (less than €4/m²/year)

2 = Moderate maintenance cost (€4–8/m²/year)

3 = High maintenance cost (more than €8/m²/year)



A stormwater swale in Kirstinpuisto, Turku, adds lush greenery to the urban landscape.
Photo: Minna Kivimäki

Measures

1. Urban forests

Urban forests are forested areas and groups of trees in cities and peri-urban areas. Urban forests provide significant benefits: they mitigate the urban heat island effect by providing shade, improve air and water quality, and reduce flooding by retaining and infiltrating storm-water. A single mature birch can absorb more than 500 litres of water per day. They also sequester carbon, support biodiversity and provide habitats for many species. Urban forests also play an important role in maintaining the physical, mental and social well-being of residents.



Urban forests provide opportunities for recreation, for example in the Skanssi Biodiversity Park. Photo: Jenni Mäkinen

<u>Climate risks</u>			<u>Biodiversity</u>	<u>Cost</u>	
Temperature	Water	Soil		Implementation	Maintenance
3	3	3	3	1	1



Stormwater on Puutarhakatu in Jyväskylä is managed using green infrastructure solutions. Photo: Leena Buller

2. Green connections and green corridors

Green connections are connections between green spaces that enable organisms to move or disperse from one green space to another. They support the continuity of habitats and the urban landscape, while strengthening the city's ecological structure and ecosystem functioning.

In fragmented urban environments, a lack of green connections reduces rainwater infiltration and increases flood risk and the burden on sewer networks. Increasing green connections reduces pressure on stormwater systems and protects the environment from flooding and polluted water. Cities are increasingly developing interconnected green solutions, such as riverside corridors, green streets, tree-lined avenues and gardens. These create micro-corridors that mitigate the urban heat island effect and extreme heat, support biodiversity and provide cooler microclimates in a changing climate. Green connections should be designed for multiple uses: they can include, for example, cycling and walking routes as well as stormwater management areas. [The stormwater management solutions implemented on Puutarhakatu in Jyväskylä using the Green Street approach](#) are an excellent example of green connections!

<u>Climate risks</u>			<u>Biodiversity</u>	<u>Cost</u>	
Temperature	Water	Soil		Implementation	Maintenance
2	1	2	2	2	2



Floodplain terraces along the Perniönjoki River. Photo: Minna Kivimäki

3. River floodplains

Cities are increasingly investing in the restoration of river floodplains, with the aim of giving rivers more space to safely accommodate higher water levels. At the same time, these measures improve the quality of riverbanks, create multifunctional recreational and natural environments, and enhance biodiversity. Key methods include setting flood embankments further back, thereby providing the river with a larger floodplain to accommodate rising water levels. Another approach is to restore bypass channels or former river meanders, which can accommodate water during floods and can be equipped with structures to regulate water flow. Together, these measures create safer, more biodiverse and more attractive riverfront environments that benefit both the urban environment and its residents.

<u>Climate risks</u>			<u>Biodiversity</u>	<u>Cost</u>	
Temperature	Water	Soil		Implementation	Maintenance
3	3	3	3	3	1



Wetland and wetland vegetation. Photo: Marcus Pellas

4. Natural wetlands

Preserving natural wetlands is particularly important for biodiversity and the valuable ecosystem services they provide. Natural wetlands are covered by water for much of the year and remain wet for the rest of the year. Wetlands sequester carbon, provide protection against both flooding and drought, and help mitigate climate change. Wetlands support specialised moisture-tolerant plant species and vegetation that filter, retain and remove sediment, nutrients and pollutants from water. Wetlands provide habitats for many animal species, aquatic organisms and endangered species, thereby supporting biodiversity. They are also important landscape and recreational assets, providing opportunities for activities such as birdwatching and outdoor recreation. The average water depth in wetlands is often relatively shallow.

<u>Climate risks</u>			<u>Biodiversity</u>	<u>Cost</u>	
Temperature	Water	Soil		Implementation	Maintenance
3	3	3	3	0	1



Constructed wetland in Elinanpuisto, Turku. Photo: Minna Kivimäki

5. Constructed wetlands

Constructed wetlands resemble natural wetlands in appearance, but are engineered systems that utilise the natural processes of wetland vegetation, soil and microorganisms to retain and treat stormwater. Constructed wetlands can be used in for example parks, where they provide recreational value for residents and important urban habitats for many bird and insect species.

Constructed wetlands vary in size and appearance. The most common types are surface-flow wetlands and subsurface-flow wetlands. As part of urban green infrastructure, they protect built-up areas from flooding and help maintain water quality in ponds, as well as improve the quality of stormwater from buildings and residential areas.

<u>Climate risks</u>			<u>Biodiversity</u>	<u>Cost</u>	
Temperature	Water	Soil		Implementation	Maintenance
3	3	3	3	2	2



Depressions designed to collect floodwater have been created in the square in Kirstinpuisto, Turku. The area can be used for various recreational activities, such as skateboarding. Photo: Aino Saarinen

6. Floodable squares

Floodable squares are low-lying areas that form basins during heavy rainfall or when the sea or a river floods. They can be used to store stormwater in city centres and may be located along rivers or on the coast. As water levels fluctuate, the square becomes partially or completely flooded. A floodable square can also serve as an urban public space, as the area can be used for sports and recreation during dry periods. Floodable squares can also function as hybrid solutions, combining nature-based solutions with grey infrastructure.

<u>Climate risks</u>			<u>Biodiversity</u>	<u>Cost</u>	
Temperature	Water	Soil		Implementation	Maintenance
1	2	0	1	3	2



Detention basin, wetland vegetation and grass-covered slopes. Photo: Marcus Pellas

7. Detention basins

Detention basins are deeper retention areas with less biological diversity than rain gardens or vegetated swales. They collect and store stormwater during heavy rainfall. The basins may fill completely, but release excess water into the stormwater system and dry out after rainfall. They can also provide attractive landscape features, for example near playgrounds and sports fields.

<u>Climate risks</u>			<u>Biodiversity</u>	<u>Cost</u>	
Temperature	Water	Soil		Implementation	Maintenance
1	2	2	1	2	1



Sedimentation basin in Pääskynvuorenrinne, Turku. Photo: Anna Räisänen

8. Sedimentation basins

A sedimentation basin does not have a permanent water level and it helps to regulate stormwater flow. It also improves water quality, as suspended solids in stormwater settle at the bottom of the basin. Sedimentation basins are designed to settle suspended solids from flow-regulation basins and detention basins, which are used to attenuate peak flows, and from filtration dams, which remove suspended solids and nutrients from stormwater. For the system to function effectively, at least three basins must be arranged in succession.

<u>Climate risks</u>			<u>Biodiversity</u>	<u>Cost</u>	
Temperature	Water	Soil		Implementation	Maintenance
1	2	1	1	2	1



Two-stage channel at Saukonoja in Pukkila, Turku. Photo: Minna Kivimäki

9. Ditches and stormwater channels

Ditches and channels often have steep sides. They may incorporate vegetation, underwater dams, or simply gravel and individual stones. Ditches and stormwater channels form the backbone of the ecological network, supporting stormwater management in the surrounding area by retaining, treating and potentially infiltrating stormwater, as well as conveying water onwards. These structures play a key role in improving water quality and have greater capacity during floods than pipes.

A two-stage channel can be used to increase stormwater storage capacity. A two-stage channel consists of a main channel and floodplain benches on one or both sides. The structure mimics natural streams. A meandering channel is more expensive to construct than a straight channel, but provides greater benefits in terms of reduced flow velocity and impacts on nature and soil.

<u>Climate risks</u>			<u>Biodiversity</u>	<u>Cost</u>	
Temperature	Water	Soil		Implementation	Maintenance
1	2	1	2	2	1



Nature-based stormwater management solutions have been successfully implemented in Augustenborg, Malmö, increasing the pleasantness of the neighbourhood and improving the area's image. Photo: Hilja Kurkinen

10. Constructed pond

Constructed ponds can be used to regulate stormwater flow and improve water quality. They may maintain a permanent water level or drain between rain-fall events. The edges of ponds often provide diverse habitats for vegetation. Ponds are best suited to parks or undeveloped areas, but can also be incorporated into residential areas, as has been done in Augustenborg in Malmö, for example.

<u>Climate risks</u>			<u>Biodiversity</u>	<u>Cost</u>	
Temperature	Water	Soil		Implementation	Maintenance
2	2	1	2	2	1



A willow arch adorns Siirinpuisto. Photo: Jenni Mäkinen

11. Pocket parks

Pocket parks are relatively small green spaces distributed throughout the urban fabric. They serve local residents and provide a variety of small-scale recreational opportunities, such as playgrounds, dog parks, outdoor exercise areas, planting boxes and other features suitable for everyday recreation. Pocket parks can also be created on vacant land and used, for example, for snow storage.

<u>Climate risks</u>			<u>Biodiversity</u>	<u>Cost</u>	
Temperature	Water	Soil		Implementation	Maintenance
2	2	2	2	2	1

12. Nature-based playgrounds

Nature-based playgrounds use natural materials such as wood, stones and water features to support children's creativity, connection with nature and health. Contact with natural ground surfaces, such as grass or forest floor, improves the regulation of children's immune systems. The use of diverse, multi-layered vegetation and deadwood also supports biodiversity. In addition to providing opportunities for nature education, nature-based playgrounds offer pleasant places for people to meet and for adults to enjoy recreation.



The playground in Jukolanpuisto features rocks and fallen tree trunks. Photo: Jenni Mäkinen

<u>Climate risks</u>			<u>Biodiversity</u>	<u>Cost</u>	
Temperature	Water	Soil		Implementation	Maintenance
1	1	1	2	2	2

13. Urban farming

Urban farming refers to growing plants in and around urban areas. Urban farming contributes to a sustainable and self-sufficient food system and provides numerous benefits, including climate change adaptation, support for biodiversity, enhanced ecosystem services and communality. When well designed, urban farming is an effective nature-based solution that enhances the well-being of urban residents, strengthens their connection with nature and enables productive use of public spaces.

Urban farming can take place in many settings: in yards and community gardens, on rooftops and balconies, on vacant land, in vertical farming systems and in aquatic environments. Different urban farming solutions include raised-bed cultivation, nature-based cultivation on artificial islands built on water, and floating cultivation.

The assessments apply to urban farming in yards and similar areas.



Lush allotment gardens in Rauvola. Photo: Minna Kivimäki

<u>Climate risks</u>			<u>Biodiversity</u>	<u>Cost</u>	
Temperature	Water	Soil		Implementation	Maintenance
1	1	1	1	1	1



Vegetated swale near Korjasmäentie in Turku. Photo: Minna Kivimäki

14. Vegetated swales and filter strips

A vegetated swale is a vegetation-covered area that lies below the surrounding ground level. It may, for example, be a linear structure along a street or a series of several swales. Filter strips are gently sloping, vegetation-covered areas that convey stormwater as surface runoff towards permeable soils. Filter strips are most commonly used between impermeable surfaces, such as car parks, and another storm-water management structure to improve stormwater quality through pre-treatment. Bioretention swales also contain filtering layers of sand and gravel.

The purpose of a vegetated swale is to retain, treat and potentially infiltrate stormwater, as well as convey water onwards. It is best suited to managing relatively small volumes of water. The type and location of vegetation in swales have a major impact on climate change adaptation, biodiversity and maintenance costs.

<u>Climate risks</u>			<u>Biodiversity</u>	<u>Cost</u>	
Temperature	Water	Soil		Implementation	Maintenance
2	2	1	2	2	2



Local plant species can be used when creating rain gardens.
Photo: Hilja Kurkinen.

15. Rain gardens

A stormwater retention structure in a yard or public square can be referred to as a rain garden. Rain gardens are shallow, densely vegetated depressions that collect stormwater from adjacent impermeable surfaces. During storms, they fill with water while promoting water infiltration and treatment. During dry periods, they enhance the quality of public outdoor spaces. [Rain gardens](#) are suitable for parks, public squares and private gardens. Rain gardens contain diverse vegetation, significantly enhance the attractiveness of outdoor spaces and provide excellent habitats for pollinators.

<u>Climate risks</u>			<u>Biodiversity</u>	<u>Cost</u>	
Temperature	Water	Soil		Implementation	Maintenance
2	2	2	2	2	1

16. Infiltration pit

An infiltration pit is a structure located mainly underground and filled with stones of various sizes, gravel or crushed stone, where stormwater is stored before infiltrating into the soil. Water can also be conveyed onwards from the pit into pipes or subsurface drains. Soil characteristics have a significant impact on water management. In clay soils, for example, simply adding gravel to an infiltration pit may not be sufficient if the soil has poor infiltration capacity. Infiltration pits are suitable for permeable soils and locations near streets. They are more commonly used in areas outside the sewer network.



A soakaway consisting of stones of various sizes. Photo: Aleksi Reini

Climate risks			Biodiversity	Cost	
Temperature	Water	Soil		Implementation	Maintenance
0	2	1	0	1	1

17. Street tree canopy cover

Green boulevards and tree-lined avenues are among the most attractive urban spaces and have historically been shown to benefit businesses, increase property tax revenues and enhance the appeal of cities. They function as ecological corridors from the outset and play an important role in climate change adaptation. An unpaved, vegetated central reservation can form part of green infrastructure and help reduce pressure on water bodies and prevent flooding.

Street tree canopies intercept and cycle rainwater, create local microclimates, reduce heat, absorb pollutants and provide shade. Continuous tree canopy cover is highly effective in mitigating urban heat. Lower temperatures, in turn, reduce the cost of cooling buildings and help create a liveable and pleasant urban environment even on the hottest summer days.



Lush deciduous trees on Kristiinankatu in Turku. Photo: Hilja Kurkinen

<u>Climate risks</u>			<u>Biodiversity</u>	<u>Cost</u>	
Temperature	Water	Soil		Implementation	Maintenance
3	2	2	2	3	2



Numerous oxeye daisies grow above the underground structures. Photo: Leena Buller

18. Stormwater tree trench

Stormwater tree trench is a system in which street trees are connected by an underground infiltration or retention structure. Beneath the surface structures is a continuous growing-medium structure that allows stormwater to infiltrate, be retained and flow through the growing medium from one root system to another. Infiltration and water treatment can be enhanced, for example, by adding biochar to the growing medium.

<u>Climate risks</u>			<u>Biodiversity</u>	<u>Cost</u>	
Temperature	Water	Soil		Implementation	Maintenance
2	3	1	2	2	1



Grass, for example, can grow between permeable paving slabs.
Photo: Aino Saarinen

19. Permeable pavements

Permeable pavements consist of a permeable surface layer (for example, gravel, sand, grass pavers or permeable paving) and underlying structural layers made of coarse aggregate. If the design is intended to retain or store water, sufficient space should be provided between the pavement and impermeable soil, such as clay. A thickness of 1.25 metres is generally recommended for the structural layer.

Permeable pavements are particularly effective during lighter rainfall, as they allow rainwater and meltwater to infiltrate where soil conditions permit, or to be retained where the soil is clayey. In addition, ground surfaces with permeable paving have better heat transfer properties than conventional asphalt. Alongside stormwater management, this also helps mitigate the urban heat island effect, particularly when vegetation is incorporated into the solution. Permeable surfaces also support biodiversity by helping to prevent the degradation of urban streams and reducing pressure on nearby water bodies.

Permeable pavements can be used in many urban settings, including pavements, cycle paths, yards, car parks and low-traffic roads. However, they are not suitable for heavily trafficked or high-speed routes or areas with large volumes of heavy traffic.

<u>Climate risks</u>			<u>Biodiversity</u>	<u>Cost</u>	
Temperature	Water	Soil		Implementation	Maintenance
2	2	2	1	2	2

20. Embankments and slope protection

Embankments are a traditional means of stabilising steep slopes and protecting urban areas from various risks, such as flooding, drought and landslides. They prevent erosion, support biodiversity and also provide benefits for agriculture, for example by increasing soil depth and improving water management. Modern technologies, such as geogrids, geotextiles and bioengineering solutions, improve the durability of embankments and growing conditions for vegetation. Surplus soil can also be used in embankments, supporting the circular economy.

Different types of embankments and slope protection solutions include:

- Living smiles remove excess water, retain sediment and improve the soil.
- Wattle fences consist of vertical posts and woven branches that slow the movement of material down a slope and act as low retaining walls.
- Vegetated gabions are stone-filled metal baskets that reinforce slopes and, over time, provide a substrate for vegetation to establish.



Stone gabions are low-maintenance, weather-resistant and long-lasting solutions. The stone gabion pictured is located in Viikki, Helsinki. Photo: Hilja Kurkinen

<u>Climate risks</u>			<u>Biodiversity</u>	<u>Cost</u>	
Temperature	Water	Soil		Implementation	Maintenance
1	2	3	2	2	1

21. Green roofs (vegetated roofs)

Green roofs consist of several layers: a growing medium, membranes that control root growth, water collection, filtration and storage layers, and structural and insulation layers. The plant species and water requirements determine the thickness and composition of the layers. Green roofs can be either extensive, with a thin growing medium, or intensive, with a thicker growing medium. They provide habitats for birds, pollinators and other species. Green roofs on low-rise buildings are particularly valuable in terms of both biodiversity and the attractiveness of the area.

Green roofs are generally not accessible to the public and are planted with drought-tolerant species that can withstand variations in temperature and sunlight. Collecting rainwater on the roof makes it possible to irrigate the roof during dry periods. Native species and, where possible, local species should be favoured on green roofs. In new buildings, green roofs should be taken into account from an early stage of planning, including in terms of maintenance and spatial requirements. It is also advisable to retain the original topsoil and use it on the green roof.

There are two types of extensive green roof: sedum roofs and semi-intensive meadow, dry meadow or grass roofs. They support biodiversity and help manage stormwater, but not as effectively as thicker intensive green roofs.

Roof gardens, or intensive green roofs, have a thick growing medium and a wide variety of plant species. Intensive green roofs save energy by reducing building cooling and heating costs. In terms of stormwater management, green roofs are comparable to low-growing vegetation such as lawns. However, a green roof with a growing medium more than 0.3 metres deep provides significantly greater stormwater management benefits. In addition to water management and cooling, intensive green roofs provide benefits for building users, such as opportunities for gardening and socialising. Roof gardens require greater investment and sufficient structural load-bearing capacity, but provide more substantial benefits and a wider range of uses.

The assessments apply to intensive green roofs:

<u>Climate risks</u>			<u>Biodiversity</u>	<u>Cost</u>	
Temperature	Water	Soil		Implementation	Maintenance
1	2	0	2	2	2



Turku Technology Properties has installed a small sedum roof at InfraCity.
Photo: Turku Energia

22. Ground-based green façades

Ground-based green façades are green walls formed by climbing plants rooted in planting beds at ground level. Climbing or self-clinging plants grow either directly along the wall or with the aid of a separate support structure. The plants obtain water and nutrients from the soil and can grow to considerable heights. Many flowering and evergreen species add aesthetic value to building façades and improve air quality. Green façades reduce heat during hot weather and make the surroundings more pleasant. When implementing green façades, care should be taken to ensure adequate ventilation of the building façade, successful overwintering of the plants and the use of local species.



Structure-mounted green systems offer plenty of scope for creativity. The photo is from the courtyard of the Kupittaa campus in Turku. Photo: Marcus Pellas

<u>Climate risks</u>			<u>Biodiversity</u>	<u>Cost</u>	
Temperature	Water	Soil		Implementation	Maintenance
2	1	0	2	2	2



23. Structure-mounted green systems

A structure-mounted green system is a type of green wall that uses specialised irrigation techniques and lightweight growing media to reduce the load on the façade. These systems are more expensive than ground-based solutions and require more resources for construction and maintenance. This solution allows combinations of 10–15 plant species, often including mosses and perennial plants, and provides rapid and uniform growth. Stormwater can also be used for irrigation. However, the thin growing medium limits their use in cold climates.

<u>Climate risks</u>			<u>Biodiversity</u>	<u>Cost</u>	
Temperature	Water	Soil		Implementation	Maintenance
2	3	0	2	3	2

Further reading

We warmly recommend exploring the materials below!

Alueellinen hulevesisuunnitelma Turku, Kaarina, Lieto, Raisio ja Rusko (Regional stormwater plan for Turku, Kaarina, Lieto, Raisio and Rusko). Available at: https://www.turku.fi/sites/default/files/document/alueellinen_hulevesisuunnitelma.pdf

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Luontopohjaiset vesienhallinnan ratkaisut (Nature-based water management solutions). A short guide to sustainable water management in agricultural and forestry areas. Valonia. Available at: <https://valonia.fi/wp-content/uploads/2025/10/Vesienhallinnan-keinoja-PDF-2025.pdf>

Nature-Based Solutions in Cities: Solutions and Examples for Municipalities and the Private Sector. Available at: <https://www.ifc.org/content/dam/ifc/doc/2024/nbs-for-cities-solutions-and-examples-for-municipalities-and-private-sector.pdf>

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CO-CARBON: Hiiliviisaan kaupunkivihreän käsikirja (Handbook for carbon-smart urban green spaces). Available at: <https://cocarbon.fi/wp-content/uploads/2026/05/Hiiliviisaan-kaupunkivihrean-kasikirja.pdf>

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Available at: <https://www.ubc-sustainable.net/project/integrated-storm-water-management>

Nature-based solutions and health. Copenhagen: WHO Regional Office for Europe; 2025.

Available at: <https://iris.who.int/server/api/core/bitstreams/07b5dbca-6a28-45db-a6f3-752a1d120e14/content>

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Kohti ilmastokestävää kaupunkisuunnittelua (Towards climate-resilient urban planning) guide. Läpäisevät pinnat siirtävät lämpöä (Permeable surfaces transfer heat). Available at: <https://www.climateguide.fi/artikkelit/lapaisevat-pinnat-siirtavat-lampoa>

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Tuomimaa, J. (2020). Kaupunkien lämpösaarekeilmiöön sopeutumisen indikaattorit: tapaustutkimuksena Helsinki (Indicators for adaptation to the urban heat island effect: Helsinki as a case study).

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Rowan leaves. Photo: Hilja Kurkinen

