Urban Resilience with Nature Based Solutions: Current Eco-oriented Approaches

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Urban resilience

- In the recent years, the popularity of **urban resilience** has exploded in both academic and policy discourse, with numerous explanations for this dramatic rise (Meerow and Newell, 2015)
- The meaning of urban resilience is malleable, allowing stakeholders to come together around a common terminology without requiring them to necessarily agree on an exact definition (Brand & Jax, 2007). But, this vagueness can make resilience difficult to operationalize, or to develop generalizable indicators.

Possible definition:

- Urban resilience refers to the ability of an urban system and all its constituent socio-ecological and socio-technical networks across temporal and spatial scales to maintain or rapidly return to desired functions in the face of a disturbance, to adapt to change, and to quickly transform systems that limit current or future adaptive capacity.

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Ecologically-oriented urban development concepts

In the wider discussions on **climate change adaptation**, strengthening the **resilience of the cities**, **rapid urbanization** solutions, providing of **urban ecosystem services**, several **ecologically-oriented urban development concepts** and approaches were introduced in the last few decades.

Four of the recently developed, which have gained prominence in academic debates and are increasingly referred to in policy-making, are the folowing:

1) Nature-based solutions (NbS)
(Balian et al., 2014)
2) Ecosystem-based adaptation (EbA)
(*Munang et al., 2013*);
3) Urban green infrastructure (UGI)
(*Benedict and MacMahon, 2006*)
4) Ecosystem services (ESS)
(*MEA, 2005*)

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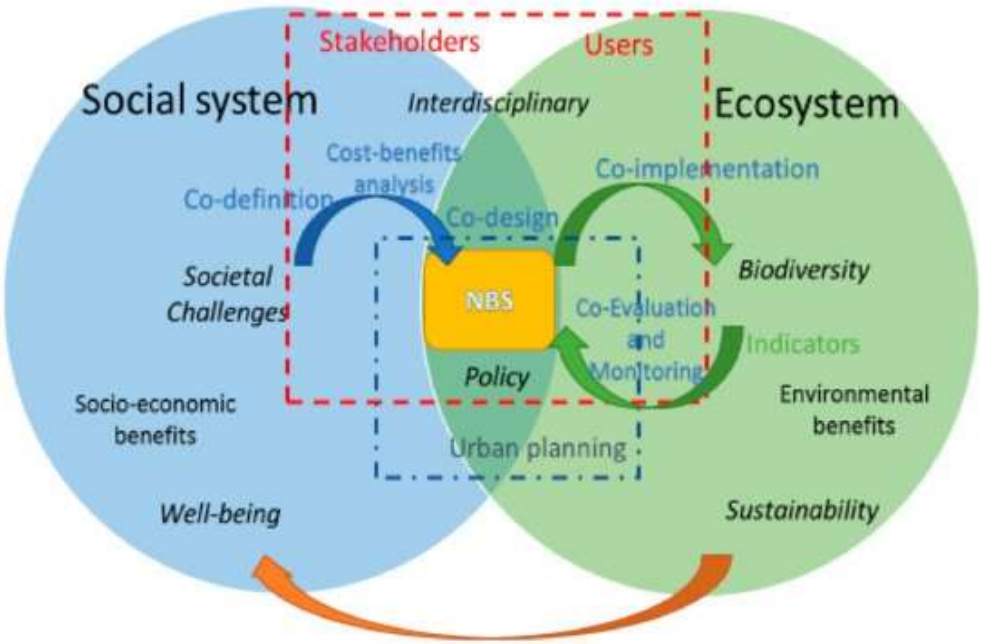
Due to the breadth of their definitions, multiple ways of describing and a wide range of interested stakeholders who promote them, it is difficult to establish clear differences between these concepts and determine the precise relationship.

However, it seems that the biggest differences arise from the breadth of thematic scope and level of operationalization of each concept.



Conceptual understanding of eco-oriented urban development concepts /in general, NBS/ (NbS, EbA, UGI and ESS), their benefits, planning process, and implementation.

Source: https://encyclopedia.pub/586

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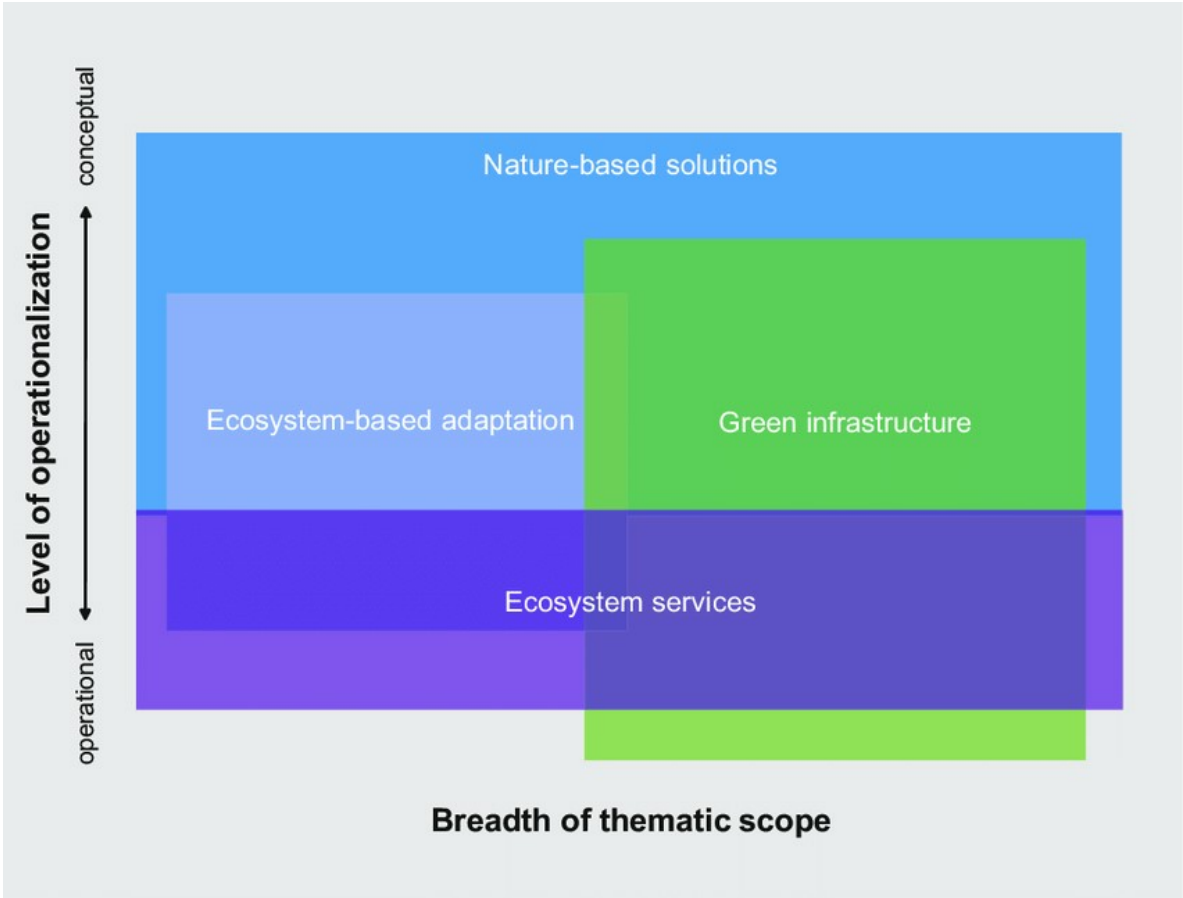
Illustration of the interrelationships, thematic scope and current level of operationalization of the four eco-oriented urban development concepts: NbS, UGI, EbA and EES



Source: Kabish et al. (eds.). Nature-based Solutions to Climate Change Adaptation in Urban Areas. Springer, 2017.

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Nature-based solutions (NbS)

- As **action-oriented**, NbS concept was introduced towards the end of the 2000s in the **context of climate change** (IUCN 2009, Kabisch et al. 2016)

- Broadly speaking, **NbS may be considered as an umbrella to the other three concepts** - EbA, UGI and ESS (Naumann, 2014)

- But, NbS also depends on UGI and ESS for its further definition and systematic uptake in urban areas because the regulatory frameworks, planning systems and economic instruments for its application are not yet adequately developed (Pauleit et al., 2020).

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Nature-based solutions (NbS)

There are different interpretations of this concept

For instance, IUCN (International Union for Conservation of Nature) defines NbS as:

''...actions to protect, sustainably manage and restore natural or modified ecosystems, which address societal challenges (e.g., climate change, food and water security or natural disasters) effectively and adaptively, while simultaneously providing human well-being and biodiversity benefits.''

More recently, EU (European Commission, 2016) defined NbS in the **urban context** as:

''solutions that are inspired and supported by nature, which are cost-effective, simultaneously provide environmental, social and economic benefits and help build resilience... Such solutions bring more, and more diverse nature and natural features and processes into cities, landscapes and seascapes, through locally adapted, resource - efficient and systemic interventions.''

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Nature-based solutions (NbS)

Paulet et al. (2017) recognized **four main NbS characteristics**:

1) NbS is **broad in definition and scope** (ranging from climate change and disaster risk reduction to addressing poverty, promoting a green economy, to further economic growth and sustainability via NbS);
2) NbS is **broad in terms of "nature"** (ranging from the protection and expansion of forest areas to capture gaseous pollutants, planting wind breaks for soil conservation to the protection of urban green spaces, or planting of green roofs for various benefits such promotion of biodiversity, carbon storage and/or stormwater management);
3) NbS relies on **integrative and governance-based approaches** in the management process; and
4) NbS is **action-oriented**.

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Nature-based solutions (NbS) – Priority areas

Restoring and protecting forests and wetlands in catchments

Bringing nature into cities

Coastal habitat restauration

Source: https://www.naturebasedsolutionsinitiative.org/what-are-nature-based-solutions/

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Ecosystem-based Adaptation (EbA)

- EbA may be considered as a **subset of NbS**, that is **specifically concerned with climate change adaptation via the use of nature** (Pauleit et al., 2020)
- The main focus of EbA relates to sustainable management, conservation and restoration of ecosystems, with the purpose of providing services which supporting humans' adaptation to climate change (Munang et al. , 2013)
- **EbA interest in urban areas and urban planning is rising in the last decades** (Brink et al., 2016)
- Measures are based on ecosystem services providing, including the design and improvement of green and blue infrastructures from micro to macro city level, both in newly planned and built-up areas (Doswald and Osti. 2011)
- However, despite the academics advocate for mainstreaming EbA into urban planning, modes of implementation and supporting legislation for its systematic integration are still limited.

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Urban Green Infrastructure (UGI)

Contrary to NbS and EbA, the UGI concept has had a **clear link to the urban context from the start**, **strongly connected to urban planning** and rooted in both landscape ecology and architecture (Fletcher et al. 2014)

- This concept is understood as a **strategic approach** to development of:

  "an interconnected network of green space that conserves natural ecosystem values and functions, and that provides associated benefits to human populations" (Benedict and McMahon, 2006)

or

- At the pan-European scale (MEA 2005; EC 2013; GREEN SURGE project 2015), as a **planning approach**:

  ''aimed at creating networks of multifunctional urban green space (UGS) (and also **blue spaces**) in urban environments''.

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Urban Green Infrastructure

- Despite differences, the following is common to all of UGI definitions - UGI can contribute to a sustainable future of the cities by addressing major urban challenges, such us land use conflicts, climate change, urban resilience, biodiversity conservation, demographic changes, and human health and wellbeing

- Like NbS and EbA, UGI also supposed to maintain and promote ecosystem services and deliver multiple benefits for humans (Fletcher et al. 2014), simultaneously provide environmental, social and economic benefits and help build and social resilience

- In practice, UGI can provide **strategic guidance for the integration of eco-oriented approaches into developing multifunctional UGBS networks at various utban scales** (Pauleit et al., 2020)

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Ecosystem Services (ESS)

- ESS is basically a categorization of the broad range of 'benefits people obtain from ecosystems' (MEA, 2005)
- From the late 1970s, when concept emerged, and through the late 1990s, when it began to be applied in cities, the literature on ecosystem services has strongly expanded, which has also led to a rich debate on the concept, with particular emphasis on methods for assessment and valuation of ecosystem services (Pauleit et al., 2020)
- Accordingly, the definition of the concept has changed over the time
- The most present current definition of ESS is:

  "the functions and products of ecosystems that benefit humans, or yield welfare to society" (MEA, 2005)
- In line with this, Goméz-Baggethun et al. (2013) concluded that the ESS concept can play a critical role in **reconnecting the cities to the biosphere and in reducing the ecological footprint and ecological debt of cities, while enhancing resilience, health, and quality of life of their inhabitants**.

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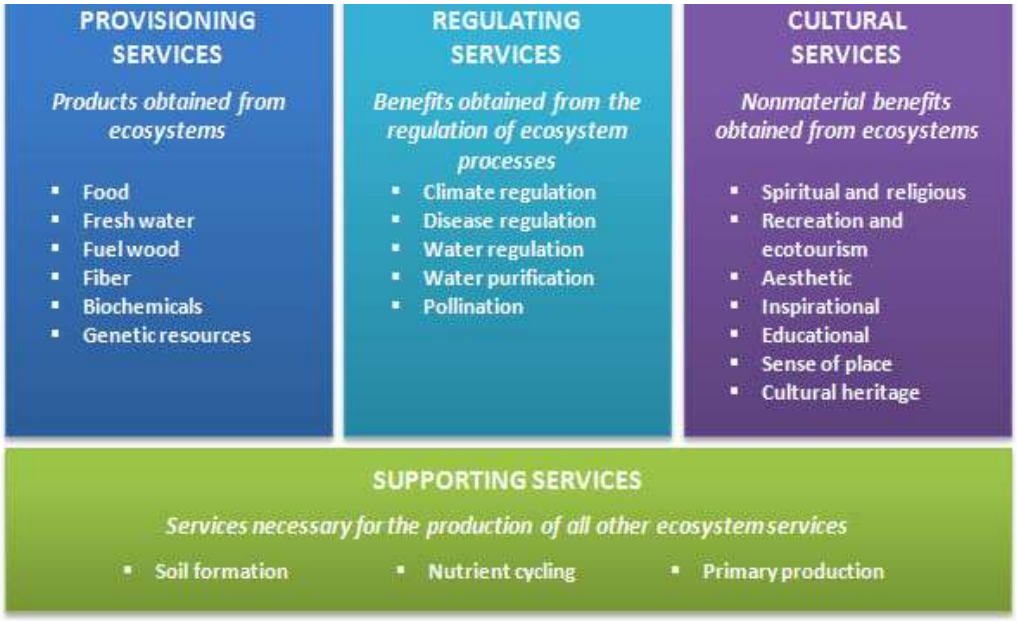
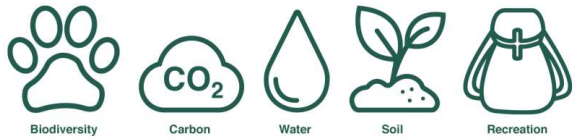
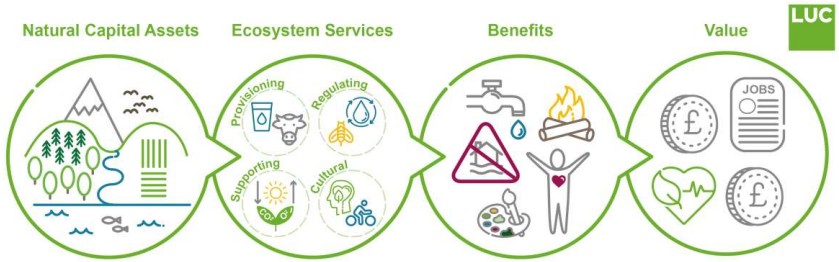
Ecosystem Services (ESS)

MEA divides ecosystem services into four basic categories:







Provisioning services	
Type and role of ecosystem service (PESS)	Appropriate type of UGBS for PESS
Raw materials (RM) PESS provide a diversity of materials for fuel and construction	Green roof (F, MR) Courtyard (F) Gardens (F) Community garden (F) Plot (F) Forest (F and RM) Lake, pond (F)
Fresh water (FW) PESS regulate the flow and purification of water (vital role in the global hydrological cycle)	
Food (F) PESS provide the conditions for growing food	
Medicinal resources (MR) PESS provide plants used as traditional medicines and raw materials for the pharmaceutical industry	
Regulatory services	
Type and role of ecosystem service (RESS)	Appropriate type of UGBS for RESS
Local climate and air quality (LCAQ) RESS regulate air quality, provide shade and influence rainfall and water availability, removing pollutants from the atmosphere	Green wall (LCAQ) Green roof(LCAQ, MEE, WWT) Bioswale (MEE, WWT, LCAQ) Tree alley and street tree, hedge (LCAQ, CSS, MEE) House garden (CSS,LCAQ, MEE) Park, neighborhood park (LCAQ, CSS, MEE) Forest (LCAQ, CSS) Wetland (CSS,MEE, WWT)
Carbon sequestration and storage (CSS) RESS store and sequester greenhouse gases, remove carbon dioxide from the atmosphere, improve the capacity to adapt to the effects of climate change	
Moderation of extreme events (MEE)	
Waste-water treatment (WWT) RESS filter both animal and human waste and act as a natural buffer to the surrounding environment	
Cultural services	
Type and role of ecosystem service (CESS)	Appropriate type of UGBS for CESS
Recreation (R) CESS provide physical and mental health, as well as socio-ecological and economic benefits	Green roof (R, AAD) House garden (R, AAD, SP) Park (R, T, AAD) Neighborhood park (R, SP) Community garden (R, SP) Forest (R, T, AAD, SP) Lake, pond (R, T, SP)
Tourism (T) CESS provide physical and mental health, as well as socio-ecological and economic benefits	
Aesthetic appreciation and inspiration for culture, art and design (AAD) CESS provide physical and mental health, as well as socio-ecological and economic benefits	
Spiritual experience and sense of place (SP) CESS provide physical and mental health, social and economic benefits	
Supporting services	
Type and role of ecosystem service (SESS)	Appropriate type of UGBS for SESS
Habitats for species (HfS) SESS provide biodiversity and closer connection with nature	Balcony (HfS), Green roof (HfS) Bioswale (HfS) Tree alley (HfS) Forest, park, garden, plot (HfS)
Maintenance of genetic diversity SESS provide biodiversity and closer connection with nature	

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***Sponge city*, Wuhan, Xiamen, Kunshan, China**

Source: https://www.re-thinkingthefuture.com/rtf-fresh-perspectives/a1937-10-nature-based-sustainable-solutions-for-cost-cutting-in-architecture

NbS **Macro urban scale**

A Sponge City is a city envisioned to act as a sponge to rainwater that allows any water to be absorbed and filtered through the ground. The water then reaches urban aquifers and increases the water level. It allows the inhabitants to extract water through urban wells that can be easily treated and used for city water supply. For the sponge city to function to its full potential, the urban region consists of continuous open green spaces, porous landscapes, and water recycling techniques. Ponds, permeable roads, filtration pools, and stormwater infiltration are a few nature-based principles used in the design. The advantages of such sponge cities are the availability of cleaner groundwater, reduced risk of floods, a lower burden on existing drainage systems, and enriched biodiversity. The city also offers healthier recreational spaces.

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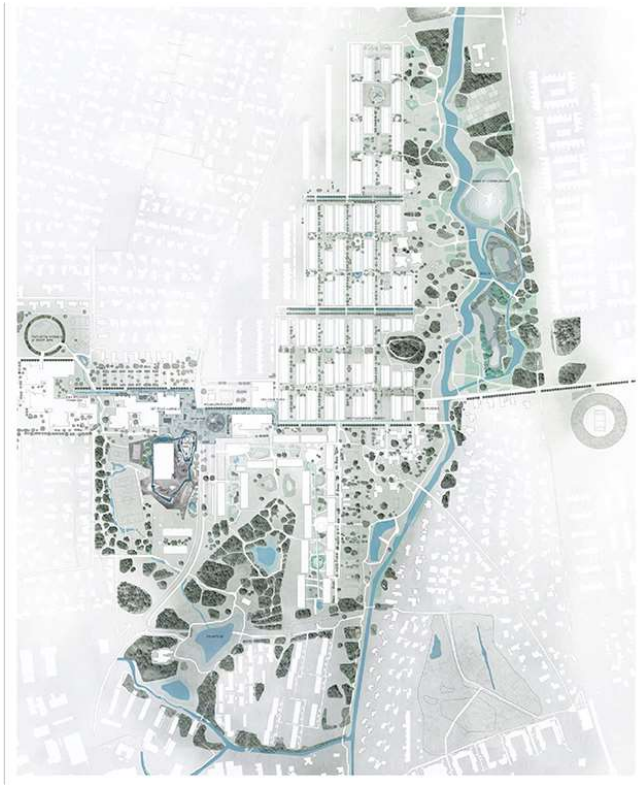

Kokkedal, Fredensborg, Denmark

Source: https://my.landscapeinstitute.org/case-study/kokkedal-blue-green-garden-city-adaptation-plan/0cfd03c2-138b-eb11-b1ac-000d3ad51568

Nbs **Macro urban scale**

One of the most ambitious climate adaptation and urban regeneration projects in Denmark. *The Climate Change Adaptation Project* in Kokkedal is a showpiece of intensive collaboration across ownership and professional groups. The project is also unique because it has managed to combine climate adaption with social inclusion by applying flood-risk measures with added social and recreational value at macro urban scale.

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Arkadien Winnenden, Stuttgart, Germany

Source: https://landezine.com/arkadien-winnenden-by-henning-larsen/

Nbs **Meso urban scale**

Arkadien Winnenden is a hardcore industrial regeneration project. A diversity of high performance components make this the world's most sustainable neighborhood and provides a fresh new vision for people-friendly and resource productive suburbs. Mixed architectural typologies are kept a cohesive neighborhood thanks to the appealing Mediterranean colour concept and "garden city" quality of the streetscapes. Water sensitive urban design provides a distinctive urban character. Although the streetscapes are distinctively pedestrian, a shared circulation concept means that the site is fully accessible for vehicles, with parking options in an underground garage, carports, and parking spots. The neighbourhood density is softened through the presence of nature in the form of generous planting, the artifitial lake as the focal point heart of the development and the restored adjacent creek with a recreational path and play areas integrated into retention meadows..

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Green bus stop in Eindhoven, Netherlands

Source: https://naturvation.eu/system/files/greeningeuropeancities accelerating_the_uptake_of_urban_nbs_final.pdf

Nbs **Micro urban scale**

Project *Green Facade* in Connewitz, Leipzig

Source: https://una.city/nbs/leipzig/kletterfix-green-walls-leipzig

"Plac na glanc", Katowice, Poland. Renovation of neglected courtyards.

Source: : https://www.bryla.pl/bryla/7,85301,20793117,katowice-plac-na-glanc-czyli-remont-zaniedbanego-podworka

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Conclusion remarks

- Despite the differences, the four concepts are closely interrelated, partly overlapping and partly complementing each other

- They share many features, starting with multi-functionality and the provision of multiple ecosystem services, which are probably the most widely used within the concepts to strengthen the role of nature in decision-making processes (Haase et al. 2014)

Integration of eco-oriented approaches into urban planning and design provide multiple benefits related to **climate change adaptation**, **mitigation** and **urban resilience**

The most important benefits are:

1) improvement of human health and well-being (Hartig et al. 2014)
2) better mental and physical health (Keniger et al., 2013)
3) more efficient and cost-effective solutions in comparison to traditional technical approaches (European Commission 2015)

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Conclusion remarks

UGS and UGBS are the key driver in all four concepts in the provision of ecosystem services, making cities more sustainable, functional and vibrant. They provide:

1) recreation and cultural activities in everyday life at different urban scales;
2) conservation and improvement of biodiversity;
3) cultural and spatial identity;
4) maintaining and improving the environmental quality; and
5) application of natural solutions in solving technical problems (for example, storm water management)

- Best practice examples Examples of best practices apply various types of urban green and blue spaces to reduce the heat island effect, improve microclimatic conditions, or prevent flooding

- In addition, building-based architectural solutions and elements, such as green roofs, green walls, or building-based rain gardens may reduce temperature and save energy (Castleton et al., 2010), or reduce the stormwater runoff.

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Thank you for your attention!

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