

GREEN SKILLS FOR CITIES

Lesson 1 **General concepts on urban areas and NbS**

UNIGE – DAD + DISTAV
AY 2022-23

01

GENERAL CONCEPTS

Slides 3 – 20

- Climate change
- Challenges
- Sustainable development goals
- Urban densification
- Biodiversity
- Urban ecology
- Natural capital and ecosystem services
- Ecosystem disservices

02

INTRODUCTION TO NBS

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- Nature-based Solutions
- Beneficial aspects for citizens
- Role of plants in urban design and planning in response to climate change and city resilience
- Ecological characteristics and distribution of the plant species in the different terrestrial environments with specific reference to urban areas;

03

GLOSSARY

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SECTION
ONE

General Concepts

General concepts

Climate Change

- **Climate change is the most significant challenge** to achieve sustainable development. World leaders and environmental activists declare that we need to take action to face it. The EU has set targets for reducing greenhouse gas emissions up to 2050.
- We should connect long-term with short-term (**Mitigation and Adaptation**) **strategies**, change our behavior, and invest in green infrastructure to manage climate change in the long run.

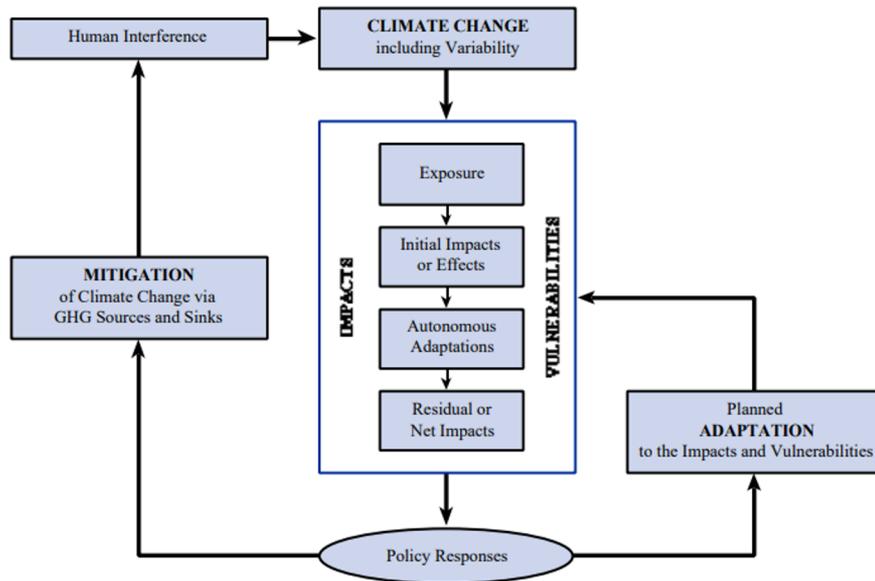


Figure 1-2: Places of adaptation in the climate change issue (Smit *et al.*, 1999).

<https://www.ipcc.ch/site/assets/uploads/2018/03/wg2TARcha>

General concepts

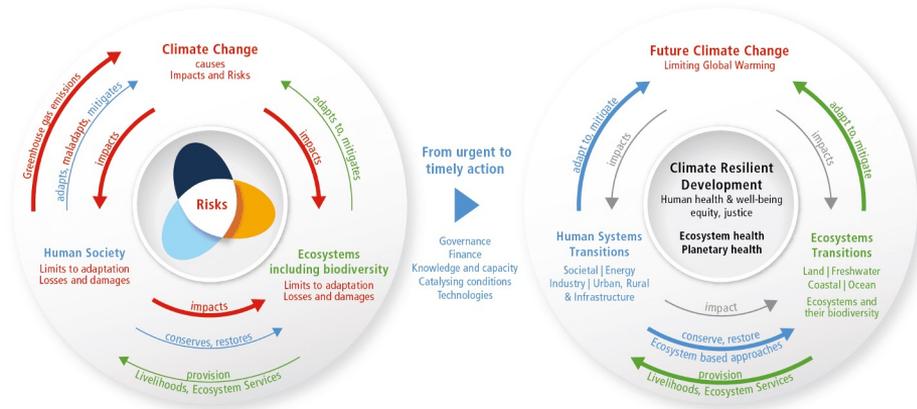
Climate Change

- **International Panel on Climate Change, IPCC 2022 Report** has a strong focus on the interactions among the coupled systems climate, ecosystems (including their biodiversity) and human society.
- **These interactions are the basis of emerging risks** from climate change, ecosystem degradation and biodiversity loss and, at the same time, offer opportunities for the future.

From climate risk to climate resilient development: climate, ecosystems (including biodiversity) and human society as coupled systems

(a) Main interactions and trends

(b) Options to reduce climate risks and establish resilience



[Climate Change Risk \(IPCC Report, 2022\)](#)

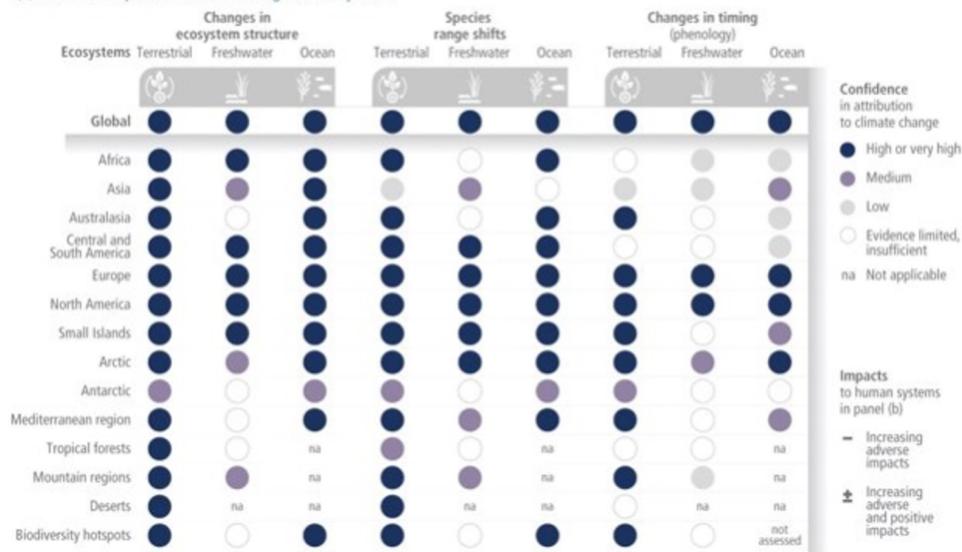
SECTION ONE

General concepts

Global assessments of the impacts of climate change focus on large studies, multi-species, meta-analyses and large reviews. Therefore, they can be assessed with higher confidence than regional studies, which rely on more limited data.

Impacts of climate change are observed in many ecosystems and human systems worldwide

(a) Observed impacts of climate change on ecosystems

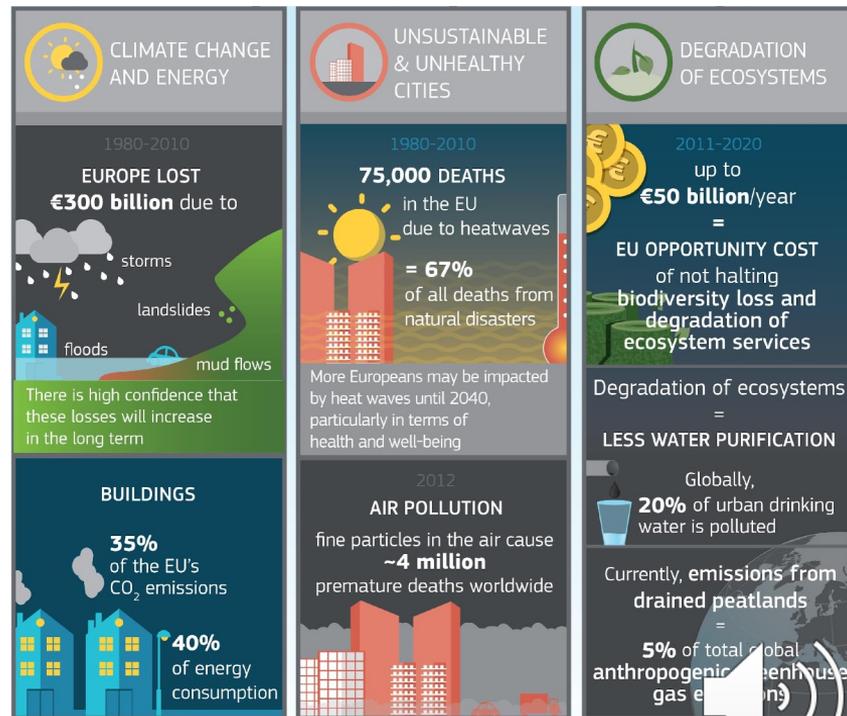


[Climate Change Risk \(IPCC Report, 2022\)](#)

General concepts

Challenges

- From 1980 to 2010 **EU lost €300 billion** due to storms, landslides, mud flows.
- **Buildings** account for **35% of the EU's CO₂ emissions** and **40% of energy consumption**.
- From 1980 to 2010 **EU had 75 000 deaths** due to heat waves
- In 2012 the **fine particles** in the air caused **4 millions of premature deaths** worldwide.
- From 2011 to 2020 degradation of ecosystems cost up to **€50 billion/year**.
- **20% of urban drinking water is polluted** and emissions from drained peatlands represent **5% of global anthropogenic CO₂ emissions**.



SECTION ONE

General concepts

The 17 Sustainable Development Goals (SDGs) were set by the United Nations in 2015 to take action to end poverty, protect the planet, and ensure that by 2030 all people enjoy peace and prosperity. The SDGs recognize that action in one area will affect outcomes in others.



[UN SDGs](#)

General concepts

Sustainable Development Goals

- **Goal 11** aims at creating economic opportunities, affordable housing and **resilient societies**, bringing investment in **public transport, green public spaces**, and **urban participatory and inclusive planning** and management.
- **Goal 13** aims to address the needs of developing countries to both **adapt to climate change** and **invest in low-carbon development**.
- **Goal 15** addresses **the loss of natural habitats** and **biodiversity** and supports **global food and water security**.



[UN SDGs](#)

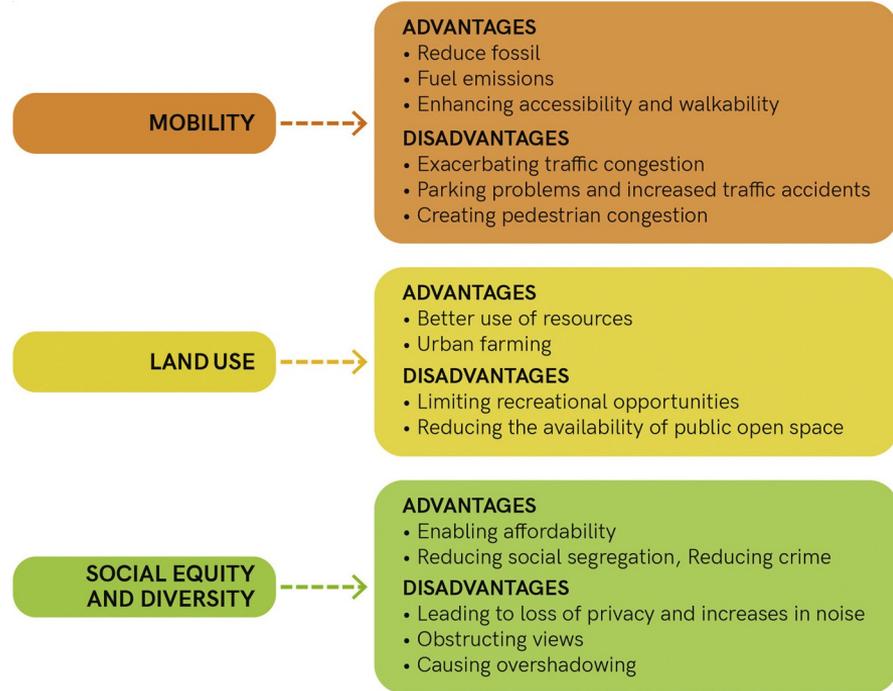


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General concepts

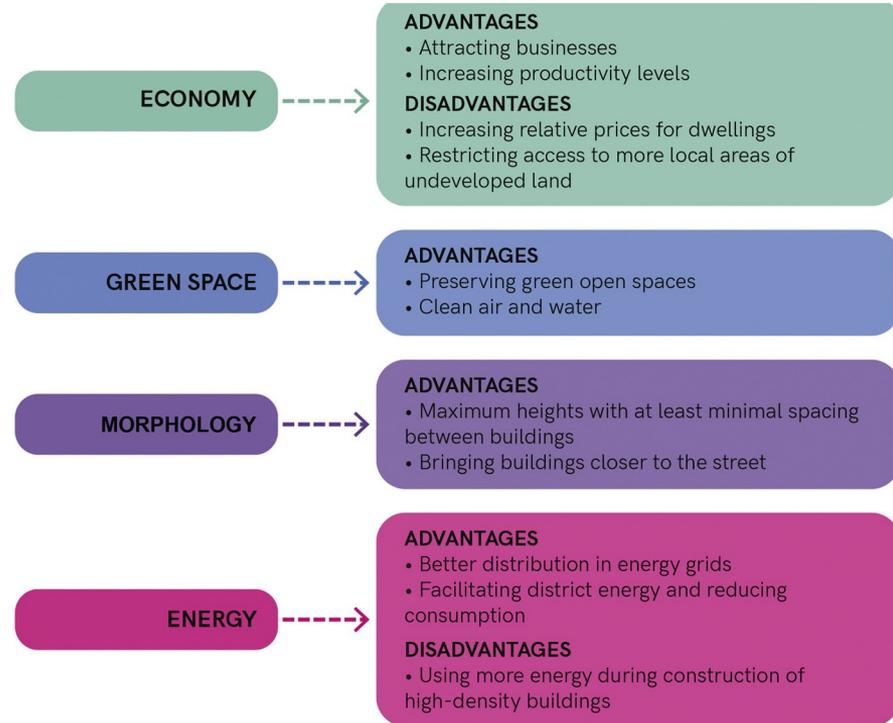
Urban densification affects mobility, land use, social equity, economy, green spaces, morphology and energy use.



[in Chokhachian et al. 2019](#)

General concepts

In all the affected areas there are **both positive and negative impacts.**



[in Chokhachian et al. 2019](#)

General concepts

Biodiversity

Key international regulations to support, restore and manage biodiversity:

- CBD - Convention on Biological Diversity (1992 – Rio de Janeiro)
- COUNCIL DIRECTIVE 92/43/EEC (21 May 1992) on the conservation of natural habitats and of wild fauna and flora
- WSSD - World Summit on Sustainable Development (2002 – Johannesburg)
- The European Green Deal (2019)
- EU Biodiversity Strategy for 2030 (2020)

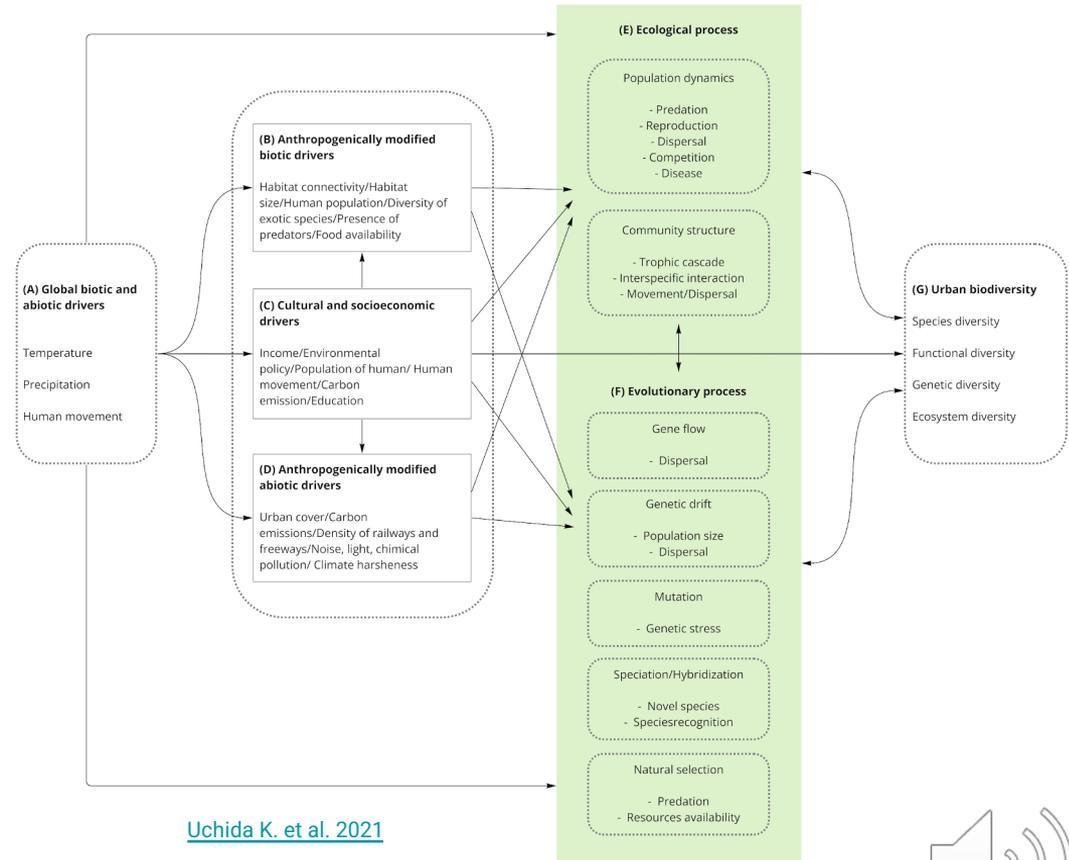
SECTION ONE

General concepts

Urban ecology studies the interactions and relationships at the urban scale.

City as human-dominated ecosystem where natural and artificial elements coexist.

New relationships are established between components of urban ecosystems (plants, animals, microbiota, human and human artifacts)



[Uchida K. et al. 2021](#)

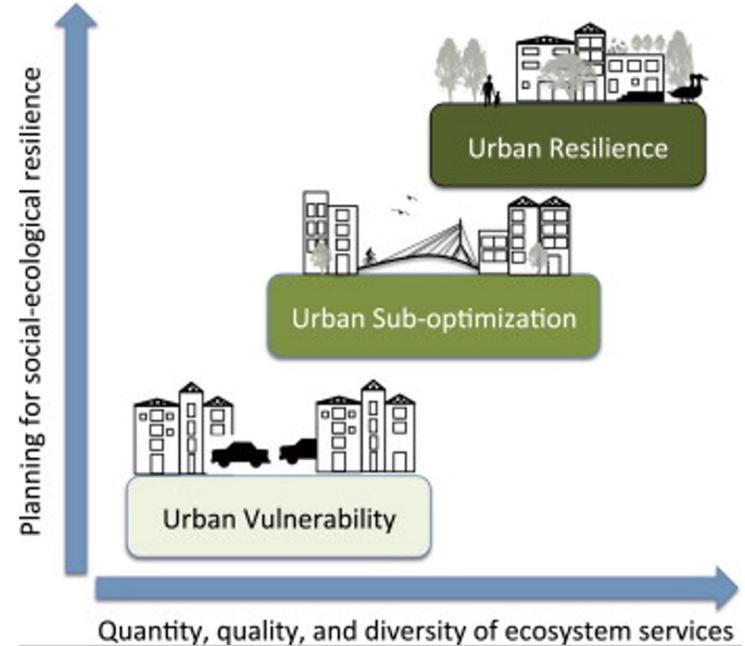
General concepts

Urban ecology

The introduction of natural elements in urban environments allows the establishment of **multitrophic interactions**, with:

- The restoration of ecological processes and functions.
- The increase of biodiversity in terms of quantity and quality (native species).
- Biological community in equilibrium, adapted to the environmental context and able to self-perpetuating over time.

The result is resilient and sustainable cities.



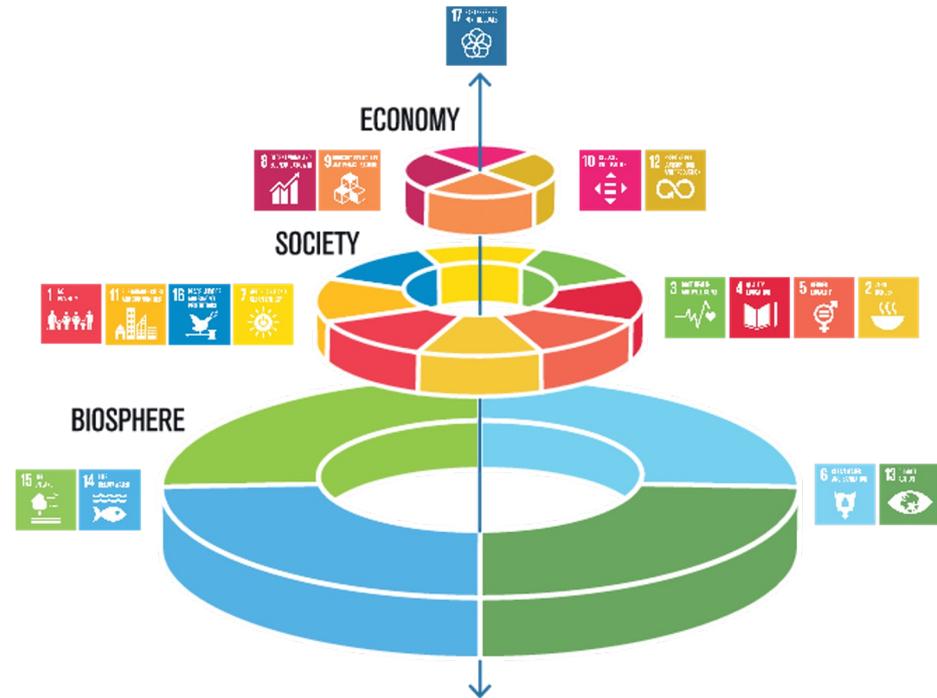
[McPherson et al. 2015](#)

SECTION ONE

General concepts

<<...Our economic prosperity and well-being depend on the good state of **natural capital**, including ecosystems that provide essential goods and services (...): Loss of biodiversity can weaken an ecosystem, compromising the provision of such **ecosystem services**...>>

(MITE, 2019)

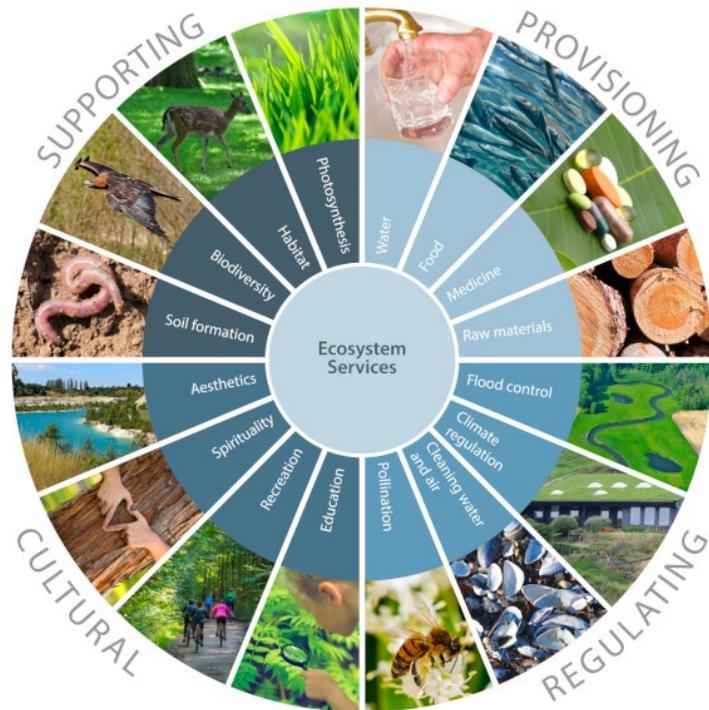


The SDGs wedding cake

General concepts

Natural capital and ecosystems services

Ecosystem services are an important **support to biodiversity** and the **regulation of ecological cycles**, are also important to provide food, medicines and raw materials, and are an important cultural source (religious, educational, aesthetic, recreational).

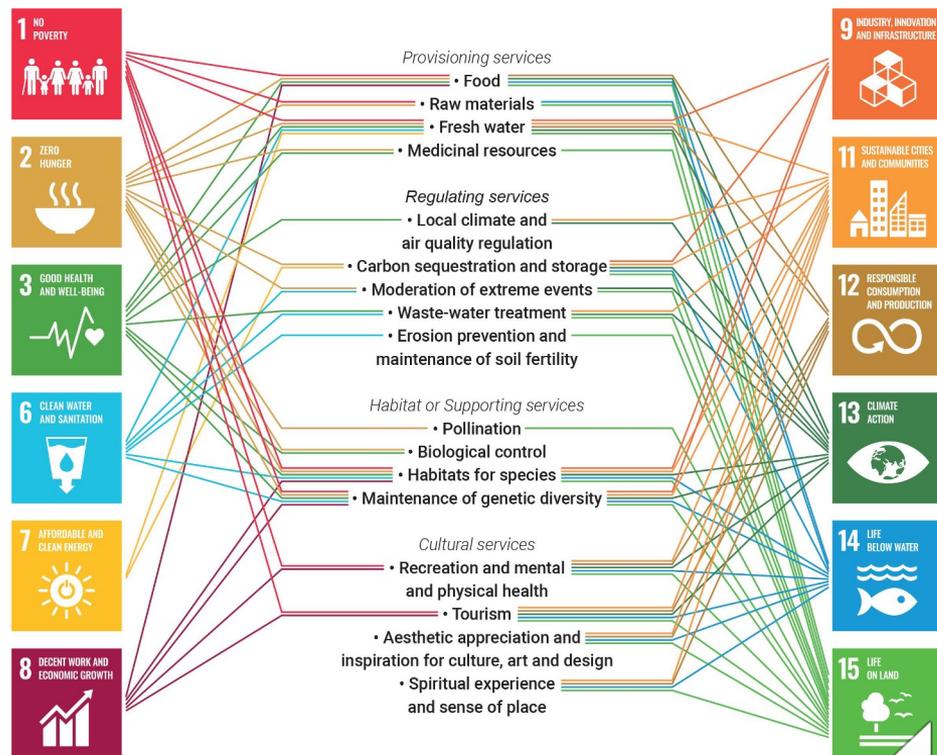


Envs.au.dk

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General concepts

Ecosystem services play a relevant role in achieving the UN Sustainable Development Goals.



In Perini, 2022



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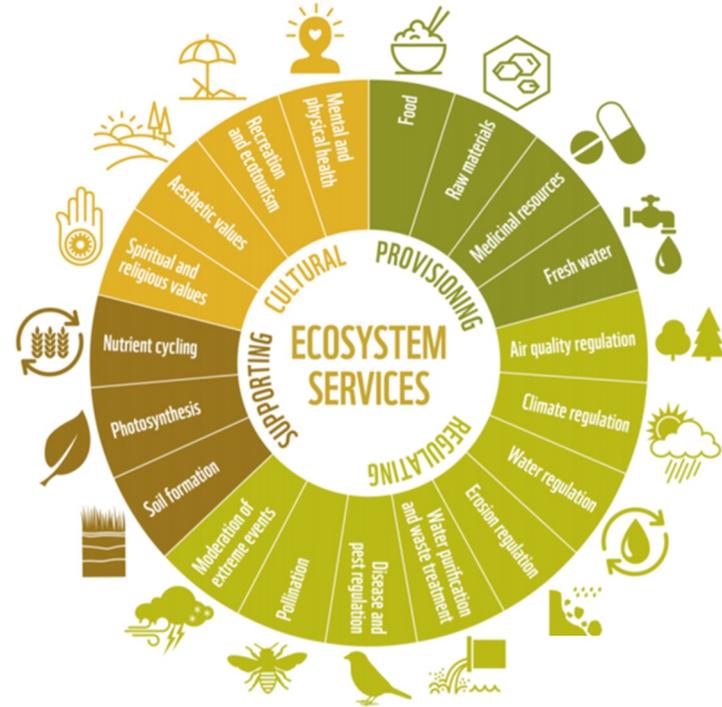
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General concepts

All the **ecosystem services** - like the provision of food, clean air, water, and resources like wood or medicine – **can only be provided by healthy ecosystems** and play a crucial role in **supporting local livelihoods**.



[Range of ecosystem services provided by nature to humans](#)

General concepts

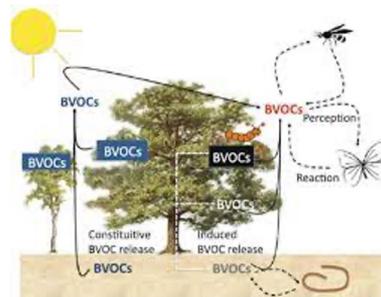


<https://youtu.be/r7UCAsBT5Yg>

General concepts

Ecosystems disservices

- **Invasive alien species occurrence**
- **Infrastructure damage (e.g., root damage on streets and buildings)**
- **Allergies, poisoning, hurting** by plants (e.g., rhinitis, accidental ingestion, thorny species)
- **Biogenic volatile organic compounds (VOCs) emission (and related O₃ formation)**
- **Unpleasant odors** (e.g., wrong selection of plant individuals)
- **Traffic obstruction** by trees or limited access to public areas.



[Tian et al., 2020](#)



[Von Döhren and Haase, 2019](#)

SECTION
TWO

Introduction to NbS

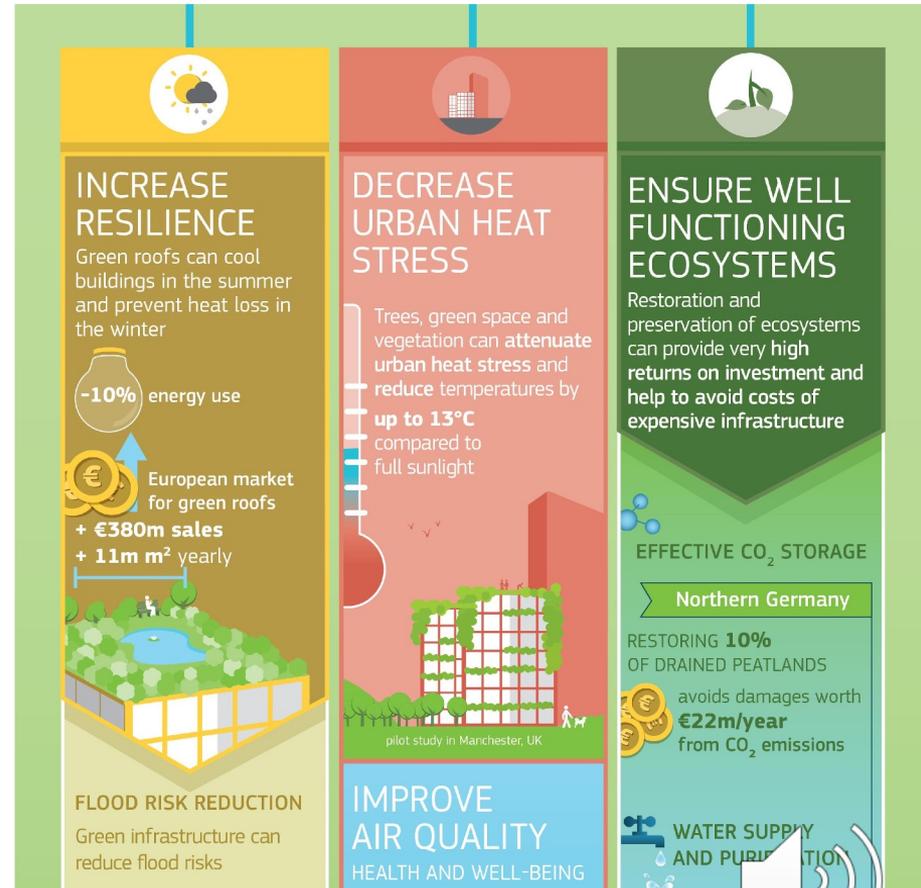
SECTION TWO

Introduction to NbS

Nature-based solutions support the delivery of a range of ecosystem services and major EU policy priorities, including EU Green Deal.

Current policy goals:

- provide the evidence for NbS
- improve framework conditions for NbS
- develop a EU research and innovation community
- advance the development, uptake, and upscale of innovative NbS
- mainstream NbS in international research and innovation



(European Commission, 2022)

Introduction to NbS

Nature-based Solutions

Potential components of a **Green Infrastructure**:



Core areas of high biodiversity value



Core areas outside protected areas containing large healthy functioning ecosystems



Restored habitats reconnecting or enhancing existing natural areas



Natural features acting as **wildlife corridors** or **stepping stones**



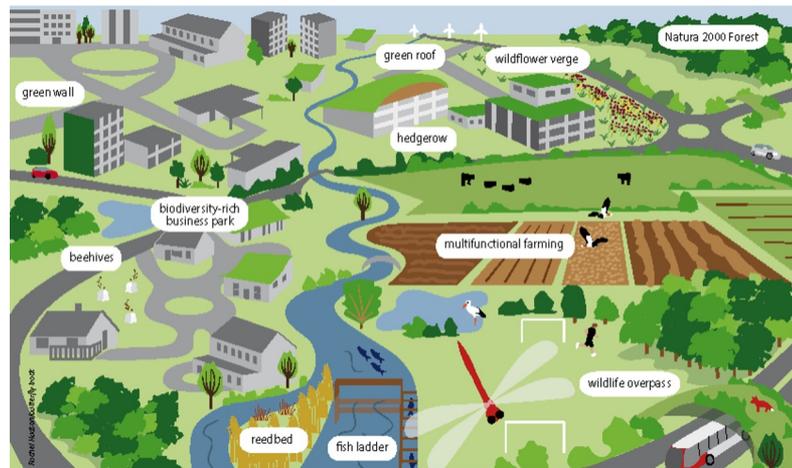
Artificial features enhancing ecosystem services or assisting wildlife movement



Sustainably managed **buffer zones** improving overall ecological quality and permeability of biodiversity



Multi-functional zones with compatible land uses creating land management combinations



Potential components of a green infrastructure



Introducion to NbS

Nature-based Solutions

NbS contribute to:

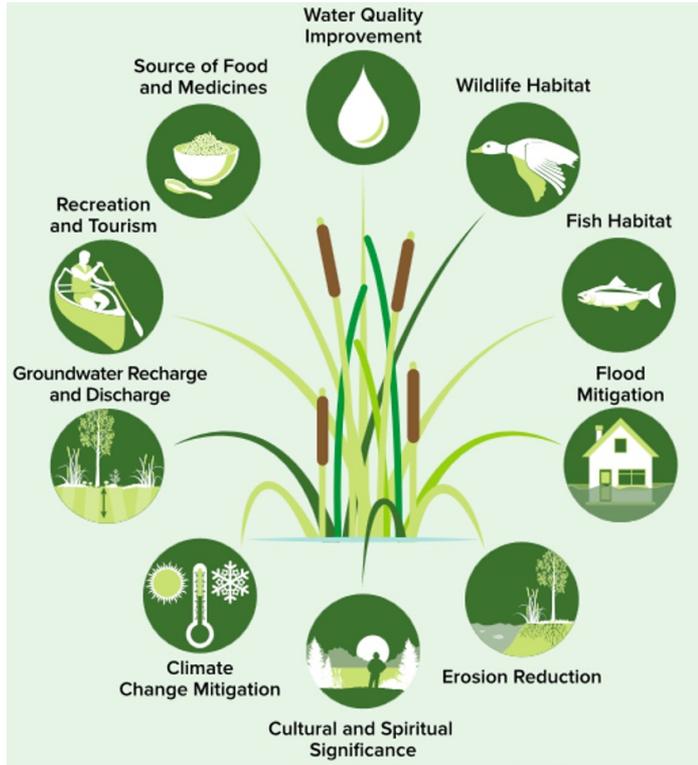
- Protection or restoration of natural ecosystems.
- Ecosystems services' provision (e.g. climate change adaptation, disaster risk reduction).
- Benefits to the environment (e.g. connect natural and artificial green areas, support biogeochemical cycles).
- Creation or restoration of multitrophic networks (e.g. plant-insect-bird interactions).
- Key solutions to connect natural and artificial ecosystems.



NbS as an umbrella term for ecosystem-related approaches Cohen-Shacham et al. 2016

SECTION TWO

Introduction to NbS



[Source: Ontario Ministry of Natural Resources and Forestry. 2017. A Wetland Conservation Strategy for Ontario 2017–2030. Queen’s Printer for Ontario. Toronto, ON. 52 pp.](#)

Introducion to NbS

Beneficial aspects for citizens

- **Protection or restoration of natural - Source of Food and Medicines, Cultural significance**
Nature is the main source of food and plants are used as medicines and for spiritual and cultural purposes too (ethnobotanical uses).
- **Recreation and Tourism**
Nature is an important element for tourism and sport activities (like trekking, hiking, biking, and more).
Urban forestry improves mental health too.
- **Water Quality improvement**
Plants can act like a filter, by removing pollutants from soil and water.



Introducion to NbS

Beneficial aspects for citizens

→ **Wildlife and Fishes Habitat**

Green areas enhance biodiversity, by hosting plant species, mushrooms, insects, birds and mammals.

→ **Flood Mitigation**

Green areas, implemented with proper plants like trees and bushes, are important to mitigate floods. Crowns are able to reduce heavy rain impact on soil, while roots till the soil, helping to prevent its accompaniment.

→ **Aesthetic Value**

More pleasant aspect to urban environments, they break the static nature of buildings, a function of biological calendar as the seasons change.



Introduction to NbS

Beneficial aspects for citizens

→ **Erosion reduction**

Plants are a key element to reduce soil erosion: the roots hold the ground, the crowns reduce the impact of rain and winds.

→ **Climate Change Mitigation**

Plants are a key element in the carbon storage process. Urban green also helps to reduce the temperature by enhancing shadow and humidity levels.

→ **Groundwater Recharge and Discharge**

Woodland soils and tree roots increase water storage and reduce run-off. Tree roots take up water and water-borne compounds, stabilize soils, prevent Sedimentation and protect riverbanks. (from: Forestry Commission – GOV.UK)



Introduction to NbS

Role of plants in urban design and planning in response to climate change and city resilience

Plants in urban design play two important functions:

- **Aesthetic value:** plants can make an environment more comfortable and pleasant.
- **Environmental function:** plants are a key element to mitigate pollution and climate change effects.

To reach these objectives it's fundamental to choose the right allocation (e.g. space suitable for tree growth), the proper species (e.g. keep in mind growth times and avoid invasive, poisonous, allergenic species) and to apply the right maintenance (e.g. proper pruning, irrigations...).

Introducion to NbS

KEEPING IT COOL

HOW THE UK CAN END ITS CONTRIBUTION TO CLIMATE CHANGE BY 2045

To help limit global temperature increases to 1.5°C, the UK must reduce greenhouse gas emissions to net zero. WWF's report, *Keeping it Cool*, provides a pathway to achieve that by 2045.

wwf.org.uk/keepingcool

1. CUT EMISSIONS IN ALL SECTORS

- Industry, agriculture, aviation and shipping: rapid, deep emissions cuts.
- People embrace a more plant-based diet over time.
- Power, buildings and transport: emissions cut rapidly to zero.
- International collaboration helps cut emissions.

2. REMOVE CARBON FROM THE AIR TO BALANCE REMAINING EMISSIONS

- Focus on nature-based solutions, such as tree planting.

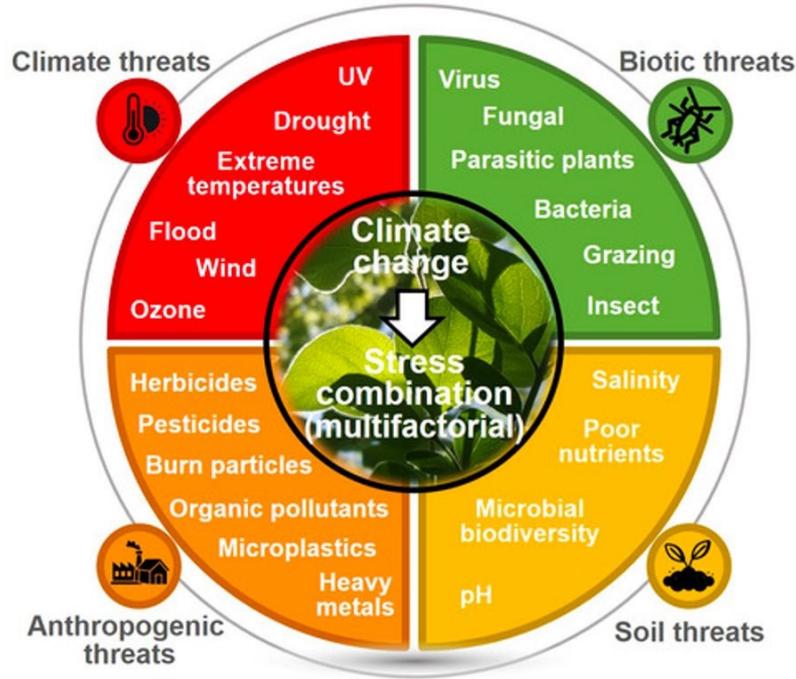
FOR YOUR WORLD

WWF

Source: WWF

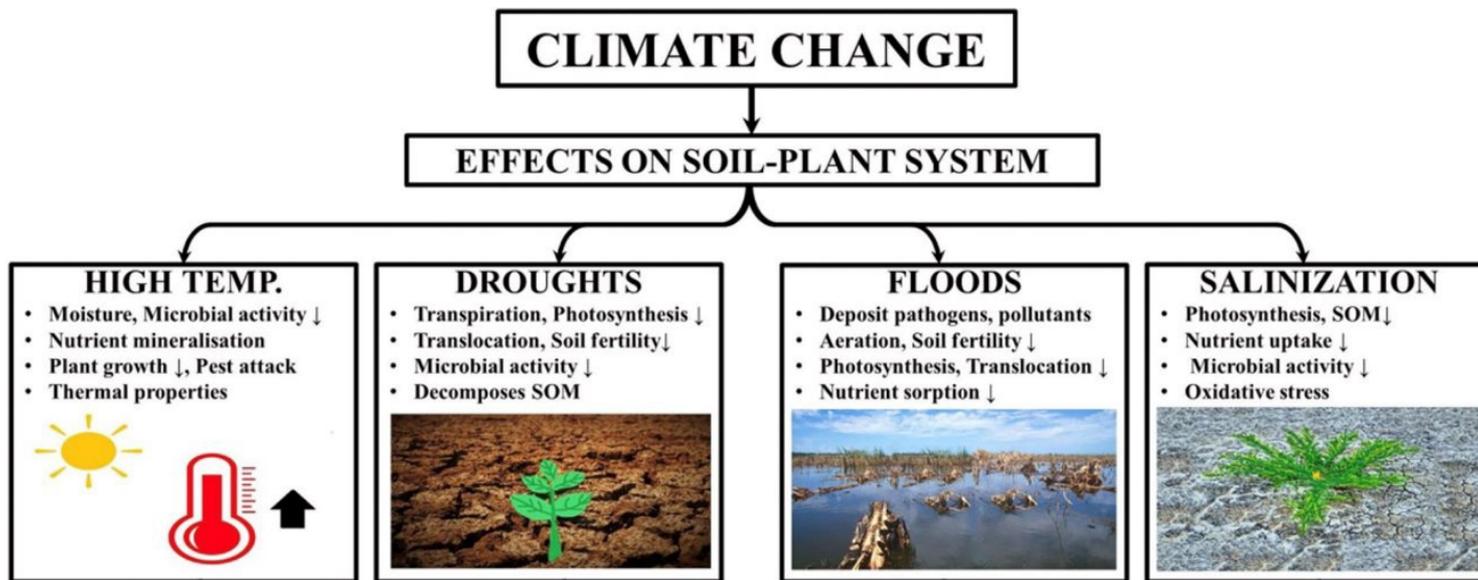


Introducion to NbS



[Source: The Plant Journal](#)

Introducion to NbS



Abhishek Kumar et al. (2022), modified

Introduction to NbS

Role of plants in urban design and planning in response to climate change and city resilience

The use of Plants and NbS helps to:

- **Increase resilience:** by cooling buildings during summer and reducing the heat loss in winter. Green Infrastructures can reduce flood risks.
- **Decrease Urban Heat Stress:** by reducing temperatures up to 13°C.
- **Ensure well-functioning ecosystems** and providing high returns on investments.

Introduction to NbS

Role of plants in urban design and planning in response to climate change and city resilience

Urban Green Areas are also important to enhance and protect biodiversity.

- Feeding plants for pollinators (e.g. bees, beetles, butterflies, flies);
- Feeding plants for birds and little mammals;
- Use of native plants to protect plants biodiversity.



Introduction to NbS

Role of plants in urban design and planning in response to climate change and city resilience

Plants can be also useful to:

- **Reduce CO₂**: Forests are department stores where carbon naturally accumulates and increasingly private companies plant a certain number of trees, especially in urban and peri-urban environments, to offset the emissions deriving from some of their activities (eg. poplars, maples).
- **Reduce PM_x and acoustic pollution** thanks to the crowns and through the deposition on the leaf surface (eg. oaks, maples, elms).



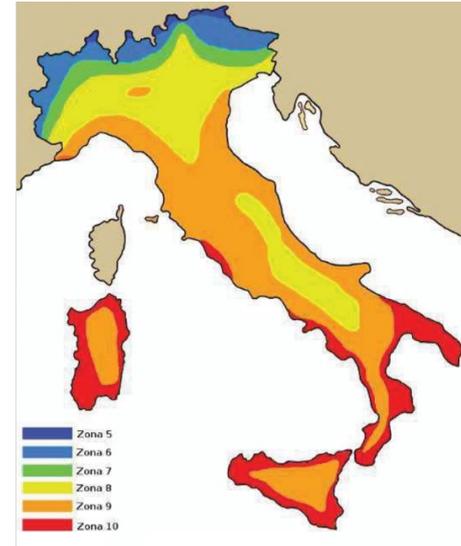
Introduction to NbS

Ecological characteristics and distribution of the plant species in the different terrestrial environments

Plants distribution is influenced by **primary factors** (light, temperature, water, chemical elements in soil, activity of organisms, natural events) and **secondary factors** (climate, physiography, mother rock and soil).

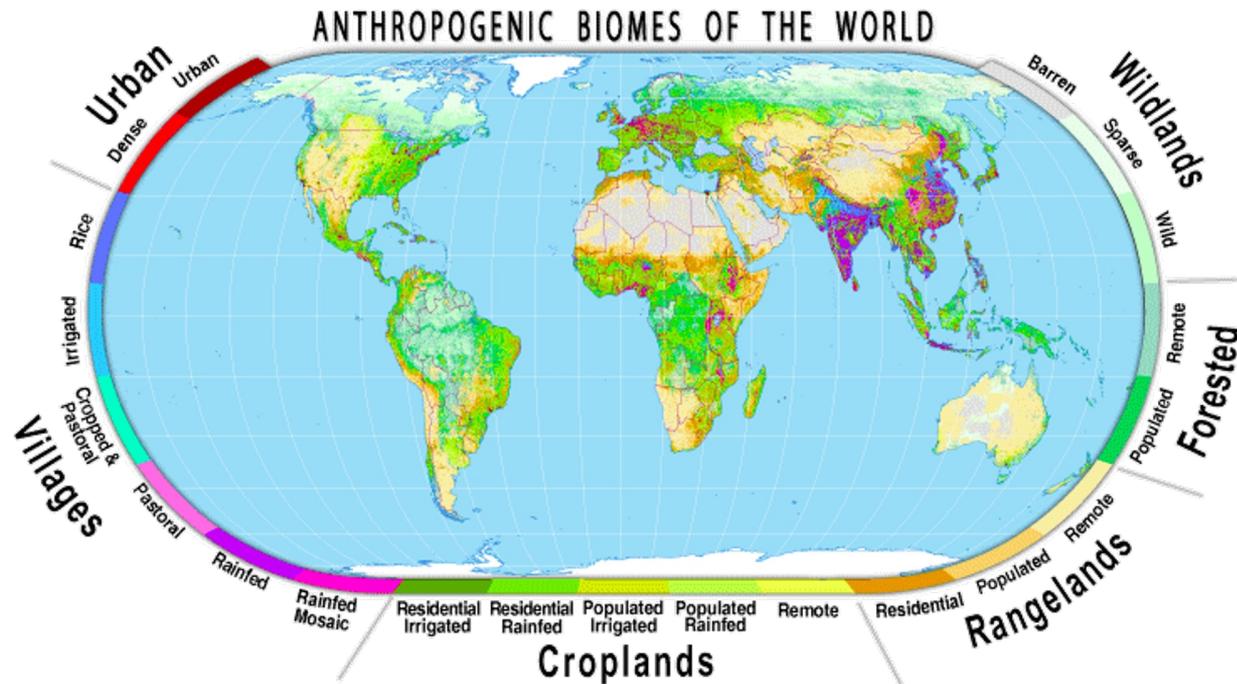
Hardiness zone: defined geographical area where a certain category of plants can grow and withstand the minimum temperatures of the area; each zone is defined by climatic conditions.

- Example: a plant described as "hardy to zone 10" means that the plant can bear a minimum temperature of $-1\text{ }^{\circ}\text{C}$ ($30.2\text{ }^{\circ}\text{F}$) to $3.9\text{ }^{\circ}\text{C}$ ($39.0\text{ }^{\circ}\text{F}$).



Source: [The United States Department of Agriculture](#)

Introduction to NbS



[Source: The Anthroecology Lab](#)



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Introduction to NbS

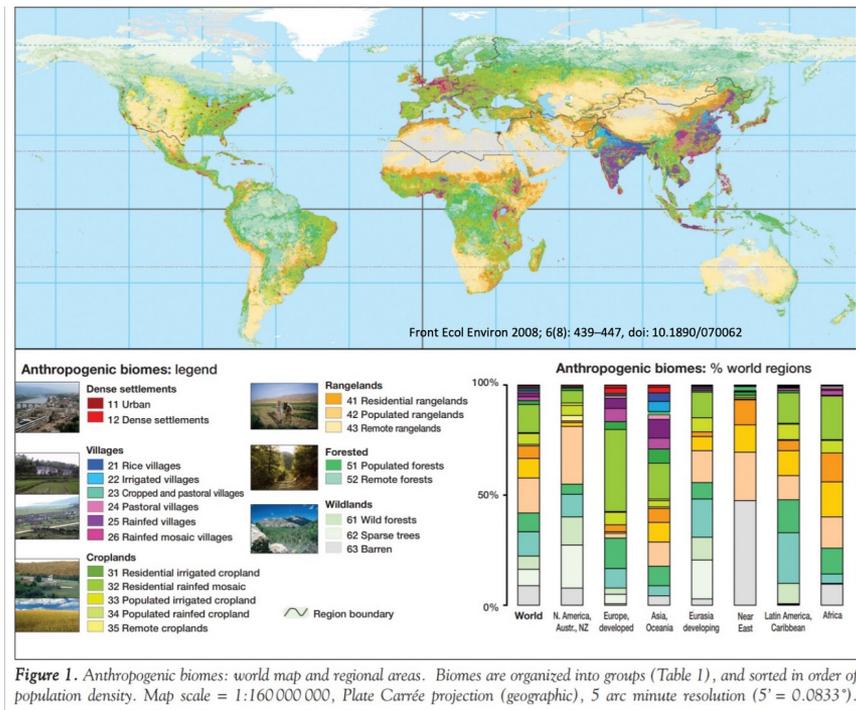
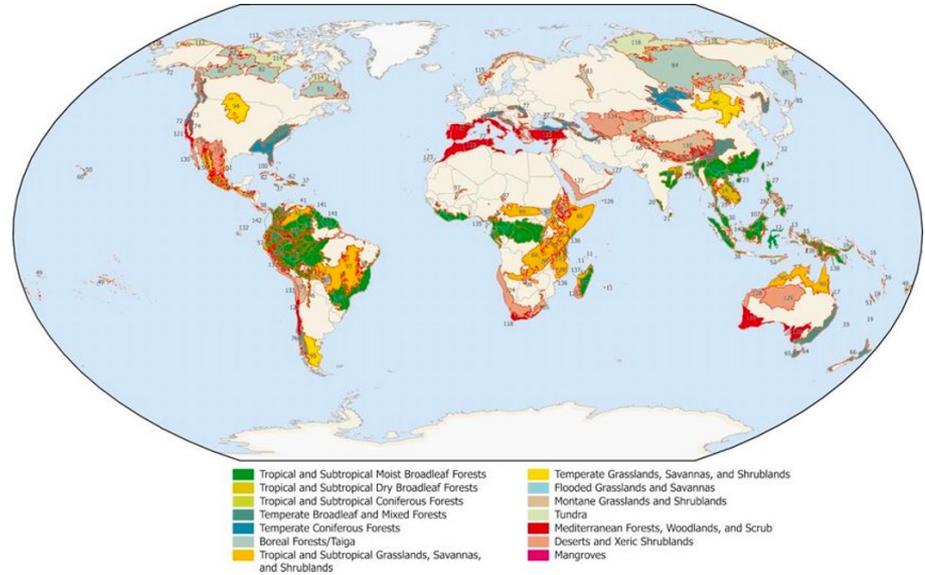


Figure 1. Anthropogenic biomes: world map and regional areas. Biomes are organized into groups (Table 1), and sorted in order of population density. Map scale = 1:160 000 000, Plate Carrée projection (geographic), 5 arc minute resolution ($5' = 0.0833^\circ$).

Introduction to NbS

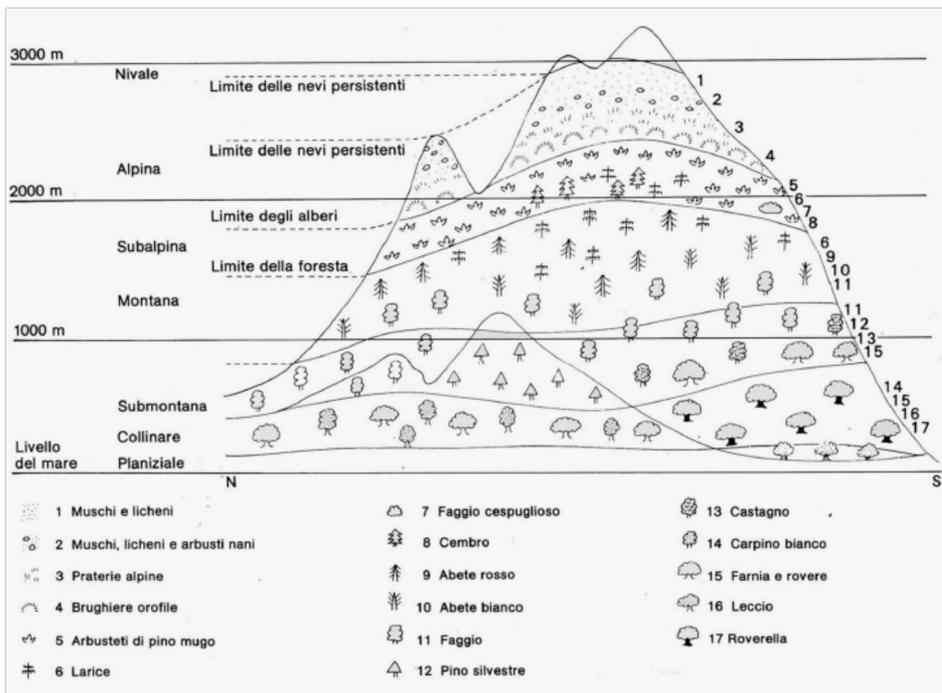
A team of biologists divided the terrestrial area into biogeographical realms and these into ecoregions, **characterized by a main biome.**



[Olson, D. and Dinerstein, E. \(2009\)](#)

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Introduction to NbS



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Source: [L. Damiani - M.N. Forgiarini - G. Puglisi, 2017](#)
“[Gestione ambientale territoriale.](#)”



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SECTION
THREE

Glossary



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GREEN SKILLS
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Glossary

- **ADAPTATION:** the process of adjustment to actual or expected climate and its effects. In human systems, adaptation seeks to moderate or avoid harm or exploit beneficial opportunities. In some natural systems, human intervention may facilitate adjustment to expected climate and its effects. Adaptation is place- and context-specific, with no single approach for reducing risks appropriate across all settings (Field et al., 2014).
- **ANTHROPOCENE:** geological epoch dating from the commencement of significant human impact on Earth's geology and ecosystems, including, but not limited to, anthropogenic climate change (Crutzen, 2006).
- **ANTHROPOCENTRISM:** Anthropocentrism refers to a human-centered, or “anthropocentric,” point of view. Anthropocentric value systems thus see nature in terms of its value to humans (www.oxfordbibliographies.com).
- **BIODIVERSITY:** the variability of living beings of all origins including, among others, aquatic ecosystems and the ecological complexes they are a part of; this includes diversity within species and the diversity of ecosystems (UN 1992 Convention on Biological Diversity).
- **BIOPHILIA:** theory assuming that humans possess an innate tendency to seek connections with nature and other forms of life (O. Wilson, 1984).



Glossary

- **BIOSPHERE:** that part of the Earth and atmosphere capable of supporting living organisms (EEA, 2004).
- **CLIMATE EXTREME EVENTS:** rare event at a particular place and time of year - a pattern of extreme weather that persists for some time, such as a season (IPCC, 2012).
- **CONSERVATION:** conservation is a common concern of humankind and represents the act of protecting Earth's natural resources for current and future generations (Convention on Biological Diversity, 1992).
- **ECOLOGICAL FUNCTIONS:** a species interaction or ecological role whereby a species or group of species prevent extinction or endangerment, maintain a biogeochemical flux or pool, or support ecosystem productivity (Brodie et al, 2018).
More simply, a set of ecological roles performed by each species in its ecosystem (Marcot et al, 2001).
- **ENVIRONMENT:** the air, water, and land in or on which people, animals, and plants live (Cambridge Dictionary, online).
- **GREEN INFRASTRUCTURE (GI)** includes natural, semi-natural, and artificial networks of multifunctional ecological systems within, around, and between urban areas: waterways, wetlands, woodlands, wildlife habitats, greenways, parks, and other natural areas (European Commission, 2010; Sandstrom, 2002; Tzoulas et al., 2007).

Glossary

- **GREENWASH:** when a company hides the true effects of its products or actions on the environment, by making it seem as though the company is very concern about the environment» (Longman 2009).
- **INFILTRATION** is defined as the flow of water from aboveground into the subsurface (Ferré and Warrick, 2005).
- **INVASIVE ALIEN SPECIES:** species accidentally or intentionally introduced, outside of their natural geographic range and that become problematic. They are often introduced as a result of the globalisation of economies through the movement of people and goods, or the transport of ornamental plants to new areas (IUCN, 2002).
- **MITIGATION:** human intervention to reduce the sources or enhancement of greenhouse gases, together with adaptation to climate change, contributes to the objective expressed in Article 2 of the United Nations Framework Convention on Climate Change (Edenhofer *et al.*, 2014).
- **MULTISTAKEHOLDERS APPROACH:** a new integrated ecosystem approach to architecture that focus equally on humans, plants, animals and associated organisms such as microbiota (ECOLOPES project, 2021).
- **MULTITROPHIC NETWORKS:** the set of multiple interactions between species of different trophic levels of the food web that affects the distribution and the abundance of organisms (de Ruiter, 2005).



Glossary

- **NATURAL CAPITAL:** available stocks of renewable and non-renewable (e. g. plants, animals, air, water, soil, minerals) natural resources which support human life (WWF Living Planet Report, 2016).
- **NATURE-BASED SOLUTIONS (NbS):** 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 (European Commission, 2015).
- **REGULATING SERVICES:** regulating services include pollination, flood control, water purification, and processes reducing threats of disease and harm from climate (Pielke, 2013).
- **RESILIENCE:** the capacity of a system for adsorbing changes to maintain foundational control on function and structure (Chapin et al., 2009).
- **SUSTAINABLE DEVELOPMENT:** development that meets the needs of the present without compromising the ability of future generations to meet their own needs (Keeble,1987).
- **STORMWATER RUNOFF** is generated from rain and snowmelt that flows over land or impervious surfaces, such as paved streets, parking lots, and building rooftops, and does not soak into the ground (United States Environmental Protection Agency, EPA).

Glossary

- **STORMWATER MANAGEMENT:** the effort to reduce runoff of rainwater or melted snow into streets, lawns and other sites and the improvement of water quality (United States Environmental Protection Agency, EPA).
- **URBAN RESILIENCE** can be defined as the ability of an urban system to adapt (maintain or rapidly return to previous functions) when facing a disturbance. According to academic and policy interests, it is crucial to improve urban resilience to cope especially with climate imbalances and related issues (Meerow et al., 2016)
- **VOC (VOLATILE ORGANIC COMPOUNDS):**
any organic chemical compound
of carbon, that under normal conditions are

gaseous and enter the atmosphere taking part to the atmospheric photochemical reactions (EEA , 2004).

SECTION
FOUR

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