

GREEN SKILLS 4 CITIES

Training for Trainers : Botany & Technology Dimension

UNIGE – DAD + DISTAV
April 2022



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SECTION 1

GLOSSARY



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01.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).
- **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 represent the act of protecting Earth’s natural resources for current and future generations (Convention on Biological Diversity,1992).



01.GLOSSARY

- **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).
- **ECOSYSTEM:** a dynamic complex of plant, animal and micro-organism communities and their non-living environment interacting as a functional unit (UN 1992 Convention on Biological Diversity).
- **ECOSYSTEM DISSERVICES:** the negative effects of nature on human wellbeing (Shackleton et al.,2016).
- **ECOSYSTEM SERVICES:** the goods and services provided by ecosystems that directly and indirectly contribute to human well-being (MAES, 2018).
- **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).
- **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).



01.GLOSSARY

- **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).
- **LIFE CYCLE ASSESSMENT (LCA)** is an internationally standardised methodology (ISO 14040 ff). LCA helps to quantify the environmental pressures related to goods and services (products), the environmental benefits, the trade-offs and areas for achieving improvements taking into account the full life-cycle of the product.
- **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).
- **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).

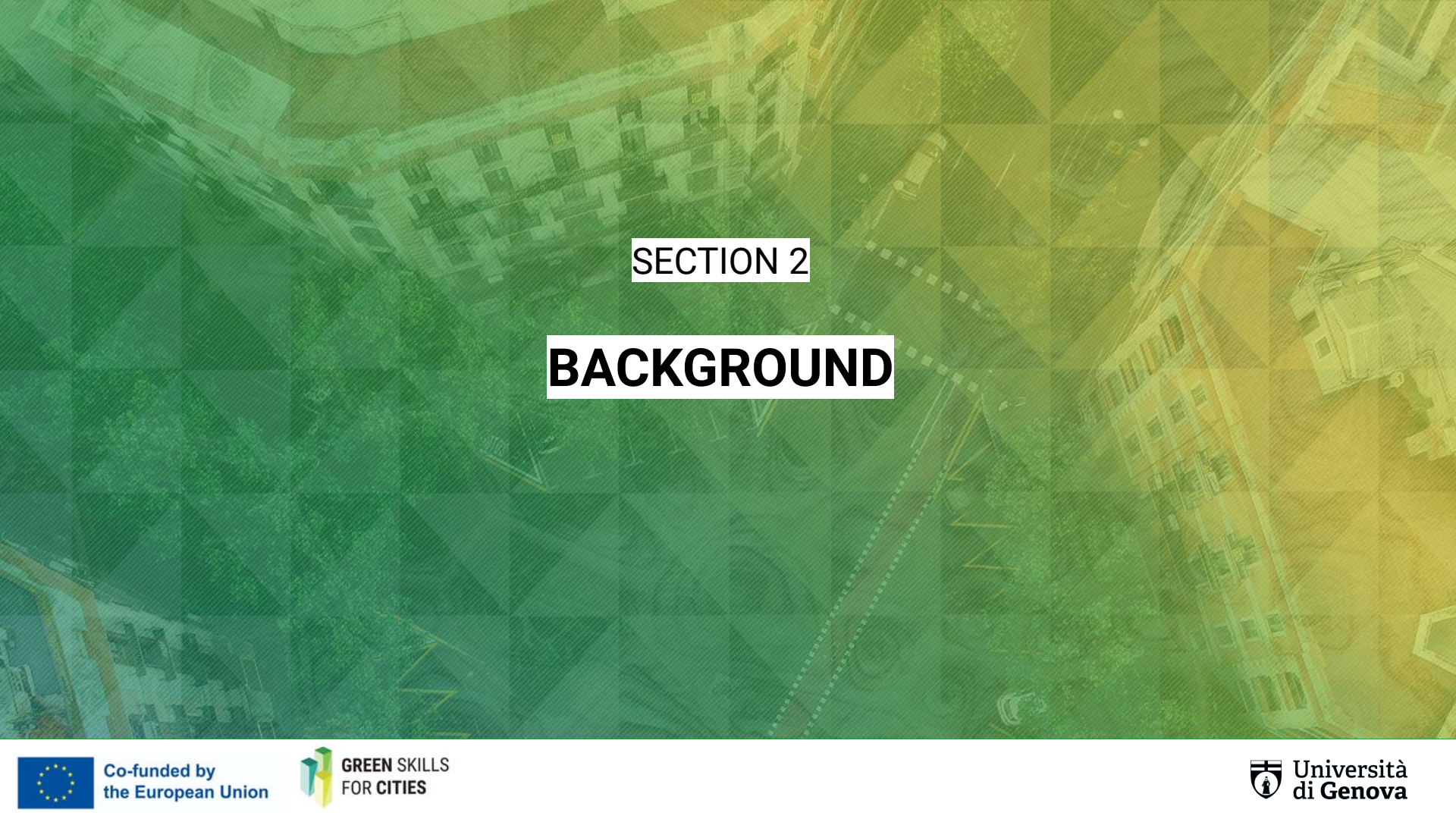
01.GLOSSARY

- **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 fundamental 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).
- **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).

01.GLOSSARY

- **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 2

BACKGROUND



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02.BACKGROUND: CLIMATE CHANGE

- **Climate change is the most significant challenge** to achieve sustainable development. World leaders, environmental activists, declare that is necessary to take action to face climate change and stop atmosphere pollution The EU has set itself targets for reducing its greenhouse gas emissions up to 2050.
- We should try to **connect long term with short term strategies (Mitigation and Adaptation strategies)**. Changing our behavior, being mindful of our overall impact, and at the same time, investing in green infrastructure, could prove a useful commitment strategy to manage climate change in the long run.

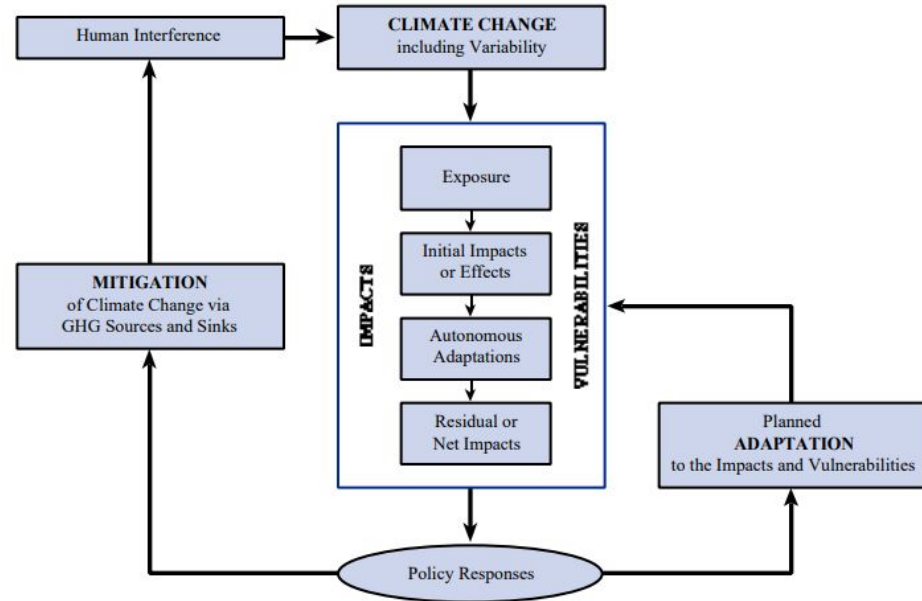


Figure 1-2: Places of adaptation in the climate change issue (Smit *et al.*, 1999).

<https://www.ipcc.ch/site/assets/uploads/2018/03/wg2TARchap1.pdf>

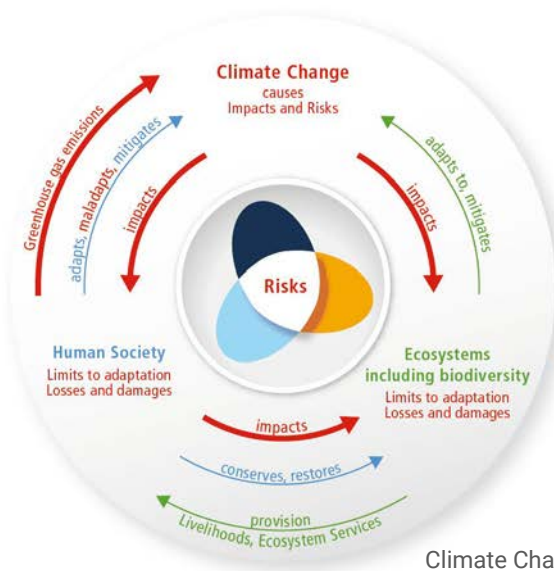
02.CLIMATE CHANGE

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

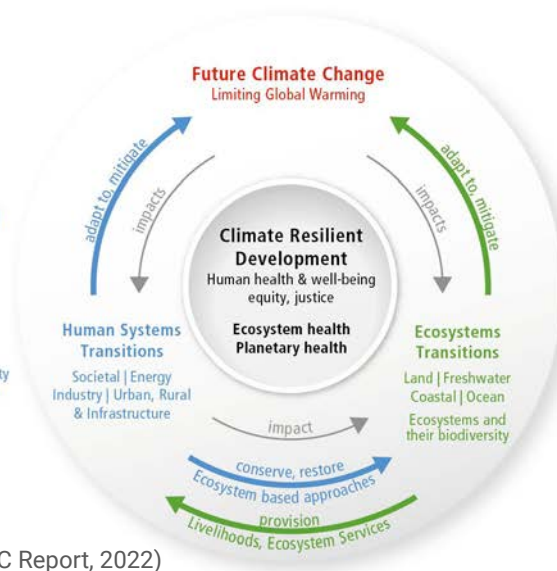
The risk propeller shows that risk emerges from the overlap of:



(a) Main interactions and trends



(b) Options to reduce climate risks and establish resilience



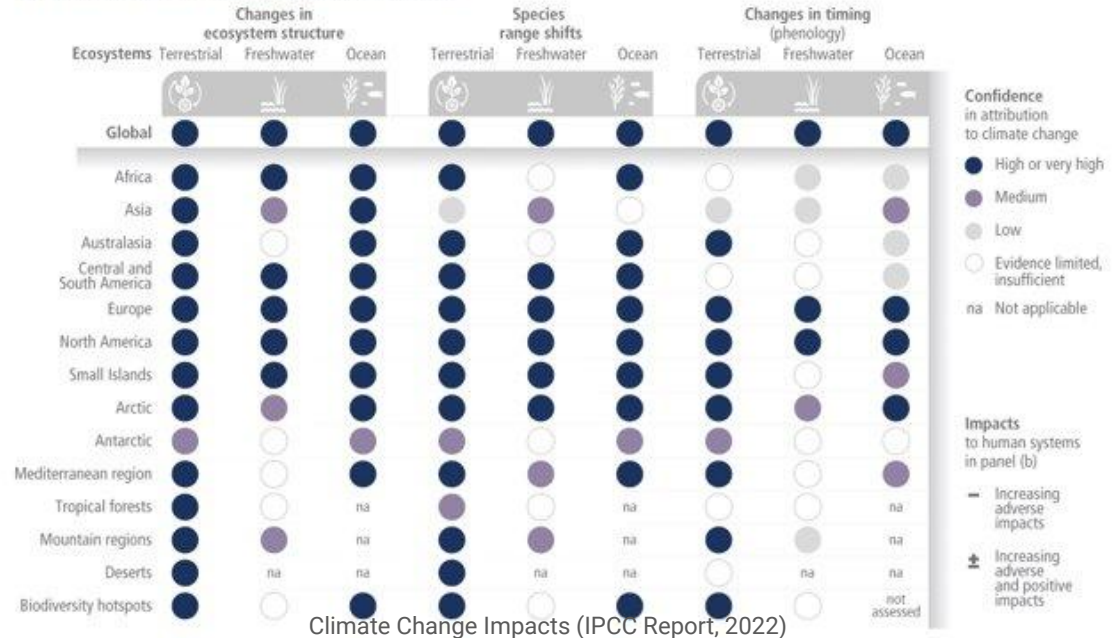
Climate Change Risk (IPCC Report, 2022)

02.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.

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

(a) Observed impacts of climate change on ecosystems



Climate Change Impacts (IPCC Report, 2022)

02.CLIMATE CHANGE

- Confidence levels reflect uncertainty in attribution of the observed impact to climate change. Global assessments focus on large studies, multi-species, meta-analyses and large reviews. For that reason, they can be assessed with higher confidence than regional studies, which may often rely on smaller studies that have more limited data.
- Climate change has already altered terrestrial, freshwater and ocean ecosystems at global scale**, with multiple impacts evident at regional and local scales where there is sufficient literature to make an assessment.

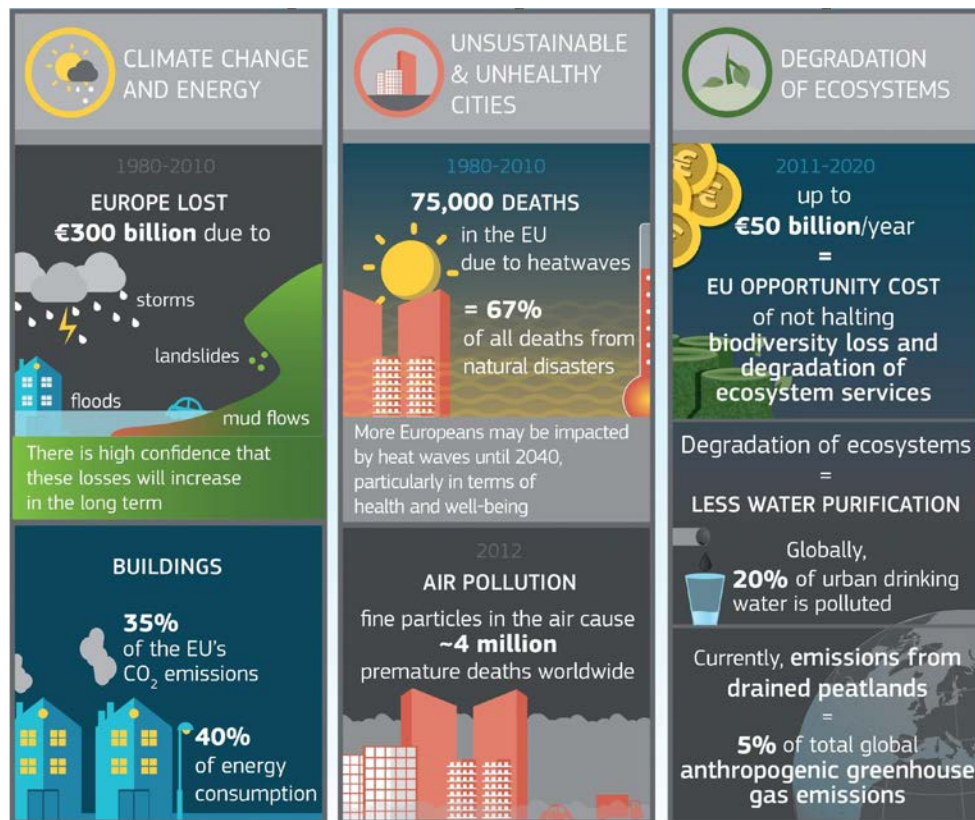
(b) Observed impacts of climate change on human systems

Human systems	Impacts on water scarcity and food production				Impacts on health and wellbeing				Impacts on cities, settlements and infrastructure			
	Water scarcity	Agriculture/crop production	Animal and livestock health and productivity	Fisheries yields and aquaculture production	Infectious diseases	Heat, malnutrition and other	Mental health	Displacement	Inland flooding and associated damages	Flood/storm induced damages in coastal areas	Damages to infrastructure	Damages to key economic sectors
Global	±	–	○	–	–	–	–	–	–	–	–	–
Africa	–	–	–	–	–	–	–	–	–	–	–	–
Asia	±	±	–	–	–	–	–	–	–	–	–	–
Australasia	±	–	±	–	–	–	–	not assessed	–	–	–	–
Central and South America	±	–	±	–	–	–	not assessed	–	–	–	–	–
Europe	±	±	–	±	–	–	–	–	–	–	–	–
North America	±	±	–	±	–	–	–	–	–	–	–	–
Small Islands	–	–	–	–	–	–	–	–	–	–	–	–
Arctic	±	±	–	–	–	–	–	–	–	–	–	±
Cities by the sea	○	○	○	–	○	–	not assessed	–	○	–	–	–
Mediterranean region	–	–	–	–	–	–	not assessed	–	–	–	○	–
Mountain regions	±	±	–	○	–	–	–	–	–	na	–	–

Climate Change Impacts (IPCC Report, 2022)

02.CHALLENGES

- **CLIMATE CHANGE AND ENERGY:** in 1980-2010 Europe lost €300 billion due to storms, landslides, mud flows. Buildings represent the **35% of the EU's CO₂ emissions** and the **40% of energy consumption**.
- **UNSUSTAINABLE & UNHEALTHY CITIES:** in 1980-2010 EU had **75 000 deaths due to heatwaves** = 67% of all deaths from natural disasters. In 2012 the air pollution, especially the **fine particles** in the air, caused **4 millions of premature deaths** in worldwide.
- **DEGRADATION OF ECOSYSTEMS:** in 2011-2020 it costs up to €50 billion/year. It means that today **20% of urban drinking water is polluted** and that emissions from drained peatlands represent 5% of total global anthropogenic greenhouse gas emissions.



Infographic EU Commission



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02.SUSTAINABLE DEVELOPMENT GOALS

The **Sustainable Development Goals** (SDGs), also known as the Global Goals, were adopted by the United Nations in 2015 as a universal call to **action to end poverty, protect the planet**, and ensure that **by 2030 all people enjoy peace and prosperity**.

The **17 SDGs** are integrated—they recognize that action in one area will affect outcomes in others, and that development must **balance social, economic and environmental sustainability**.



<https://www.undp.org>



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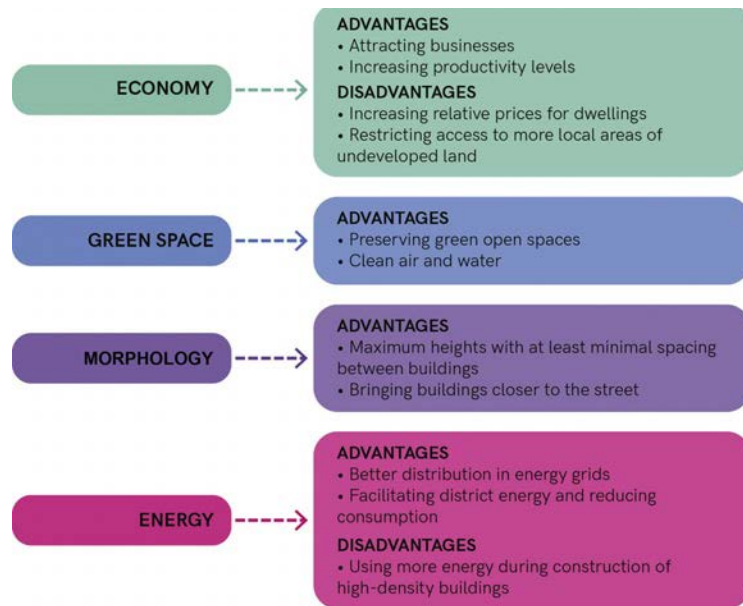
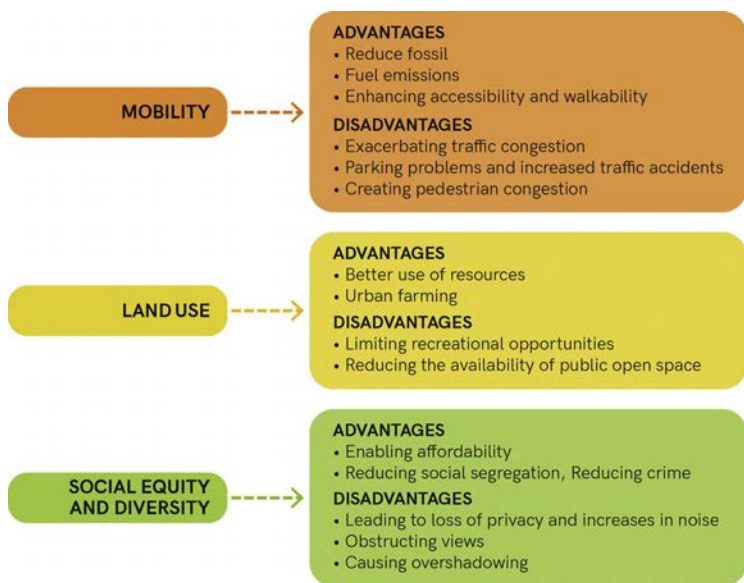
02.SUSTAINABLE DEVELOPMENT GOALS

- **Goal 11 _ Making cities sustainable** means creating career and business opportunities, safe and affordable housing, and **building resilient societies** and economies. It involves investment in **public transport**, creating **green public spaces**, and **improving urban planning** and management in participatory and inclusive ways.
- **Goal 13 _** The goal aims to mobilize **US\$100 billion annually** by 2020 to address the needs of developing countries to both **adapt to climate change** and **invest in low-carbon development**.
- **Goal 15 _** Urgent action must be taken to **reduce the loss of natural habitats** and **biodiversity** which are part of our common heritage and **support global food and water security, climate change mitigation** and **adaptation**, peace and security.



<https://www.undp.org/sustainable-development-goals>

02.URBAN DENSIFICATION



Advantages and disadvantages of urban densification (Churchman, 1999; Alexander, Reed, & Murphy, 1988; Alexander & Tomalty, 2002; Planning, 1994; Tratalos, Fuller, Warren, Davies, & Gaston, 2007; Kamal-Chaoui & Robert, 2009; Breheny, 1992), in Chokhachian et al. 2019

02.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)

Main regulations provide the knowledge and rules to manage, support, promote, restore biodiversity of natural and anthropic habitats.

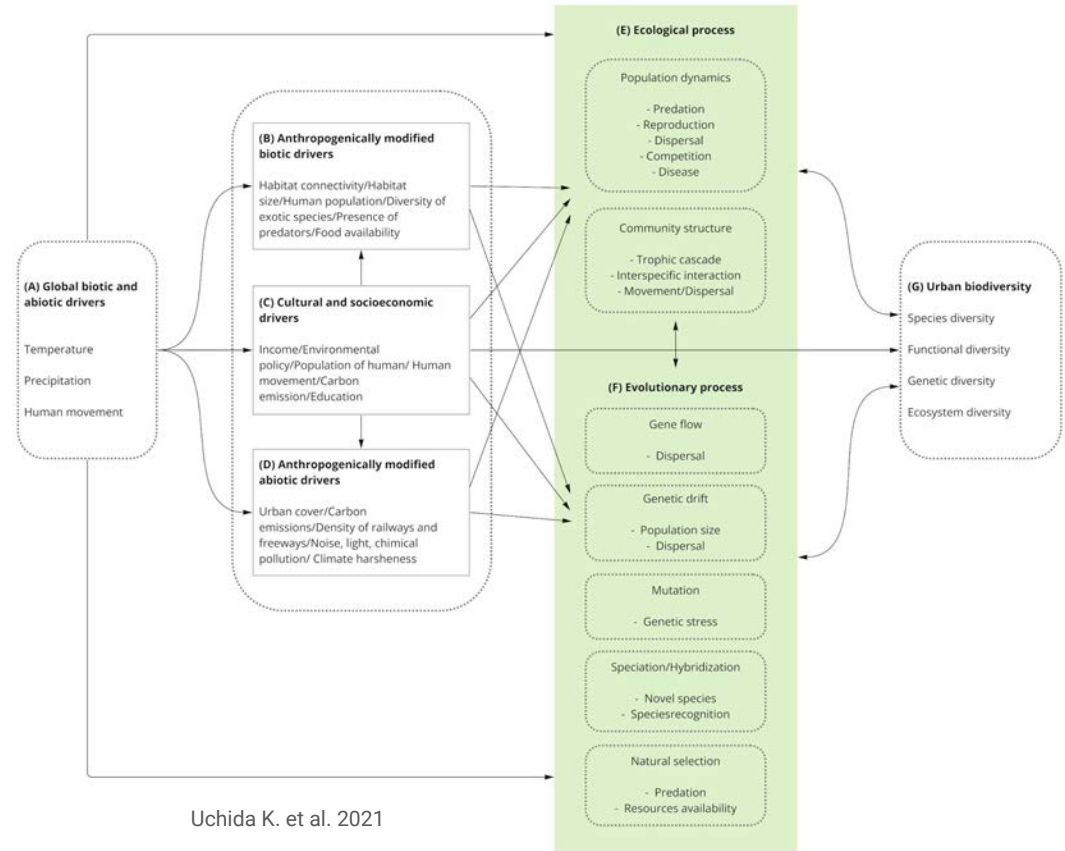


02.URBAN ECOLOGY

INTERACTIONS AND RELATIONSHIPS AT THE URBAN SCALE

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

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

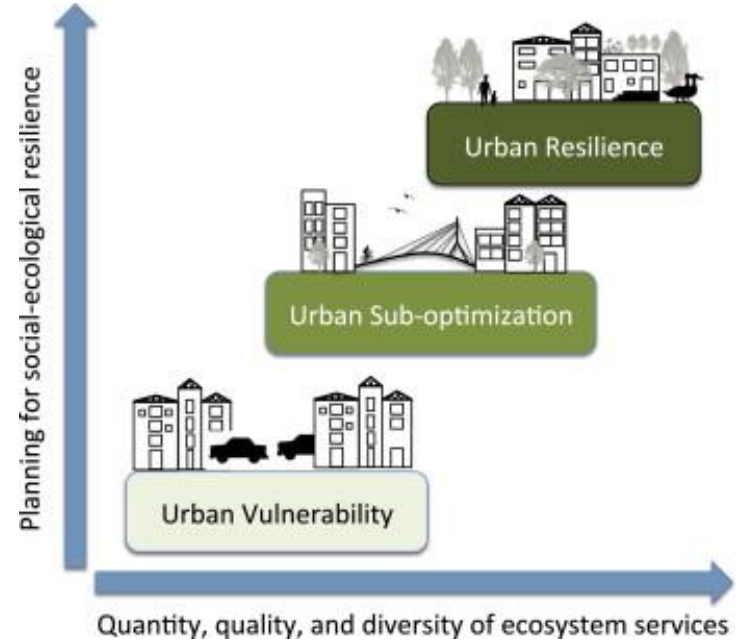


02.URBAN ECOLOGY

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

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

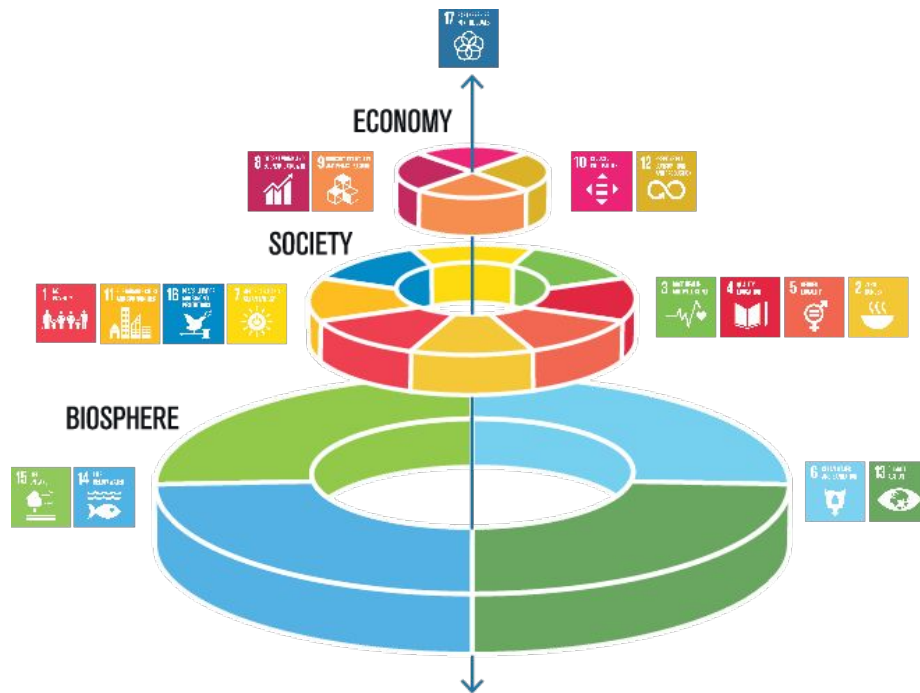
RESULT: **resilient and sustainable cities**



McPherson et al. 2015

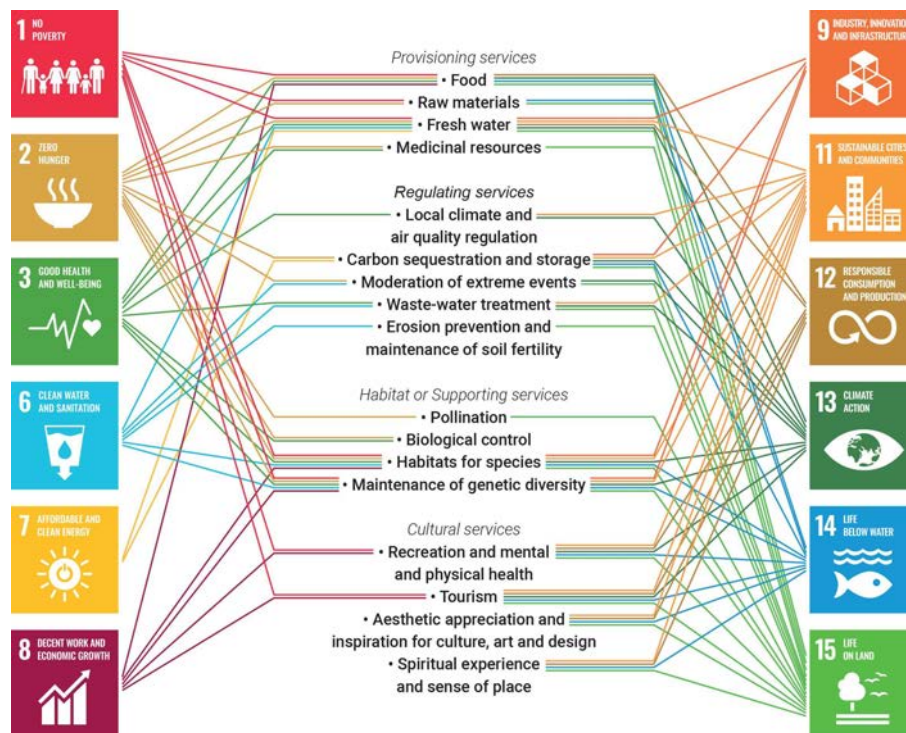
02.NATURAL CAPITAL AND ECOSYSTEM SERVICES

<<...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)



<http://www.stockholmresilience.org/research/research-news/2016-06-14-how-food-connects-all-the-sdgs.html>
Natural Capital Committee (2018)

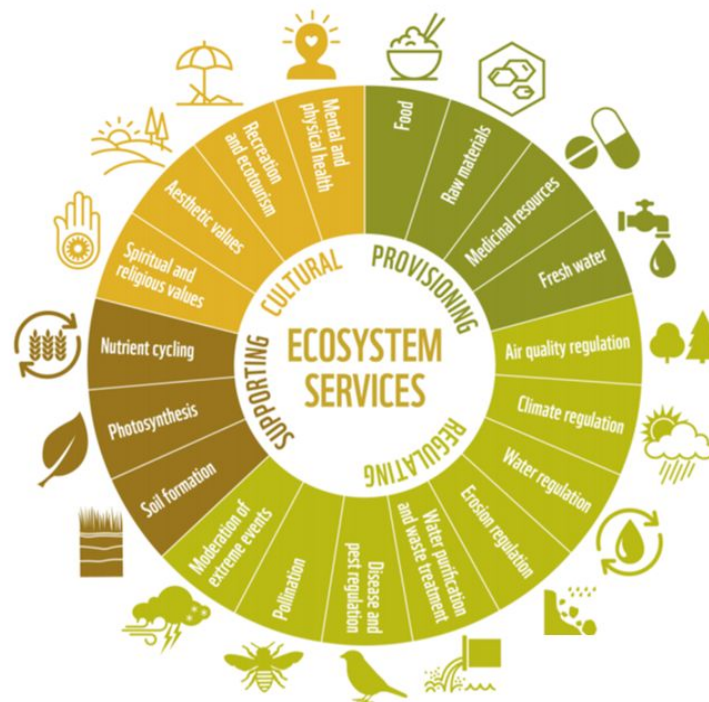
02.NATURAL CAPITAL AND ECOSYSTEM SERVICES



Relation in terms of strong-perceived support between **ecosystem services** (classification according to TEEB, 2011) and **Sustainable Development Goals**, based on (Wood et al., 2018). In Perini, 2022

02.NATURAL CAPITAL AND ECOSYSTEM SERVICES

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



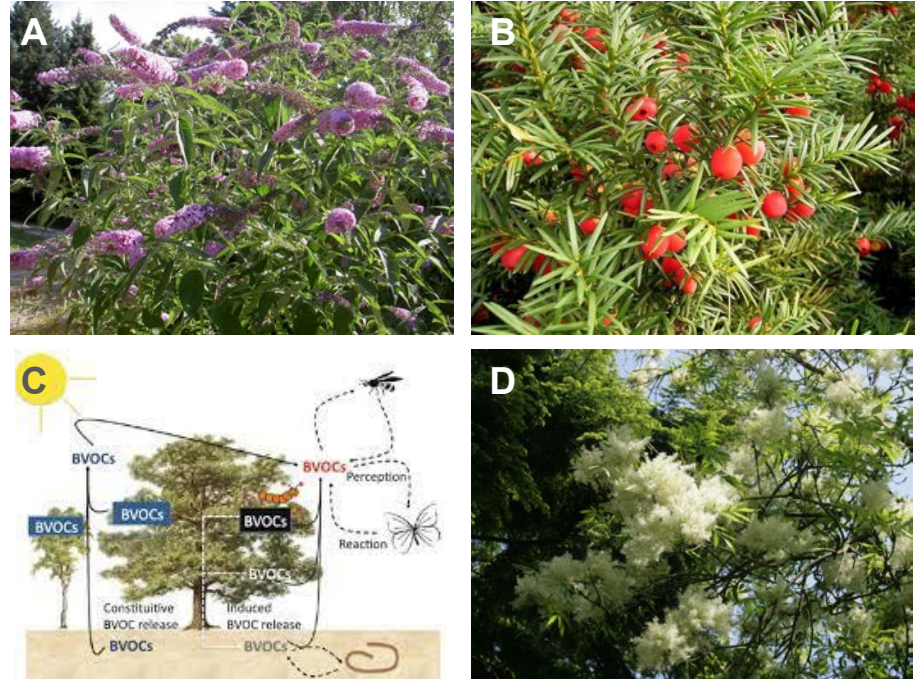
Range of ecosystem services provided by nature to humans
(WWF Living Planet Report, 2016)

02.ECOSYSTEM DISSERVICES

- **Invasive alien species** occurrence
- **Infrastructure damage** (e.g., root damages 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 **odours** (e.g., wrong selection of plant individuals)
- **Traffic obstruction** by trees or limited access to public areas

(Von Döhren and Haase, 2019; Tian et al., 2020)

Figures. **A** *Buddleja davidii* (butterfly bush), invasive alien species;
B *Taxus baccata* (European yew), poisoning species;
C, VOCs emission by e.g., *Quercus ilex* (holm oak);
D, *Fraxinus ornus* (manna ash) flowers with allergenic pollen



02.NATURE-BASED SOLUTIONS

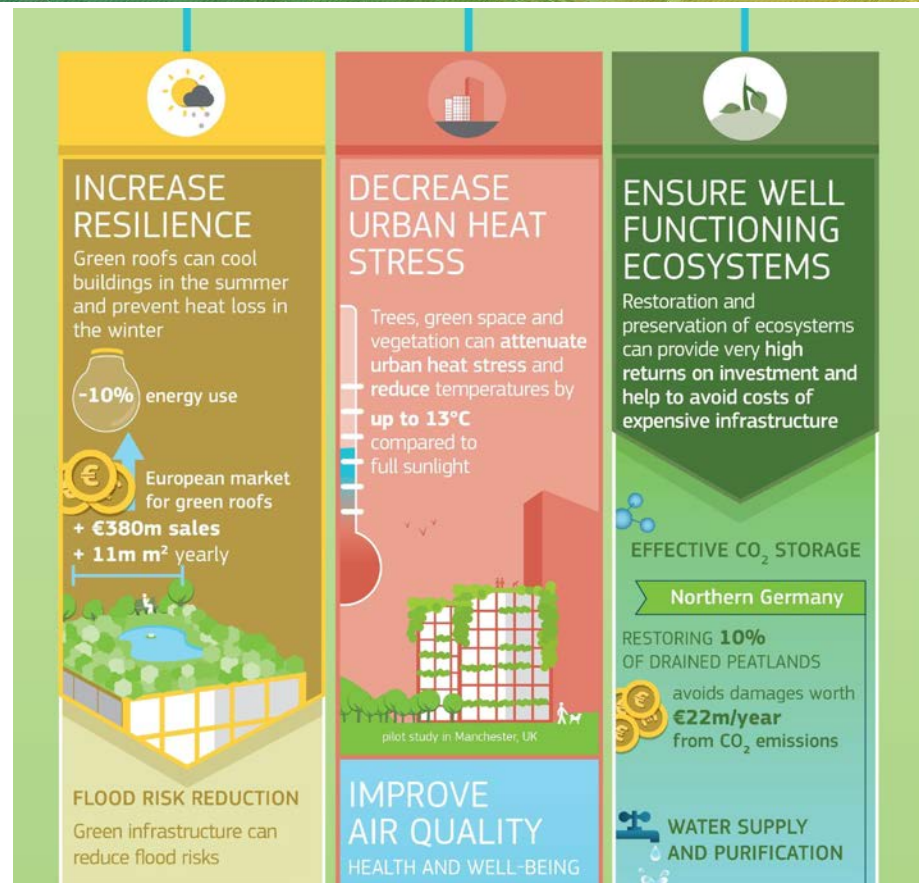
Nature-based solutions must support the delivery of a **range of ecosystem services**.

Nature-based solutions **support major EU policy priorities**, in particular the European Green Deal, biodiversity strategy and climate adaptation strategy, as a way to **foster biodiversity** and make Europe more **climate-resilient**.

Current policy goals:

- provide the evidence for nature-based solutions
- improve framework conditions for nature-based solutions at EU policy level
- develop a European research and innovation community
- advance the development, uptake and upscale of innovative nature-based solutions
- mainstream nature-based solutions in international research and innovation

(European Commission, 2022)



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02.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 that help reconnect or enhance existing natural areas



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



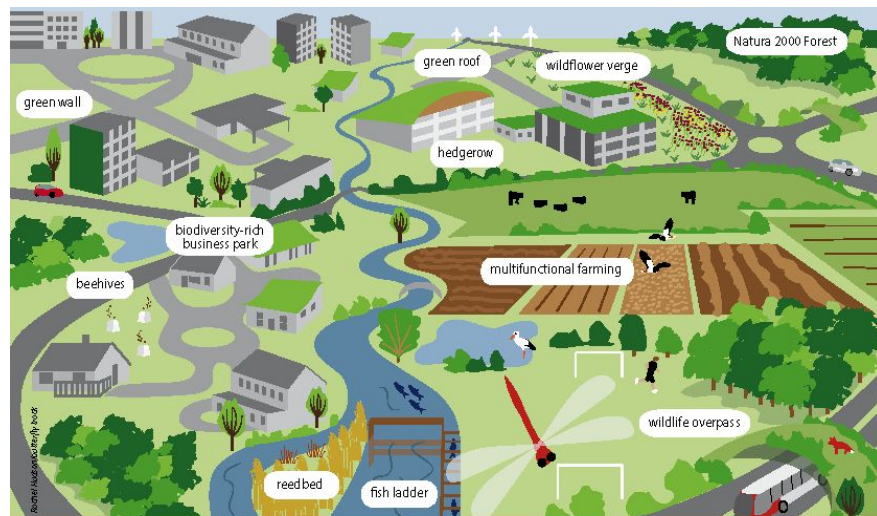
Artificial features that enhance ecosystem services or assist wildlife movement



Buffer zones that are managed sustainably and help improve the general ecological quality and permeability to biodiversity

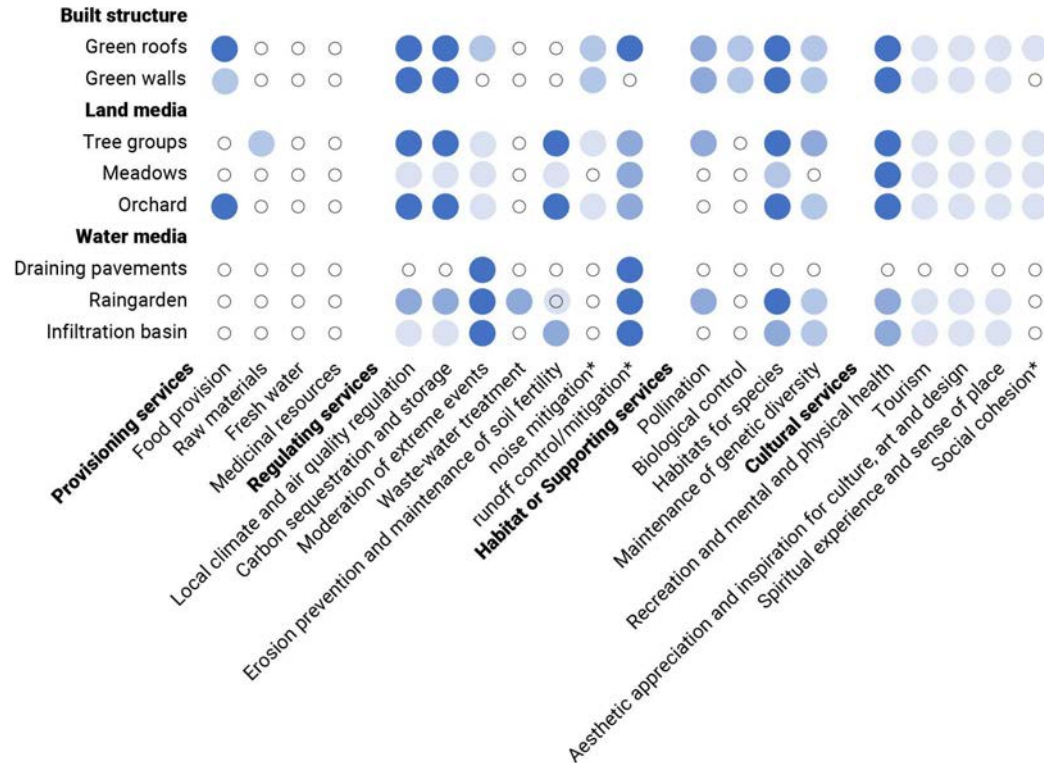


Multi-functional zones where compatible land uses lead to create land management combinations



https://www.eea.europa.eu/themes/sustainability-transitions/urban-environment/urban-green-infrastructure/green_infrastructure_infographic_EC.png/image_view_fullscreen

02.NATURE-BASED SOLUTIONS



Ecosystem services provided by Nature-based Solutions, classified according to Babí Almenar et al. (2021), for built structures according to: Coma et al. 2018; Köhler and Ksiazek-Mikenas 2018; Kotzen 2018; Palla and Gnecco 2018; Rowe 2018, Magliocco 2018; Mayrand et al. 2018; Pérez et al. 2018a 2018b, Harada and Whitlow, 2020); for land media Akbari et al. 2001; Atkins 2018; Lazzari et al. 2018; Perini et al. 2018); for water media (Ballard et al. 2007; Perini and Sabbion 2017).

The gradient of colour represents the most relevant (dark blue) to the less relevant (light blue) for each Nbs.

In Perini, 2022

02.NATURE-BASED SOLUTIONS

- 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 to biogeochemical cycles)
- Creation or restoration of **multitrophic networks** (e.g. plant-insect-bird interactions)
- Key solutions to connect natural and artificial ecosystems



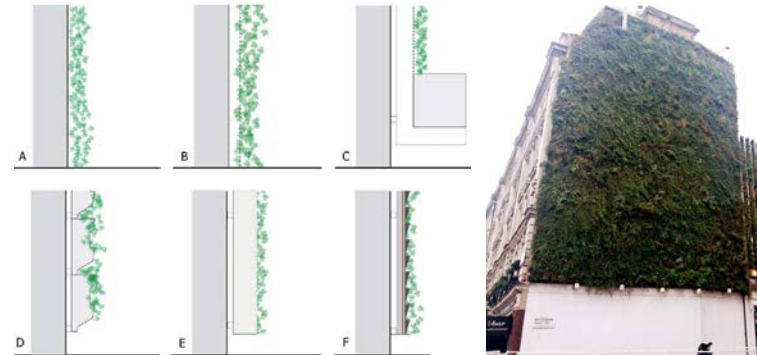
NbS as an umbrella term for ecosystem-related approaches Cohen-Shacham et al. 2016

02.NATURE-BASED SOLUTIONS: BUILT STRUCTURES

- **Green roofs** (fig. 1): areas of living vegetation, on building roofs, to provide visual benefit, ecological value, enhanced building performance, reducing surface runoff. They are divided in: - **Extensive roofs**: low substrate depths, simple planting and low maintenance requirements; - **Intensive roofs**: deeper substrates, wide variety of planting, more intensive maintenance (Woods Ballard et al. 2015, page 233).
- **Green facades** (fig. A,B,C): application of **climbing or hanging plants** along the wall. Plants can grow upwards or downward the vertical surface (in case they are hanged at a certain height) (Manson, Joao-Castro, 2015).
- **Living wall systems (LWS)** (fig. D,E,F): classified as continuous or modular. **Continuous LWS**: based on the application of lightweight screens in which plants are inserted individually. **Modular LWS**: elements with a specific dimension, which include the growing media for plants. Each element is supported by a complementary structure or fixed directly on the vertical surface (Manson, Joao-Castro, 2015).



Delft University Library photo credit: Nol Aders CBY-SA 3.0,
<https://commons.wikimedia.org/w/index.php?curid=19823965>



Green façade and living wall schemes: K. Perini, The huge green façade of the Palace Hotel in Victoria by Green Roof Consultancy (photo A. Magliocco)

02.NATURE-BASED SOLUTIONS: LAND MEDIA

- **Tree groups** (fig. 1): in addition to the ability to absorb CO₂ and retain fine dust, they are able to form **large shady areas** by modifying the **microclimatic characteristics** and to **increase biodiversity**, by hosting various living beings (Ordóñez, C.,2019).
- **Meadows** (fig. 2): you can leave **free natural areas growing** by itself and you'll find a wildflowers meadow, full and rich, hosting **insects and birds** living on the border of towns and agricultural fields, **absorbing rain** towards natural cycle and **improving biodiversity** (Babi Almenar et al., 2021).
- **Orchards** (fig. 3): they have almost disappeared from urban areas, concentrating mainly on extensively cultivated areas. Given the **intense productivity of flowers and fruits**, this category of trees is able, in addition to absorbing a lot of CO₂ from the atmosphere, to be a **powerful engine for increasing biodiversity**.
<https://www.naturebasedsolutionsinitiative.org/news/nature-based-solutions-nature-day-documentaries-cop26/>



Tree Library Park in Milan,
photo: Luca Bruno



Wildflowers meadow, photo: Chris Gomersall



www.naturebasedsolutionsinitiative.org

02.NATURE-BASED SOLUTIONS: WATER MEDIA

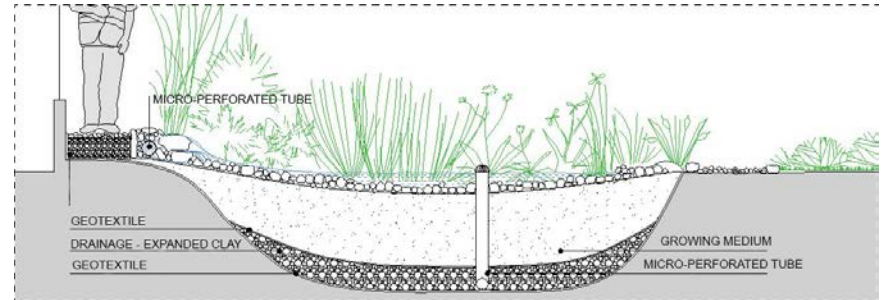
- **Draining pavements** (fig. 1): pavement suitable for pedestrian and/or vehicular traffic, while allowing rainwater to infiltrate through the surface. The water is temporarily stored beneath the overlying surface before use, infiltration to the ground, or controlled discharge downstream (Woods Ballard et al. 2015, page 387).
- **Rain garden** (fig. 3): landscaped area that collects, absorbs, and filters stormwater runoff from waterproof surfaces, sized to accommodate temporary ponding after it rains, but not meant to be permanent ponds. They are made with soil mixes that allow water to soak in rapidly, treat runoff, support plant growth and can be landscaped with a variety of plants to fit the surroundings (Rain Garden Handbook, page 3).
- **Infiltration basins** (fig. 2): flat-bottomed, shallow landscape depressions that store runoff (allowing pollutants to settle and filter out) before infiltration into the subsurface soils (Woods Ballard et al. 2015, page 258).



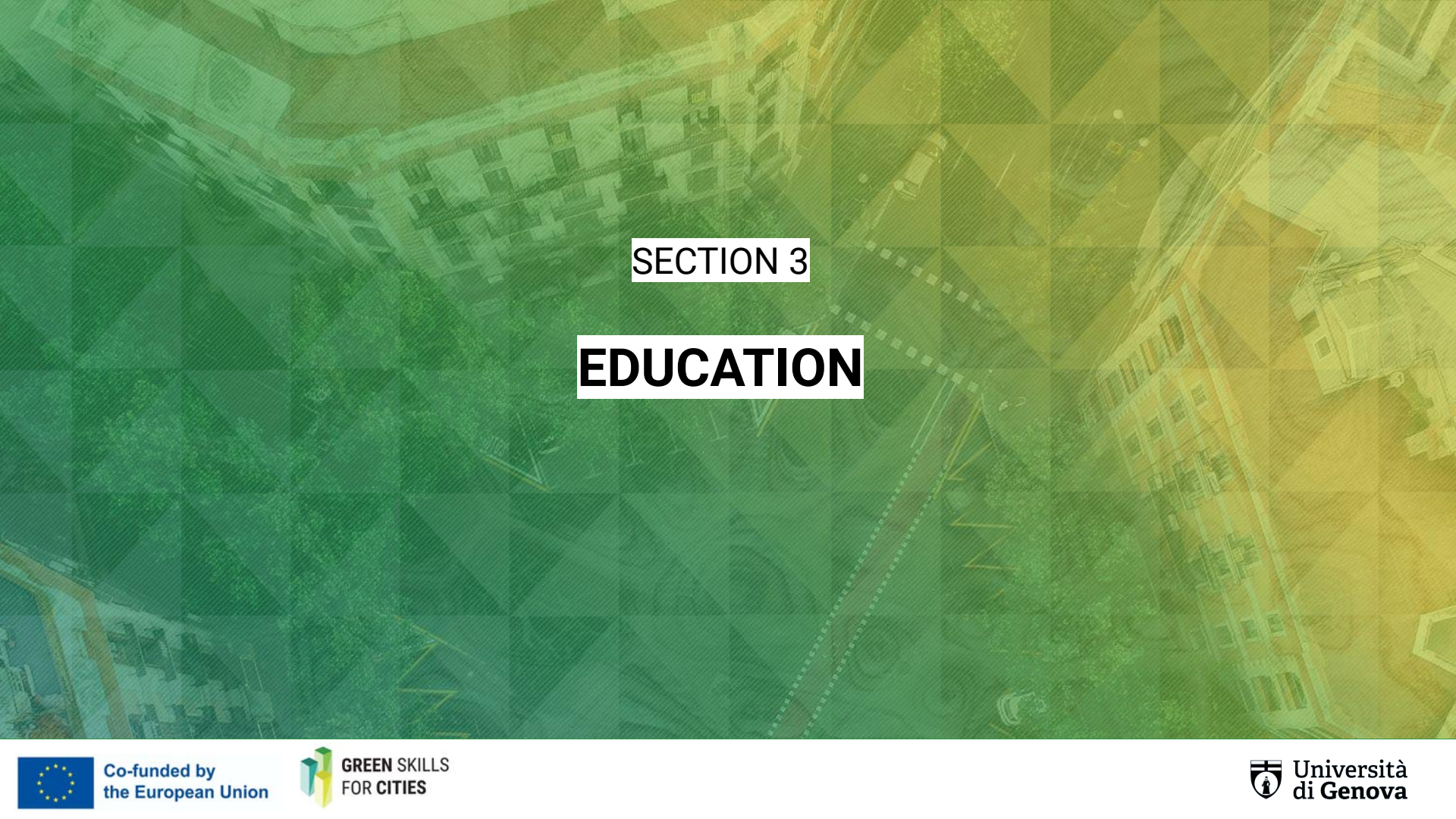
1. Draining pavement (photo: K. Perini)



2. Infiltration basin (photo: K. Perini)



3. Section drawing of a Rain Garden (drawing: Paola Sabbion)



SECTION 3

EDUCATION



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03. EDUCATION ON BOTANY AND TECHNOLOGY

Pedagogy and methodology applied

World Cafè

Three groups working all on the suggested **topics/themes**:

- The principle of responsibility in environmental, social and economic terms
- Sustainability and architecture, landscape and design projects
- Resilient urban areas

Activities: each group starts working on one of the topic, after 20 minutes each group changes focus so that all the students contributes to all the topics. Finally, a presentation and a debate allow discussing all the inputs (more details slide 39)



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03. EDUCATION ON BOTANY AND TECHNOLOGY

Pedagogy and methodology applied

On site visit - Milan

Visit to significant sites (buildings and renovated areas of the city). Part of the visit was organized with an architect from the firm LAND.

- Bosco verticale, Stefano Boeri Architects
- Biblioteca degli alberi, Inside-Outside Studio
- Gae Aulenti Square, César Pelli
- City Life
- Parco Industria Alfa Romeo – Portello, Jencks and Kipar



Photo credit: A. Cherchi



<https://www.city-life.it/it/vivere>



<https://cittaclima.it/portfolio-items/milano-gae-aulenti-piazza/>



UNIGE field trip, photo by F. Mosca

03. EDUCATION ON BOTANY AND TECHNOLOGY

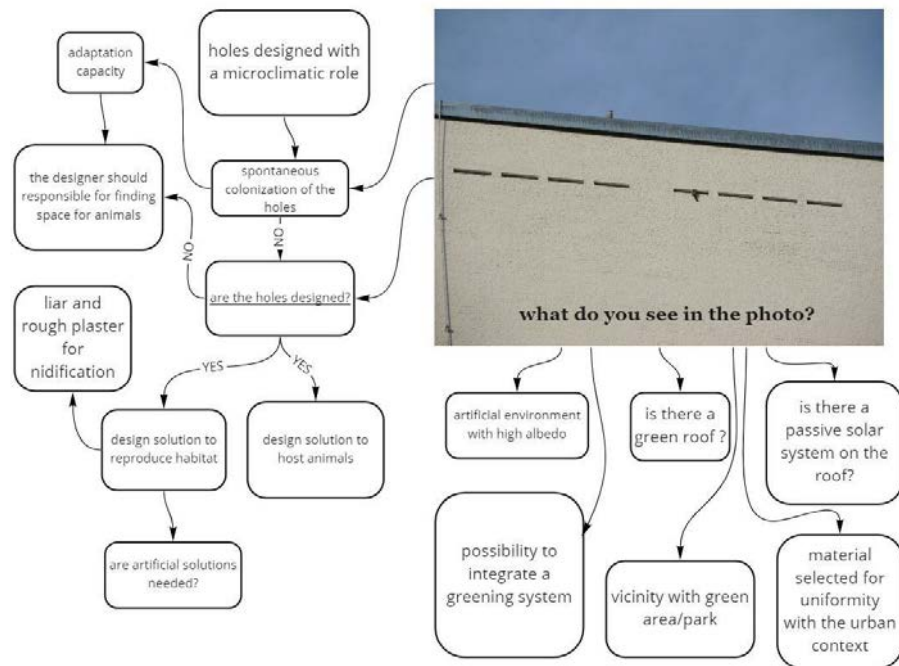
Pedagogy and methodology applied

Group discussion on architecture photo

Aim: push the students to see beyond the photo and to start thinking at some of the topics of the course.

- We asked the students to start thinking at the photo few days before classes
- During classes we created mixed groups for debate and gave them 15 min for discussion
- Thanks to a joint brainstorming we built the miroboard (on the right)

DISCLAIMER: this is a residential building designed by Studio Animal Aided Design in Munich, with the aim to increase biodiversity. The building is surrounded by a green area and has a green roof.



EDUCATION ON BOTANY AND TECHNOLOGY

Pedagogy and methodology applied

Field work with plant collection and identification

Aim: to train students' in recognizing and using plant component for effective NbS

- several field activities with plant sampling and identification (plant morphology) and understanding of related ecological functions and vegetation assemblage within urban ecosystems
- selection of useful traits and properties for NbS purposes maximising local biodiversity and ecosystem services
- setting up of plant data sheets for suitable species



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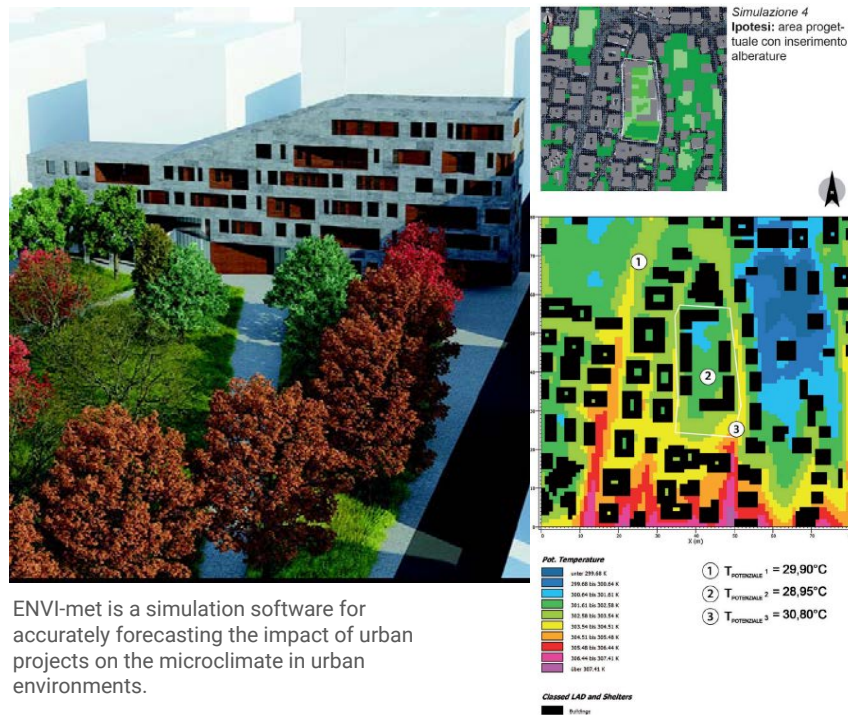
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03. EDUCATION ON BOTANY AND TECHNOLOGY

Courses already developed

Environment Technology Studio

- The Environment Technology Project Lab course is in the second year of the Master's degree in Architecture, University of Genoa.
- A design studio specifically in the field of architectural technology, focusing attention on the relationship between needs, contextual constraints and buildability.
- Green technologies are designed and integrated with particular attention to the building energy performance, with the use of technological solutions including vegetation as NBS.
- The course currently has a duration of 120 hours and consists of one module of 100 hours in technological design and a module of 20 hours in energy performance calculation.



ENVI-met is a simulation software for accurately forecasting the impact of urban projects on the microclimate in urban environments.

03. EDUCATION ON BOTANY AND TECHNOLOGY

Courses already developed

Environment Technology Studio

- Every year a new site/area for the design studio is selected to work in different contexts.
- If the site has large open areas, a wide range and amount of NbS can be integrated; if so, it becomes interesting to verify its ability to influence the microclimate characteristics. In this case, the students are asked to run simulations and to compare different design outcomes.
- In other cases, integrated vegetation solutions are used in the building envelope (green facades, green roofs), paying attention to construction details.



A.A. 2019-20 L. Spinozzi, L. Cevasco, D. Croxatto

03. EDUCATION ON BOTANY AND TECHNOLOGY

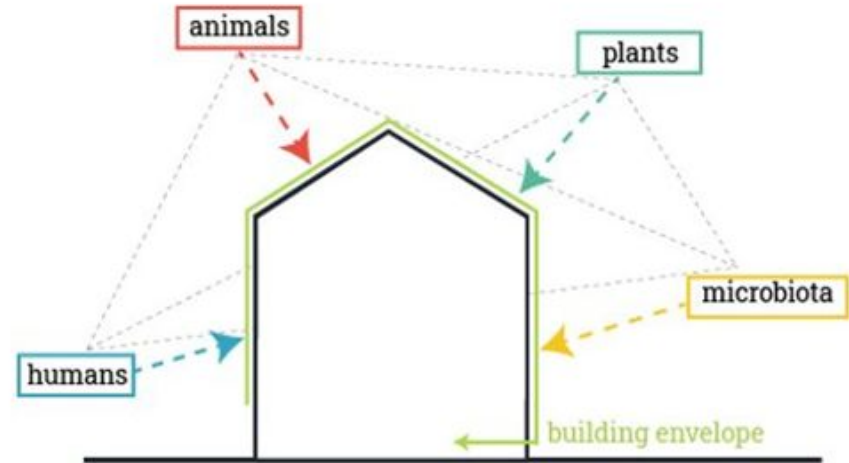
Courses already developed

ECOLOPES design exercise

Collaboration for a small design exercise between the courses of technology and applied botany (bachelor in architecture and landscape architecture).

The students work in groups to identify design strategies for the retrofitting of a building envelope, following the ECOLOPES approach.

ECOLOPES is a FET-h2020 project and it is based on a radical change for city development through a new integrated ecosystem approach to architecture that focus equally on humans, plants, animals and associated organisms such as microbiota (multistakeholders approach).



ECOLOPES approach to design, in Perini et al. 2022

Technical University of Munich

TUM

Università di Genova

McNeel Europe
Europe - Middle East - Africa

TU WIEN

TECHNISCHE UNIVERSITÄT WIEN

TECHNION
Israel Institute of Technology

Studio
Animal-Aided Design

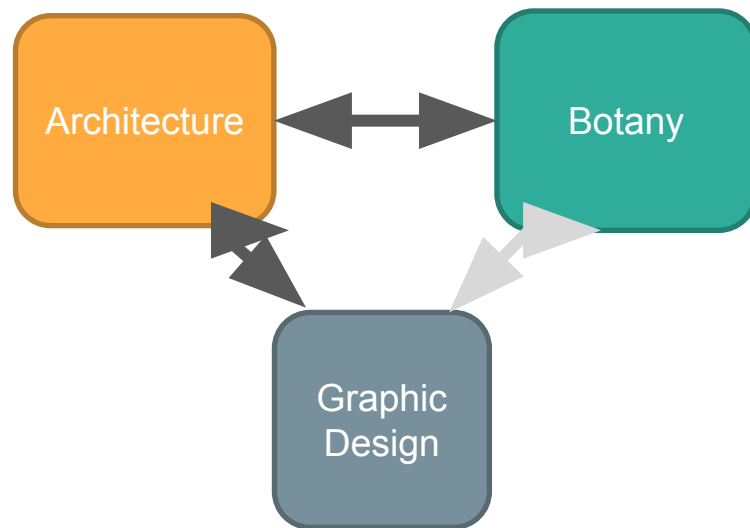
03. EDUCATION ON BOTANY AND TECHNOLOGY

Courses already developed

ECOLOPES design exercise

- The students identify architectural and ecological design objectives. The activity is followed by a discussion and the construction of a shared MIRO board;
- The architecture students draft first design ideas;
- The botany and graphic design students contribute by selecting plant species able to attract animals and by drafting a logo for the project

Expected results: design of a building envelope with a list of desired plant characteristics (and species) suitable for green envelope for multistakeholder purpose use within urban ecosystems



03. EDUCATION ON BOTANY AND TECHNOLOGY

Overview of best practice teaching methods

Team-based Learning

Team-based learning (TBL) is a pedagogical strategy that **engages student knowledge** through **individual testing** and **group collaboration**. Following individual answers, students join teams and work through problems, appealing when they are incorrect. This process **motivates students** by holding them accountable to themselves and one another, while introducing them to a variety of thought processes devoted to a single problem. To increase motivation and introduce a fun gaming environment, instructors often **group their students into teams** and have them compete on **various classroom learning tasks**.

<https://poorvucenter.yale.edu/Team-Based-Learning>



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03. EDUCATION ON BOTANY AND TECHNOLOGY

Overview of best practice teaching methods

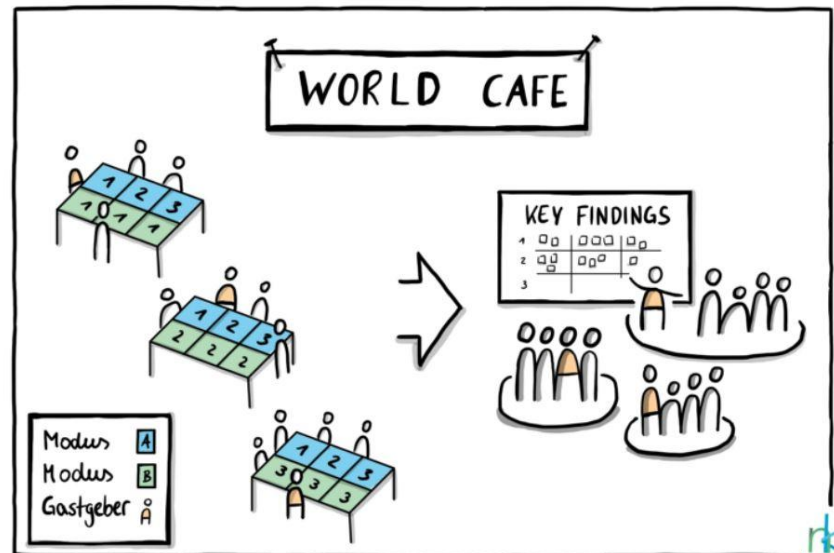
What is a World Café?

The World Café method is designed to create a safe, welcoming environment in which to intentionally connect multiple ideas and perspectives on a topic by engaging participants in several rounds of small-group conversation.

When should I use this method?

The World Café method is particularly useful when you want to be sure to explore a topic from multiple perspectives, to ensure that everyone in a room contributes in a conversation, and/or when you want to encourage participants to make new connections. The method can also be useful for gathering information from grantees and beneficiaries at the community level.

https://www.fsg.org/wp-content/uploads/2021/08/World-Cafe-Method_0.pdf



<https://miro.com/miroverse/world-cafe-remote-edition/>



SECTION 4

MATERIALS & CASE STUDIES



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04.MATERIALS AND CASE STUDIES: videos

VIDEO 1

**“The architectural
wonder of
impermanent cities”**

Rahul Mehrotra

TED talks

13 min

VIDEO 2

**“Urban Nature-based
Solutions: What are
they and why are they
so important?”**

WWF International

3 min

VIDEO 3

**“Nature-based
solutions in the fight
against climate
change”**

Thomas Crowther

TEDxLausanne

17 min

04.CASE STUDIES: UNaLab

Evaluation of **NbS ecosystem services** in a new urban park (former military barrack)

Key performance Indicators evaluated:

- Biodiversity (plants and birdlife)
- Pollinator insects
- Evapotranspiration rate
- Carbon sequestration by plant
- Citizen wellbeing with environmental conditions

To obtain the benefits derived from a complex network of NbS

www.unalab.eu



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04.CASE STUDIES: INPS Green Facade

INPS Green Facade

INPS Green Façade is a pilot project built in the city Genoa (Italy) in 2014 on the south wall of a four stories office building built early in the last century and renovated in the 1980's, owned by INPS (National Institute of Social Insurance). The research results deriving from the monitoring activities are used to quantify the environmental impact for the entire life of the green facade in relation to the obtainable environmental and microclimatic benefits, through a life cycle assessment and the economic sustainability, thanks to a cost benefit analysis.



Photo A. Positano



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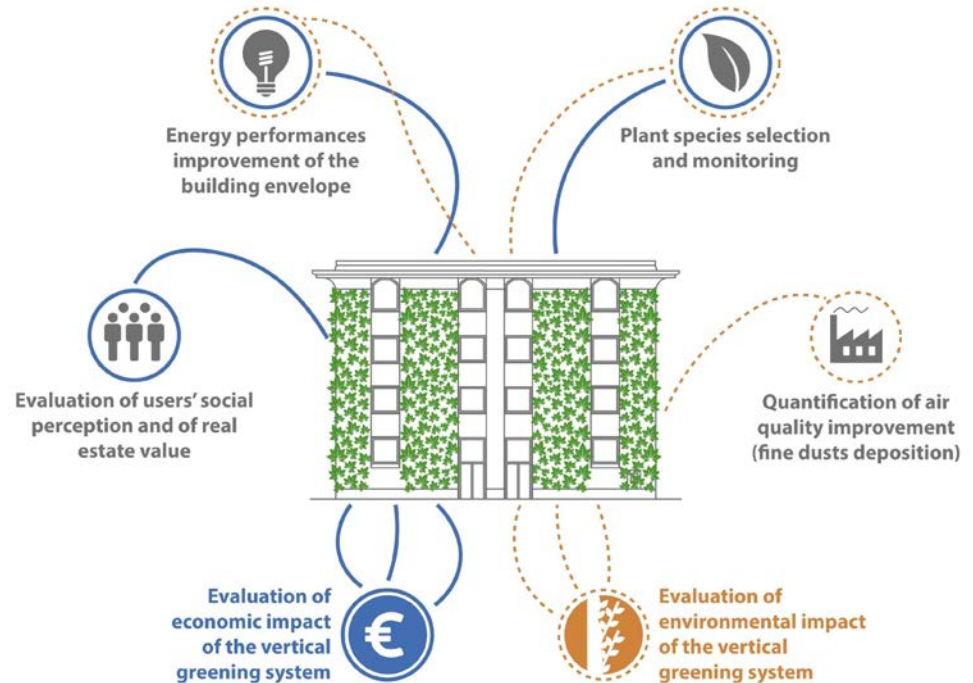
04.CASE STUDIES: INPS Green Facade

Video:

<https://www.youtube.com/watch?v=Dn6ZAXHzcTQ>

Research papers (abstracts):

- Perini Katia, Ottelé Marc, Giulini Saverio, Magliocco Adriano, Roccotiello Enrica (2017). **Quantification of fine dust deposition on different plants in a vertical greening system**. ECOLOGICAL ENGINEERING 100 (2017) 268–276. doi:10.1016/j.ecoleng.2016.12.032
- Perini Katia, Magrassi Fabio, Giachetta Andrea, Moreschi Luca, Gallo Michela, Del Borghi Adriana, 2021. **Environmental Sustainability of Building Retrofit through Vertical Greening Systems: A Life-Cycle Approach**. Sustainability 13, 4886. <https://doi.org/10.3390/su13094886>



Monitoring activities scheme (Rosasco and Perini 2018)

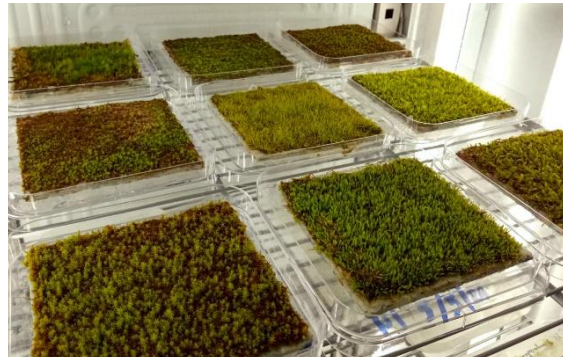
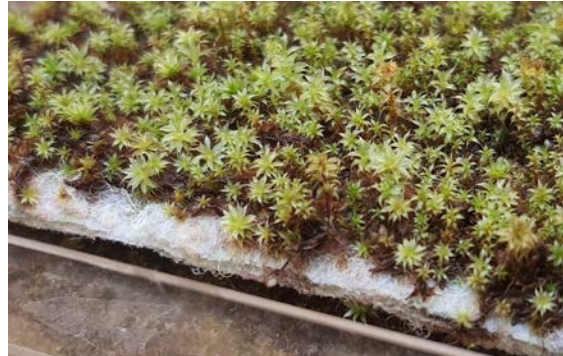
04.CASE STUDIES: MosSkin

New green envelopes: lightweight building systems with mosses

A low cost and lightweight moss envelope system for buildings has been developed to address the problem of the lack of greening in densely urbanized areas.

Several moss species have been sampled in the wild, selected, based on their ability to tolerate the abiotic stresses of urban environments and a modular multi-layer panel, with a built-in irrigation system, has been developed, designed and tested.

MosSkin is a low-cost low maintenance, versatile and lightweight system, with interesting performances in terms of water management and surface temperature reduction (up to 14°C).



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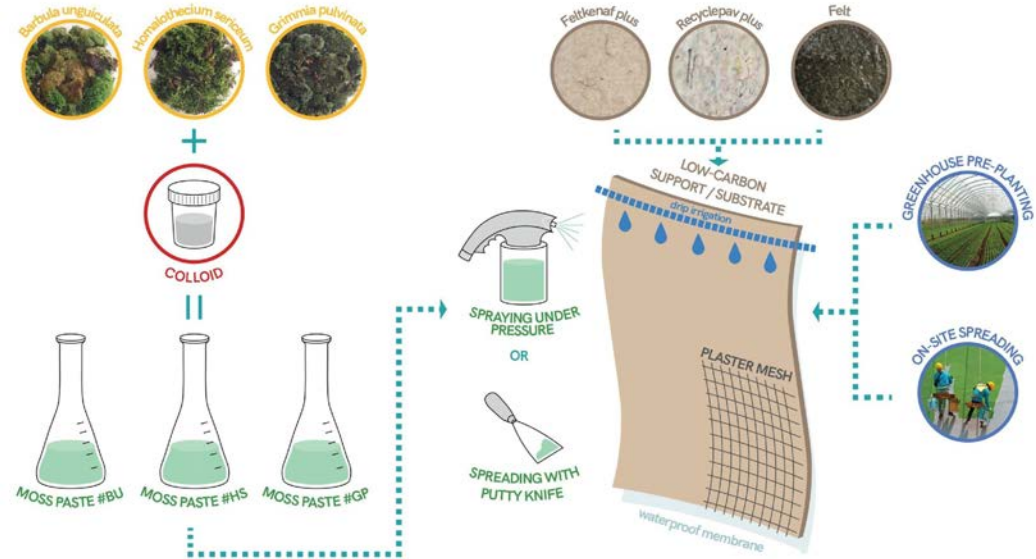
04.CASE STUDIES: MosSkin

Video:

<https://www.youtube.com/watch?v=XK8mxjFfL4E>

Research paper (abstract):

- K. Perini, P. Castellari, A. Giachetta, C. Turcato, and E. Roccotiello, 'Experiencing innovative biomaterials for buildings: Potentialities of mosses', Build. Environ., vol. 172, p. 106708, Apr. 2020, doi: [10.1016/j.buildenv.2020.106708](https://doi.org/10.1016/j.buildenv.2020.106708)



Scheme of the patented invention

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