Nature-based solutions

What is all about?

asist. prof. dr. Darja Istenič

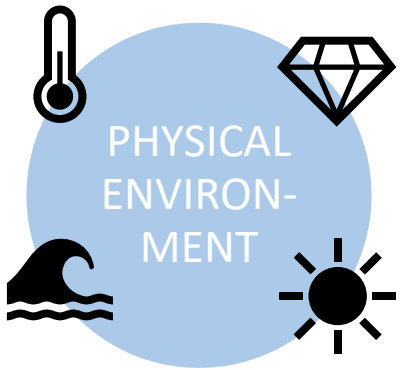
Global Water Partnership

Univerza v Ljubljani

11th Sava Youth Parliament
Webinar, 30. 03. 2023

When the water flows over the 7 stones, it is purified

Natural ecosystems have the capacity to restore themselves



ECOSYSTEM

Physical	• Filtration • Sedimentation • Evaporation
Chemical	• Sorption • Ion exchange • Photodegradation
Biological	• Plant uptake • Microbial degradation • Transpiration

Nature-based solutions (NBS)

Definition by the European Commission

"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."

In last 20 years NBS have evolved from marginal, less spread technologies/measures to mainstream

Ecoremediation *Green technologies*

(Blue-)green infrastructure *Ecological engineering*

Cobenefits – multipurpose functionality

Flood mitigation

Biodiversity - fauna

Biodiversity - flora

Temperature regulation

Recreation

Aesthetic value

Carbon sequestration

Biomass production

Food source

Pollination

Groups of NBS

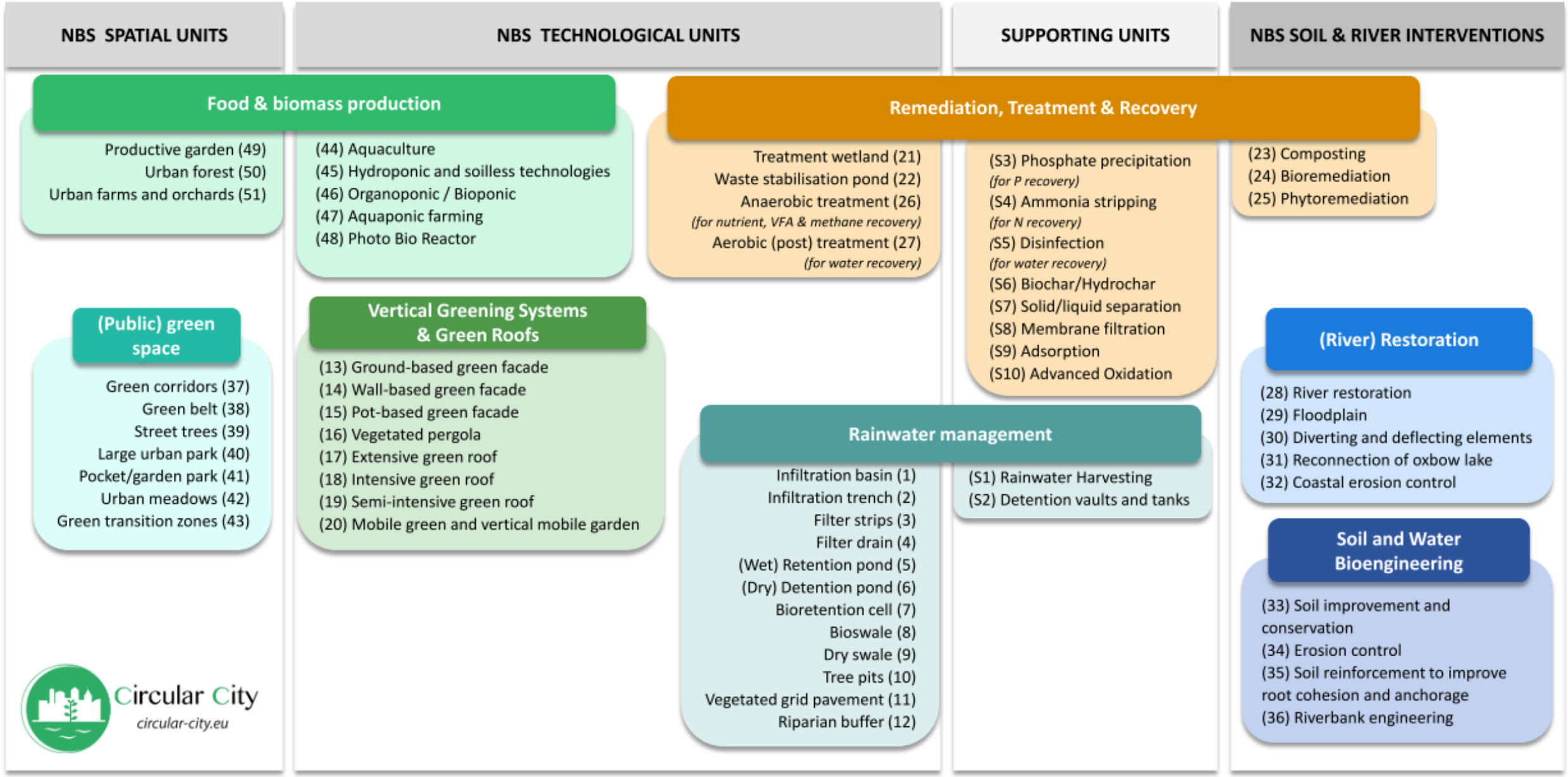


Figure 2. NBS units (NBS_u), NBS interventions (NBS_i), and Supporting units (S_u) clustered into categories (dark gray squares, adapted from [15] and sub-categories proposed by consulted experts within the COST Action Circular City (colored squares).

Remediation, treatment and recovery

Why we need them?

- **Wastewater pollution**
- **Contaminated soils (e.g. heavy metals)**
- **Waste biomass (from households, urban parks, agriculture)**

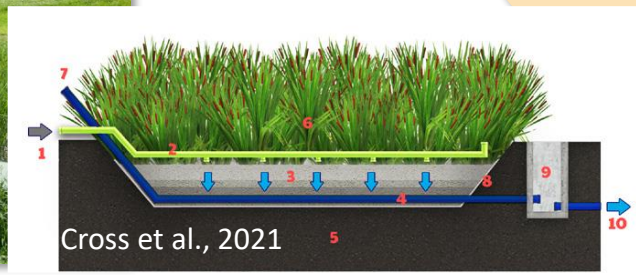
Remediation, treatment and recovery

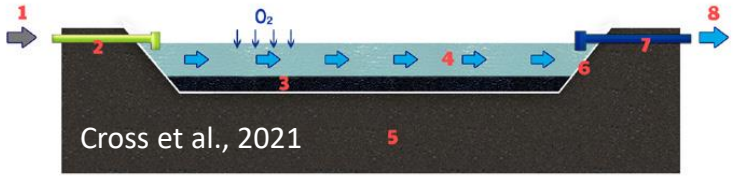
Biochar

A char produced from different types of biomass residues, tree cuttings, wood chips or dried fecal matter. Used as soil amendments - can increase soil health.

Treatment wetland

To treat different wastewaters; produce treated water and biomass. Also called constructed wetland.



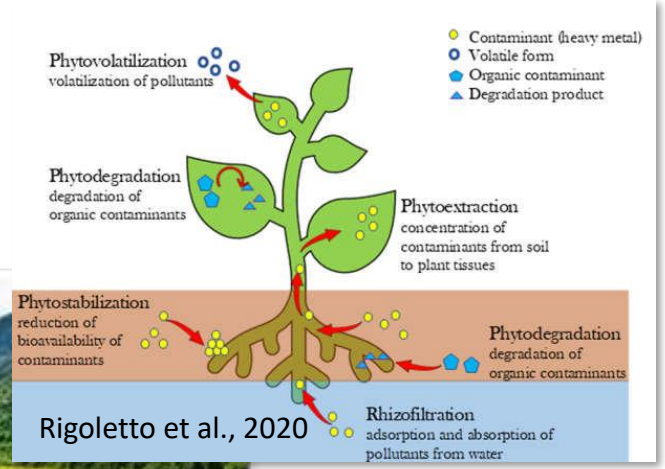


Waste stabilization pond

To treat municipal wastewater and produce treated water, energy (biogas) and sludge.

Phytoremediation

To restore contaminated or degraded soils while producing biomass for industrial use, such as energy or fibre.



Composting

Oxidation of organic matter (food waste, vegetable materials, crop residues, etc.). Used to increase soil fertility (resource recovery).

Rainwater management

Why we need them?

- **To retain and store stormwater**
  - to reduce the stormwater runoff in cities
  - To avoid pluvial floods (floods caused by rain)
- **To treat stormwater**
- **To reuse rainwater and increas biodiersity**

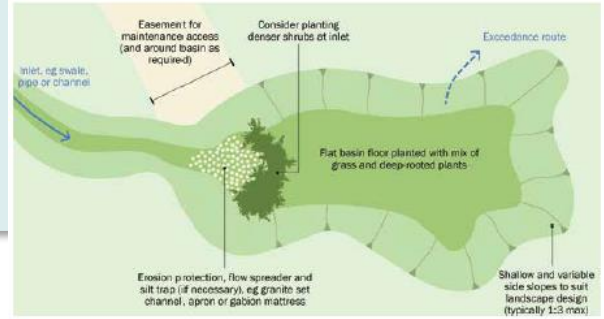
Rainwater management

Vegetated grid pavement and porous pavement

To infiltrate stormwater on site

Infiltration basin

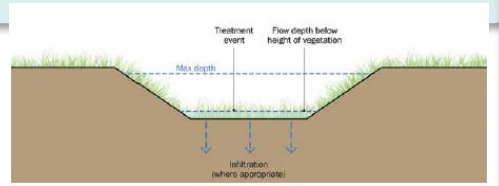
For short storage of stormwater; water soaks/infiltrates into the ground. Dry during dry weather.



Source: https://www.stormwaterpartners.com/facilities-infiltration-basin

Infiltration trench and swales

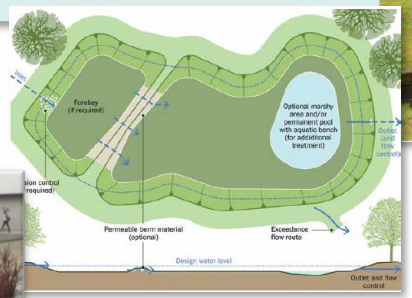
Longitudinal structures to infiltrate water from a nearby road or parking lot.



Source: http://nwrm.eu/measure/infiltration-trenches

Dry retention pond

For short storage of stormwater; water is discharged to a receiving water body. Dry during dry weather.



Bioretention cell

to collect, store, filter and treat stormwater; vegetated with wetland plants.

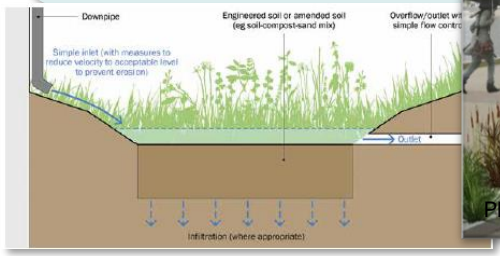


Photo: A. Rizzo, Iridra slr.

Wet retention pond

Permanent water. During rain events, the water level in the wet retention pond rises.

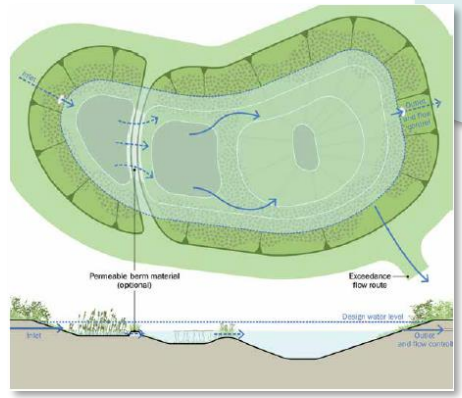
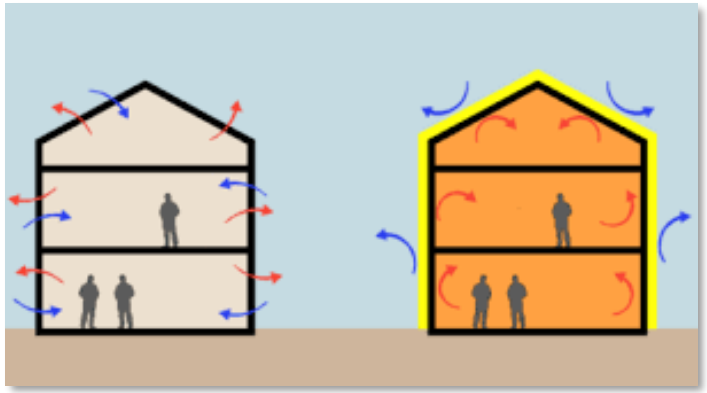


Photo: C.A. Arias

Vertical greening systems and green roofs

Why we need them?

- **To increase insulation of buildings**
- **To reduce stormwater runoff**
- **To increase aesthetic value**
- **Improve microclimate**



Vertical greening systems and green roofs

Wall-based green facade

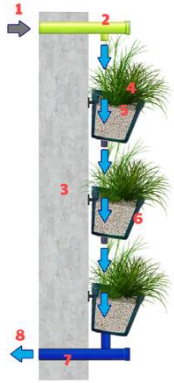
A greened vertical panel that is fixed onto façades. Irrigation and fertilization needed.

Vegetted pergola

Climbing plants growing on a structure.

Pot-based green facade

Plants planted in containers (pots planters). Irrigation and fertigation needed.



Cross et al., 2021

Ground-based green facade

Climbing plants planted in the ground; climbing directly on a wall or on a frame.

Extensive green roof

Light-weight planated systems not open to the public.

Intensive green roof

Higher diversity of vegetation, usually open to public; needs stronger structure.

Food and biomass production

Why we need them?

- **To reduce environmental footprint of agriculture**
- **To shorten the food supply chain in the city**
- **To use the nutrients and biomass produced in the city**

Food and biomass production

Productive garden

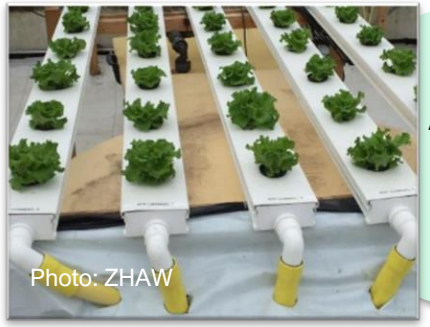
To grow vegetables, herbs, fruits (fruit trees), flowers and small livestock (chicken) for the main purpose of food production. Can be public or private.

Urban farms and orchards

Agriculture ventures dedicated to food production in a city, often professionally run and considerably larger than gardens.

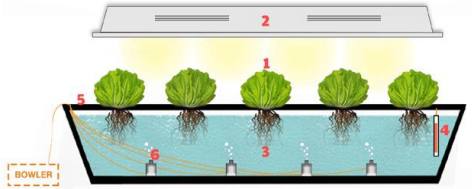
Urban forest

Is a forest in an urban setting. Used for recreation, food and biomass.



Hydroponics

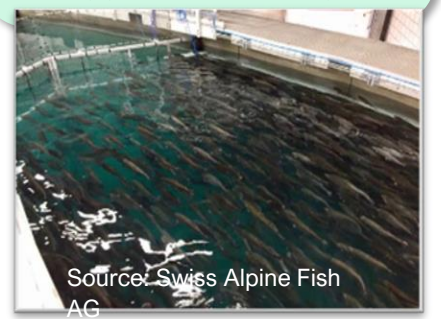
A technology for crop production without soil Can be applied in the city (rooftops, warehouses etc.). Uses less water than conventional farming.



Cross et al., NBS for wastewater treatment, 2021

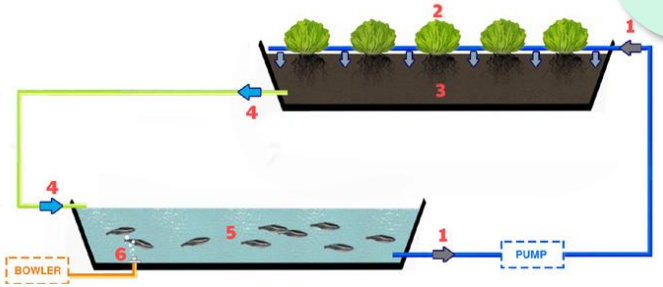
Aquaculture

Farming of aquatic organisms. Can be applied in the city.



Aquaponics

Combination of aquaculture and hydroponics. Nutrient rich wastewater from fish production is used to produce plant biomass. Can be applied in the city.

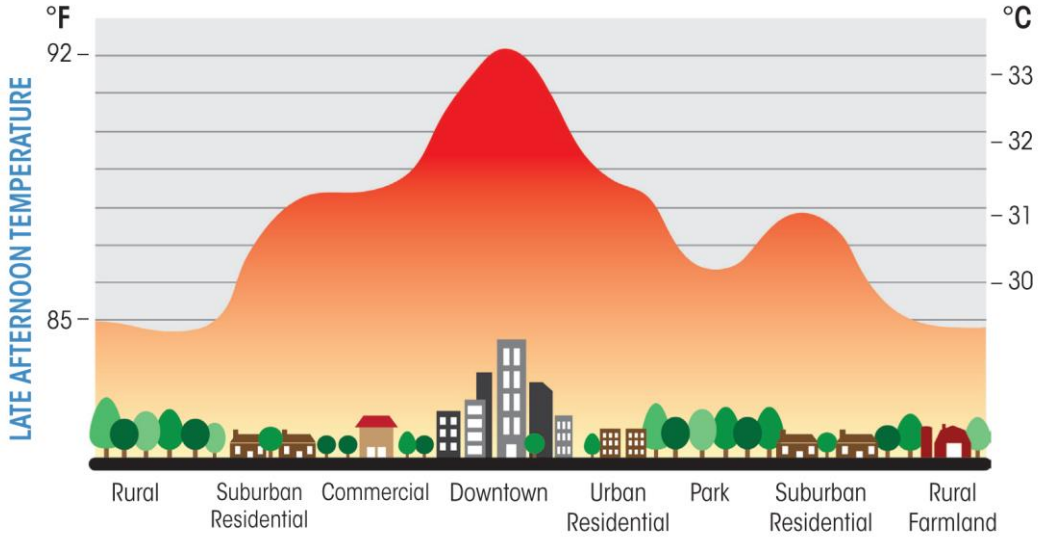


Cross et al., NBS for wastewater treatment, 2021

(Public) green spaces

Why we need them?

- **Improve wellbeing in (peri)urban areas**
  - Reduce heat islands
  - Improve air quality
  - Recreation, social needs
- **Provide habitat for wildlife**



(Public) green space

Large urban parks

Large green areas within the city (>0.5 ha). Serves the entire city. For recreation, social activities.

Pocket/garden parks

Compact green areas or small gardens. Serves mainly the neighbourhood. For leisure.

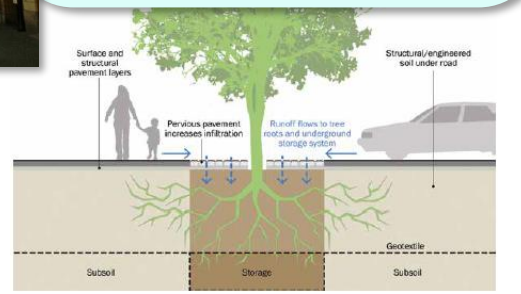
Source: https://www.landscapeinstitute.org/news/riverside-park-nine-elms/

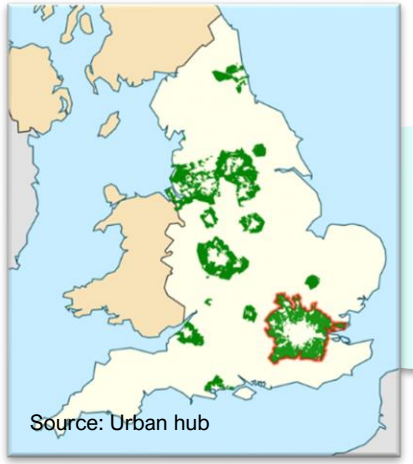
Green corridors

Or linear parks; renaturation of railway lines, roads, along waterways, etc.

Street trees

Trees along roads, parking lots, sidewalks, etc. Suitable species must be used; water sourse provided.





Source: Urban hub

Green belts

Is a green area sorrounding a built up area. Countryside is maintained and further urbanization is not allowed.

Urban meadows

Species-rich grasslands benefitial to wildlife.

Source: https://www.pictorialmeadows.co.uk/case_study_type/urban-meadows/

Global Water Partnership

For the end

Instead of conclusion

NBS are a wide range of technologies that seem to be simple to design, construct, operate and maintain.

- **Basic knowledge from different disciplines is needed for effective NBS**
- **Interdisciplinarity**
  - biology, chemistry, civil engineering, architecture, social sciences, health sciences, economics…

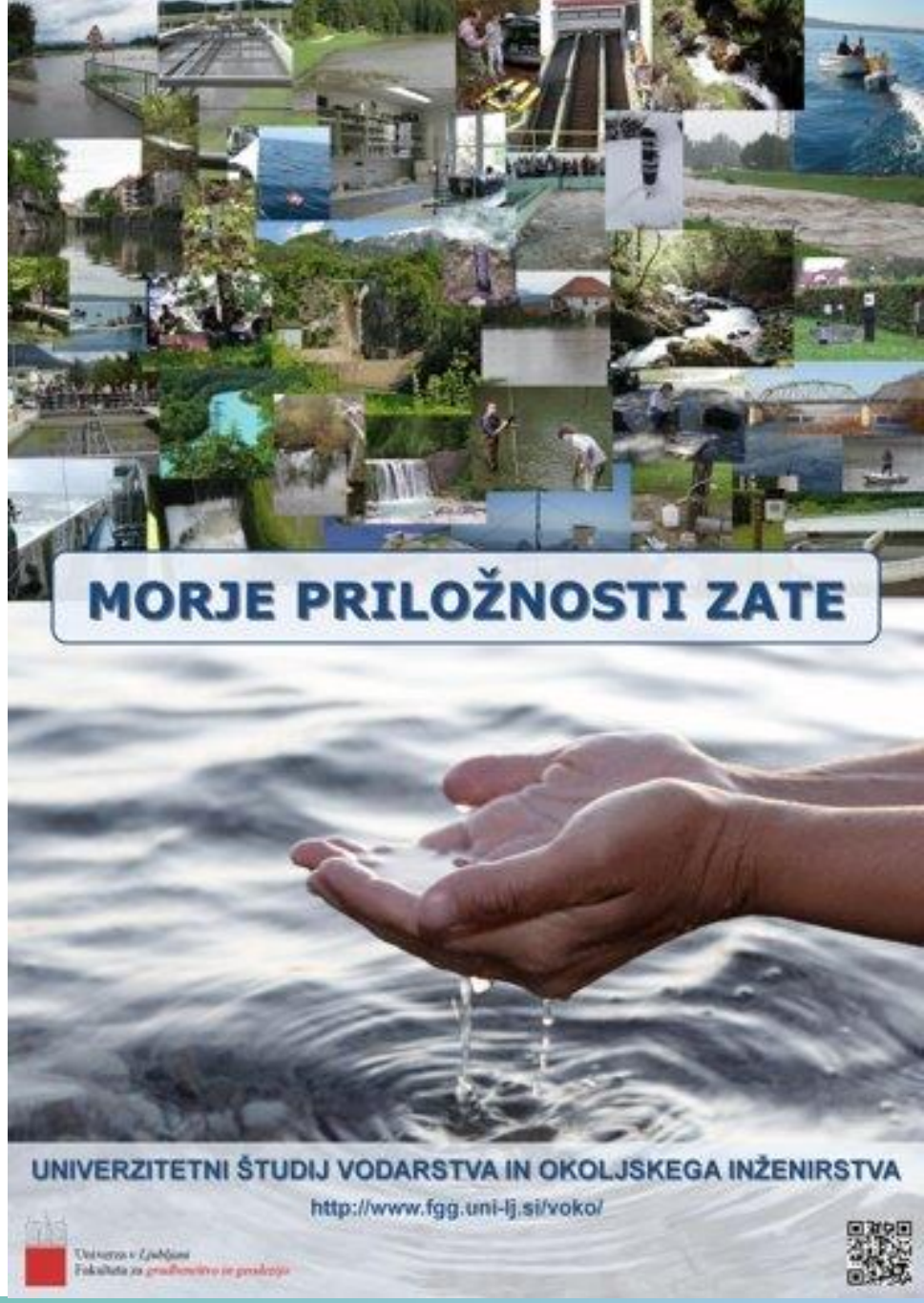
Want to design NBS?

Water and environmental engineering study programme

Univerza v Ljubljani
Fakulteta za gradbeništvo in geodezijo

More info on the study:
http://www.fgg.uni-lj.si/studijski-programi-1-stopnje/vodarstvo-in-okoljsko-inzenirstvo-un/

FB:
https://www.facebook.com/VOI.UL.FGG



Thank you for attention

darja.istenic@fgg.uni-lj.si

Global Water Partnership

Univerza v Ljubljani

(River) restoration

Why we need river restoration?

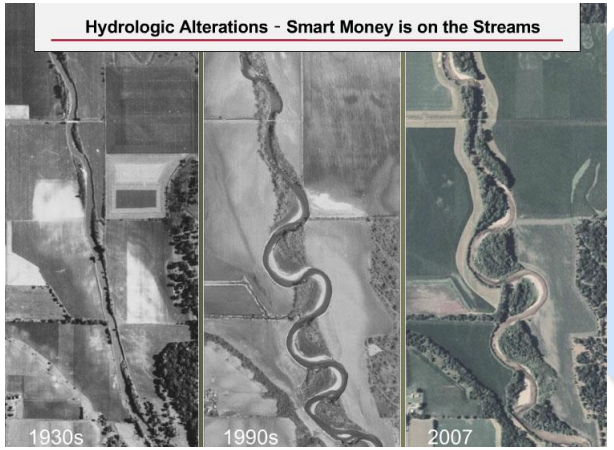
- **Many rivers were heavily modified due to industrialization, urbanization and spread of agricultural areas**
- **Rivers lost the capacity to store water – more frequent and severe floodings**
- **Water quality deteriorated due to loss of bio and physical diversity**

(River) restoration

Floodplain

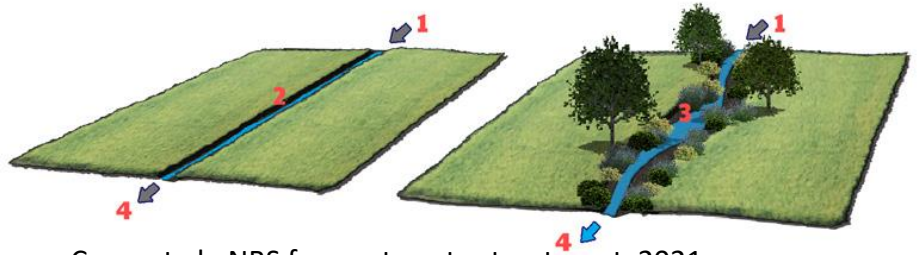
Establishment of new floodplains to reduce flood risk. Dry during dry weather and flooded during higher water levels.

Source: https://www.therrc.co.uk/why-restore



Restoring the meanders

And other measures aiming to an original (pre-chanalization) stage of a river to increase diversity in flow, and habitats.



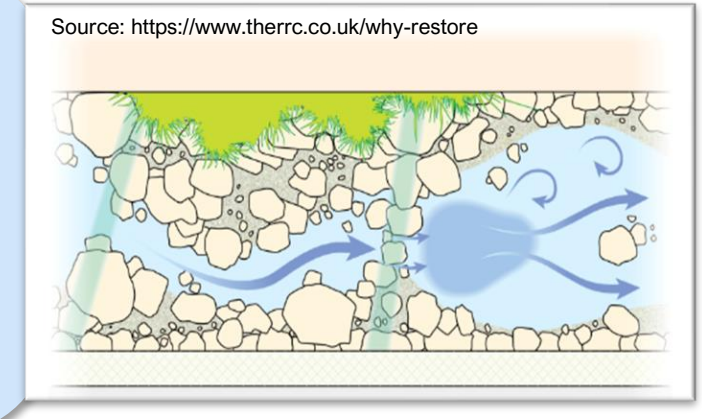
Cross et al., NBS for wastewater treatment, 2021

Coastal erosion control

A set of techniques to reduce coastal erosion by reducing wave velocity and trapping sediments. E.g. coastal wetlands, salt marshes, wood debris, coral reef.

Diverting and deflecting elements

Rocks, larger tree trunks, willow branches placed near the river bank or in the middle to diversify the flow and sediment shifting processes.



Source: https://www.therrc.co.uk/why-restore

Soil and water bioengineering

Why we need this?

- **Using living organisms (seeds, plants, parts of plants) to substitute or complement classical engineering practices**
- **For erosion control**
- **For bank stabilization**

Soil and water bioengineering

Erosion control

To revegetation, hydro-seeding, erosion control mats, wooden structures etc. to stabilise soil structure on steepened slopes, to prevent the wind or water erosion, landslides and sedimentation problems.

Soil reinforcement, anchorage

Using live plant materials for egineering purposes; plants grow roots and stabilize the bank/slope.

Soil improvement and conservation

Application of biochar, mulching, use of leguminous species for enhancing nitrogen fixation, use of organic matter to maintain and enhance soil quality in terms of physical, chemical, and biological features.

Riverbank engineering

Willow branch matresses, fascines, living and dead wood combined for riverbank protection.

Common advantages and frequent challenges of NBS

Common advantages

- Very reliable and sustainable
- Good quality of environment
- Ease of construction
- Simple and low cost operation and management
- Multi-purpose functionality

Frequent challenges

- High area demand
- Accumulation of phosphorous and persistent pollutants
- Lack of standard guidelines on design