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10 Possibilities of climate change mitigation and adaptation measures

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"It´s warming. It's us. We are sure. It's bad. But we can fix it."

Kimberley Nicholas

Content of the lecture

1. Mitigation options for climate change
2. Adaptation options for climate change

Mitigation vs adaptation

- **Mitigation**
  - actions to reduce or prevent greenhouse gas emissions (GHG) from human activities
    - implementing mechanisms to reduce GHG emissions
- **Adaptation**
  - actions to prepare and adjust to the current and projected impacts of climate change
- **Synergies** between mitigation and adaptation measures
  - e.g. thermal protection the house against heat leaks and shading the facade with greenery

Mitigation options for climate change

Mitigation options for climate change

- **Reducing the use of fossil fuels and replacing them with other sources**
  - 3% decrease in the rate of increase in GHG emissions (2010–2020)
  - cancelation of fossil fuel subsidies
  - introduction/increase of a carbon tax
  - synthetic fuels (e-fuels) as a solution?
  - climate dividend?
  - phasing out coal-fired power plants (22 EU countries without coal-fired power plants by 2024)

Mitigation options for climate change

- **Decarbonising the economy** and the transition to a sustainable economy
  - **Europe as an example of decarbonisation** (*leading by example*)
  - decrease of EU´s GHG emissions by 31% (1991–2021)
  - **diplomatic export** of the decarbonisation idea to the world (education, historical responsibility)

Mitigation options for climate change

- **More efficient use of** energy **resources**
  - the use of appropriate renewable energy sources (RES)
  - thermal insulation of buildings
- Reducing deforestation and desertification
- Higher **reforestation** of the landscape
  - 1 ha of forest in Central Europe absorbs up to 22 t CO_2/year = production of a car with 1 passenger after 120 000 km

More emphasis on recycling and upcycling

- **Upcycling**: converting waste or unwanted products into new or better-quality materials
- Moving from a linear to a **circular economy**

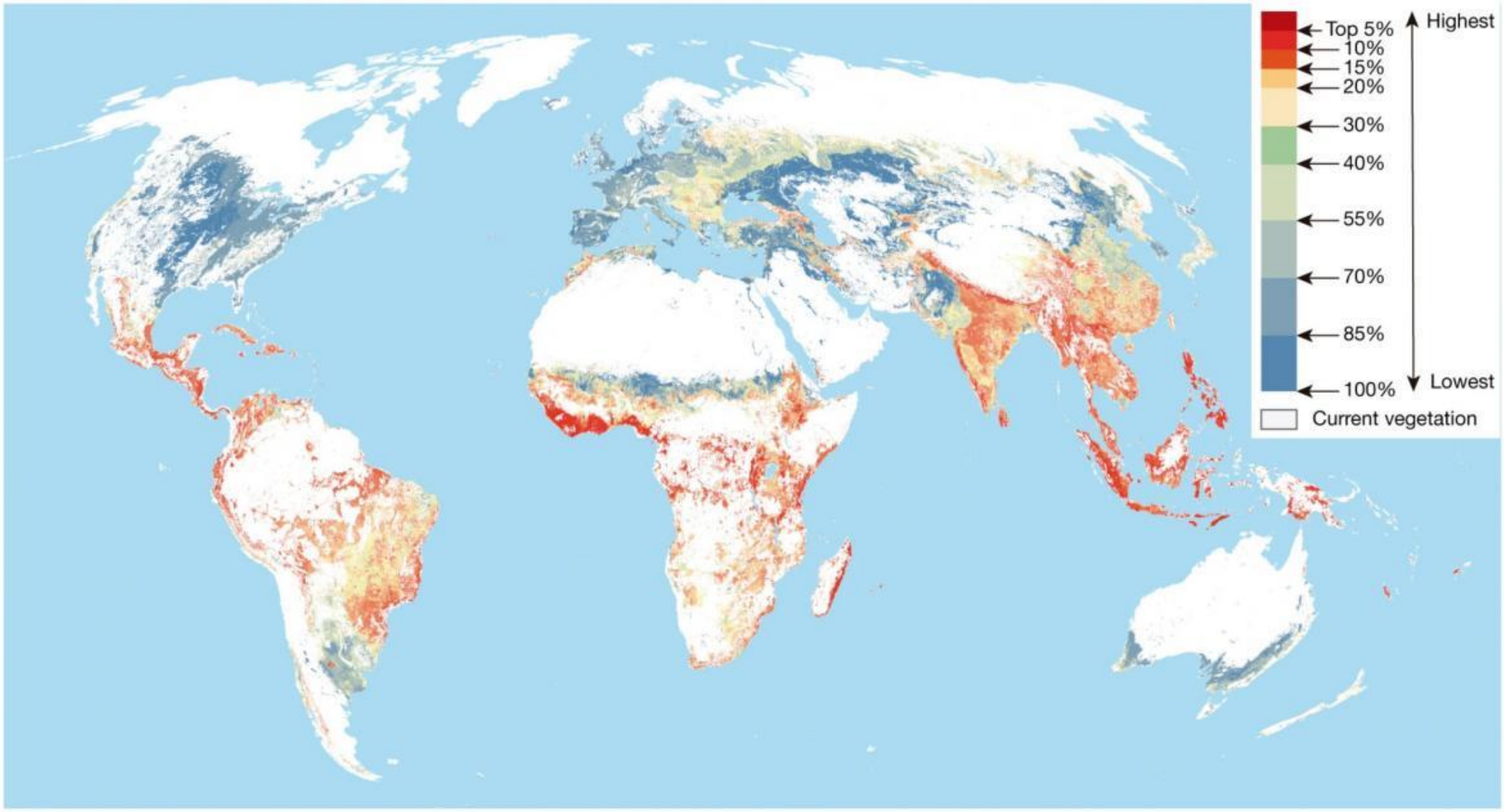
eastdunbarton.gov.uk, 2024

Reforestation

- **New reforestation and protection of environment:**
  - possibility of removing up to 33% of anthropogenic CO_2 and reducing CO_2 emissions to 350 ppm
- **Areas with the greatest potential:**
  - tropical areas (issue of agriculture and high population density)
  - E and SE Europe (minimum restoration costs)
- **Areas with minimum potential:**
  - W Europe and east North America

Reforestation

Reforestation priority in terms of CO_2 sequestration efficiency; lower % = higher priority



Reforestation

- **Reforestation** and ecosystem protection **cannot compensate for the end of fossil fuel burning**
- **The matter of** planting **locations** and tree **species**
  - absurdity of planting trees on, e.g. savannahs or steppes

Great Green Wall (China)

- **Reforestation project in China** to suppress (reduce) the expansion of the Gobi Desert to the south and southeast China
- **Project period:** 1978–2050
- **Reasons:**
  - desertification (intensive agriculture, pastoralism, deforestation, excessive water pumping)
  - erosion
  - sandstorms

WMO, 2018

Great Green Wall (China)

- Plan for **reforestation** of about **300 000 km²** with a length of 4 500 km
  - – so far approximately 220 000 km² forested
  - – increase in China's forest cover from 17% (1990) to 23% (2020)
  - – local desert retreat

Great Green Wall (China)

- **Problems:**
  - **loss** of approximately 4 000 km^2 of agricultural land/year
  - predominance of **monocultures** (3 tree species)
  - **inappropriate environment** for forest (steppe)
  - **increase in drought episodes** due to drop in groundwater levels

WMO, 2018

Great Green Wall (Africa)

- **Reforestation** project of 21 African countries in the South Sahel
- **Aims to protect** green areas, use land more efficiently, increase fertility
- **Planned end of the project**: 2030
- **Reasons:** desertification, erosion
- **Various results:**
  - so far only 4% of the area planted, mortality up to 80% seedlings
  - improved landscape management, increased crop yields

Great Green Wall (Africa)

Profimedia, 2020

Profimedia, 2020

Mitigation options for climate change

- Reducing GHG emissions in **transport**, promoting electromobility, **sustainable agriculture**, **cleaner technologies**
- **Capturing** and **storing** CO_2 from the atmosphere
- Approval of the **Global Oceans Convention**
  - marine reserves for 30% of the open seas

Capturing and storing CO2 from the atmosphere

- **Methods of CO_2 capture and storage**
  - Direct Air Capture (DAC)
    - reverse extraction from the atmosphere
  - Carbon Capture and Storage (CCS)
    - reverse extraction from the atmosphere and its storage
  - regenerative agriculture
- Not emitting emissions is preferable to capturing them (CCS as a last possibility)

Direct Air Capture (DAC)

- **Prototypes of CO_2 extraction equipment** and $CaCO_3$ production (Iceland):
  - **2017**: 50 t/year = 1 small household
  - **2021**, Orca: 4 000 t/year = 800 pers. cars/year
  - **2024**, Mammoth: 36 000 tonnes/year
- **Utilization of removed CO_2:**
  - construction, carbon nanofibers, food processing, oil extraction

Source: cantechletter.com, 2016

Direct Air Capture (DAC)

- **IPCC targets (2050)**: 1 Gt/year
- **All DAC targets (2050)**: 4.5 Gt/year
  - 4.5 Gt equivalent of 130 000 Mammoth plants = construction of 13 Mammoth plants per day (total electricity consumption of 13 500 TWh = 10% of electricity consumption in 2050)
- **Disadvantages:**
  - high extraction costs (600–1 200 USD/t)
  - fossil fuels as a source of energy for factories

Carbon Capture Storage (CCS)

- **Extraction of** CO_2 from the atmosphere and its **storage**
- Efficiency up to 90%
- **Suitable locations for storage:**
  - mines, groundwater deposits, salt deposits, oceans, soil
- **But:**
  - insufficiently developed and costly technology
  - risk of accidents and subsequent releases

"Pumping that much CO_2 underground would be like starting the entire oil industry backwards"

John Doerr

Regenerative agriculture – principles

- **Minimal soil disturbance** (mechanical and chemical)
- Continuous **ground cover** with vegetation (intercropping)
- Highest possible **biodiversity**
- Keeping **roots alive** in the soil all year round
- Use of livestock **grazing**

carboneg, 2023

Regenerative agriculture – the benefits

- **Environment friendly farming**
- **Reduction** of **mechanical work** in the field (ploughing, pest spraying...)
- Reducing the amount of **fertilisers**, **pesticides** and **herbicides**
- Minimal disturbance to soil micro-organism populations
- Reducing **soil erosion**
- Increased **absorption** of (heavy) **rainfall**
- **Increased harvest** in the long term view
- Improving the soil's ability to **sequester CO_2**

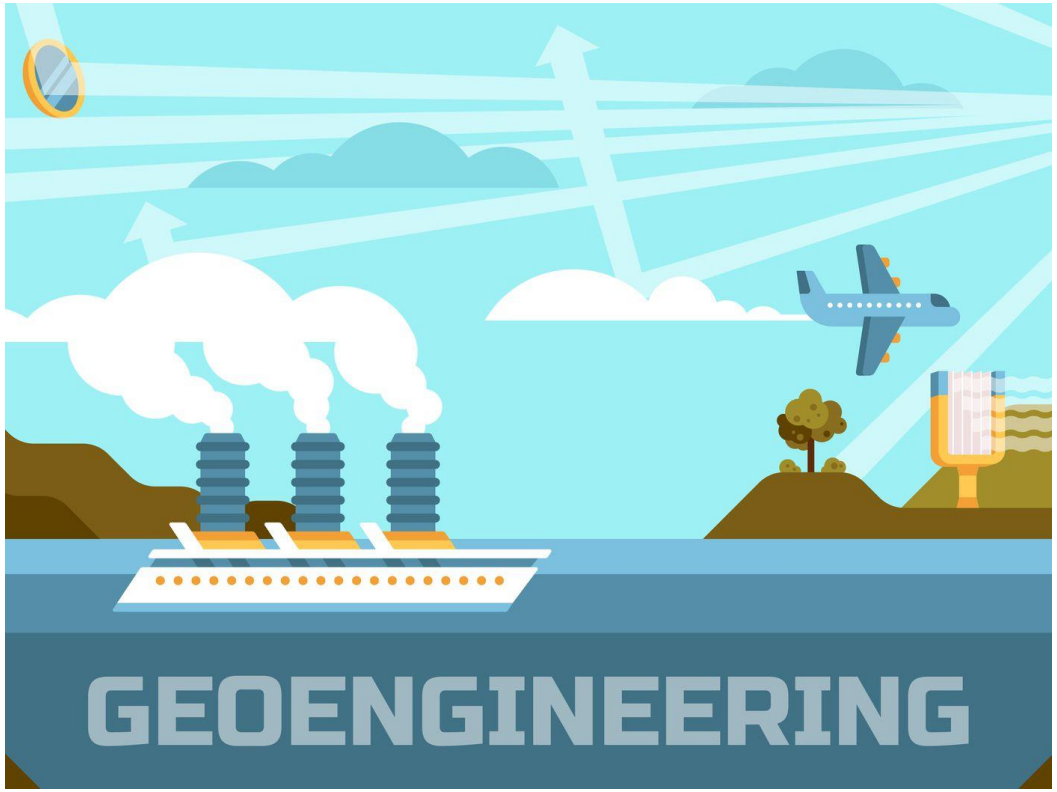
Regenerative agriculture – disadvantages

- **Temporarily lower yields** when introducing regenerative agriculture
- Risk of temporary **pest overpopulation**

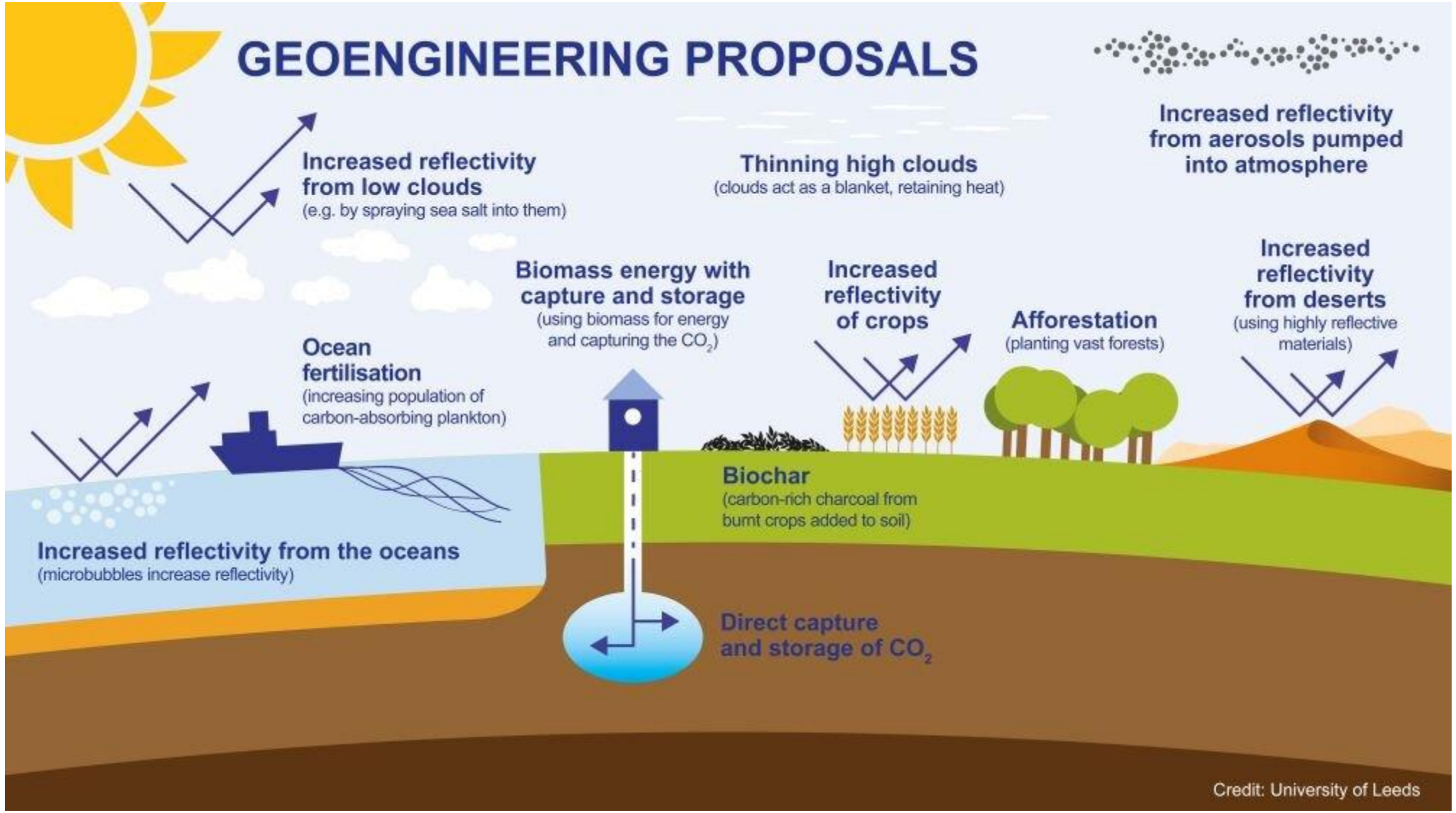
moore-unidrill.com, 2023

The matter of geoengineering

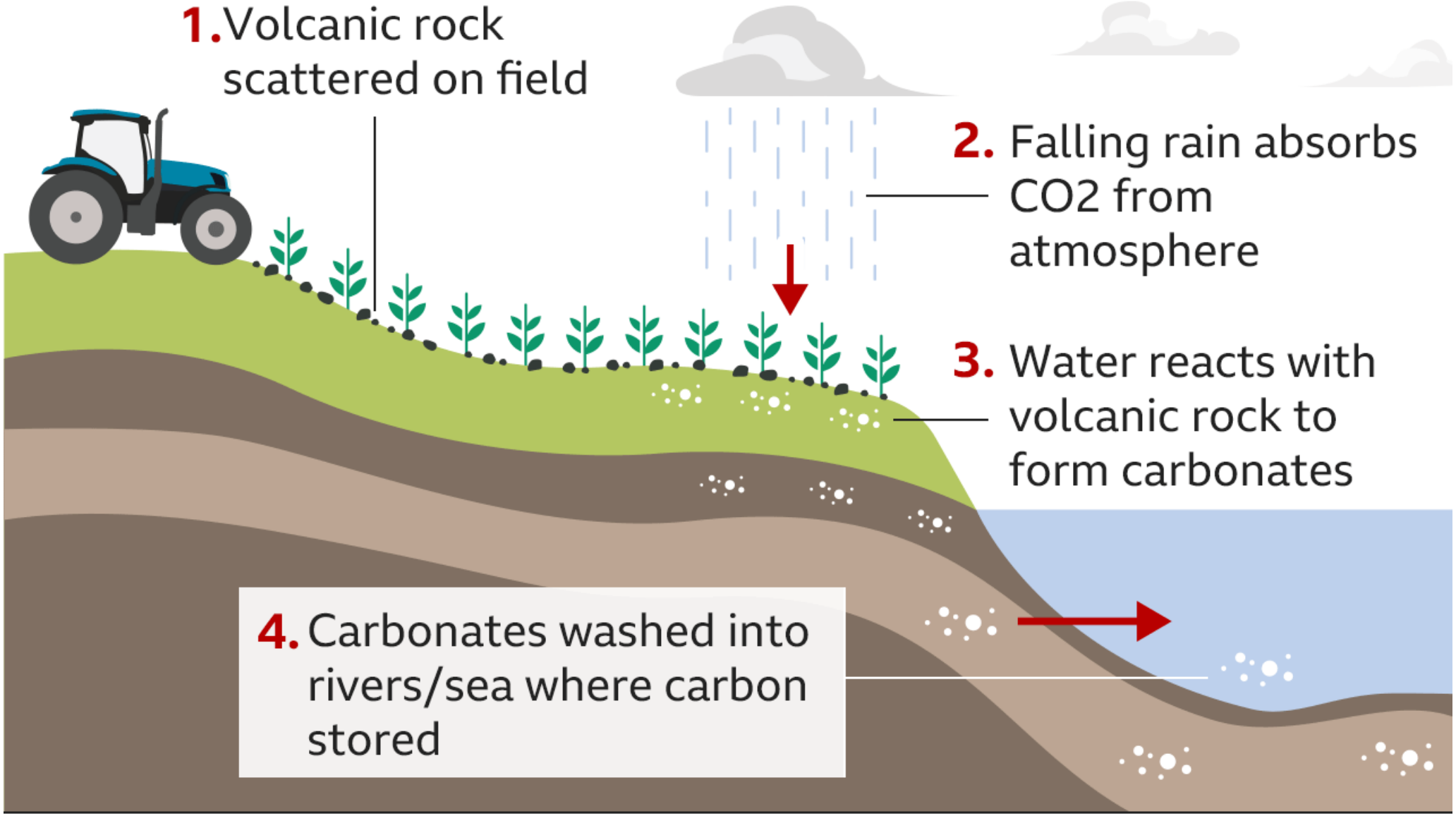
- **Geoengineering**: targeted human influence on the state of the Earth (climate)
  - space mirrors
  - aerosol spraying into the atmosphere
  - cloud strengthening over the oceans
  - weakening of high clouds
  - fertilising the oceans



vox.com, 2014


GEOENGINEERING PROPOSALS
Increased reflectivity from low clouds
(e.g. by spraying sea salt into them)
Thinning high clouds
(clouds act as a blanket, retaining heat)
Increased reflectivity from aerosols pumped into atmosphere
Biomass energy with capture and storage
(using biomass for energy and capturing the CO_2)
Increased reflectivity of crops
Afforestation
(planting vast forests)
Increased reflectivity from deserts
(using highly reflective materials)
Ocean fertilisation
(increasing population of carbon-absorbing plankton)
Biochar
(carbon-rich charcoal from burnt crops added to soil)
Increased reflectivity from the oceans
(microbubbles increase reflectivity)
Direct capture and storage of CO_2
Credit: University of Leeds

How enhanced rock weathering works



Source: BBC research, Getty Images

BBC

Adaptation options for climate change

Adaptation measures to reduce glacier melting

Rhone Glacier near Furka, Switzerland

Arnd Wiegmann-Reuters, 6.8. 2015

Adaptation measures to reduce glacier melting

Stubai Glacier, Austria

Dolák, 2017

Adaptation measures for climate change

- **Infrastructure transformation** to cope with more frequent natural disasters
- **Relocation of** human settlements and industry (Kiribati -> Fiji)
- Helping the most vulnerable areas and their development
- **Change of farming** methods (agriculture, forestry)
- **Reduction of** drinking water **usage**
- Increasing **general** public **awareness**

Coastal strengthening – Maldives

Source: Profimedia, 2022

Coastal strengthening – Maldives

Source: Profimedia, 2022

Bank erosion of the Padma River in Bangladesh

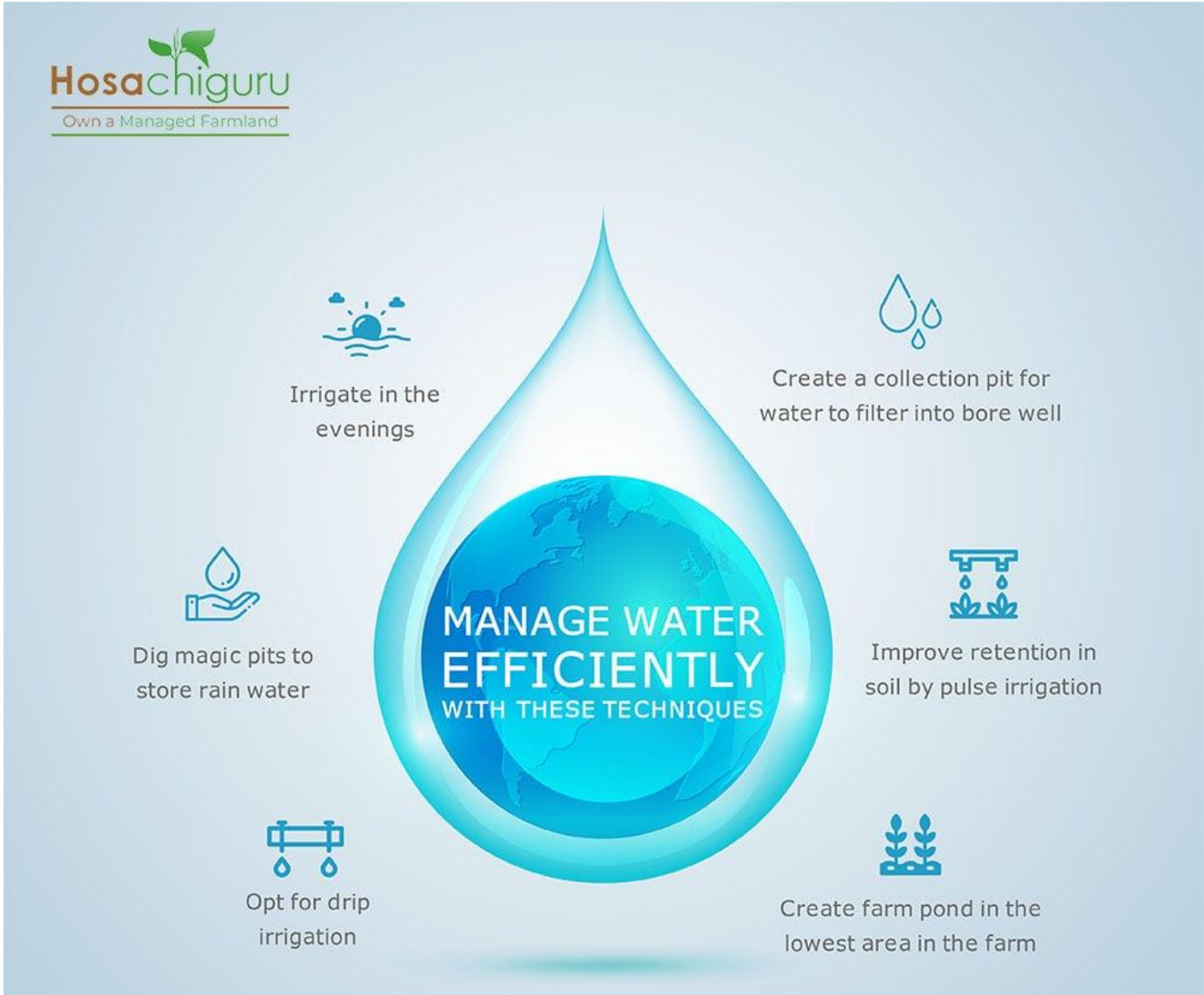
Source: Profimedia, 2023

Erosion of the Padma river bank in Bangladesh – consolidation

Source: Profimedia, 2023

Options for efficient water management

- Frequent use of **surface water**
- **Reconstruction of** water supply systems
- Seawater **desalination**
- Wastewater **recycling**



Specific ways of obtaining water in arid regions

- S.A.W.E.R.: autonomous system for water extraction by condensation from air - capture up to 500 l of water/day

Sawer.cz, 2024

Specific ways of obtaining water in arid regions

- Capture up to 400 l/day of water from morning mist

Profimedia, 2016

Reducing the heat island of the city and the impacts of heat waves

- Change in the **architectural structure** of cities (building of wind corridors)
- Planting of **greenery**, passive **homes**
- **Solar parking**

Carport, 2009

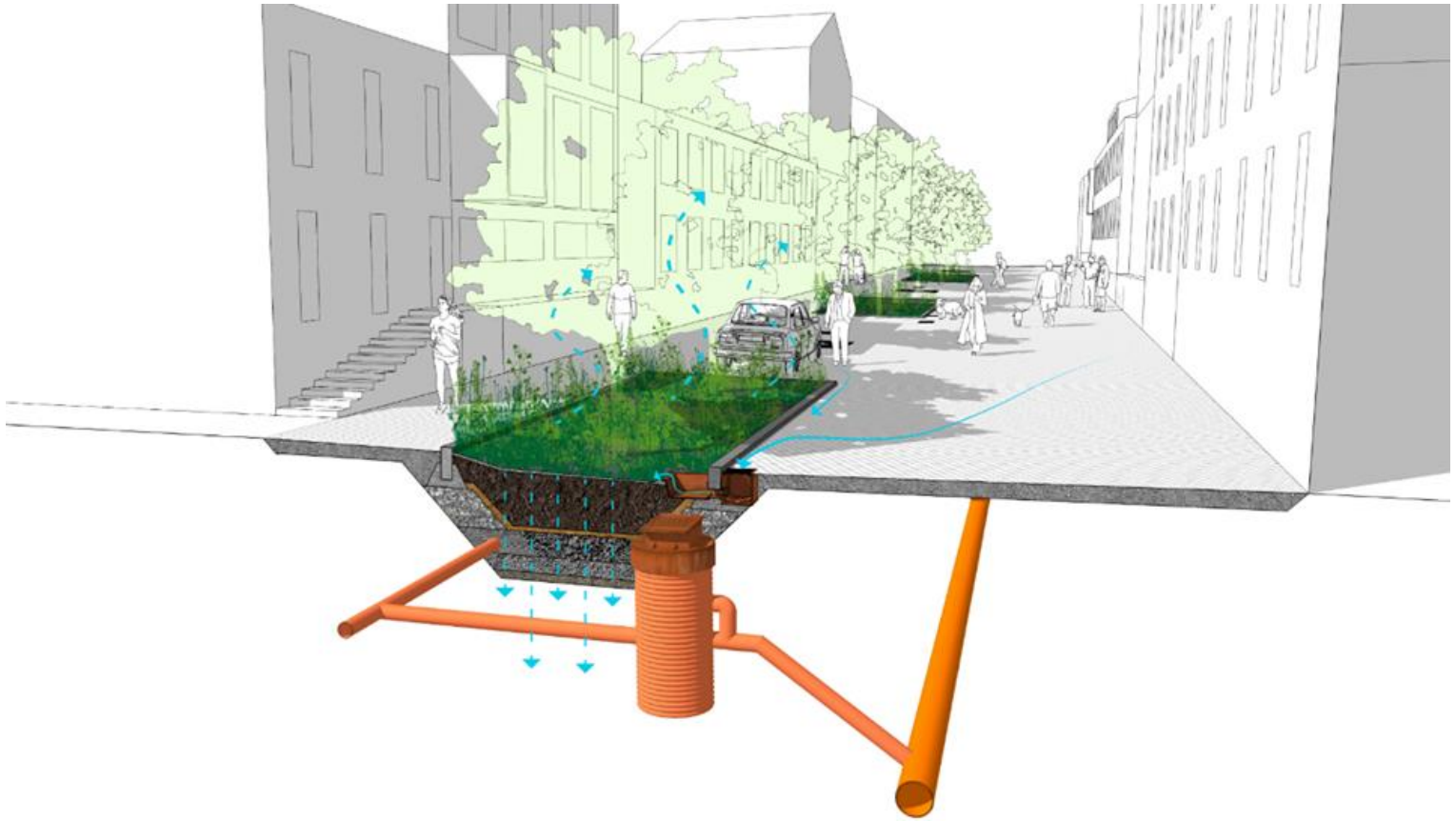
Reducing the heat island of the city and the impacts of heat waves

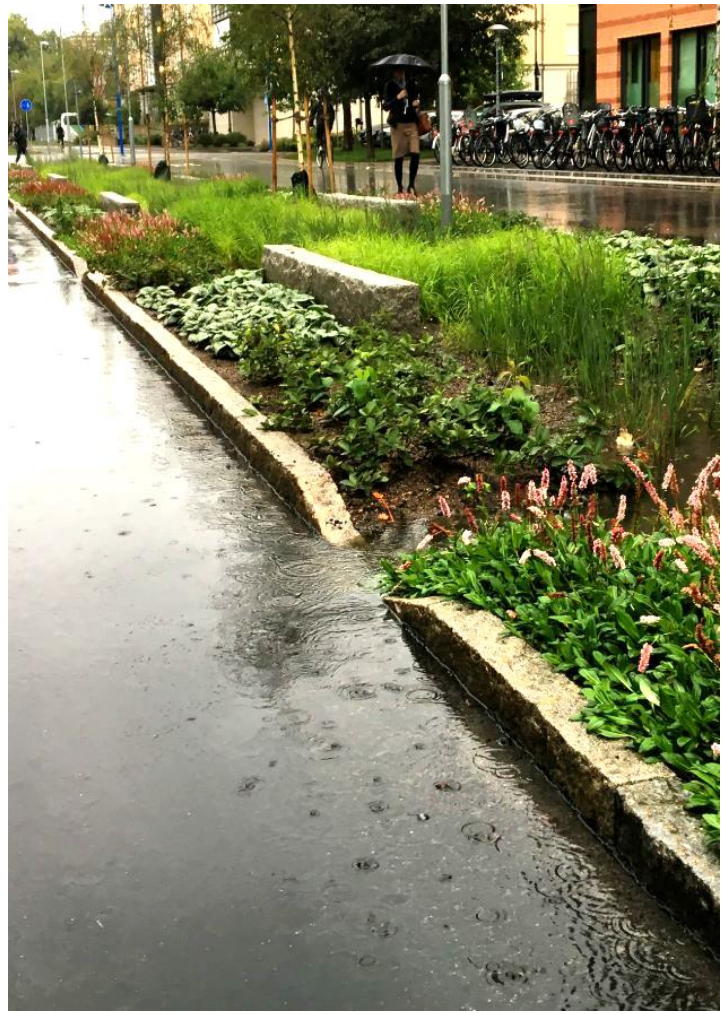
- **Special surface paintings,** white roofs and facade

Qatar Living, 2019

Reducing the heat island of the city and the impacts of heat waves

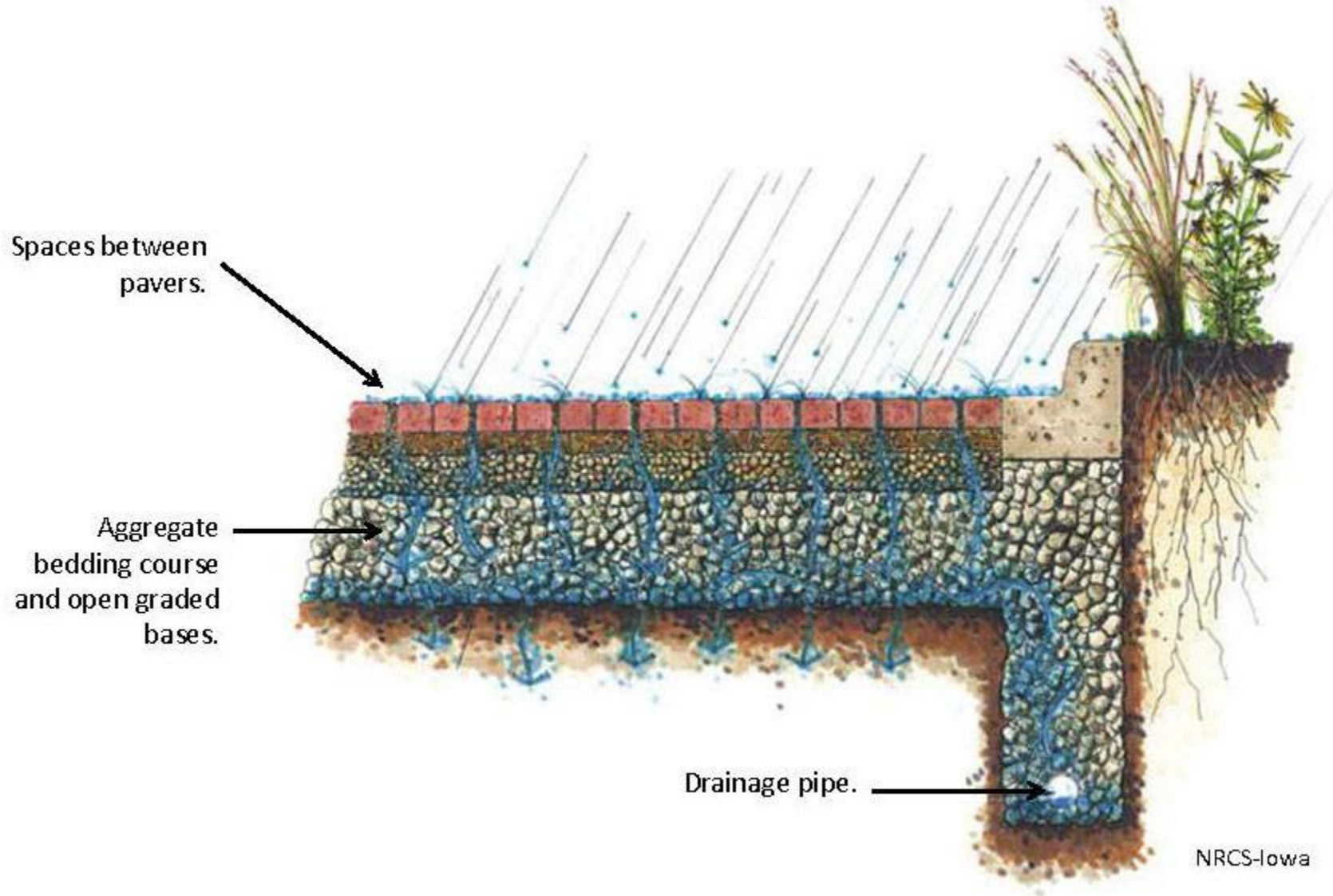
- **Water retention** from pavements, roadways and shopping areas





Reducing the heat island of the city and the impacts of heat waves

- Building **permeable/porous surfaces** in cities



Change of management method

- Focusing on **sustainable**, **environment friendly agriculture** rather than to maximise finacial gain
- Better timing of **agricultural activities**
- Supporting the use of **organic fertilisers**
- Breeding and sowing **more resistant varieties of plants**
- Increased **species diversity** of agricultural crops

Agrovoltaics

- **Combining** (semi-transparent) **solar panels** and **agriculture**
- **Advantages**:
  - shading of crops
  - wetter microclimate (cooling of the landscape and panels)
  - keeping yields in dry periods
- Installations in Japan, China (Gobi), India, W and S Europe

Agrovoltaics

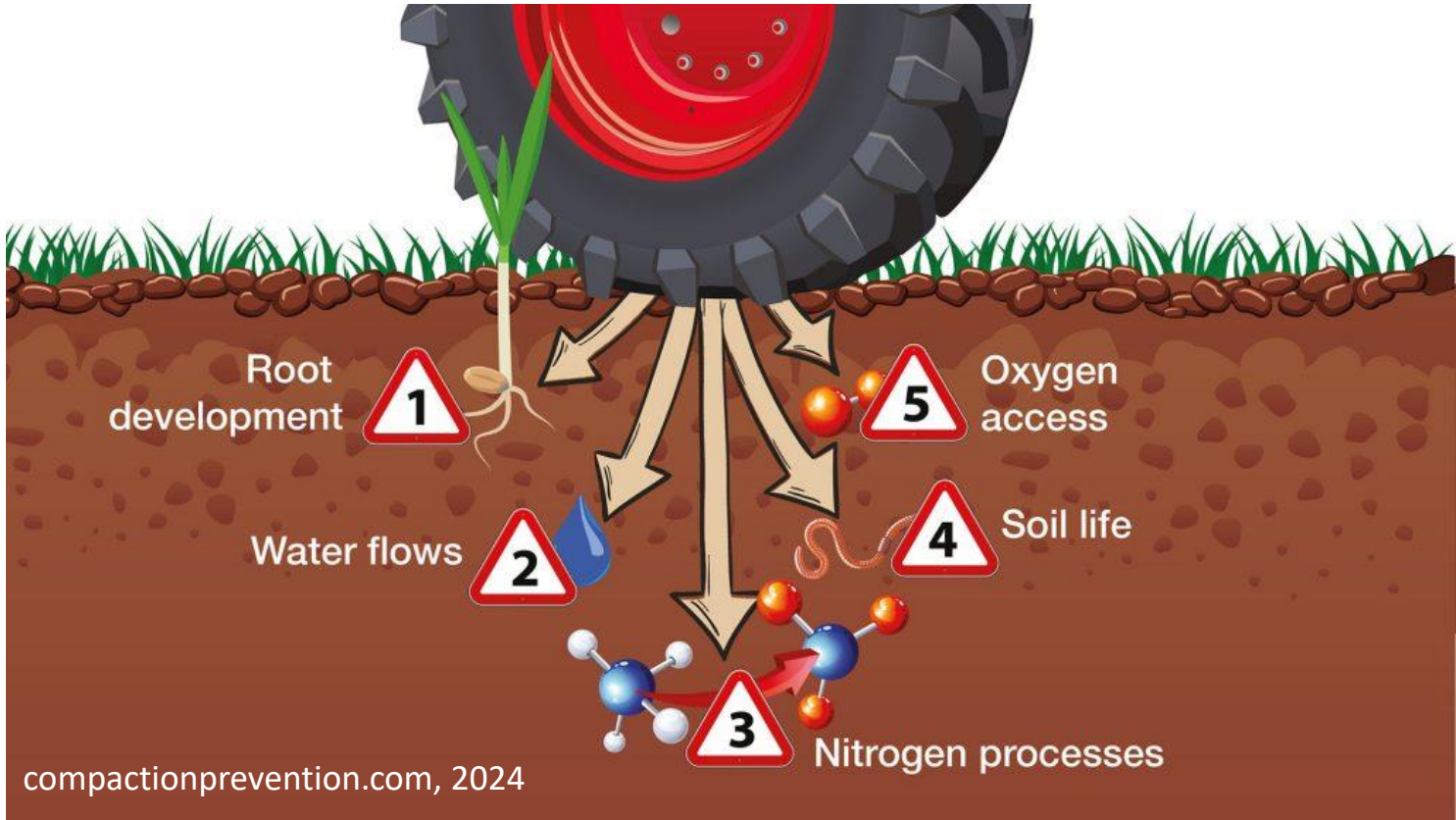
Next2Sun, 2020

Agroforestry (on the example of the Czech Republic)

Photo: B. Lojka

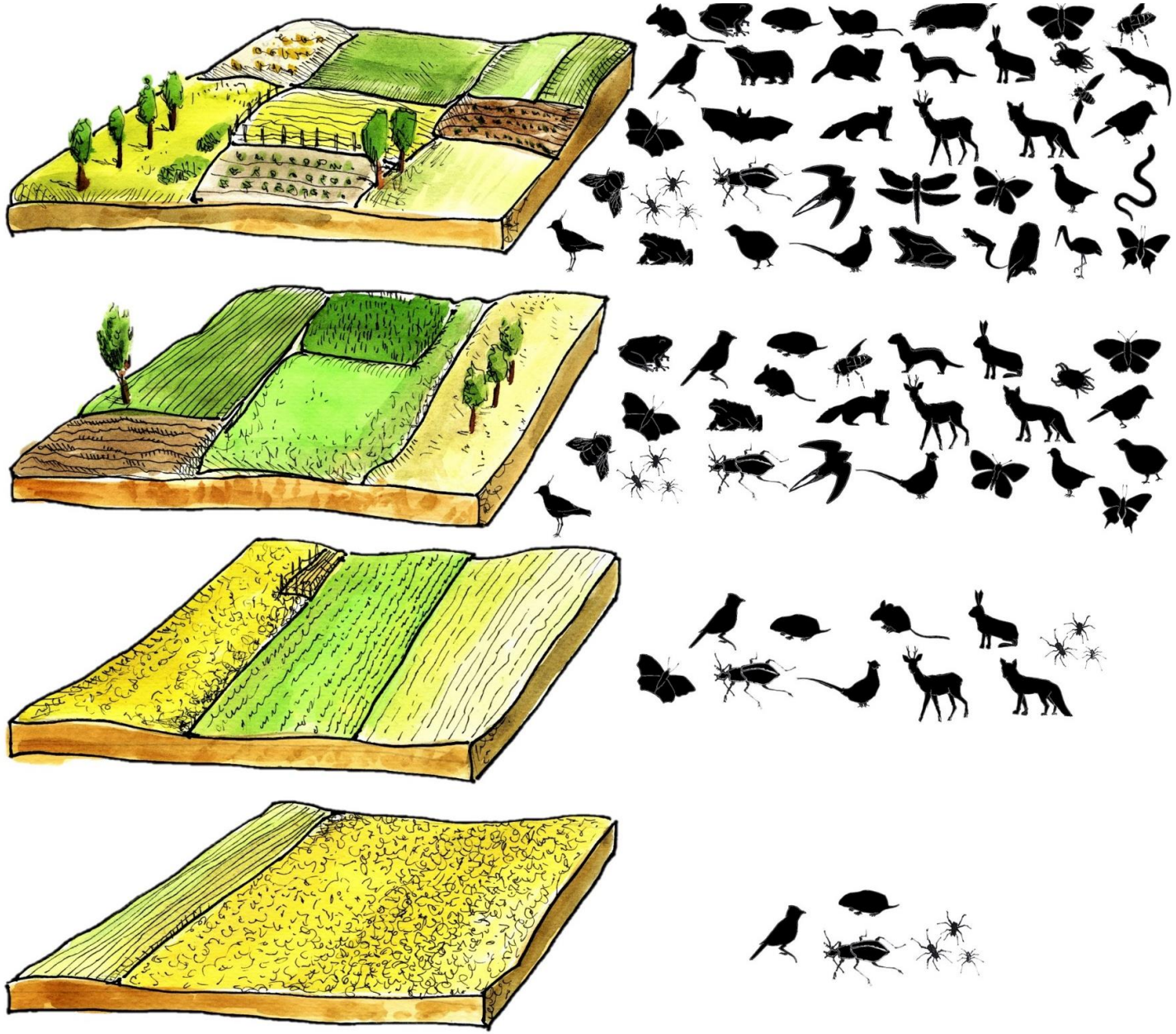
Reducing erosion of agricultural land

- Surface stabilisation **by interspecific (various) plants**
- **Lower** soil **compaction/hardening** by agricultural machinery
- Increasing the **biotic component** – fertilisation
- **Vine** planting



Restoring the biodiversity of the landscape

- **Reduction** of fields extent and their separation
- **Recultivation** of forests, **revitalisation** of wetlands and watercourses, **restoration** of lines of trees



Revitalisation of straightened stream beds (on the example of the Baštýnský Brook)

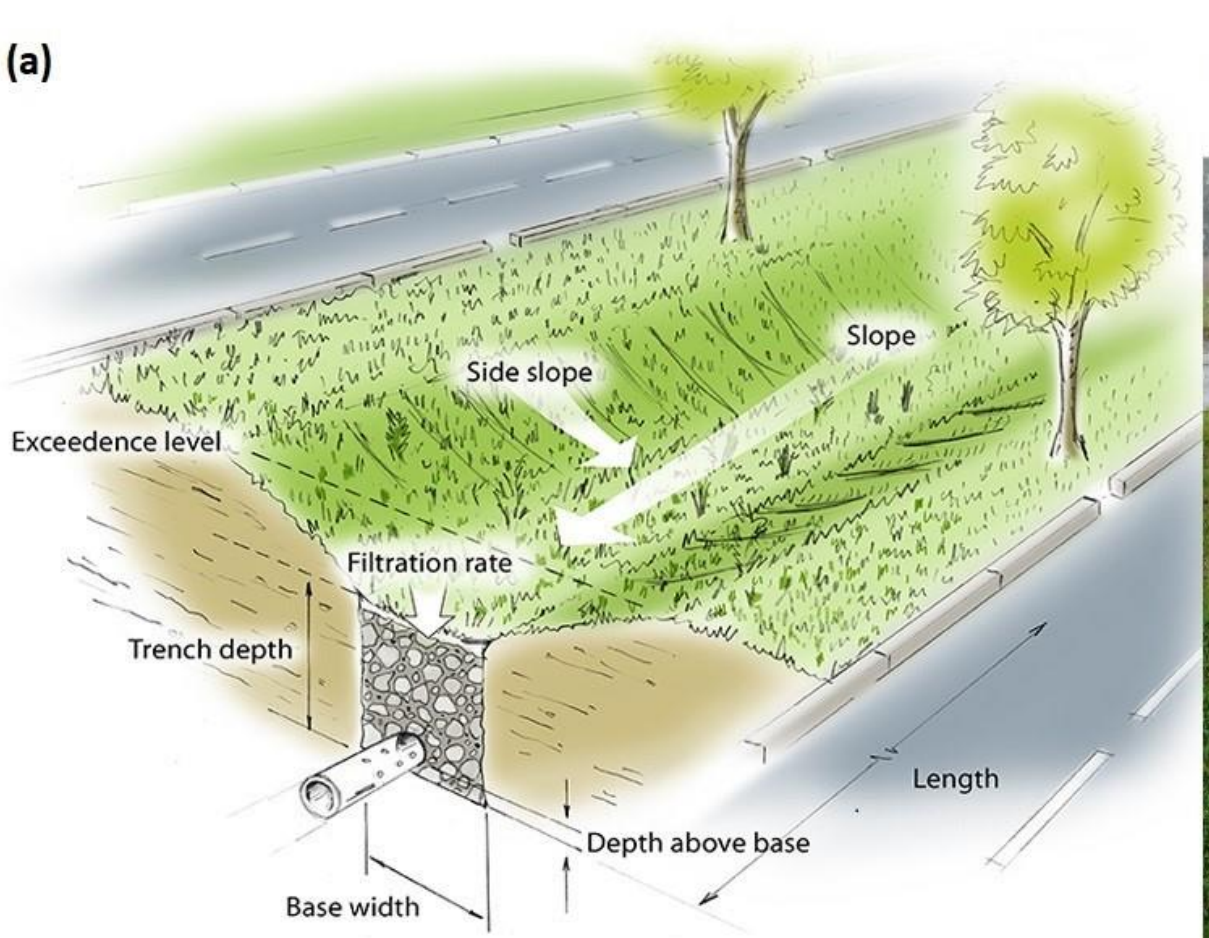
Water retention in the landscape – technical measures

- Construction of **new water reservoirs**
- **Restriction of new building** on arable land
- Higher **interconnection** of the **water supply system**
- **Drip irrigation**

mipatex.in, 2020

Water retention in the landscape – environment friendly measures

- Building **terraces** or **infiltration trenches**



tool.urbanproof.eu, 2024

Grass strips in the field near Bošovice (Czechia) increasing soil retention capacity and limiting erosion

Photo: K. Zhdanov

Building pools in forests

pools on the approximate 70 m long path on the Big Javorník, Moravian-Silesian Beskydy Mountains (Czechia)

(150 000 l of water)

Photo: AOPK ČR, 2020

Restoration of peat bogs and wetlands (Giant Mountains, Czechia)

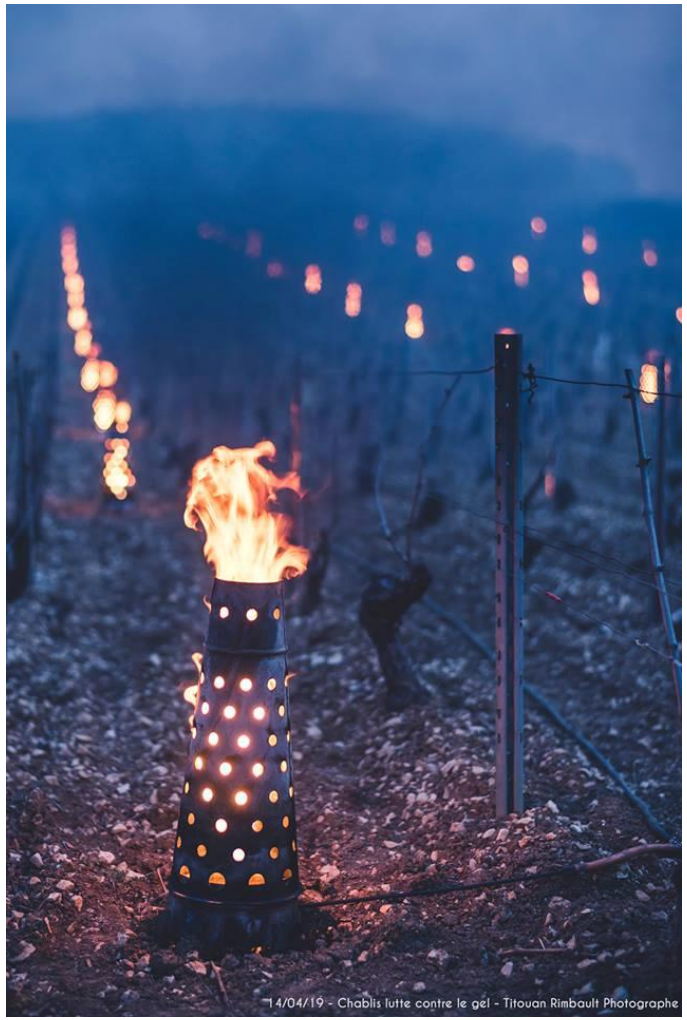
Photo: Plíhal, 2020

Protective measures against the effects of natural disasters

Installation of hail nets in orchards

gintec.ca, 2022

Warming of the ground layer of the air as protection against late frosts

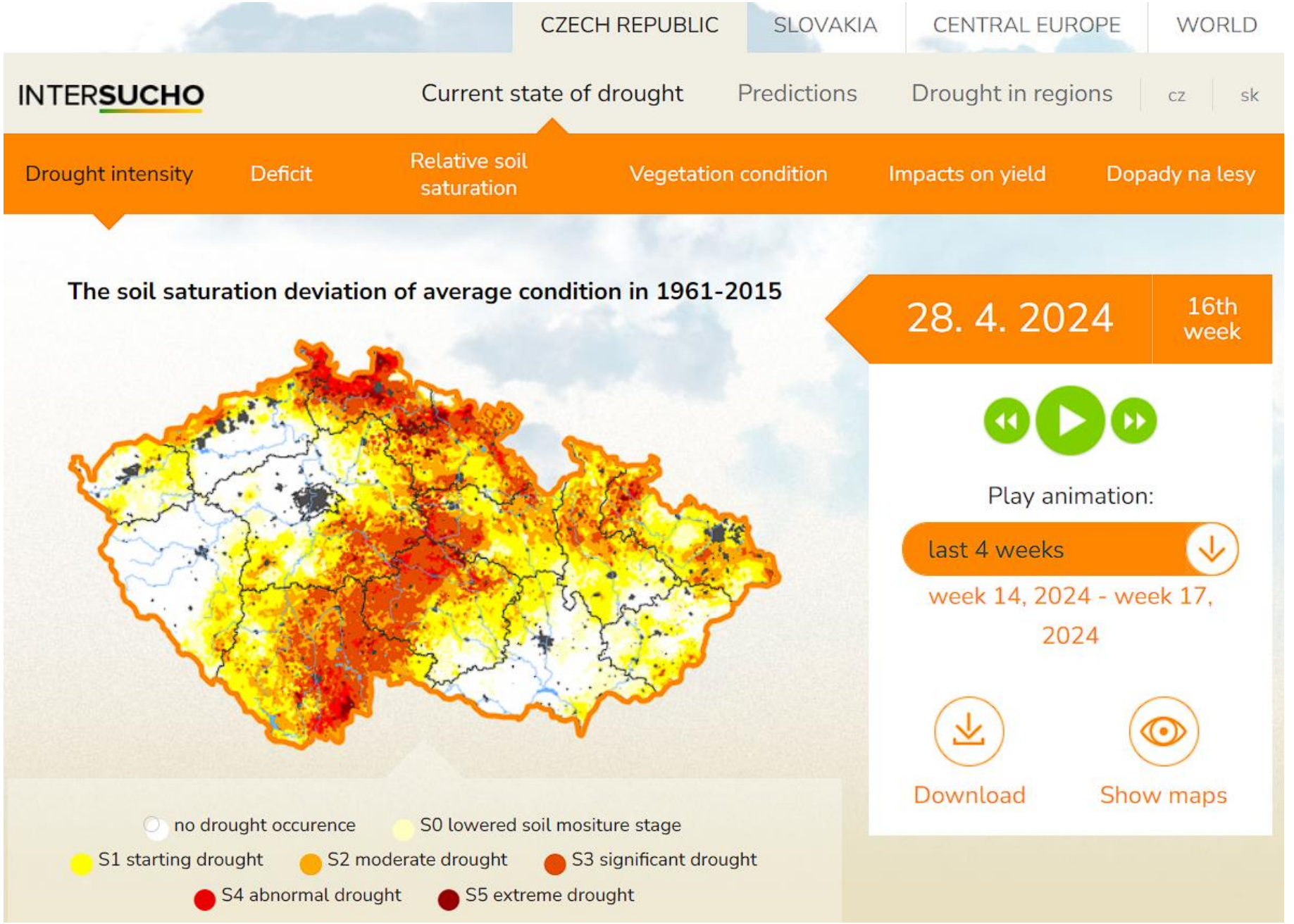


Warming of the ground layer of the air as protection against late frosts

How to fight drought

- **Proper water management** and water storage
- **Raising awareness** of **drought** and disseminating information to the public
- Establishment of **national and regional drought commissions** (drought, water shortage, emergency)
- **Water price increases** in times of drought

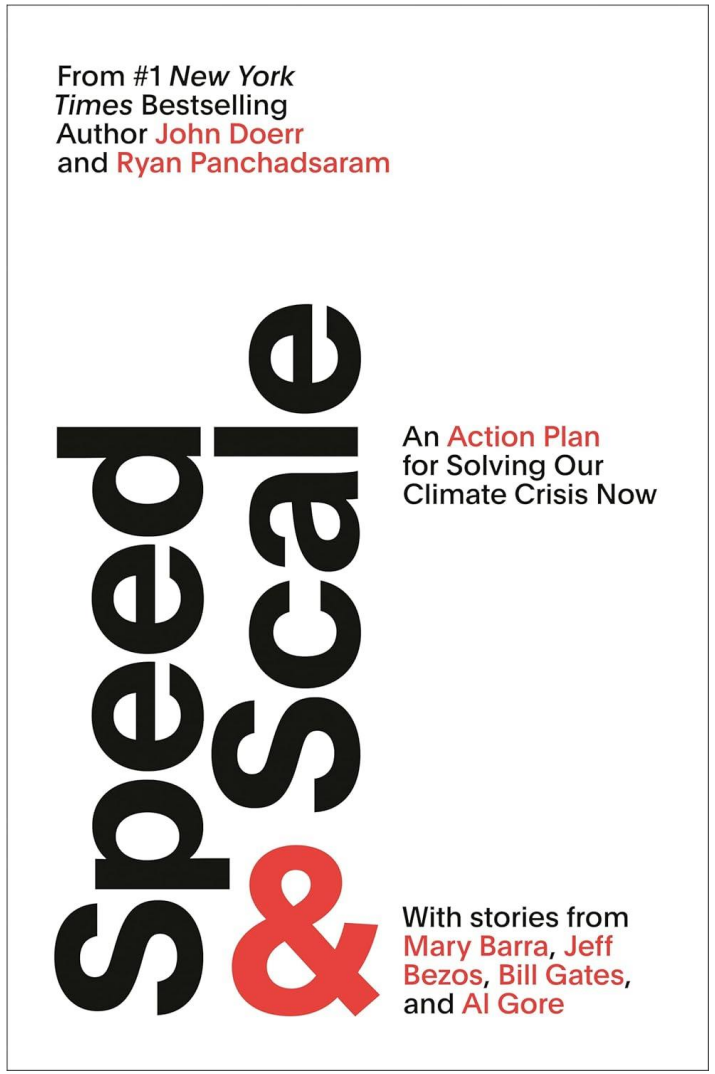
Creating an information platform on drought and water scarcity

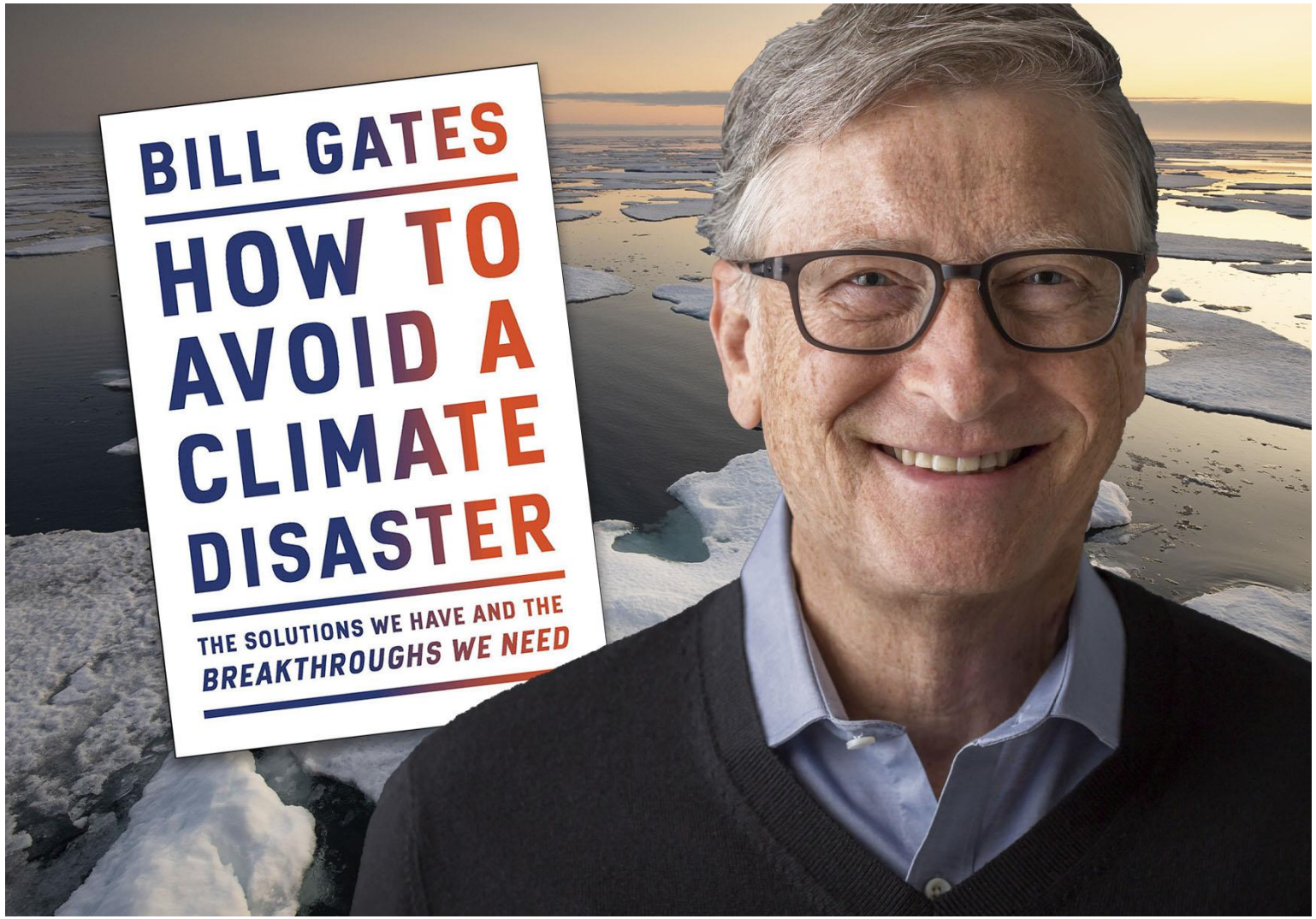


http://www.intersucho.cz/

intersucho.cz, 2023

Recommended literature





Literature

- What is soil compaction?
- Gates, B. (2021): How to Avoid a Climate Disaster: The Solutions We Have and the Breakthroughs We Need. Allen Lane, 257 p.

Thank you for your attention