Food and Agriculture Organization of the United Nations

Global Soil Partnership

Key ecosystem services for food and agriculture - the Status of the World's Soil Resources -

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Trondheim Conferences on Biodiversity

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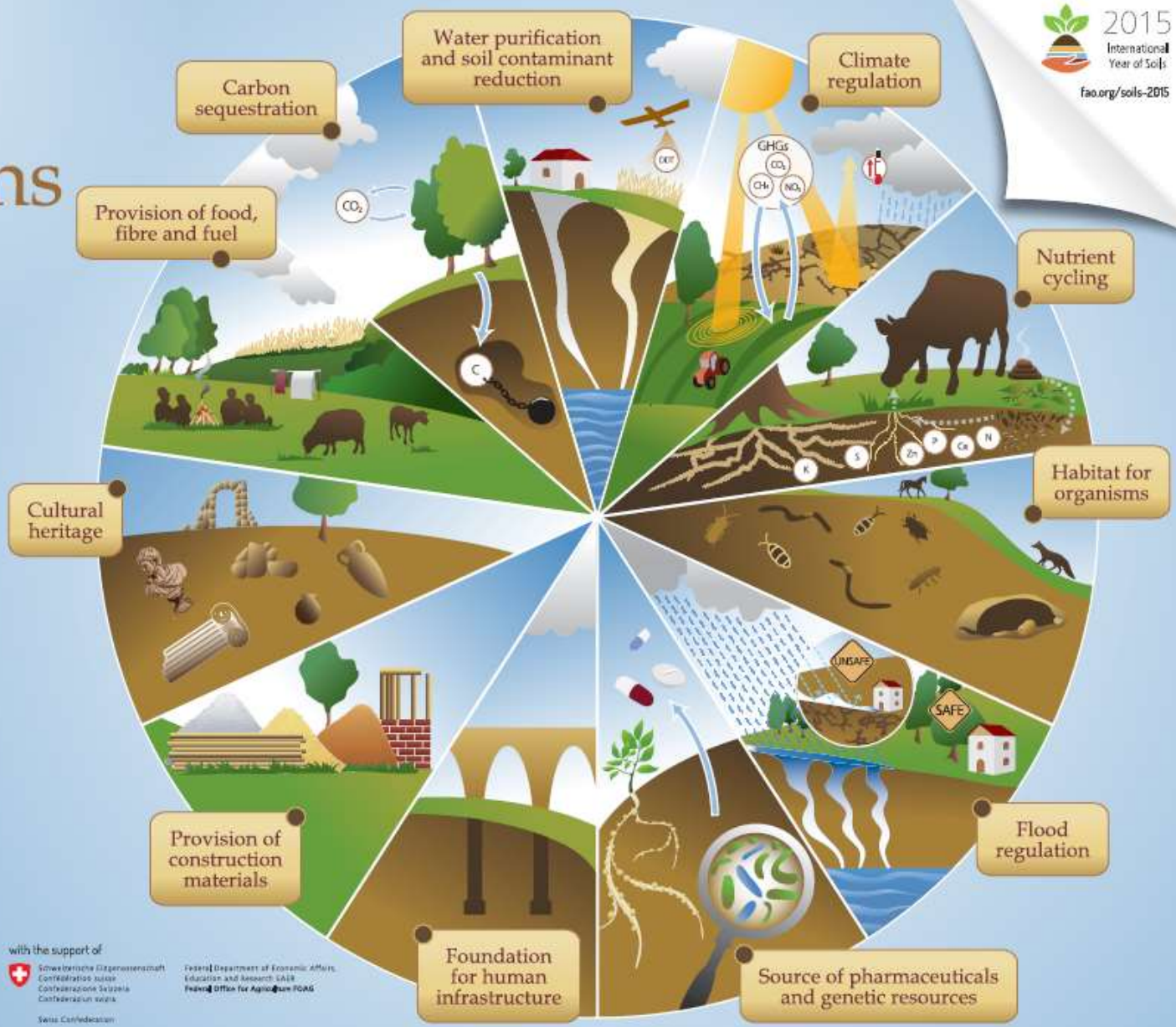
GLOBAL SOIL PARTNERSHIP

Soil functions

Soils deliver ecosystem services that enable life on Earth



2015 International Year of Soils

fao.org/soils-2015

Food and Agriculture Organization of the United Nations

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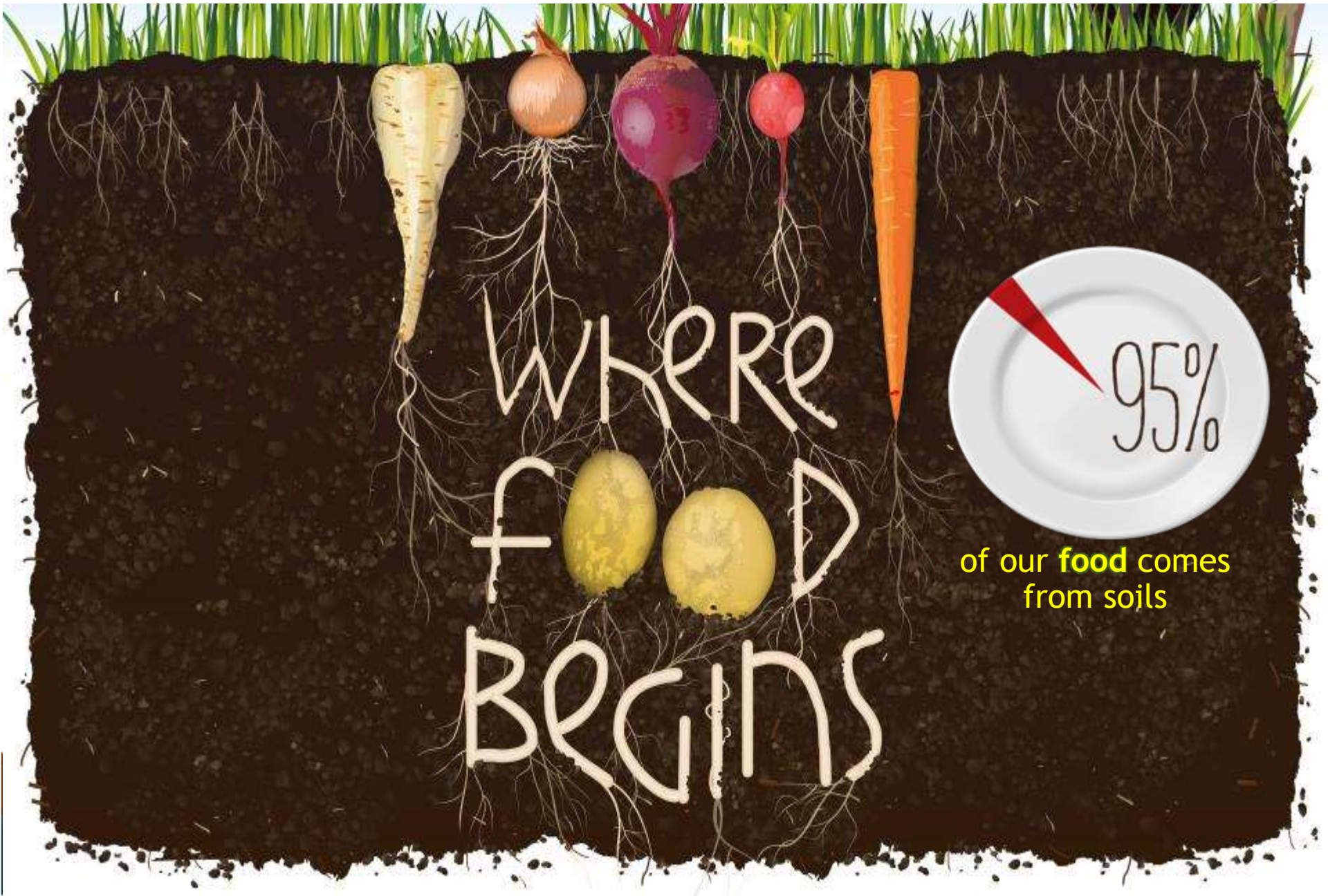

Where food begins
95%
of our food comes from soils

SOILS HOST A QUARTER OF OUR PLANET'S BIODIVERSITY

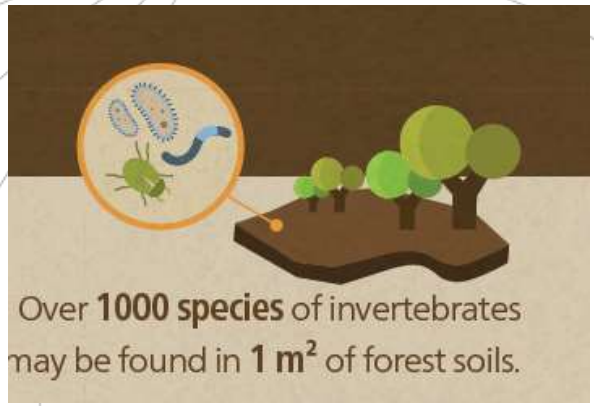
Soil is one of nature's most complex ecosystems: it contains a myriad of organisms which interact and contribute to the global cycles that make all life possible.

A typical healthy soil might contain:

- vertebrate animals
- earth worms
- nematodes
- 20-30 species of **mites**
- 50-100 species of **insects**
- hundreds of species of **fungi**
- thousands of species of **bacteria & actinomycetes**

A single gram of healthy soil contains millions of organisms…

Soil biodiversity knowledge is still limited!



Soil is alive!

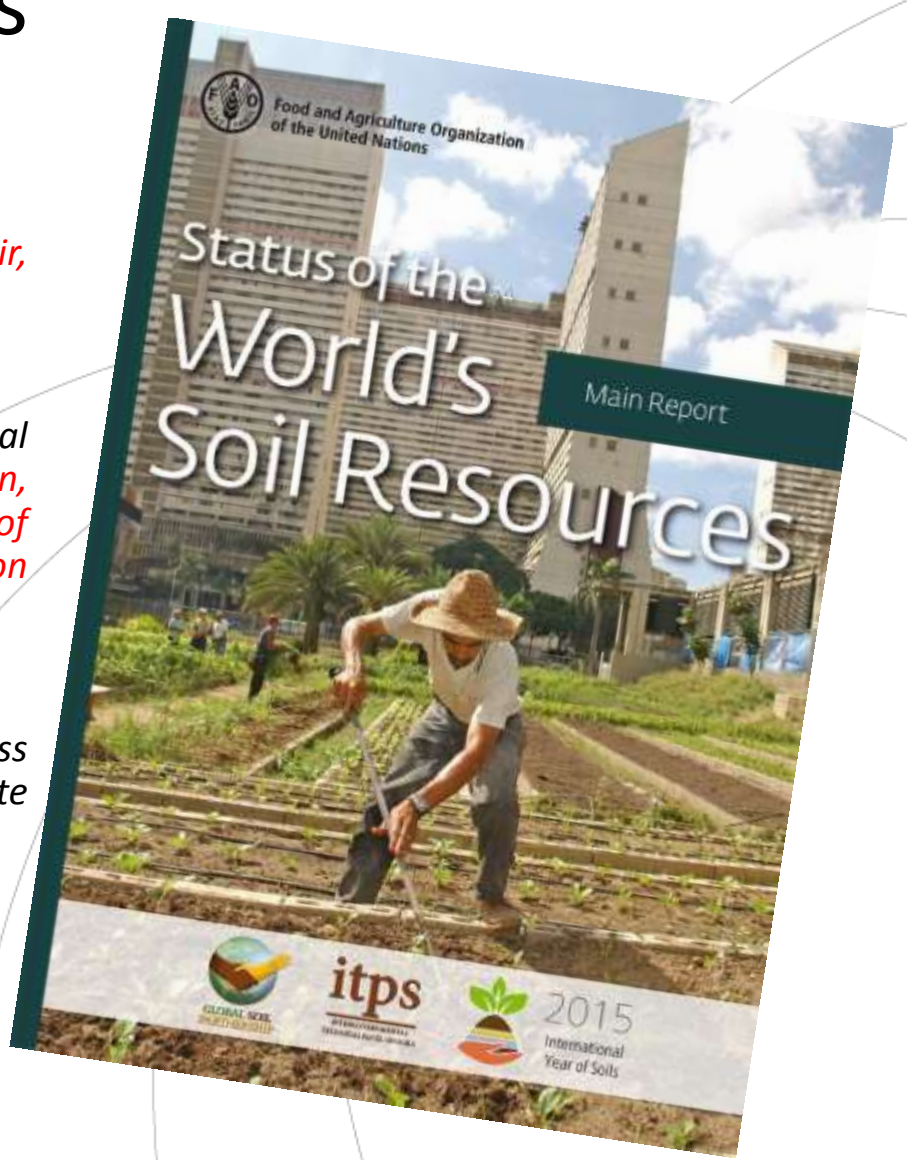
Soil organisms are responsible for performing vital functions in the soil ecosystem:

- Maintenance of **soil structure**
- **Nutrient cycling**
- Sources of **food and medicines**
- Regulation of soil **hydrological processes**
- Soil **detoxification**
- **Symbiotic and asymbiotic relationships** with plants and their roots
- **Decomposition** of organic matter
- CO_2 O_2 **Gas exchanges** and carbon sequestration
- **Suppression of pests,** parasites and diseases
- **Plant growth** control

Biodiversity is essential for **food security and nutrition.**

The Status of the World's Soil Resources report

- *The majority of the world's soil resources are in only fair, poor or very poor condition*
- *The most significant threats to soil function at the global scale are soil erosion, loss of soil organic carbon, nutrient imbalance, soil salinization, soil sealing, loss of soil biodiversity, soil pollution, acidifcation, compaction and water logging.*
- *The current outlook is for the situation to worsen unless concerted actions are taken by individuals, the private sector, governments and international organizations.*



Soil threats

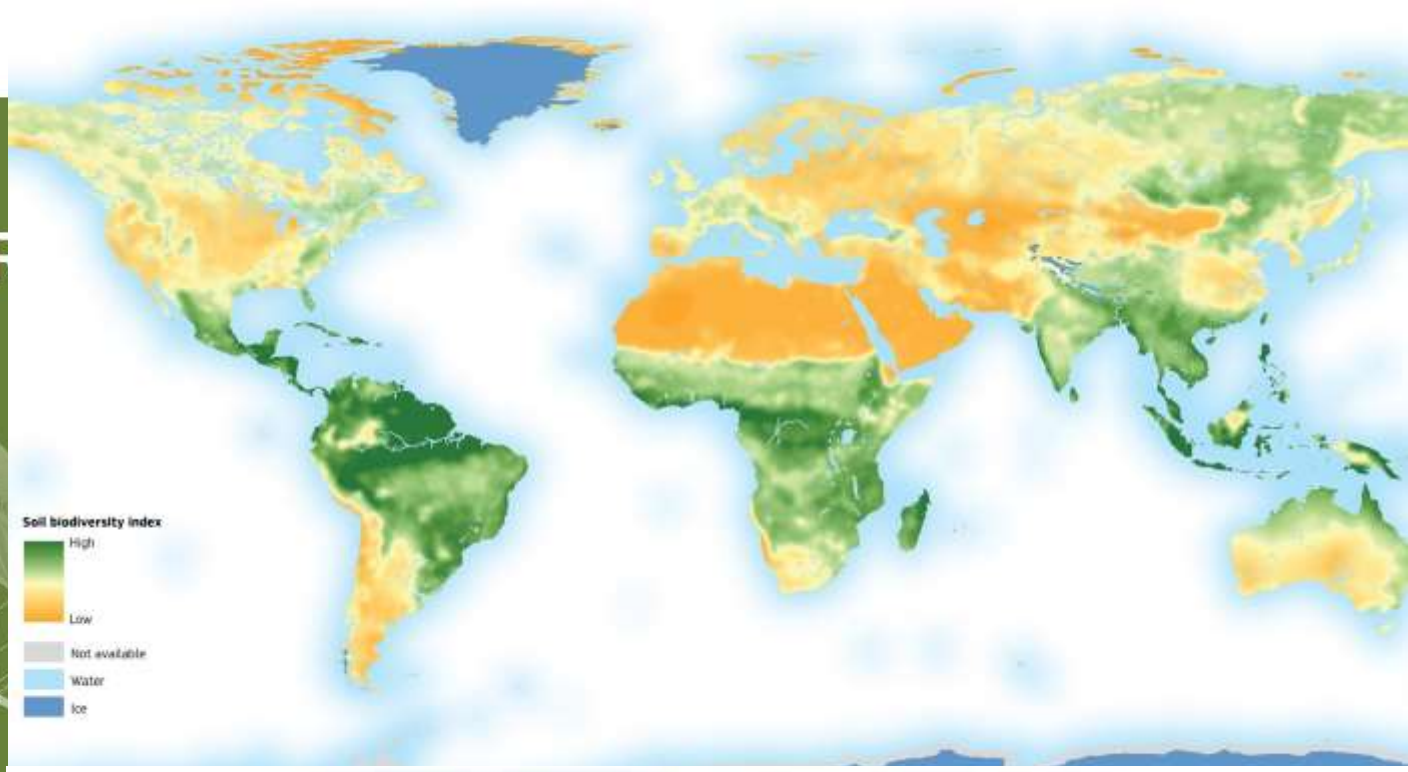
- *Soil erosion* → *Loss of soil biodiversity* ✓
- *Soil organic carbon loss* → *Loss of soil biodiversity* ✓
- *Nutrient imbalance* → *Loss of soil biodiversity* ✓
- *Salinization* → *Loss of soil biodiversity* ✓
- *Soil sealing* → *Loss of soil biodiversity* ✓
- *Soil pollution* → *Loss of soil biodiversity* ✓
- *Acidification and sodification* → *Loss of soil biodiversity* ✓
- *Soil compaction* → *Loss of soil biodiversity* ✓
- *Waterlogging* → *Loss of soil biodiversity* ✓

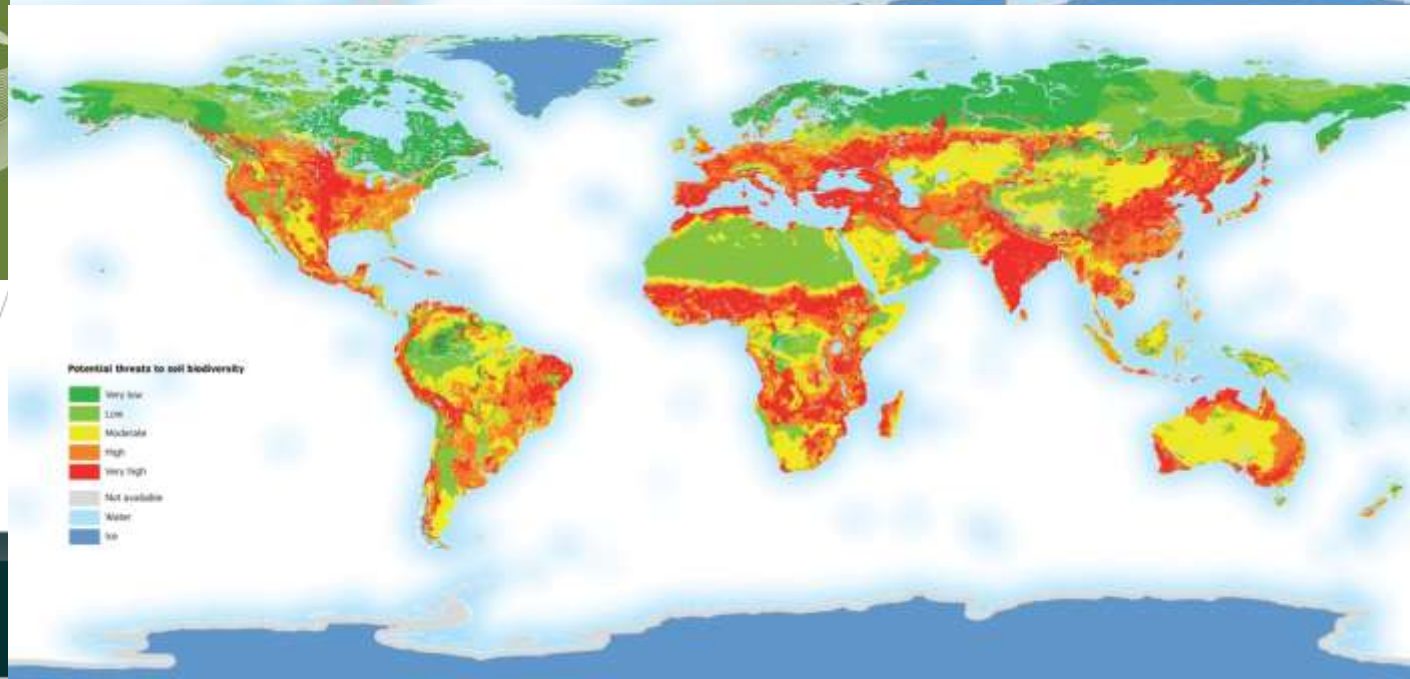
→ Loss of soil biodiversity is a soil threat itself

European Commission

GLOBAL SOIL BIODIVER ATLAS

Joint Research Centre



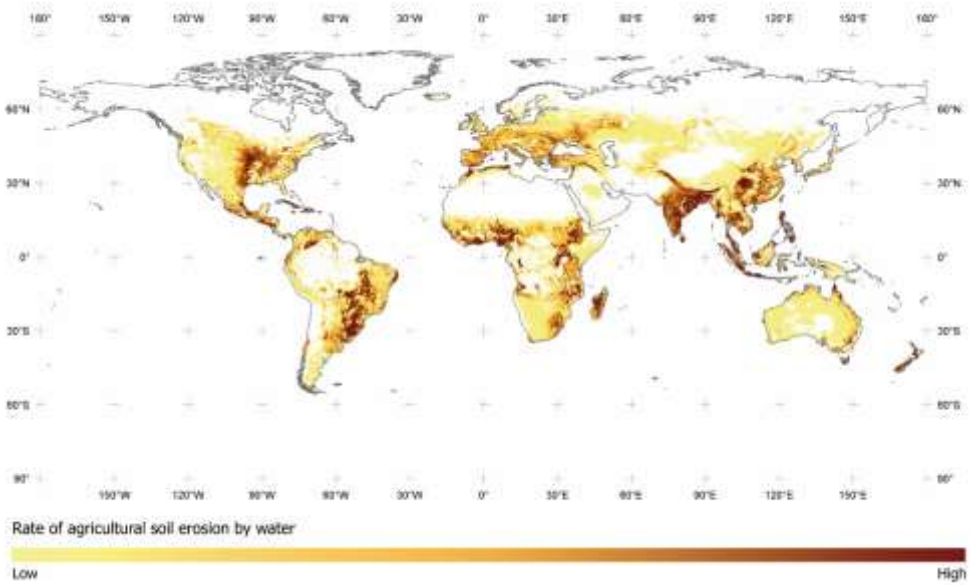


Trends of Soil Threats by region

Region	Soil erosion	Organic carbon change	Nutrient imbalance	Salinization	Soil sealing	Loss of biodiversity	Soil pollution	Acidification	Compaction	Water-logging
Sub-Saharan Africa	Poor ↘	Poor ↘	Poor ↘	Fair →	Good =	Fair ↘	Good ↘	Poor →	Good =	Good =
Asia	Poor ↘	Poor →	Poor ↘	Poor →	Poor ↘	Fair →	Poor ↘	Poor ↘	Poor ↘	Fair ↘
Europe and Eurasia	Fair ↗	Poor →	Poor →	Poor ↘	Poor ↘	Fair ↘	Poor ↗	Poor ↗	Fair →	Fair →
Latin America and the Caribbean	Poor ↘	Poor ↘	Poor ↘	Poor ↘	Fair →	Poor ↘	Fair →	Fair →	Poor ↘	Fair =
Near East and North Africa	Very Poor ↘	Poor ↘	Good →	Fair ↘	Very Poor ↘	Poor ↘	Very Poor ↘	Good →	Poor ↘	Good →
North America	Fair ↗	Fair ↗	Poor ↘	Good ↗	Fair ↘	Good →	Good ↗	Poor ↘	Fair →	Good →
Southwest Pacific	Fair ↗	Fair →	Fair ↘	Good →	Good ↘	Good →	Good ↗	Fair ↘	Fair →	Good →

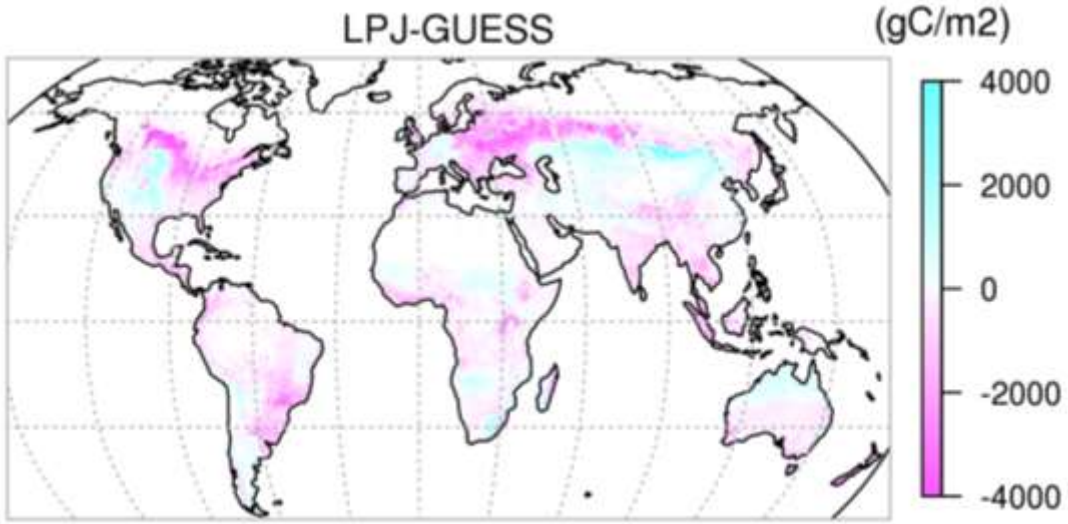
Erosion → Loss of habitat

- **Erosion carries away 25 to 40 billion tonnes of topsoil every year** significantly reducing crop yields and the soil's ability to store and cycle carbon, nutrients, and water.
- **Annual cereal production losses** due to erosion have been estimated at **7.6 million tonnes lost each year**.
- **If action is not taken to reduce erosion, a total reduction of over 253 million tonnes of cereals could be projected by 2050**. This yield loss would be equivalent to removing 1.5 million km^2 of land from crop production – or roughly all the arable land in India.



Soil Organic Carbon (SOC) loss

Land use changes decrease the amount of soil organic matter



Map of change in soil carbon due to land use change and land management from 1860 to 2010 from three vegetation models.

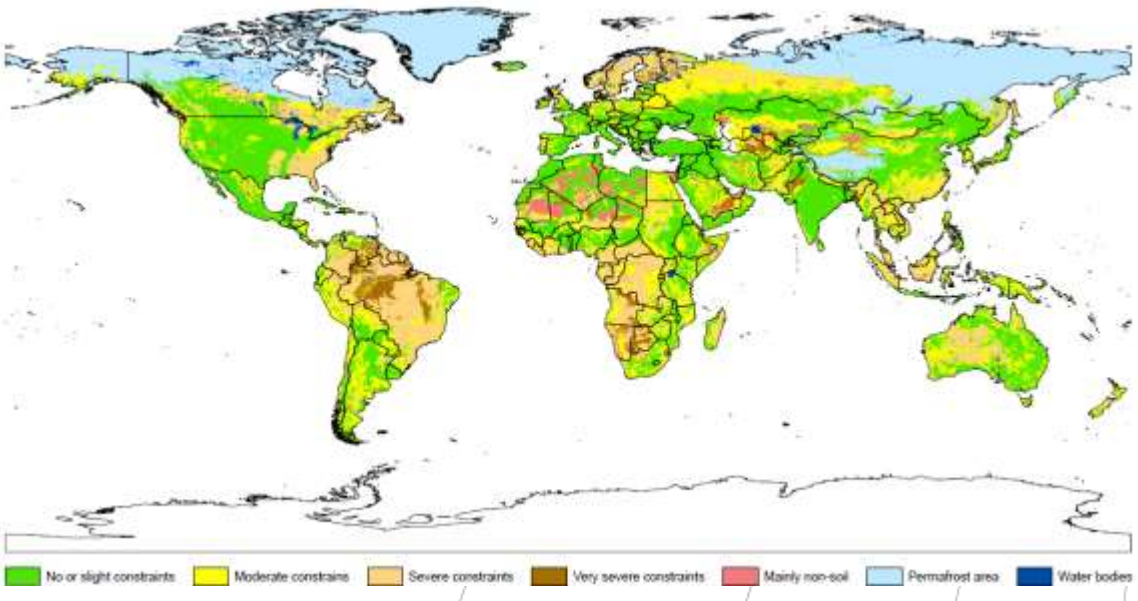
Pink indicates loss of soil carbon, blue indicates carbon gain.

- **Soils contain nearly three times as much carbon as is stored in all terrestrial plants.**
- The primary driver of loss in soil organic carbon is **land use change**.
- When land is converted from native **forest to crops, soil carbon decreases by about 40%. pasture is converted to crops** the reduction in soil carbon is even greater – **about 60%.**
- Loss in the global pool of soil organic carbon since 1850 is estimated at 66 billion tonnes, much of which remains in the atmosphere.

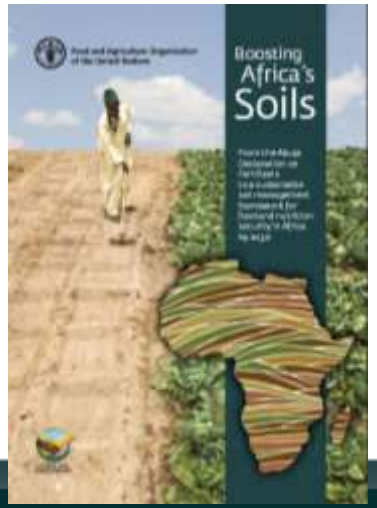
Nutrient imbalance

Affects plant growth (organic matter production) & soil nutrient availability

- Lack of soil nutrients (especially nitrogen and phosphorus) is the greatest obstacle to improving food production and soil function in many degraded landscapes.
- **In Africa, all but three countries mine more nutrients from the soil every year than are returned through use of fertilizer, crop residues, manure, and other organic matter**
- **In many industrialized countries, oversupply of nutrients contaminates soil and water** resources and contributes to greenhouse gas emissions.



Nutrient availability in soils



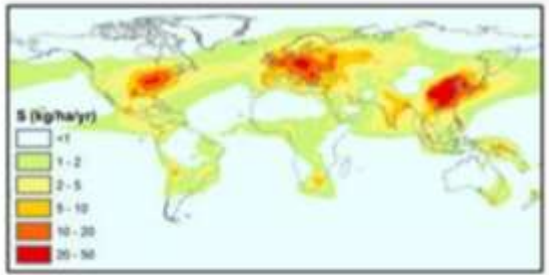
Soil salinization → Loss of habitat

- An estimated 760,000 km^2 of land worldwide are affected by human-induced salinity – an area larger than all the arable land in Brazil.
- Ill-designed, large-scale irrigation projects are the main cause of human-made salinization.
- Increasing soil salinity takes an estimated 3,000 to 15,000 km^2 of irrigated cropland out of production every year and decreases the production potential of much more land.

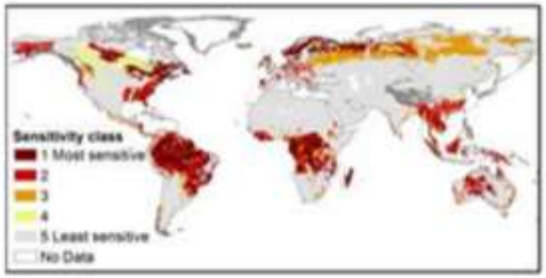
Soil contamination → Loss of habitat

- Soil contamination threatens food security, both because toxic levels of contaminants reduce crop yields and because crops that are produced can be unsafe to consume.
- **Nearly a fifth of the farmland in China is contaminated with heavy metals.**
- **Over 130 million people worldwide routinely consume well-water with arsenic concentrations** that exceed the recommendations of the World Health Organization
- More than 2.5 million potentially contaminated sites have been identified in Europe, of which 340,000 are actually expected to be contaminated.

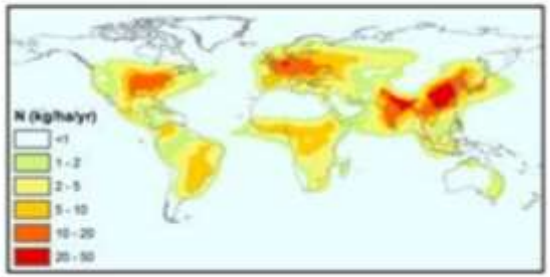
a) Atmospheric sulphur deposition (2001)



b) Soil sensitivity to acidification

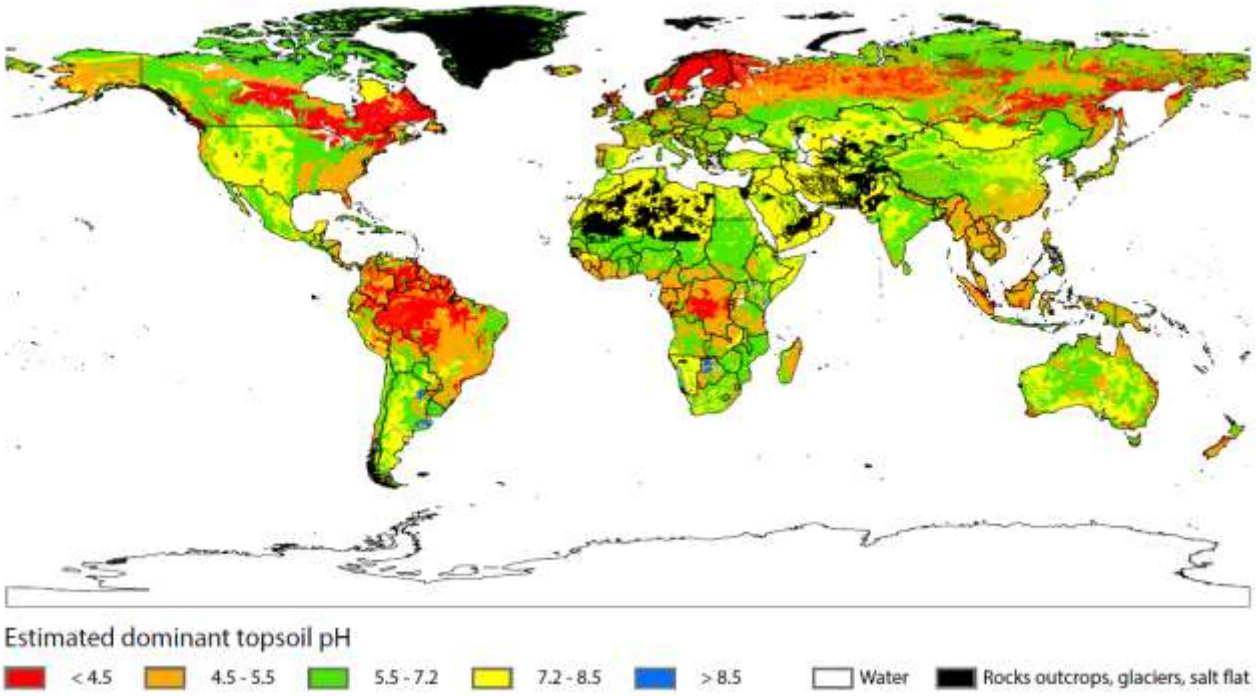


c) Atmospheric nitrogen deposition (2001)



Soil acidification → Loss of habitat

- **Around 30 percent of the topsoil and 75 percent of subsoil on the world's ice-free land is affected by acidity.**
- The main causes of human-induced acidification are **acid deposition** commonly called acid rain) and **massive application of ammonium-based fertilizers.**
- Use of high-nitrogen fertilizers and high rates of product removal increase soil acidity in intensively cultivated agricultural areas.



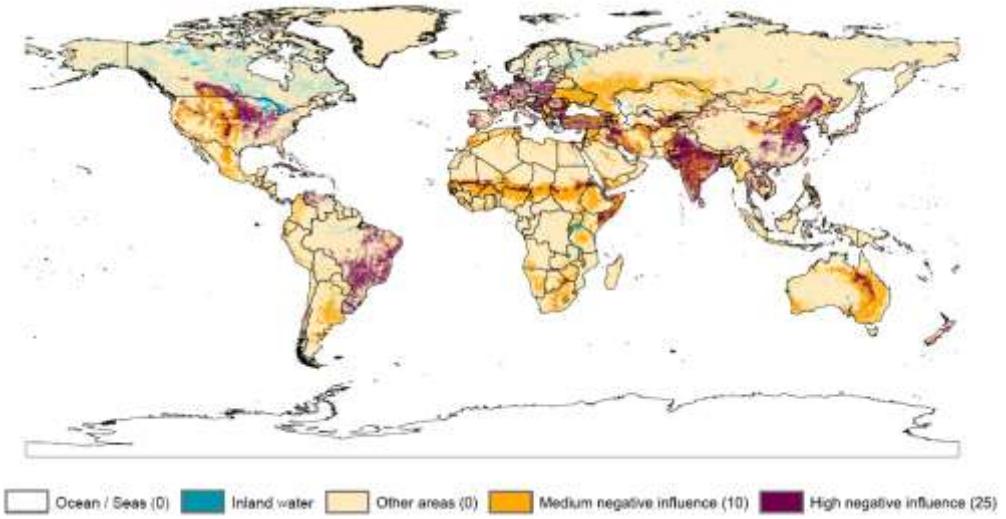
The most acidic topsoils in the world are located in areas of South America that have experienced deforestation and intensive agriculture.

Soil sealing → Loss of habitat

- Land take and soil sealing are considered the greatest threat to soil functions in Europe and Eurasia.
- **Over 70% of the land take in the European Union between 1990 and 2000, and over half of the land take between 2000 and 2006 consumed agricultural land.**
- In the year 2000, urban areas covered about 660 000 km^2, equivalent to almost 4% of the arable land on the planet.
- Between 1990 and 2006, the total extent of urban area worldwide increased by nearly 60 000 km^2.

Soil compaction → Loss of habitat

- **Soil compaction has degraded up to 330 000 km² in Europe**.
- **Worldwide compaction** has degraded an estimated 680 000 km² of soil, or around **4% of the total land area**.
- **Soil compaction can reduce crop yields by as much as 60 percent**.
- Cattle trampling and insufficient cover of top soil by natural vegetation or crops account for compaction of 280 000 km² in Africa and Asia.
- The damage caused by soil compaction is long-lasting and may even be permanent. A one-time compaction event can lead to reduced crop yields up to 12 years later.



Soil compaction risk derived from intensity of tractor use in crop land and from livestock density in grasslands.

Waterlogging → Loss of habitat

- The combined impact of waterlogging with soil salinity has been estimated to cut soil productivity by 30 to 35 percent.
- In Asia, waterlogging and salinization affect nearly 100,000 km^2 of irrigated land in India and Pakistan.

Technical Recommendations

Eight priority sustainable soil management practices and their benefits	
Soil management practice	**Degradation mitigated**
minimize soil disturbance by avoiding mechanical tillage	erosion, soil organic carbon (SOC) loss, nutrient imbalance, soil biodiversity loss
enhance and maintain a protective organic cover on the soil surface, using cover crops and crop residues	erosion, SOC loss, nutrient balance, soil biodiversity loss
cultivate a wide range of plant species – both annuals and perennials – in associations, sequences and rotations that can include trees, shrubs, pastures and crops	erosion, nutrient imbalance, SOC loss, soil biodiversity loss
use well-adapted varieties with resistance to biotic and abiotic stresses and improved nutritional quality planted at an appropriate time, seedling age and spacing	salinization, nutrient imbalance, soil biodiversity loss
enhance crop nutrition and soil function through crop rotations and judicious use of organic and inorganic fertilizer	nutrient imbalance, SOC loss, soil biodiversity loss
ensure integrated management of pests, diseases and weeds using appropriate practices, biodiversity and selective, low-risk pesticides when needed	soil biodiversity loss, contamination
manage water efficiently	erosion, salinization, waterlogging, SOC loss, nutrient imbalance, soil biodiversity loss
control machines and field traffic to avoid soil compaction	compaction, SOC loss, nutrient balance, soil biodiversity loss

Saving our soils and preserving their biodiversity

Effective education & extension programmes

Targeted soil research

Investment in sustainable soil management

Soil information systems

Inclusive policies and governance

We need to know more about soil biodiversity!

What can we do to protect soil biodiversity?

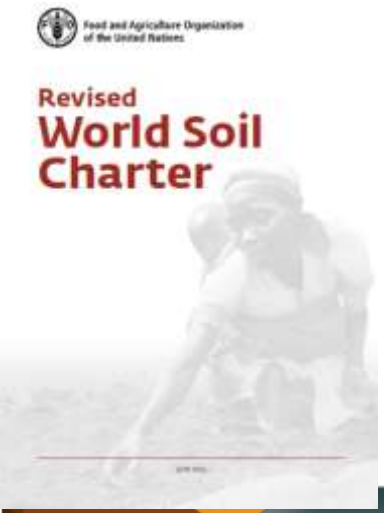
- Support soil-friendly cultivation that minimises the use of chemical fertilisers or pesticides. Look for organic products in the supermarket.
- Try to provide opportunities to encourage soil biodiversity where you live. Leave parts of your garden unmanaged, allow branches and garden waste to rot naturally.
- Reduce your rubbish! Recycle where possible so that we minimise the chances of soil pollution.
- Think about your 'carbon footprint'. How are you contributing to global warming and climate change? Look at your energy consumption, try to use a bicycle or public transport instead of a car.
- Support woodland regeneration schemes.
- Encourage your local authorities to target new developments on brownfield sites so as to minimise their environmental impact. Limit, where possible, the sealing of surfaces by concrete or asphalt.
- Limit soil erosion, organic matter decline, compaction, salinisation and landslides, by identifying and communicating risk areas to land owners and local authorities.
- Carefully dispose of old medicines. Several pharmaceuticals can have significant impacts on organisms. Take old drugs to the pharmacy. Never flush them down the toilet.

How?

GLOBAL SOIL PARTNERSHIP

An Agenda for Action

To promote Sustainable Soil Management



Voluntary Guidelines on Sustainable Soil Management

Thanks for
your attention