



Food and Agriculture
Organization of the
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A woman crossing one of several streams which feed an irrigation canal used for climate-smart agriculture in Tanzania. ©FAO/Daniel Hayduk

Soils help to combat and adapt to climate change by playing a key role in the carbon cycle



2015
International
Year of Soils

Healthy soils provide the largest store of terrestrial carbon. When managed sustainably, soils can play an important role in climate change mitigation by storing carbon (carbon sequestration) and decreasing greenhouse gas emissions in the atmosphere. Conversely, if soils are managed poorly or cultivated through unsustainable agricultural practices, soil carbon can be released into the atmosphere in the form of carbon dioxide (CO₂), which can contribute to climate change. The steady conversion of grassland and forestland to cropland and grazing lands over the past several centuries has resulted in historic losses of soil carbon worldwide. However, by restoring degraded soils and adopting soil conservation practices, there is major potential to decrease the

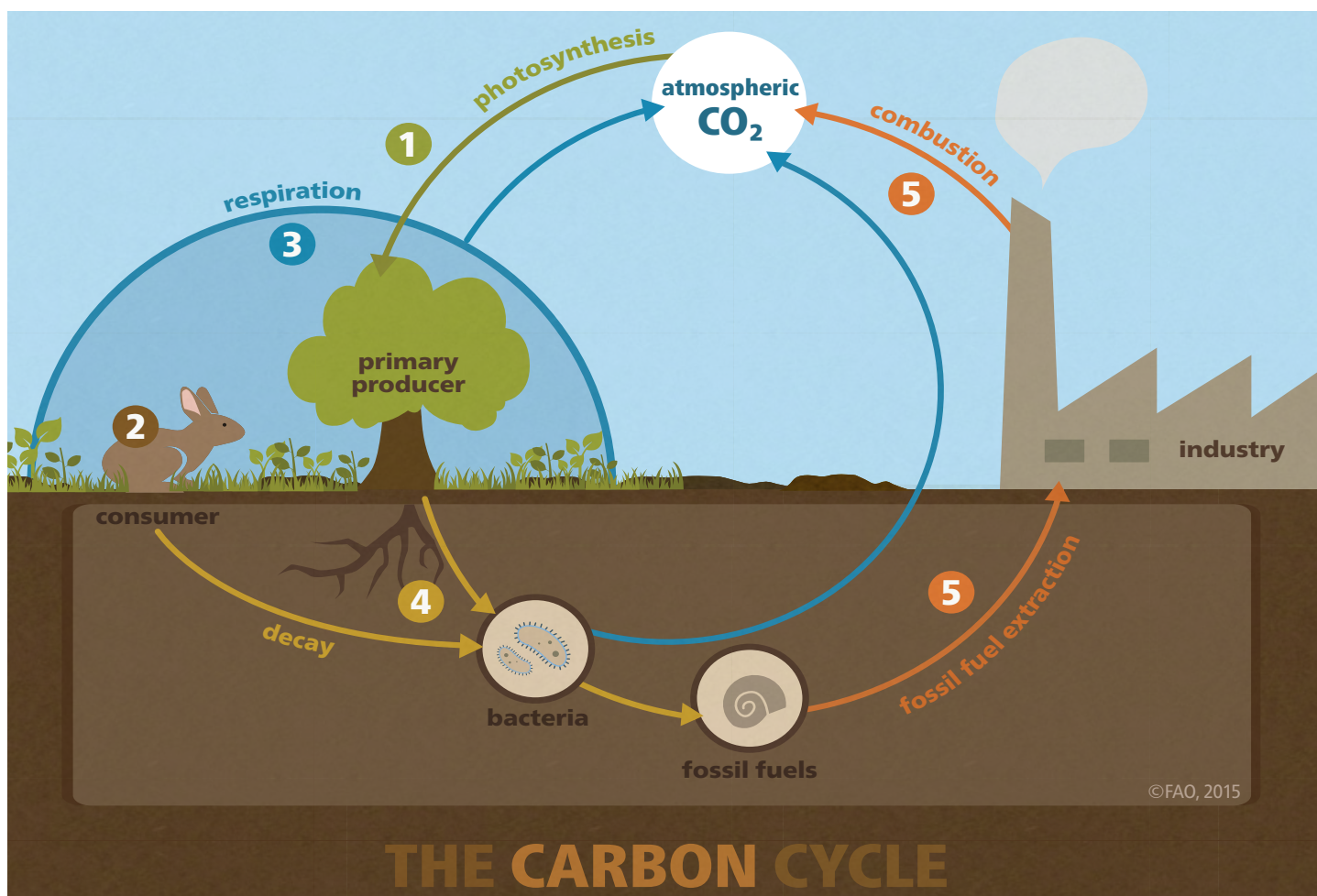
emission of greenhouse gases from agriculture, enhance carbon sequestration and build resilience to climate change.



Sustainable Satoyama-Satoumi landscape management in Japan builds resilience to climate change. ©FAO/Kazem Vafadari

SOILS AND THE CARBON CYCLE

The carbon cycle is the exchange of carbon (in various forms, e.g., carbon dioxide) between the atmosphere, ocean, terrestrial biosphere and geological deposits. Most of the carbon dioxide in the atmosphere comes from biological reactions that take place in the soil. Carbon sequestration occurs when carbon from the atmosphere is absorbed and stored in the soil. This is an important function because the more carbon that is stored in the soil, the less carbon dioxide there will be in the atmosphere contributing to climate change.



THE CARBON CYCLE

1. Plants use carbon dioxide from the atmosphere, water from the soil and sunlight to make their own food and grow in a process called photosynthesis. The carbon they absorb from the air becomes part of the plant.
2. Animals that feed on the plants pass the carbon compounds along the food chain.
3. Most of the carbon the animals consume is converted into carbon dioxide as they breathe (respiration), and is released back into the atmosphere.
4. When the animals and plants die, the dead organisms are eaten by decomposers in the soil (bacteria and fungi) and the carbon in their bodies is again returned to the atmosphere as carbon dioxide.
5. In some cases, the dead plants and animals are buried and turn into fossil fuels, such as coal and oil, over millions of years. Humans burn fossil fuels to create energy, which sends most of the carbon back into the atmosphere in the form of carbon dioxide.

KEY CHALLENGES

Climate change represents a serious threat to global food security, not least because of its effects on soils. Changes in temperature and rainfall patterns can have a great impact on the organic matter and processes that take place in our soils, as well as the plants and crops that grow from them. In order to meet the related challenges of global food security and climate change, agriculture and land management practices must undergo fundamental transformations. Improved agriculture and soil management practices that increase soil organic carbon, such as agro-ecology, organic farming, conservation agriculture and agroforestry, bring multiple benefits. They produce fertile soils that are rich in organic matter (carbon), keep soil surfaces vegetated, require fewer chemical inputs, and promote crop rotations and biodiversity. These soils are also less susceptible to erosion and desertification, and will maintain vital ecosystem services such as the hydrological and nutrient cycles, which are essential to maintaining and increasing food production. FAO also promotes a unified approach, known as Climate-Smart Agriculture (CSA), to develop the technical, policy and investment conditions that support its member countries in achieving food security under climate change. CSA practices sustainably increase productivity and resilience to climate change (adaptation), while reducing and removing greenhouse gases whenever possible (mitigation).



Moringa seedlings at a tree nursery. The moringa tree can play an important role in mitigating climate change and increasing the incomes of poor farmers in Africa. ©FAO/Daniel Hayduk



A villager walking through a peat bog in Tunisia. ©FAO/Giulio Napolitano

FAO IN ACTION

The Organic Soils and Peatlands Climate Change Mitigation Initiative

Peatlands store tremendous amounts of carbon. However, when they are drained and used, mainly for agriculture, grazing and forestry, peatlands become significant sources of greenhouse gas emissions. Peatlands drainage and peat fires are responsible for almost 10 percent of greenhouse gas emissions from the Agriculture, Forestry and Other Land Use sector (AFOLU). The vital role peatlands play in avoiding and reducing greenhouse gas emissions, as well as in water regulation and unique biodiversity conservation, is insufficiently recognized. The Organic Soils and Peatlands Climate Change Mitigation Initiative is an informal network of organizations established to raise awareness about peatlands, promote strategic action for reducing greenhouse gas emissions from peatlands and organic soils, and safeguard their other vital ecosystem services. FAO and the Initiative identify three main strategies for reducing emissions from peatlands and organic soils: 1. secure undrained peatlands to prevent emissions; 2. rewet drained peatlands to reduce emissions; and 3. adapt management strategies for peatlands that cannot be rewetted.

FAO IN ACTION



A view of terraced hills, which help soils retain water and prevent erosion.
©FAO/Giulio Napolitano

Three Rivers Sustainable Grazing Project in China

Restoring degraded grasslands through sustainable grassland management can lock more carbon in soils and biomass, increase the water-holding capacity of the soil and enhance grassland biodiversity. The Three Rivers Sustainable Grazing Project in the Qinghai province of China aims to restore degraded grazing land and sequester soil carbon, while at the same time increasing productivity, building resilience and improving livelihoods in smallholder herder communities. The pilot programme is helping local yak- and sheep-herding households adopt a combination of sustainable grassland management options related to grazing intensity, grass cultivation and animal husbandry. The average annual mitigation potential in the first 10 years of the project was estimated at 63 000 tonnes of CO₂ equivalent per year.

Climate-Smart Agriculture for smallholder farmers in Kenya and Tanzania

As part of its two pilot projects in Tanzania and Kenya, FAO's Mitigation of Climate Change in Agriculture (MICCA) programme selected and promoted the uptake of different practices based on experts and participatory assessments with farmers. Some 9 000 farmers in both

countries, 40 percent of whom were women, received training on climate-smart agriculture, resulting in 736 energy-efficient cooking stoves being adopted to reduce deforestation. 79 tree nurseries were created, 417 000 tree seedlings were planted and 6 ha of terraces were established (on 204 farms) to conserve soil and water. Two biogas digesters were also installed to produce renewable energy from cow manure.

KEY FACTS

- Land-use conversions and drainage of organic soils for cultivation are responsible for about 10 percent of all greenhouse gas emissions.
- It is estimated that because of drainage, peatlands are currently the third-largest emitter of greenhouse gases in the AFOLU sector.
- It is estimated that soils can sequester around 20 PgC (petagrams of carbon) in 25 years, more than 10 percent of the anthropogenic emissions.
- Greenhouse gas emissions from agriculture, forestry and fisheries have nearly doubled over the past 50 years, and could increase an additional 30 percent by 2050 without greater efforts to reduce them.
- Emissions generated during the application of synthetic fertilizers accounted for 14 percent of agricultural emissions in 2012, and are the fastest growing emissions source in agriculture, having increased some 45 percent since 2001.
- Peatlands and organic soils contain nearly 30 percent of the world's soil carbon but only cover three percent of the earth's land area.
- The AFOLU sector is responsible for just under a quarter (~10–12 GtCO₂eq/yr) of anthropogenic greenhouse gas emissions, mainly from deforestation and agricultural emissions from livestock, soil and nutrient management.
- Soil carbon sequestration increases the ability of soils to hold soil moisture, withstand erosion and enrich ecosystem biodiversity, which helps cropping systems to better withstand droughts and floods.

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