Interreg
Alpine Space

EUROPEAN UNION

Links4Soils

EUROPEAN RECIONAL DEVELOPMENT FUND

Soil Ecosystem Services in Brief

Caring for Soils
- Where Our Roots Grow

Info box

Did you know?

- Soil retains and cycles nutrients so that plants and living organisms can use them over and over again.
- About 33% of the world's soils are degraded due to erosion, acidification, compaction, salinization, pollution, loss of soil organic matter, and nutrients (FAO).
- About 50 to 70% of the world's original soil carbon stocks have been released into the atmosphere as CO_2.
- A single handful of soil may contain billions of organisms.
- Due to the thousands and even tens of thousands of years it needs to develop, soil is considered a non-renewable natural resource.

The Alpine Soil Partnership

The Alpine Soil Partnership (AlpSP) is a regional initiative focused on promoting sustainable soil management and protection of the soils in the Alps.

It was officially founded with the confirmation of the Memorandum of Understanding in March 2018 in Grenoble. Since then, the AlpSP has established a network based on the Links4Soils project partners and extended it to include new individual and institutional members.

The future activities of the AlpSP will focus on five key areas in the Alpine Region:

i) Sustainable soil management;
ii) Soil awareness raising, education, and didactics;
iii) Soil information and research;
iv) Regional cooperation; and
v) The harmonization of data and methods.

Thomas Peham
Office of the Regional Parliament of Tyrol

Typical small-scale mosaic of traditional cultural landscape in the Alps with forest, hayfields, orchards, and vineyards; Etsch valley, South Tyrol, Italy (Photo: C. Geitner).

Agricultural Biomass Production

- **Outputs:** Food, fodder, technical fibre, medicinal plants, energy biomass.
- **Provision:** The provision of this service depends on water and nutrient availability, which is controlled by a variety of soil properties, climate, and agricultural management practices.
- **Demands:** As the world's population grows, the demand for this service will also grow.
- **Threats:** Unsustainable agricultural practices (e.g. conventional agriculture, overgrazing), soil loss (extensive sealing of the best soils, accelerated erosion) and processes (soil organic matter depletion, acidification, and salinization) as well as climate change effects hamper agricultural production.

Pure spruce stands on deep, podzolized (leached) soils developed on a carbonate moraine, Pokljuka, Slovenia (Photo: B. Vrščaj).

Forest Biomass Production

- **Outputs:** Wood, timber, wood-based biofuel, forest-derived edible wood products.
- **Provision:** The provision of this SES depends on the soil water and nutrient content, which are controlled by the soil properties, climate, and forest management practices.
- **Demands:** The demand for wood products as a renewable energy source and for building materials is increasing.
- **Threats:** Unsustainable forestry practices (e.g. inappropriate tree composition or destructive harvesting), wildfires, and climate change can impair soil fertility and promote erosion.

Water Retention

- **Outputs:** Water available for plants, soil biota, and evaporation.
- **Provision:** Soils can capture water despite gravity and store it. Thus, water is available for plants as well as soil organisms at the site. The water retention capacity of soils depends in particular on soil depth, soil pores (thus, soil texture and structure), soil organic matter content, and soil density/compaction.
- **Demands:** Water availability for plants is essential for productive agriculture and forestry; therefore the need for this service is becoming more important with the growth of the population and due to climate change.
- **Threats:** Unsustainable forest and agricultural management practices and especially soil sealing cause a significant decrease in soil available water and lead to various degradation processes and hamper other soil ecosystem services.

Surface Runoff Regulation

- **Outputs:** The reduction of surface runoff and flood risk.
- **Provision:** The uptake of water by soils reduces the risk of flooding and erosion. Furthermore, it enables groundwater recharge. The provision of this service depends on the ability of the soil to let water in (infiltration) and pass through (seepage), both of which are processes that are controlled by a variety of soil properties and land-use types.
- **Demands:** Climate change is likely to produce extreme weather events more often. Fur-thermore, sealed areas are currently growing and thus the demand for natural retention is increasing.
- **Threats:** Urban and touristic developments result in sealing and unsustainable forest and agricultural management practices may lead to compaction and erosion, and thus to re-duced surface runoff regulation.

Local climate regulation (Photo: M. D'Amico).

Local Climate Regulation ("the Cooling Effect")

- **Outputs:** The regulation of air temperature and humidity- heat/microclimate control.
- **Provision:** The evapotranspiration of soil and vegetation leads to a cooling effect, as the conversion of water from the liquid phase to the gas phase requires energy and thus the air temperature is reduced. The capacity of soils to deliver this service is closely linked to the water storage capacity, which depends on the soil texture, density, and organic matter.
- **Demands:** With climate change, this cooling effect will gain importance for the health of humans and other living beings.
- **Threats:** Soil degradation processes, such as sealing, compaction, and erosion, as well as the cultivation of inappropriate plant species, decrease the water storage capacity and thus threaten local climate regulation.

Histosol – organic matter rich soil formed from peat (Photo: S. Stanchi).

Global Climate Regulation ("the Carbon Cycle")

- **Outputs:** Terrestrial carbon storage, climate regulation and climate change mitigation on a global scale.
- **Provision:** Through photosynthesis, carbon is withdrawn from the atmosphere and, via litter and root residue, stored as organic matter in soils. The C content is controlled by the organic matter input and its decomposition within soils. Soils stores more C than the atmosphere and terrestrial vegetation combined.
- **Demands:** In order to mitigate climate change with its negative impacts (e.g. global warming), regulating the global climate should be of the highest importance.
- **Threats:** Inappropriate soil management can result in greater C emissions than sequestration, which makes the soil a C source rather than a C sink.

Water Filtration and Purification

- **Outputs:** Clean ground and spring water, drinking water.
- **Provision:** Undesirable substances are removed from water by infiltrating into and percolating through the soil. Physical, chemical, and biological processes, which are controlled by soil depth, soil texture, soil structure, the amount and quality of organic matter, pH, and the level of biological activity, contribute to this cleaning process.
- **Demands:** As the global population grows, the demand for clean water for personal use (e.g. drinking, domestic use) or agricultural and industrial use will also grow.
- **Threats:** The degradation of soils (i.e. heavy soil pollution, erosion, compaction, soil organic matter decline, soil acidification) threatens water filtration and purification.

Nutrient Cycle Regulation

- **Outputs:** The retention and cycling of nutrients for plants and soil biota.
- **Provision:** Soil enables and regulates nutrient cycling in general. Thereby, nutrients are made available to plants and other biota.
- **Demands:** Rising demands for food and other plant biomass require an adequate availability of nutrients, well regulated nutrient cycling, and nutrient retention.
- **Threats:** Inappropriate (under- or over-fertilization – both unsustainable) soil management threatens nutrient availability, and can cause soil and groundwater pollution, e.g. through the leaching of nitrates and phosphorus to ground and surface waters.

High plant biodiversity in an Alpine grassland (Photo: M. D'Amico).

Soil Habitat and Biodiversity

- **Outputs:** Biodiversity itself (from genes to organisms) and related benefits (e.g. species for medicinal purposes, the resilience of ecosystems to climate change, pests, etc.).

- **Provision:** Soil is a habitat for living organisms, a complex of biological communities, and a gene pool. Different soils offer different living conditions and steer the diversity and dynamics of populations of organisms. The abundance and diversity of populations of soil organisms ensure the performance of soil ecosystem services. It is difficult to record and compare aboveground and soil biodiversity as the latter includes a much greater range of different organism groups, only some of which are fairly known.

- **Demands:** Soil biodiversity is an aspect and indicator of soil health, and therefore of soil productivity. Thriving and resilient local environments, as well as the needs and well-being of humans and animals, require living, biodiversity-rich, and healthy soils.

- **Threats:** Soil sealing and unsustainable soil management in all sectors that negatively affect the living organisms in soil.

Hiking in the Alps – as an important component of the landscape soils contributes to the recreation and spiritual experience; Fotsch valley, Tyrol, Austria (Photo: C. Geitner).

Recreational and Spiritual Services

- **Outputs:** Recreation, outdoor, and other leisure activities and aesthetic enjoyment; contributions to human health.
- **Provision:** Soil provides the ground for recreation activities and tourism, thus enabling a wide range of outdoor activities and providing cultural, spiritual, and aesthetic experiences. For some activities, specific soil management is required, which changes the physical and chemical properties of the soil.
- **Demands:** Many recreational activities are particularly relevant for the Alpine Region (e.g. skiing, mountain biking, hiking, golfing) and drive local economies.
- **Threats:** Inappropriate management of infrastructure (e.g. ski runs and mountain biking and hiking trails) promotes severe erosion, which in turn threatens the provision of recreational services.

Soil excavation, presenting a more than 7.000 years old fire place on 2000 m a.s.l.; Fotsch valley, Tyrol, Austria (Photo: C. Geitner).

Cultural and Natural Archives

- **Outputs:** The preservation of cultural and natural traces.
- **Provision:** Soils with special nature- or culture-related properties have a high potential for scientific and educational application in order to obtain new and site-specific information. Wetland and peatland soils in particular are highly suitable as archives due to their ability to conserve remains under oxygen exclusion and chronological stratification, thereby revealing the natural and cultural history.
- **Demands:** An understanding of the landscape and human-environment interactions can contribute to the development of a sustainable way of life.
- **Threats:** Soil sealing, construction, deep soil tillage, and peatland drainage threaten such archives.

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About the Links4Soils Project

Soil is the basis of Alpine ecosystems and is a fundamental natural resource. Through sustainable soil management and protection, we, the inhabitants of the Alps, can considerably improve the performance and resilience of key ecosystem services, preserve natural resources and biodiversity, and thereby ensure the well-being of humans.

Soil protection in the Alps was initiated by the Soil Conservation Protocol (SCP) of the Alpine Convention. Unfortunately, the Soil Conservation Protocol is still not adequately practised.

The Links4Soils project aims to help overcome some gaps and obstacles in soil protection and management practices in the Alps. It is focused on disseminating general soil knowledge, collecting Alpine soil information as well as soil management know-how, and improving the general awareness of the importance of soils and soil ecosystem services.

Thereby, the Links4Soil project aims to contribute to better soil protection and the implementation of the Soil Conservation Protocol of the Alpine Convention.

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The **"Soil Ecosystem Services in Brief"** pocket book shortly presents most important soil ecosystem services. The longer and illustrated version Soil Ecosystem Services in the Alps - An introduction for decision-makers is available as a book (info@alpinesoils.eu, www.alpinesoils.eu)

The Links4Soils project is focused on raising awareness of Alpine soils, promoting efficient soil protection strategies and contributing to better implementation of the Alpine Convention Soil Protection Protocol (www.alpine-space.eu/projects/links4soils).

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