

## Soil as a Reservoir for Biodiversity: Protecting Soil Ecosystems

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### INTRODUCTION

Soil has been called the "living skin of the Earth" since it is an essential environment where life thrives. Hidden beneath the ground, it supports an astonishing array of organisms necessary to the operation of ecosystems and planetary stability. These hidden worlds of biodiversity consist of a range of microorganisms, invertebrates, fungi, and plants that are crucial for the cycling of nutrients, filtration of water, and development of soil structure. Soil ecosystems are frequently not considered in conservation strategies, though they are vital. Soil biodiversity conservation is not simply a question of healthy soils, but is intimately connected with the general aim of conserving world biodiversity and promoting the sustainability of our ecosystems.

Here, we discuss the contribution of soil as a reservoir of biodiversity, the essential roles that soil organisms play, the threats to soil ecosystems, and what can be done to conserve and promote soil biodiversity.



Source:ESDAC

### The Role of Soil Biodiversity

Soil biodiversity refers to all the living components of the soil ecosystem, from the tiny bacteria to larger species like earthworms and roots of plants. These living beings interact with each other in sophisticated ways, developing complex food webs and symbiotic relationships that facilitate the health and functionality of the soil.

## 1. Soil Microorganisms: The Invisible Workforce

Microorganisms such as bacteria, fungi, and protozoa dominate soil biodiversity. Although small in size, these microorganisms play a variety of functions such as decomposing organic matter, cycling nutrients, and establishing symbiotic relationships with plants. For instance, mycorrhizal fungi establish mutualistic associations with plant roots to facilitate nutrient uptake, especially phosphorus. Soil fungi and bacteria also play an important role in nitrogen fixation, enabling plants to obtain nitrogen from the atmosphere.

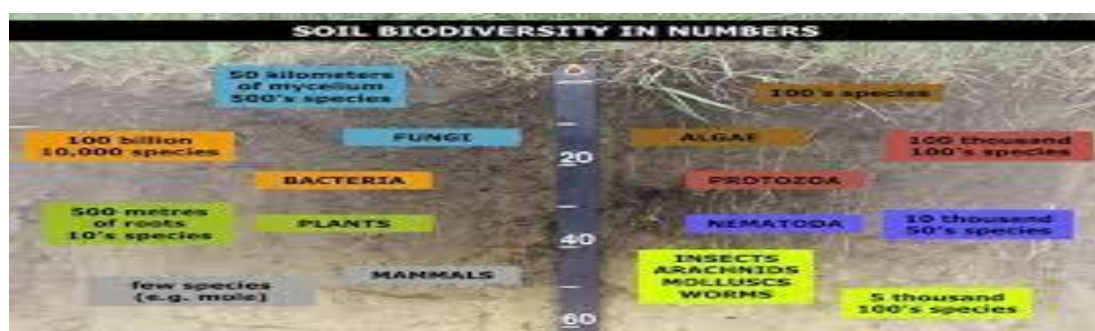
## 2. Invertebrates: The Soil Engineers

Soil invertebrates, including earthworms, ants, beetles, and nematodes, play central roles in maintaining the health of soil. Soil invertebrates

serve as soil engineers that aerate the soil, improve its structure, and increase the movement of water and nutrients. Earthworms, for example, ingest organic matter and deposit nutrient-dense castings, which enhance soil fertility. Burrowing by soil invertebrates also enhances water infiltration and root penetration, which prevents erosion of the soil and improves plant growth.

## 3. Plants: The Basis of Soil Ecosystems

Plants, especially their roots, are a fundamental part of soil biodiversity. Roots give a physical framework that holds the soil in place, stabilizing it and preventing erosion, and their exudates nourish a diverse array of microorganisms. Plants also add organic matter to the soil as they break down, adding carbon and other nutrients to the soil. Soil ecosystem health is thus directly related to plant species diversity in an area.



Source:ESDAC

## 4. Soil as a Genetic Diversity Hotspot

In addition to the observable organisms, soil harbors a staggering amount of genetic diversity. The incredible diversity of microorganisms, each possessing distinctive genetic characteristics, allows soil ecosystems to evolve with shifting conditions. Not only is this genetic diversity important for soil ecosystem resilience but also to agricultural productivity, disease resistance, and ecosystem stability.

### The Functions of Soil Biodiversity

Soil organisms execute a variety of essential processes that help in ecosystem health and human well-being. Some of the most critical functions are:

#### 1. Nutrient Cycling

Soil life plays a crucial role in nutrient cycling, where organic matter is decomposed and

nutrients are converted into forms that can be utilized by plants. Microorganisms like bacteria and fungi break down dead plant and animal residues, releasing vital nutrients such as nitrogen, phosphorus, and potassium into the soil. This process provides these nutrients for plant growth and maintains soil fertility.

#### 2. Carbon Sequestration

Soil is an important component of the global carbon cycle. Soil biota help sequester carbon through the decomposition of organic matter and its storage as soil organic carbon (SOC). This minimizes climate change by lowering atmospheric concentrations of carbon dioxide (CO<sub>2</sub>). Soils that are well maintained and high in biodiversity are better capable of sequestering carbon, rendering soil preservation a crucial strategy in the mitigation of climate change.

### **3. Water Regulation and Filtration**

Soil ecosystems play a critical role in managing water flow and water quality. Soil structure, as a result of soil organism activities, decides whether the soil can absorb and hold water. Soil organisms, especially earthworms and plant roots, produce channels through which water can easily pass, thus minimizing surface runoff and erosion. Soil also serves as a natural filter, retaining pollutants and excess nutrients, thereby ensuring clean water for ecosystems and human consumption.

### **4. Erosion Control**

Healthy soils are less susceptible to erosion since they possess stable structure that tends to keep the particles together. Soil organisms' biological activity, e.g., earthworms and other burrowing animals, facilitates soil aggregation, which strengthens the structure of the soil and minimizes susceptibility to wind and water erosion. Plant roots also serve to stabilize the soil from being eroded by rain or blown away by wind.

### **Threats to Soil Biodiversity**

Although central to ecosystem function, soil biodiversity is under greater threat. Following are several reasons contributing to the decline of soil ecosystems and soil biodiversity:

#### **1. Soil Degradation and Erosion**

Soil erosion due to mainly unsustainable agriculture, deforestation, and urbanization is one of the most major risks to soil biodiversity. Topsoil that contains nutrients and organic matter is eroded away by erosion, and the available habitat for organisms in the soil is reduced. Compaction due to heavy machinery also decreases soil porosity, which makes it more difficult for organisms to live.

#### **2. Chemical Pollution**

Application of chemical fertilizers, pesticides, and herbicides in agriculture affects soil biodiversity deeply. Chemicals directly affect soil organisms by interrupting their physiological functions, declining their numbers, or changing their behavior. Secondly, chemical build-up in the soil can damage soil health and decrease its potential to harbor a variety of life forms.

### **3. Climate Change**

Climate change threatens soil biodiversity immensely through the change of temperature and precipitation patterns, consequently influencing the behavior and distribution of soil organisms. Increased temperatures cause the soil to lose moisture, thus diminishing the habitat for numerous organisms. Additionally, intense weather conditions, like floods and droughts, interfere with soil ecosystems and cause a loss of biodiversity.

### **4. Land Use Change**

The degradation of natural habitats to agricultural or urban land is one of the leading causes of soil biodiversity loss. Urbanization, deforestation, and agricultural intensification all lead to habitat destruction for soil organisms. Monoculture agriculture, where one crop is grown, decreases plant diversity and breaks the intricate interactions between plants and soil organisms.

### **Conserving Soil Biodiversity**

Conservation of soil biodiversity calls for an integrated strategy that targets the causes of soil degradation and addresses sustainable land use. Strategies to protect soil ecosystems include:

#### **1. Sustainable Agriculture**

Implementation of sustainable agriculture methods, including crop rotation, reduced tillage, and organic agriculture, can be used to maintain soil biodiversity. These methods lower soil disturbance, reduce the application of harmful chemicals, and enhance a variety of plant species. Agroforestry systems incorporating trees with crops can also assist in maintaining soil biodiversity by creating varied habitats for soil organisms.

#### **2. Soil Conservation Techniques**

Soil conservation practices including contour plowing, terracing, and the planting of cover crops can prevent erosion and enhance soil structure. They enhance organic matter and nutrient retention, which maintain soil biodiversity. In addition, sowing native vegetation and preserving natural habitats, including wetlands and forests, can offer beneficial refuges for the organisms in the soil.

### 3. Reforestation and Habitat Restoration

Reforestation of degraded land and restoration of natural ecosystems can contribute to the recovery of soil biodiversity. Forests, with their elaborate root system and wide range of species, provide optimal conditions for soil fauna. Wetland and riparian area restoration can also improve soil health and diversity through enhanced water retention and filtration of impurities.

### 4. Climate Change Mitigation

Attempts to combat climate change, including curbing greenhouse gas emissions and encouraging carbon sequestration in the soil through land management, are crucial for conserving soil biodiversity. Techniques that increase the storage of carbon in the soil, including agroecological agriculture and conservation tillage, can reduce the impacts of climate change on soil ecosystems.

### CONCLUSION

Soil is a precious reservoir of biodiversity, hosting a wide range of organisms that are critical to ecosystem functioning and human well-being. Soil biodiversity is increasingly threatened by human activities such as land degradation, pollution, and climate change. Conservation of soil ecosystems is thus an integral component of wider biodiversity conservation. By embracing sustainable land management, rehabilitating degraded soils, and

mitigating the effects of climate change, we can make soil a healthy habitat for a diverse range of life forms and continue to deliver the vital ecosystem services on which we rely. The future of soil ecosystems, and the future of life on Earth, hinges on how we treat and conserve the soil under our feet.

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