

Soil Science Society of America

Grand Challenge

Ensuring Sustainability by Protecting and Enhancing Soil-based Ecosystem Services

Soil Sustains Life

Soil is the foundation of all terrestrial and most aquatic ecosystems. Ecosystem services provided by soil promote human health and nutrition, mitigate climate change, protect the environment, and ensure sustainable food and bioenergy production.

American prosperity and quality of life are directly linked to our ecosystems, which are under increasing human-linked pressures and duress, resulting from contamination, development and urban sprawl, desertification, salinization erosion

and natural disasters. At the same time, the demand for soil-based ecosystem services—carbon sequestration, nutrient cycling, water purification, and waste treatment—continues to grow.

The traditional approach for studying soil has been to investigate various components; valuable science has been conducted in this manner. Today, more comprehensive, integrated, interdisciplinary approaches are required to gain an in-depth understanding of complex ecosystems.

“Civilization itself rests upon the Soil”

-Thomas Jefferson

Human Health & Nutrition

- Biofortification
- Antibiotics/pharmaceuticals
- Food safety/reduced pathogens

“The Nation That Destroys its Soil, Destroys Itself”

-Franklin DeLano Roosevelt

Food Security & Energy

- Crop and feedstock productivity
- Nutrient and water cycling

Soil Ecosystem Services

Environment

- Greenhouse gas mitigation
- Water purification
- Water infiltration and availability



Critical Knowledge Gaps

How do feedback mechanisms between soils and the atmosphere differ between managed and natural ecosystems?

What are the scales of critical soil-atmospheric processes and how can the feedback mechanisms be modeled?

What critical feedback mechanisms control the movement of water vapor between soils and the atmosphere? How do these mechanisms drive climate patterns?

What are the “omics” of the soil matrix and how do these “omics” relate to ecosystem function and services?

What are the affects of atmospheric chemistry and climate change on soil biodiversity and pathogenic microorganisms?

What innovations can be developed to facilitate multidisciplinary studies of soil ecosystem services across all relevant scales?

How can we strengthen databases on terrestrial/aquatic ecosystems to ensure the capacity to process many levels of spatial and temporal detail?

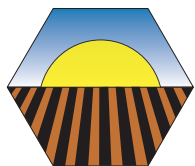
How do plant compounds in the root zone drive the development of critical feedback loops between plants, soil microorganisms, and soil fauna?

Definitions

Ecosystem: A functional system which includes the organisms of a natural community together with their environment.

Ecosystem services: Conditions and processes through which natural and managed ecosystems, and the species that are part of them, help sustain and fulfill human life.

Resilience: Capacity of a system to undergo disturbance and maintain its function and controls.



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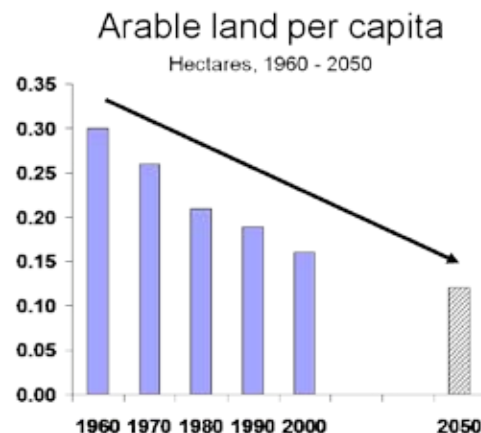
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Soil factoids:

- Soil is the home of billions of microorganisms with unimaginable diversity.
 - ¼ acre contains 10^{18} bacteria (1000 quadrillion) yet we know less than 1% of these bacteria.
- The plants growing in a 2-acre wheat field can have more than 30,000 miles of roots, a length greater than the circumference of the Earth.
- A teaspoon of farm soil may contain tens of yards of fungi. The same amount of soil from a coniferous forest may hold tens of miles of fungi.
- Earthworms move from lower strata up to the surface and move organic matter from the soil surface to lower layers. Where earthworms are active, they can turn over the top 6 inches of soil in 10 to 20 years.



Soil Derived Products Benefit Human Health

Prescription drugs	40	Strobel and Daisy, 2003
New chemical products registered by U.S. Food and Drug Administration	49	Brewer, 2000
Approved drugs between 1989 and 1995	60	Grabley and Thiericke, 1999
Approved cancer drugs between 1983 and 1994	60	Concepcion et al., 2001
Approved antibacterial agents	78	Concepcion et al., 2001