Soil: Crucible of Life

Daniel Hillel*

What does the soil mean to us, what does it do for us, and what does it do for the entire system of life on earth?

Considering the height of the atmosphere, the thickness of the earth’s rock mantle, and the depth of the ocean, we note that the soil is an amazingly thin body, typically not much more than one yard thick and often less than that. Yet it is the crucible of terrestrial life, within which biological productivity is generated and sustained. It acts like a composite living entity, being home to a community of innumerable microscopic and macroscopic plants and animals. A mere fistful of soil typically contains billions of microorganisms, which perform the most vital functions of biochemistry. Another amazing attribute of the soil is its sponge-like porosity and its enormous internal surface area. That same fistful of soil may actually consist of several acres of active surface, upon which physicochemical processes take place continuously.

Realizing humanity’s utter dependence on the soil, ancient peoples, who lived in greater intimacy with nature than many of us today, actually revered the soil. It was not only their source of livelihood, but also the material from which they built their homes and which they learned to shape, heat, and fuse into household vessels and writing tablets (ceramic being the first synthetic material in the history of technology). In the Bible, the name assigned to the first human was Adam, derived from “adama,” meaning soil. The name given to that first earthling’s mate was Hava (Eve, in transliteration), meaning “living” or “life-giving.” Together, therefore, Adam and Eve signified quite literally “soil and life.”

The same powerful metaphor is echoed in the Latin name for the human species—Homo—derived from humus, the material of the soil. Hence, the adjective “human” also implies “of the soil.” Other ancient cultures evoked equally powerful associations. To the Greeks, the earth was a manifestation of Gaia, the maternal goddess who, impregnated by Uranus (god of the sky), gave birth to all the gods of the Greek pantheon.

Our civilization depends on the soil more crucially than ever, because our numbers have grown while available soil resources have diminished and deteriorated. Paradoxically, however, even as our dependence on the soil has increased, most of us have become physically and emotionally detached from it. The majority of the people in the so-called “developed” countries spend their lives in the artificial environment of a city, insulated from direct exposure to nature. Many children now assume as a matter of course that food originates in supermarkets.

Detachment has bred ignorance, and out of ignorance has come the arrogant delusion that our civilization has risen above nature and set itself free of its constraints. Agriculture and food security, erosion and salination, degradation of natural ecosystems, depletion and pollution of surface waters and aquifers, and decimation of biodiversity—all of these processes, which involve the soil directly or indirectly—have become mere abstractions to the majority of our people. The very language we use betrays disdain for that common material underfoot, often referred to as “dirt.” Some fastidious parents prohibit their children from playing in the mud and hurry to wash their “soiled” hands when the children nonetheless obey an innate instinct to do so. Thus is devalued and treated as unclean what is in fact the terrestrial realm’s principal medium of purification, wherein wastes are decomposed and nature’s productivity is continually rejuvenated.

Scientists who observe the soil closely see it in effect as a seething foundry in which matter and energy are in constant flux. Radiant energy from the sun streams onto the field and cascades through the soil and the plants growing in it. Heat is exchanged, water percolates through the intricate passages of the soil, plant roots suck up some of that water and transmit it to their leaves, which transpire it back to the atmosphere. The leaves absorb carbon dioxide from the air and synthesize it with soil-derived water to form the primary compounds of life—carbohydrates, fats, proteins, and numerous other compounds (many of which provide not only nutritional value but medical uses as well). Oxygen emitted by the leaves makes the air breathable for animals, which consume and in turn fertilize the plants.

The soil is thus a self-regulating biophysical factory, utilizing its own materials, water, and solar energy. It also determines the fate of rainfall and snowfall reaching the ground surface—whether the water thus received will flow over the land as runoff, or seep downward to the subterranean reservoir called groundwater, which in turn maintains the steady flow of springs and streams. With its finite capacity to absorb and store moisture, the soil regulates all of these phenomena. Without the soil as a buffer, rain falling over the continents would run off immediately, producing violent floods rather than sustained stream flow.

The soil naturally acts as a living filter, in which pathogens and toxins that might otherwise accumulate to foul the terrestrial environment are rendered harmless and transmuted into nutrients. Since time immemorial, humans and other animals have been dying of all manner of disease and have then been buried in the soil, yet no major disease is transmitted by it. The term “antibiotic” was coined by soil microbiologists who, as a consequence of their studies of soil bacteria and actinomycetes, discovered streptomycin (an important cure for tuberculosis and other infections). Ion exchange, a useful process of water purification, was also discovered by soil scientists studying the passage of solutes through beds of clay.

However unique in form and function, the soil is not an isolated body. It is, rather, a central link in the larger chain of interconnected domains and processes comprising the terrestrial environment. The soil interacts both with the overlying atmosphere and the underlying strata, as well as with surface and underground bodies of water. Especially important is the interrelation between the soil and the climate. In addition to its

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function of regulating the cycle of water, it also regulates energy exchange and temperature.

When virgin land is cleared of vegetation and turned into a cultivated field, the native biomass above the ground is often burned and the organic matter within the soil tends to decompose. These processes release carbon dioxide into the atmosphere, thus contributing to the earth’s greenhouse effect and to global warming. On the other hand, the opposite act of reforestation and soil enrichment with organic matter, such as can be achieved by means of conservation management, may help to absorb carbon dioxide from the atmosphere. To an extent, the soil’s capacity to store carbon can thus help to mitigate the greenhouse effect.

It takes nature thousands of years to create life-giving soil out of sterile bedrock. It takes but a few decades for unknowing or careless humans to destroy that wondrous work of nature. It is for us who do care for future generations to treat the soil with respect and with humility, which is another word derived from “humus.” In the Book of Genesis, humans were placed in the Garden of Eden for a purpose, “to serve and preserve it.” There is a profound truth in that perception. The earth and its soil can be a veritable Garden of Eden, but only if we do not despoil it and thereby banish ourselves and our children from a life of harmony within it.
Soil in the Environment is key for every course in soil science, earth science, and environmental disciplines. This textbook engages students to critically look at soil as the central link in the function and creation of the terrestrial environment. For the first time, Dr. Hillel brilliantly discusses soils as a natural body that is engaged in dynamic interaction with the atmosphere above and the strata below that influences the planet's climate and hydrological cycle, and serves as the primary habitat for a versatile community of living organisms. The book offers a larger perspective of soil as the breath of life to the terrestrial environment. About the Author. Born in California and raised in Israel, Dr. Daniel Hillel acquired an early and lifelong love of the land and a commitment to understanding and protecting the natural environment. Through decades of work in some thirty countries, he has become an international authority on sustainable management of land and water resources. Dr. Hillel has served as professor of soil physics, hydrology and the environmental sciences at leading universities in the U.S. and abroad, and has been a consultant to the World Bank. This textbook engages students to critically look at soil as the central link in the function and creation of the terrestrial environment. First textbook to unite soil science and the environment beyond what is traditionally taught. Incorporates current knowledge of such hot topics as climate change, pollution control, human expropriation of natural resources, and the prospects for harmonious and sustainable development. Organized in a student-friendly format with examples, discussion boxes, and key definitions in every chapter. Full color throughout.