Nature's Services

Societal Dependence on Natural Ecosystems

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difficult or impossible to reverse on any time scale of relevance to society. Finally, if current trends continue, humanity will dramatically alter or destroy virtually all of earth’s remaining natural ecosystems within a few decades.

What Are Ecosystem Services?

Ecosystem services are the conditions and processes through which natural ecosystems, and the species that make them up, sustain and fulfill human life. They maintain biodiversity and the production of ecosystem goods, such as seafood, forage, timber, biomass fuels, natural fiber, and many pharmaceuticals, industrial products, and their precursors. The harvest and trade of these goods represent an important and familiar part of the human economy. In addition to the production of goods, ecosystem services are the actual life-support functions, such as cleansing, recycling, and renewal, and they confer many intangible aesthetic and cultural benefits as well.

One way to appreciate the nature and value of ecosystem services (originally suggested by John Holdren) is to imagine trying to set up a happy, day-to-day life on the moon. Assume for the sake of argument that the moon miraculously already had some of the basic conditions for supporting human life, such as an atmosphere and climate similar to those on earth. After inviting your best friends and packing your prized possessions, a BBQ grill, and some do-it-yourself books, the big question would be, Which of earth’s millions of species do you need to take with you?

Tackling the problem systematically, you could first choose from among all the species exploited directly for food, drink, spice, fiber and timber, pharmaceuticals, industrial products (such as waxes, lac, rubber, and oils), and so on. Even being selective, this list could amount to hundreds or even several thousand species. The space ship would be filling up before you’d even begun adding the species crucial to supporting those at the top of your list. Which are these unsung heroes? No one knows which—nor even approximately how many—species are required to sustain human life. This means that rather than listing species directly, you would have to list instead the life-support functions required by your lunar colony; then you could guess at the types and numbers of species required to perform each. At a bare minimum, the spaceship would have to carry species capable of supplying a whole suite of ecosystem services that earthlings take for granted. These services include:

- purification of air and water
- mitigation of floods and droughts
- detoxification and decomposition of wastes
All of these cycles are ancient, the product of billions of years of evolution, and have existed in forms very similar to those seen today for at least hundreds of millions of years. They are absolutely pervasive, but unnoticed by most human beings going about their daily lives. Who, for example, gives a thought to the part of the carbon cycle that connects him or her to the plants in the garden outside, to plankton in the Indian Ocean, or to Julius Caesar? Noticed or not, human beings depend utterly on the continuation of natural cycles for their very existence. If the life cycles of predators that naturally control most potential pests of crops were interrupted, it is unlikely that pesticides could satisfactorily take their place. If the life cycles of pollinators of plants of economic importance ceased, society would face serious social and economic consequences. If the carbon cycle were badly disrupted, rapid climatic change could threaten the existence of civilization. In general, human beings lack both the knowledge and the ability to substitute for the functions performed by these and other cycles (Ehrlich and Mooney 1983).

For millennia, humanity has drawn benefits from these cycles without causing global disruption. Yet, today, human influence can be discerned in the most remote reaches of the biosphere: deep below earth’s surface in ancient aquifers, far out to sea on tiny tropical islands, and up in the cold, thin air high above Antarctica. Virtually no place remains untouched—chemically, physically, or biologically—by the curious and determined hand of humanity. Although much more by accident than by design, humanity now controls conditions over the entire biosphere.

Interestingly, the nature and value of Earth’s life-support systems have been illuminated primarily through their disruption and loss. Thus, for instance, deforestation has revealed the critical role of forests in the hydrological cycle—in particular, in mitigating flood, drought, and the forces of wind and rain that cause erosion. Release of toxic substances, whether accidental or deliberate, has revealed the nature and value of physical and chemical processes, governed in part by a diversity of microorganisms, that disperse and break down hazardous materials. Thinning of the stratospheric ozone layer sharpened awareness of the value of its service in screening out harmful ultraviolet radiation.

A cognizance of ecosystem services, expressed in terms of their loss, dates back at least to Plato and probably much earlier:

What now remains of the formerly rich land is like the skeleton of a sick man with all the fat and soft earth having wasted away and only the bare framework remaining. Formerly, many of the mountains were arable. The plains that were full of rich soil are now marshes. Hills that were once covered with forests and produced abundant pasture now produce only food for bees. Once
the land was enriched by yearly rains, which were not lost, as they are now, by flowing from the bare land into the sea. The soil was deep, it absorbed and kept the water . . . , and the water that soaked into the hills fed springs and running streams everywhere. Now the abandoned shrines at spots where formerly there were springs attest that our description of the land is true.

—Plato (quoted in Hillel, p. 104)

Ecosystem services have also gained recognition and appreciation through efforts to substitute technology for them. The overuse of pesticides, for example, leading to the decimation of natural pest enemies and concomitant promotion of formerly benign species to pest status, has made apparent agriculture’s dependence upon natural pest control services. The technical problems and cost of hydroponic systems—often prohibitive even for growing high-priced, specialty produce—underscore human dependence upon ecosystem services supplied by soil. Society is likely to value more highly the services listed above, and to discover (or rediscover) an array of services not listed, as human impacts on the environment intensify and the costs and limits of technological substitution become more apparent.