Natural Capital

Natural capital is an economic construct that describes the natural world, its ecosystems, and their value to society. How people value the natural world determines how businesses and societies both conserve and deplete it. Economists who think about natural capital as an irreplaceable resource and those who believe that it is like any other input into an economy have very different ideas about how society should treat the natural world.

Economists use the concept of natural capital to explain the contribution that the natural world's resources make to human economies. Different schools of economic thought have a number of different ways to approach the topic, and these approaches have different consequences for sustainable development.

Conceptual History

In the eighteenth and nineteenth centuries, economists identified the factors of production (that is, the resources that go into producing goods and services), as capital, labor, and land. Capital was defined as an input that is not consumed in the manufacture of a product (Smith 1776) or, alternatively, as something human made that contributed to production (Böhm-Bawerk 1891), for example, machinery. Land, which included all natural resources, was treated as distinct from capital because it was a gift of nature and because humans could not affect its supply. In the twentieth century, economists redefined capital as any asset that produces a stream of income over time (Fisher 1906). By this definition, land is lumped together with other capital, and the factors of production are reduced to two: capital and labor. After the redefinition, natural resources were increasingly ignored as a factor of production to the point where an eminent economist could suggest that "the world can, in effect, get along without natural resources" (Solow 1974). In the 1970s, however, growing evidence of the limitations on natural resources and environmental problems made worse by accelerating economic growth led many economists to call for explicitly recognizing natural capital—defined as a stock that yields a flow of natural services and tangible natural resources—as a distinct and essential factor of production.

The first explicit reference to natural capital appears in *Small Is Beautiful* (Schumacher 1973). In this book, the British economist E. F. Schumacher argued that irreplaceable natural capital stocks make up the larger part of all capital, and that modern economists erroneously treat their depletion as income. Schumacher identified two types of natural capital. The first was fossil fuels, which were rapidly being exhausted. The second was the ability of natural systems to regenerate themselves, threatened by novel chemicals against which nature had no defenses. Although they did not use the specific phrase *natural capital*, other researchers, including Herman Daly (1973, 1977) and Nicholas Georgescu-Roegen (1971) were simultaneously stressing that the goods and services provided by nature are essential, non-substitutable factors of production, and that the finite supply of these resources limits continued economic growth. Furthermore, both Daly and Georgescu-Roegen carefully distinguished between the two types of natural capital discussed by Schumacher. Fossil fuels, along with all other raw materials from nature (both renewable and nonrenewable), are identified as stock-flow resources, which are consumed and therefore depleted in the act of production. Humans can decide how quickly to deplete such resources. In contrast, the ability of ecosystems to reproduce themselves, along with other services provided by ecosystems, is a

fund-service resource. A fund is not consumed in the act of producing a service. For example, when a forest helps regulate water flow, processes waste, provides shelter for other species, or produces the seeds required for renewal, it is not consumed in the process. Nature's fund services are generated from a particular configuration of its stock-flow components. Just as a car factory is a particular configuration of metal, glass, and concrete, a forest is a particular configuration of plants, animals, water, and soil. Funds provide services at a given rate over time. The term *natural capital* generally refers both to stock flows and to fund services.

The concept of natural capital caught on fairly quickly, particularly in the field of ecological economics, whose theoretical foundations stressed the dependence of the economic system on the planet's finite supply of natural resources and the invaluable services they generate. The economists David Pearce (1988) and Herman Daly (1990) argued that sustainable development required a constant natural capital stock. Daly listed specific rules for maintaining a constant stock: extraction of renewable resources could not exceed regeneration rates, extraction of nonrenewable resources could not exceed the rate at which renewable substitutes were developed, and waste emissions could not exceed the ecosystem's absorption capacity. The concept of natural capital suited ecological economic theory so well that the proceedings of the second international Ecological Economics Conference were published as the book *Investing in Natural Capital* (Jansson et al. 1994). The first section of this book focuses on maintaining and investing in natural capital, the second focuses on methods and research topics, and the third on policy implications and applications. These three topics parallel and anticipate the way researchers later developed the ideas around natural capital.

Much of the early research on natural capital focused on the economic value of ecosystem services. In May 1997, the journal *Nature* published a paper that integrated these studies into a single global assessment of natural capital. That paper, "The Value of the World's Ecosystem Services and Natural Capital" (Costanza et al. 1997), has become one of the most cited in the environmental sciences.

At the same time, various nations attempted to integrate natural capital into their national accounts (Ahmad, El Serafy, and Lutz 1989), leading the United Nations to propose a System of Environmental and Economic Accounts (SEEA) (United Nations 1993), eventually implemented in 2003. The researchers William Rees (from Canada) and Mathis Wackernagel (from Switzerland) introduced the concept of the ecological footprint as a biophysical measure of humanity's demands on natural capital (Rees and Wackernagel 1994). A growing number of countries, regions, and businesses around the world adopted the ecological footprint as a measure of sustainability.

The book *Natural Capitalism* (Hawken, Lovins, and Lovins 1999) and the nonprofit organization The Natural Step both played a critical role in popularizing the concept of natural capital outside of academia, particularly in the business world, by laying roadmaps for a society that obeys Herman Daly's specific rules for sustaining natural capital. The triple bottom line is one increasingly popular approach to business that accounts for natural capital, human capital, and financial capital (Elkington 1997). National and international policies designed to protect and restore natural capital including cap and trade regulations for pollutants and fisheries and payments for ecosystem services are now multibillion-dollar global markets (Farley et al. 2010).

Strong and Weak Sustainability

Natural capital, however, remains poorly defined and subject to controversy. One ongoing debate is whether or not natural capital is, in fact, irreplaceable. If it is true that some natural capital is essential and has no substitutes, then that capital must be preserved and so cannot be lumped together with other forms of capital. This belief, generally shared by ecological economists and known as strong sustainability, led to the emergence of the concept of natural capital in the early 1970s. Other economists argue that human-made capital can substitute for natural capital and that as long as the value of both types of capital together is not declining, sustainability is achieved. According to this model, clear-cutting the Amazon could be viewed as sustainable as long as future generations were left with an equal value of roads and buildings. This approach is called weak sustainability. David Pearce was instrumental in developing the concept of weak sustainability (Pearce and Atkinson 1993), although he had initially stressed the irreplaceable nature of natural capital. Many scholars now use the phrase *critical natural capital* for natural capital that is essential to human welfare and has no substitutes (Ekins et al. 2003).

A related debate concerns the labels *natural capital* and *ecosystem services*, which, some argue, imply the treatment of nature as a commodity, or market good, and hence weak sustainability. Many economists do believe that natural capital should be treated as just another commodity and incorporated into the market model. Others, however, interpret natural capital as a metaphor that calls attention to the productive capacity of ecosystems and the need to invest in their protection and restoration. If natural capital is defined as an asset that produces a flow of income over time, then the term implies that we must

live only off the flow of income without depleting the capital stock. According to this way of thinking, the metaphor does not imply that natural capital can be bought and sold like any other asset.

Valuing ecosystem services goes a step further than the natural capital metaphor to suggest that such services have a monetary exchange value and are neither essential nor nonsubstitutable. Advocates of weak sustainability typically believe that markets will lead to the optimal provision of ecosystem services if the services are correctly priced. Even many advocates of strong sustainability argue that valuation calls attention to the importance of natural capital and that failure to value ecosystem services assigns an implicit value of zero to them. They point out that food is also essential and nonsubstitutable, yet it is nonetheless valued in monetary terms.

Critics of monetary valuation argue that it is based on preferences weighted by purchasing power, which gives no voice to the poor and prioritizes Western over indigenous values. Furthermore, preferences are often based on incomplete or inaccurate knowledge, because people rarely understand precisely how ecosystems generate services or how human activities will affect them. The dominant critique is that valuation implies weak sustainability. In fact, many conventional economists focused on dollar values have explicitly stated that global climate change is relatively unimportant because it primarily affects agriculture, which constitutes a negligible share of gross domestic product, or GDP (Schelling 2007). Most ecological economists argue that society should impose the specific quantitative rules for sustainable use of natural capital that Herman Daly suggested, and then let prices adjust to these ecological constraints (Farley 2008). They also suggest that because natural capital is part of a shared inheritance, scientific and democratic principles, rather than the market, should be used to value it.

Another controversial application of the concept of natural capital is payments for ecosystem services (PES). Those who favor the integration of natural capital into the market tend to favor PES systems in which private sector beneficiaries of ecosystem services pay landowners for land uses that provide specific services. Such payments are often for a single service and do not take into account other services provided by the system. Critics of PES typically argue that ecosystem services are public goods and cannot be forced into the market model. Protecting and restoring natural capital does, however, impose real costs on society, which somebody must pay. Many ecological economists believe that investments in natural capital should be a cooperative endeavor, in which the wealthiest nations and regions shoulder the financial cost of restoration and conservation wherever it is needed (Farley and Costanza 2010).

Outlook for the Future

The importance of the natural capital concept continues to grow, as measured by a steadily increasing use of the term in the scientific literature. Human society must recognize that we, like all other species, depend on the flow of goods and services provided by nature. In the past, humans have treated natural capital as if there were enough to meet all human and ecological needs for all time, with no trade-offs involved and hence no need to ration access. The market system is very effective at allocating natural capital toward market products, but it fails to take account of natural capital's growing scarcity. As a result, societies are now depleting natural capital faster than it can regenerate and returning waste to the environment faster than it can be absorbed. Depletion of this natural capital will diminish not only nature's capacity to regenerate itself but also the raw materials needed for all economic production and the flow of ecosystem services essential to human wellbeing. Future generations are left dependent on dwindling resources. The concept of strong sustainability makes it obvious that people must learn to live on the interest from natural capital, the annual flow of benefits, without depleting the stock.

Natural capital is inherently different from other forms of capital—produced capital and natural capital are ultimately complements, not substitutes for one another. It is not enough to simply put a price on natural capital and force it into competitive market boundaries. Instead, economic institutions must adapt to the fact that natural capital is irreplaceable and generates a flow of public good services best protected by cooperative efforts. Society faces a new allocation challenge: how much natural capital should be converted to economic production, and how much should be conserved for the provision of ecosystem

services? Both uses of natural capital are essential and have no substitutes. The concept of natural capital, correctly applied, can help society make these choices.

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See also Agricultural Intensification; Agroecology; Ecosystem Services; Human Ecology; Irrigation; Landscape Planning, Large-Scale; Marine Protected Areas (MPAs); Ocean Resource Management; Permaculture; Reforestation; Soil Conservation; Viewshed Protection; Water Resource Management, Integrated (IWRM); Wilderness Areas

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