Ecological Impacts of Economic Activities

Healthy ecosystems are the foundation for sound economies, sustaining and enhancing human life with services ranging from food and fuel to clean air and water. As such, ecology has an important role to play in society's efforts to improve the quality of life throughout the world. Although ecological scientists have neither the remit nor the capacity to judge the right of people to grow their economies, they do have the expertise and the responsibility to identify the ecological consequences of current and alternative growth strategies, recognizing that:

- *Human activities can degrade ecosystems, diminishing ecosystem services of value to society* ***(loss of natural capital)***
- *Many ecosystem services such as clean air are* ***public goods—****they are freely and indiscriminately available to all members of a community, giving stakeholders little incentive to maintain them*
- *In cases where ecosystem services do have a market value (e.g. food and fiber), economic activities may have ecological impacts that are not captured in market prices (****environmental externalities)***
- *Society's ablity to predict the consequences of ecosystem change is limited* ***(environmental uncertainty****) but can be improved with newmodelling and forecasting tools*

The Sustainability of Economic Growth

At present, economic growth is a double-edged sword: Although it enhances the standards of living in the short-term, it can degrade the ecological infrastructure needed to sustain long-term welfare. This dichotomy may be humanity's central challenge in the 21st century—sustaining living standards and spreading the benefits of economic development to the large fraction of humanity still mired in poverty, while preserving the ecological life-support system on which future welfare depends. The nine Millennium Development Goals[1] of the United Nations include both eradicating extreme poverty and hunger and ensuring environmental sustainability, reflecting an understanding that these two endeavors are intertwined.

Development will remain a priority in light of the millions currently living without the resources to satisfy their most basic needs. Yet there are limits to the amount of material consumption and pollution the Earth can sustain. The problem is not economic growth, *per se*, but the ways in which it is implemented. In 1987, the World Commission on Environment and Development released the Brundtland Report[2], which stated that "sustainable development…can be consistent with economic growth, provided the content of growth reflects the broad principles of sustainability." Sustainable development requires that individual wealth—including natural capital assets—does not decline. This requires technological and behavioral changes to reduce both the demand for material resources and the volume and toxicity of waste products, while simultaneously improving human wellbeing. It also requires investments to offset the degradation or depreciation of natural capital, and to maintain robust ecosystems.

For millennia, the impacts of human population growth and the demands it placed on the natural environment were felt only at local or regional scales. Since the industrial revolution, however, these impacts have expanded, and are now often global. In the last 50 years, the Earth's population has grown by a factor of 2.5, and the global economy, as measured by the gross domestic product (GDP), has grown by a factor of 8. Economic growth has increased material standards of living throughout many parts of the world, with significant improvements in nutrition, health, and life expectancy. In many cases, however, economic and population growth and the increasing rate of per-capita consumption have also disrupted ecosystems. Examples include the depletion of water resources, the fragmentation of plant and animal populations, and the conversion of habitat for the harvesting of natural resources. The burgeoning scale of these impacts raises the question of whether the aforementioned gains are sustainable or will instead result in the widespread degradation of the very ecosystems on which society relies.

The Ecological Impacts of Economic Growth

The Millennium Ecosystem Assessment[3] provides a comprehensive review of the status, trends, and possible future conditions of ecosystems, ecosystem services, and human welfare. Its findings include:

– "Over the past 50 years, humans have changed ecosystems more rapidly and extensively than in any comparable period of time in human history, largely to meet rapidly growing demands for food, fresh water, timber, fiber and fuel. This has resulted in a substantial and largely irreversible loss in the diversity of life on Earth."

– "The changes that have been made to ecosystems have contributed to substantial net gains in human well-being and economic development, but these gains have been achieved at growing costs in the form of the degradation of many ecosystem services, increased risks of nonlinear changes, and the exacerbation of poverty for some groups of people. These problems, unless addressed, will substantially diminish the benefits that future generations obtain from ecosystems."

Why is our current approach to development unsustainable?

Ecologically sustainable development must maintain ecosystem resilience—the continued ability of ecosystems to provide future generations with services in spite of natural and human-driven disturbances. Many current ecosystem management strategies are unsustainable, focusing on a single service—such as the production of food, fuel, or fiber—to the neglect of others. Such strategies can reduce biodiversity and ecosystem resilience by eliminating native species, introducing new and harmful species, converting and simplifying habitat, and polluting the surrounding environment.

In addition to reducing resilience, these strategies reduce the capacity of ecosystems to deliver other important services. For example, harvesting timber might provide a near-term profit to the owner of wooded land, but only at the expense of the ecosystem services that the forest ecosystem once provided, such as clean water, carbon sequestration, and recreational opportunities. Humanity as a whole will not necessarily be "richer."

How can we determine sustainability?

Human wellbeing depends on numerous forms of wealth. People's quality of life is determined not only by their property (produced capital), but also by their skills (human capital), their social institutions (social capital), and their biophysical environment (natural capital). Some of this wealth is in private hands, but much belongs to communities, and resources such as the atmosphere belong to all of humanity. Sustainable investment should be informed by gains and losses in all forms of capital, across all ownership categories.

Most conventional measures of economic growth, such as Gross National Product, focus exclusively on produced capital. This provides decision makers with little incentive to safeguard natural, social, and human capital. The best test of sustainability is to determine whether average inclusive wealth (all forms of capital taken together) is being maintained. There have been very few attempts to measure inclusive wealth, but measurements that do exist, such as the World Bank's concept of adjusted net saving, indicate that the growth patterns of many nations are currently unsustainable.

Sustainable Development: Strategies for Achieving Ecologically Sustainable Growth

To encourage decision makers to account for the environmental costs of growth, we propose the following four strategies:

1. *Internalize externalities*

Environmental impacts and resource shortages caused by economic activities often affect people far removed in space and time from those whose actions produced these problems. This separation of cause from consequence represents what economists refer to as externalities. Agribusiness, for example, benefits from using nitrogen fertilizers but does not bear the costs associated with oxygen-depleted "dead zones" that agrochemical runoff produces in aquatic ecosystems. Because the adverse environmental impacts of fertilizer use are not reflected in fertilizer prices, they do not affect decisions about how much fertilizer to use.

Resolving this disparity would drive more environmentally and socially sustainable investments, but only following significant changes to our existing economic framework. Environmental economists advocate a range of measures to internalize externalities. Examples include property rights for environmental assets, payments for ecosystem services, and liabilities for environmental damage. Developing effective incentives requires an in-depth understanding of the ecological implications of externalities.

2. *Create mechanisms for sustaining ecosystem services*

Environmental economists have long recommended creating markets for ecosystem services such as pest control and carbon sequestration. Such markets would provide incentives for environmentally sound investments, while allowing communities to be compensated for actions that benefit others. Whether this means clean air in Beijing, China or safe drinking water in Central Valley, California, people would be able to invest in their welfare and the welfare of their children, just as they are currently able to invest in more material forms of security.

Markets must often be coupled with other strategies in order to be effective. In the emerging market for carbon sequestration, for example, if sequestration is priced while other services like freshwater provisioning remain unpriced, negative ecological outcomes may ensue. Carbon markets need to be paired with other strategies, such as the regulation of land use, the direct protection of biodiversity, and the development of "green standards" to which projects must adhere.

3. *Enhance decision makers' capacity to predict environmental impacts*

Society is growing increasingly aware of the economic repercussions of environmental change. Still, this linkage often only becomes apparent after the environment has been damaged, sometimes irreversibly. Routine assessments of environmental risks, such as environmental impact statements, play an important role in identifying short-term environmental damage, but they rarely account for impacts that take decades to emerge. For example, DDT, a synthetic pesticide, was widely used for almost 20 years before its harmful effects on human and bird populations were recognized. The resulting US ban on DDT led to marked recoveries in bald eagles and other impacted species, but not all environmental impacts can be reversed with such success. Similarly, deforestation in Panama displaced mosquito populations in the canopy, causing a dramatic increase in Yellow Fever cases. Such outbreaks of zoonotic diseases are rarely foreseen in routine environmental risk assessments but can quickly escalate to unmanageable proportions, leading to the loss of countless human lives as well as billions of dollars in damages, lost output, and livestock mortality.

Recognizing that environmental impacts are often highly uncertain, it is important to develop models better able to project the consequences of anthropogenic environmental change. Equally important are new monitoring systems to detect problematic trends before they surpass society's ability to address them.

4. Manage for resilient ecosystems

When ecosystem thresholds are breached, undesirable and often irreversible change can occur. For instance, grassy savannas capable of supporting grazing and rural livelihoods can suddenly "flip" to woody systems with lower productive capacity. Many common management strategies move ecosystems closer to these thresholds. Ecosystem management strategies need to leave a "margin of error", trading some short-term yield for long-term resilience that sustains a suite of services.

Guidelines for Implementing an Environmentally Sustainable Framework

To move toward sustainable growth, ecological scientists, economists, and public and private decision-makers should collaborate to incorporate the following factors into investment decisions:

– **The value of ecosystem services and the economic impacts of changes in the availability of these services:** Decision makers should take all forms of capital into account. Natural capital *can* be integrated quantitatively into economic indicators, as demonstrated by the World Bank's concept of adjusted net saving, which calculates an economy's rate of savings after factoring in natural resource consumption, pollution-related damages, and other environmental impacts.

– **Environmental externalities:** Data on environmental costs of public and private investment decisions should be used to develop methods to internalize externalities, reassigning to decision makers the full consequential cost of their activities. In regulating greenhouse gas emissions, for example, these methods might include carbon taxes or cap-and-trade systems. More generally, this effort will require several strategies (e.g. market creation, direct protection) to work in concert, providing stakeholders with incentive to protect unpriced ecosystem services

– **Improved predictive capacity:** Society must further develop its capacity to predict future environmental costs of public and private investments and, where these costs are uncertain, take precautionary measures. Such measures already exist in many national regulations and international agreements concerning human, animal, and plant health—a recent example is the World Trade Organization's Sanitary and Phytosanitary Agreement.

References

[1] United Nations. The Millennium Development Goals Report 2008. United Nations, New York.

[2] World Commission on Environment and Development. 1987. Our Common Future. Oxford University Press, Oxford.

[3] Millennium Ecosystem Assessment (MA). 2005. Ecosystems and Human Well-being: Synthesis. Island Press, Washington, D.C.