NEXUS OF ECOLOGICAL ECONOMICS AND ECOSYSTEM MANAGEMENT

Tony Prato
University of Missouri-Columbia, Columbia, Missouri, USA

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Summary

Although ecological economics (EE) and ecosystem management (EM) are forged on somewhat dissimilar pre-analytic visions, they have similar implications for natural resource management and policy. The central premise of EE is that the ecosystem imposes biophysical limits on the size and growth of the economic sub-system that cannot be overcome by technological innovation and substitution of manufactured capital for natural capital. EM attempts to achieve ecologically sustainable management of ecosystems on large spatial and long temporal scales, and attempts to balance production of ecological goods and the capacity of ecosystems to provide ecological services. The nexus between EE and EM suggests that natural resource management decisions should based on multiple social, economic, and ecological values, and interdisciplinary knowledge. Economic efficiency-based criteria, such as cost-benefit analysis, have shortcomings in this regard that can be alleviated using multiple criteria evaluation (MCE). MCE allows a decision-maker to evaluate and rank management actions for maintaining or enhancing ecosystem sustainability based on multiple criteria and the decision-maker's preferences for criteria. Advantages of MCE are that it considers multiple ecological and socioeconomic values, interdisciplinary knowledge, and a variety of spatial and temporal scales, and accounts for risk.

The adaptive ecosystem management approach proposed here is implemented using a two-stage, multiple criteria, and risk-based procedure. In the first stage, Bayes' rule is used to determine whether the current state of an ecosystem is unsustainable or

sustainable. If not, then Bayes' rule is used to identify management actions that maximize the likelihood of achieving sustainable ecosystem states. In the second stage, the decision-maker uses MCE to select the ecologically sustainable ecosystem state that achieves the most preferred combination of socioeconomic criteria. Integrating EE and EM in an adaptive ecosystem management framework facilitates attaining ecologically sustainable and socioeconomically acceptable use of natural resources.

1. Introduction

Ecological economics (EE) is a transboundary discipline that examines the complex interrelationships between the economy and the natural ecosystem to which it belongs (Costanza et al. 1991). It attempts to develop policy prescriptions for keeping economic systems within biophysical limits imposed by a finite and non-expanding ecosystem. Exceeding those limits reduces the capacity of natural ecosystems to supply ecological goods and services, which results in soil, air and water pollution, global climate change, loss of biodiversity and other forms of resource degradation. Ecosystem management (EM) is a process for managing whole ecosystems so as to maintain ecological functions and processes over large spatial and long temporal scales. The common ground for EE and EM is that both seek to sustain human activities and ultimately human existence by preserving the capacity of ecosystems to supply ecological goods and services. Accordingly, EE and EM are mutually reinforcing or synergistic paradigms.

This chapter examines the synergistic relationships between ecological economics and ecosystem management. Four topics are considered: a) elements of EE, b) elements of EM, c) the nexus of EE and EM, d) implications of the nexus for natural resource management and policy, and e) implementation of EM.

2. Elements of Ecological Economics

(This section draws heavily from Prato (1998a).)

EE takes the holistic view that humans, culture and biological systems co-evolve. Co-evolution implies that the cultural objective of maximizing short-term economic output, which is the cornerstone of neoclassical economics, should be subservient to long-term biological constraints on economic activity. Constraints include the capacity of natural systems to assimilate residuals, ethical concerns for future generations (intergenerational equity) and the survival of non-human species (biodiversity). EE views the economy as a sub-system of a larger finite and non-growing ecosystem. Neo-classical economics takes a human-centered (anthropocentric) view of the economy. EE takes a biologically based (bio-centric) or ecologically based (eco-centric) view of ecosystems and their embedded economic sub-systems.

Ecological economic theory differs from neo-classical economic theory in three important ways. First, neoclassical economics assumes that natural resources are not a constraint on economic growth because of unlimited potential for technological innovation and substitution of manufactured capital for natural capital. Substitution implies that natural capital is not a constraint on production, and hence economic growth. EE recognizes that technological innovation almost always increases the use of natural resources and/or environmental degradation, and that natural capital and manufactured capital are complements rather than substitutes.

Second, a major goal of EE is to maintain long-term sustainability of the integrated ecological-economic system. Achievement of this goal requires determining the optimum scale of the economy relative to the ecosystem and implementing policies and institutions that maintain that scale. Neo-classical theory only addresses optimum scale in terms of the size of the physical facilities chosen by a firm in the long run. The economy does not automatically achieve an optimum scale. As Daly (1991) points out "... just as there is nothing in the price system that can identify the best distribution of ownership according to criteria of justice, neither is there anything that allows the price system to determine the best scale of throughput according to ecological criteria of sustainability."

Daly (1991) defines optimal scale in terms of the physical size of the total capital stock, which includes people and their physical artifacts. The latter includes service-yielding capital assets such as automobiles, buildings and natural resources. Total capital stock is directly proportional to population growth and the accumulation of artifacts (inflow) and inversely proportional to death of people and depreciation of artifacts (outflow). Maintaining the optimal scale of the economy is equivalent to balancing inflow and outflow of matter-energy in the economy. An optimum scale could be achieved by stabilizing the population and stock of physical artifacts, keeping throughput flow below ecological limits, and controlling the degree of inequality in the distribution of goods and services among people (Daly 1991).

Third, whereas EE attempts to maintain the optimum scale of the economy, neoclassical economics promotes economic growth and the supporting goal of maximizing gross national product (GNP). Maximizing GNP implies maximizing the flow of matter and energy through the economy. In contrast, the steady state goal of EE requires minimizing the cost of the throughput flow of matter and energy needed to sustain the optimum scale of the economy. In summary, there are major differences between neoclassical economics and EE, which have implications for how natural resources are managed and utilized.

3. Elements of Ecosystem Management

EM represents a fundamental change in the way land and water resources are managed that emphasizes larger spatial scales, longer time periods and more variables than commodity-based resource management (Thomas 1997). Adoption of EM was stimulated by widespread concern regarding the ecological impacts of human activities and the desire to manage natural resources in an ecologically sustainable manner (National Research Council 1992, Williams et al. 1997). Diaz and Bell (1997) point out that "… on federal lands [in the United States] the concept of resource management (in the sense of managing the production of individual resources like timber, minerals, forage for livestock, and scenery) has virtually given way to the more systematic view of ecosystem management—managing the patterns and processes in a holistic manner to provide for sustained character and function, as well as for benefits and commodities for humans."

Eighteen federal agencies have adopted or are considering adoption of programs based on EM (Haeuber and Franklin 1996). Sedjo (1995) points out that the US Forest Service has all but abandoned multiple-use management in favor of EM where the preeminent output is the "complex of forest organisms and their environment functioning as an ecological unit in nature."

There are many definitions of EM. Thomas (1997) maintains that "... ecosystem management is only a concept for dealing with larger spatial scales, longer time frames, and many more variables (ecological, economic, and social) than have commonly been considered in past management approaches." Schowalter et al. (1997) indicate that EM attempts to manage for sustainable productivity of the whole ecosystem. EM focuses on achieving and sustaining a balance between producing ecological goods and services for human consumption and sustaining ecological services (MacKenzie 1996). Ecological goods include items such as timber, biomass fuels (coal, oil and natural gas) and natural fiber, which are used to produce intermediate goods and consumer products. Ecological services include air and water purification, mitigation of floods and drought, detoxification and decomposition of wastes, generation and renewal of soil, maintenance of biodiversity and partial stabilization of climate (Daily 1997).

While no US statute mandates EM (Keiter 1996), a Federal Ecosystem Management Initiative emanated from the White House's 1993 National Performance Review. The Initiative requires federal land management agencies to take "a proactive approach to ensuring a sustainable economy and a sustainable environment through ecosystem management" (Gore 1993). In addition, the Organic Acts for many US land management agencies and several environmental statutes, such as the National Environmental Policy Act (NEPA) and the Endangered Species Act, provide some authority for implementing EM on federal lands. NEPA requires management of federal lands to "encourage productive and enjoyable harmony between man and his environment; to promote efforts which will prevent or eliminate damage to the environment and biosphere and stimulate the health and welfare of man; (and) to enrich understanding of the ecological systems and natural resources important to the Nation."

There are disparate views regarding the importance of human needs in EM. Definitions given above imply that EM should achieve a balance between satisfying human needs and protecting ecological integrity. This interpretation is corroborated by Wagner's (1995) position that EM entails "skillful manipulation of ecosystems to satisfy specified societal values," Overbay's (1992) claim that EM's goal is "maintenance of sustainable ecosystems while providing for a wider array of uses, values, products and services from the land to an increasingly diverse public," and Malone's (1999) contention that EM is based on "collaboratively developed visions of desired future conditions identified by stakeholders." In contrast to these interpretations, Sedjo (1995) contends that "the perspective of ecosystem management is almost purely biological, with no serious attention given to social values …" Sedjo's viewpoint is understandable given that EM intentionally departs from the traditional commodity-based orientation of natural resource management, focuses on reducing adverse impacts of human activities,

and does not define which societal values are to be pursued. Malone (1999) addresses the latter point by emphasizing that EM goals should be established by society and that implementation requires collaborative decision making among interested stakeholders.
EM suffers from some of the same problems as sustainable development, namely a proliferation of definitions and lack of an acceptable framework to guide implementation. On the other, EM's fuzziness makes it possible to accommodate a wide variety of stakeholder interests in land and water resources management.

4. Nexus of Ecological Economics and Ecosystem Management

One of the obvious dissimilarities between EE and EM is that EE is a discipline and EM is a process. In this respect, they are not strictly comparable. Despite this distinction, there are many noteworthy similarities between EM and EE. They are both: a) biocentric in terms of viewing the economy as a sub-system of a larger ecosystem, b) treat economic value as one of many values to be considered in managing natural resources, c) employ a wide range of spatial scales and long temporal scales, and d) recognize the complexity of ecological economic systems, and the uncertainty regarding the state of ecosystems and the effectiveness of management actions in achieving sustainability.

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Biographical Sketch

Tony Prato is H.A. Cowden Professor, Co-Director of the Center for Agricultural, Resource and Environmental Systems, and Director of the Great Rivers Cooperative Ecosystems Studies Unit at the University of Missouri-Columbia. He has 38 years of research and teaching experience in agricultural and natural resource economics and management. Tony has published over 200 journal articles, reports, and book chapters, and four books. His research interests include integrated modeling of coupled human-natural systems, assessing ecological economic impacts of climate and land use changes, adaptive management, benefits and costs of converting cropland to wetlands, conservation and management of national parks and protected areas, application of geospatial technologies (GIS and remote sensing), multiple attribute decision-making, watershed and water resources management, environmental impacts of agricultural production, and spatial decision support systems. In 2006, Tony received the Distinguished Researcher Award from the College of Agriculture, Food and Natural Resources at the University of Missouri-Columbia. He received a Ph.D. degree in Agricultural Economics and an MA degree in Applied Statistics from the University of California-Berkeley, an MS in Agricultural Economics from Purdue University, and a BS with honors in Agriculture from the University of Connecticut.