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Environmental management in development: the evolution of paradigms

Michael E. Colby
2104 N. Quantico St., Arlington, VA 22205, USA
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ABSTRACT

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Environmental management and its relationship to human development are in a period of dramatic change. Societies are now beginning to have serious discussions about 'sustainable development', but there is still a great deal of confusion over what this means and how to achieve it. Conceptions of what is economically and technologically practical, ecologically necessary, and politically feasible are rapidly shifting. Implicit in changing strategies are differing philosophies of human–nature relationships. Five fundamental paradigms of environmental management in development, of human–nature relationships, are described. From the primordial dichotomy of 'frontier economics' versus 'deep ecology', paradigms of 'environmental protection', 'resource management', and 'eco-development' are evolving, in a progression which involves increasing integration of economic, ecological, and social systems into the definition of development and the organization of human societies. Each perceives different evidence, imperatives, and problems, and prescribes different solutions, strategies, technologies, roles for economic sectors, culture, governments, and ethics, etc. Each actually encompasses several schools of thought, not always in complete agreement, and there are also areas of overlap. The paper explores the distinctions, connections, and implications of these five paradigms for the future of environmental management in development.

INTRODUCTION

The scope and scale of environmental problems has expanded considerably over the past three decades, from pollution issues at local, regional and then international levels, to deforestation, soil erosion, declining water tables, and other forms of natural resource depletion and degradation, to global concerns such as climate change and the ozone layer. This expansion has coincided with unprecedented growth in the scope and scale of human activities, and in many countries, improvements in human welfare.

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All human activities take place in the context of certain types of relationships between society and the bio-physical world (the rest of nature). 'Development' involves transformations of these relationships. When human activities took place on a scale that was minor compared to that of nature's own, it did not matter much whether the relationships were of a 'parasitic' or 'mutualistic' sort. However, in this century, world population has tripled, and the world economy has expanded to 20 times its size in 1900 (Speth, 1989). Vitousek et al. (1986) have estimated that humankind now is responsible for the consumption of some 40% of all terrestrial primary productivity. Matter and energy flows – the physical presence of the economy within the ecosphere – now rival in magnitude the flow rates of many natural cycles and fluxes.

Consequently, the subject of environmental management and its integration with development has become a major concern for people, businesses, and governments of the world. The practices of environmental management and economic development, the planning of both, and the theoretical constructs on which they rest, are in a period of major revision. Since the landmark 1972 Stockholm Conference on the Human Environment, there have been many developments which portend major changes in the way societies will think about the management of the relationship between nature and human activity in the future. However, on the eve of another conference to celebrate the 20th anniversary of Stockholm, many of these advances have yet to be institutionalized.

A TAXONOMY OF THE RELATIONSHIP BETWEEN ENVIRONMENTAL MANAGEMENT AND DEVELOPMENT

As many authors have recognized, what we now call 'environmental' problems are by no means new. In fact, they probably have contributed as much to the collapse of many earlier civilizations as did the typically cited military fortunes (Cronon, 1983; Weiskel, 1989).

Five basic 'paradigms' of the relationship between humans and nature, or of 'environmental management in development', are proposed here. Each paradigm has different assumptions about human nature, about nature itself, and their interactions. Each asks different questions and perceives different evidence, dominant imperatives, threats or risks (problems for development), has different modeling techniques for how the world works, and different preferred solutions and management strategies. They also have different flaws. All too often, the implications of changing conditions and innovations in thought have not been well-recognized; all variations are viewed by the prevailing paradigm as belonging in a single basket of strange thoughts. This paper will identify the core differences between the paradigms and begin to explore their implications.

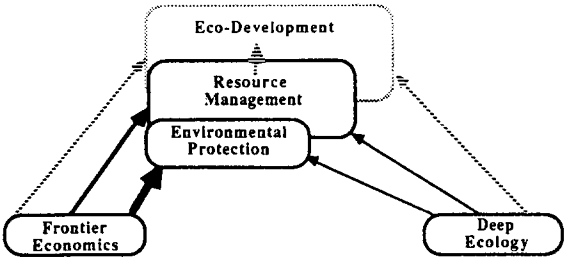

Fig. 1. Evolution of environment-development paradigms. The diagram attempts to indicate schematically the non-linearity of paradigm evolution in the following ways. The vertical scale represents the progression in time from one paradigm to the next going upward; the horizontal scale indicates the upper three paradigms' position on a spectrum between the 'diametrically opposed' frontier economics and deep ecology paradigms. The size of the boxes signifies (roughly) the degree of inclusiveness or integration of social, ecological and economic systems in the definition of development and organization of human societies. Non-solid lines indicate the hypothesized future.

Figure 1 depicts graphically the nature of the 'evolutionary' relationships between the five paradigms. Table 1 provides a summary of the distinctions between them, along some of the dimensions mentioned above. One could also construct a list of particular problems or risks and then a whole additional matrix of the 'solutions' preferred by each of the paradigms (Colby, 1990a, pp. 194–198). Following the tables is a discussion of each paradigm and many of the concepts raised.

1. FRONTIER ECONOMICS

'Frontier economics' is a paraphrase of the term used by Kenneth Boulding (1966) to describe the approach that prevailed in most countries until at least the late 1960s. At its most basic, it treats nature as an infinite supply of physical resources (i.e., raw materials, energy, water, soil, and air) to be used for human benefit, and as an infinite sink for the by-products of the consumption of these benefits, in the form of various types of pollution and ecological degradation. This throughput aspect of the flow of resources from nature into the economy and the flow of wastes back out into the 'environment' did not enter into economic thinking, because it was believed to be infinite in extent, while neoclassical economics was chiefly concerned with the allocation of resources perceived to be scarce (Daly, 1989) and Marxist economics focused on distribution. Thus, there was no explicit biophysical 'environment' to be managed, since it was seen as irrelevant to the economy. According to Lester Thurow (1980, p. 112), "worries about natural resource exhaustion are hard to rationalize from the point of view of economics."

TABLE 1. Basic Distinctions Between Five Paradigms of Environmental Management in Development

Paradigm: / Dimension	Frontier Economics (FE)	Environmental Protection (EP)	Resource Management (RM)	Eco-Development (ED)	Deep Ecology (DE)
Dominant Imperative:	"Progress," as Infinite Economic Growth & Prosperity	"Tradeoffs," as in Ecology versus Economic Growth	"Sustainability" as necessary constraint for "Green Growth"	Co-developing Humans and Nature; Redefine "Security"	"Eco-topia": Anti-Growth, Constrained Harmony with Nature"
Human-Nature Relationship:	Very Strong Anthropocentric	Strong Anthropocentric	Modified Anthropocentric	Ecocentric ?	Biocentric
Dominant Threats:	Hunger, Poverty, Disease, "Natural Disasters"	Health Impacts of Pollution, Endangered Species	Resource Degradation; Poverty, Population growth	Ecological Uncertainty Global Change	Ecosystem Collapse "Unnatural" Disasters
Main Themes:	Open Access/ Free Goods Exploitation of Infinite Natural Resources	Remedial/Defensive "Legalize Ecology" as Economic Externality	Global Efficiency "Economize Ecology" Interdependence	Generative restructuring "Ecologize Economy" & Social System Sophisticated symbiosis	Back to Nature "Biospecies Equality" Simple Symbiosis
Prevalent Property Regimes:	Privatization (Neoclass.) or Nationalization (Marx.) of all property	Privatization dominant; Some Public Parks set aside	Global Commons Law (GCL) for Conservation of: Oceans, Atmosphere, Climate, Biodiversity	GCL + Local Common & Private Property regimes for Intra- & Inter-Generational Equity & Stewardship	Private, plus Common Property set aside for Preservation
Who Pays?	Property Owners (Public at Large; especially Poor)	Income Tax payers (Public at Large)	"Polluter Pays" (producers & consumers) (Poor)	"Pollution Prevention Pays;" Income-indexed Environmental Taxes	Avoid costs by fore-going development
Responsibility for Development & Management	Property Owners: Individuals or State	Fragmentation: Development decent-ralized, Management centralized	Toward Integration - across multiple levels of gov't.(fed./state/local)	Private/Public Institutional Innovations & Redefinition of Roles	Largely decentralized but integrated design & management
Fundamental Flaws:	Creative but mechanistic; No awareness of reliance on ecological balance	Defined by F.E. in reaction to D.E.; Lacks vision of abundance	Downplays social factors; Subtly mechanistic; Doesn't handle uncertainty	May generate false security; Magnitude of changes require new consciousness	Defined in reaction to F.E.; Organic but not Creative; How reduce population?

TABLE 1, continued. Basic Distinctions Between Five Paradigms of Environmental Management in Development

Paradigm: / *Dimension*	*Frontier Economics (FE)*	*Environmental Protection (EP)*	*Resource Management (RM)*	*Eco-Development (ED)*	*Deep Ecology (DE)*
Environmental Management Technologies and Strategies:	Industrial Agriculture: High Inputs of Energy, Biocides, Nutrients, & Water; Monocultures & Mechanized Production Fossil Energy Pollution Dispersal Unregulated Waste Disposal High Population Growth "Free Markets"	"End-of-the-Pipe" Clean-up, or "Business as Usual—Plus a Treatment Plant" "Command & Control" Market Regulation: Some Prohibition or Limits, Repair, & Set-asides. mainly focus on Protection of Human Health, "Land Doctoring" Environmental Impact Statements	Impact Assessment & Risk Management, Pollution Reduction, Energy Efficiency, Renewable Resource/ Conservation Strategies, Restoration Ecology, Population Stabilization & Technology-Enhanced Carrying Capacity, Some Structural Adjustment	Uncertainty (Resilience) Management, Industrial Ecology Eco-Technologies, e.g: Renewable Energy, Waste/Resource Cycling for Throughput Reduc-tion, Agro-forestry, Low Input Agriculture, Extractive Forest Reserves; Population Stabilization & Enhan-ced Capacity as for RM	Stability Management Reduced Scale of Market Economy (inc. Trade) Low Technology Simple Material Needs Non-dominating Science Indigenous Technology Systems "Intrinsic Values" Population Reduction
Analytic/ Modeling and Planning Methodologies:	Neoclassical or Marxist: Closed Economic Systems: Reversible Equilibria, Production Limited by Man-made factors, Natural factors not accounted for. Net Present Value Maximization Cost-Benefit Analysis of tangible goods & services	Neoclassical Plus: Environmental Impact Assessment after Design; Optimum Pollution Levels; Equation of Willingness to Pay & Compensation Principles	Neoclassical Plus: Include Natural Capital. True (Hicksian) Income Maximization in UN System of National Accounts; Increased, Freer Trade Ecosystem & Social Health Monitoring; Linkages between Population, Poverty, & Environment	Ecological Economics: Biophysical-Economic Open Systems Dynamics; Socio-Technical & Ecosystem Process Design; Integration of Social, Economic, & Ecological Criteria for Technology; Trade & Capital flow regulated based on Community Goals & Mgmt; Equity in Land distribution; Geophysiology	Grassroots Bioregional Planning; Multiple Cultural Systems; Conservation of Cultural & Biological Diversity; Autonomy

Hence, the economy became disembodied from nature, in theory and in practice. "The standard textbook representation of the economic process by a circular diagram, a pendulum movement between production and consumption within a completely closed system," with all flows being completely reversible, was widely accepted (Georgescu-Roegen, 1971). The primary limiting factors of production are perceived, in both neoclassical and Marxist economic analysis, to be human labor and man-made capital. There is an unbridled faith in the 'progress' of human ingenuity, in the benevolence of technological advancement, and their combined capacity to reckon with any problems that might arise, usually through substitution when scarcity causes prices to rise. Since both nature's capacity and human ingenuity are seen as boundless, there is little conceptual possibility for the combination of the accumulation of damage and the depletion of resources to eventually constrain production and human opportunity.

Depleting or degrading resources increases their measured value, but it often eventually decreases people's quality of life and degrades the functionality of the ecosystem on which it rests, making it and them more vulnerable. This paradox of generating 'value' by creating scarcity results from a narrow definition of efficiency within modern economics' exchange theory of value. Only exchangeable resources that are considered scarce must be used efficiently, so that non-scarce items inexorably become scarce, and therefore valuable.

Consistent with widespread interpretations of the major Western religions and Francis Bacon's "Technological Program" for the development of modern Western science, nature is seen in this paradigm as existing for man's instrumental benefit, to be explored, manipulated, exploited, modified, and even 'cheated' in any way possible that could improve the material quality of human life (White, 1967; Berman, 1981; Pepper, 1984). In fact, nature was to be remade according to man's image, transformed so as to be more suitable to humans' needs and desires.

Many technologies that have been used for 'development' are basically technologies or strategies for managing the environment, since they were developed for the purpose of increasing man's power to extract resources and production from nature, and/or to reduce the impacts of nature's variability on society. A prime example is modern industrial agriculture, which in order to solve the basic problem of hunger, replaced natural nutrient cycles, climate, plant–plant/herbivore interactions, and diverse ecosystems with fossil fuel energy, irrigation, man-made chemical 'pesticides' and specialized monocultural agro-ecosystems. Another example is the 'tall smokestacks' strategy of waste dispersal. Based on the illusion that if pollution is spread thinly enough, it will go unnoticed, by people or by nature, this led to the problem of acid rain.

Most developing nations have emulated this basic approach to economic and environmental management in one way or another. This Frontier Economics approach is often justified as a minor evil, 'necessary' during the early-industrial stages of development, along with rapid population growth, in order to achieve a more advanced state. It is believed that damage can easily be repaired where necessary, after development has proceeded to some point where explicit environmental management can be afforded (see section Environmental protection). The fundamental flaw is a lack of awareness of the human economy's basic dependence on a vast array of physical and biological resources for materials, energy, and food, and even more basic, the fine balance of interdependent ecological services on which they all depend (after Westman, 1977).

2. DEEP ECOLOGY

'Deep ecology' (Naess, 1973; Devall and Sessions, 1985) is one name for a worldview that has been widely interpreted as the polar opposite of frontier economics; a fundamentally different value/ethical system. In many regards, it is a reaction to consequences of the dominant paradigm. It is much less widely understood or accepted, though as a political movement it is growing. *Deep* ecology is not to be confused with the *science* of ecology. In its current form, it is an attempt to synthesize many old and some new philosophical attitudes about the relationship between nature and human activity, with particular emphasis on ethical, social, and spiritual aspects that have been downplayed in the dominant economic worldview (Nash, 1989).

Deep ecology is far from a unified, consistent philosophy as of this date, though some of its advocates consider this to be a strength rather than a weakness, promoting diversity and flexibility. [1] It draws eclectically on various schools of thought such as wilderness preservationism; 19th century romanticism and transcendentalism, eastern philosophies and religions such as Taoism and Buddhism; various religions' concepts of ethics, justice, and equity; ecofeminism; pacifism; Jeffersonian decentralized, participatory democracy; and some of the social equality aspects of socialism, in addition to the modern science of systems ecology.

Deep ecologists advocate merging appreciation of some of the more scientific aspects of systems ecology with a 'biocentric' (non-anthropocentric) or 'harmonious' view of the relationship between man and nature. Among the basic tenets are intrinsic 'biospecies equality'; major reductions in human population; bioregional autonomy (reduction of economic, technological, and cultural dependencies and exchanges to within integrous

[1] See, for example, *The Ecologist*, Vol. 18, No. 4/5 (1988).

regions of common ecological characteristics); promotion of biological and cultural diversity; decentralized planning utilizing multiple value systems; non-growth oriented economies; non-dominant (simple or low) technology; and more use of indigenous management and technological systems. Deep ecologists (and many others) see technological fixes as usually leading to larger, more costly, more intractable problems, rather than 'progress'.

In practice, these strategies often mean making man subservient to nature, the reverse of the frontier economics hierarchy. The application of this philosophy would result in radical changes in social, legal and economic systems, and definitions of 'development'. The extreme imperative is of an anti-growth 'Eco-topia', of a constrained 'harmony with nature'. While some of these principles can be used to inform future development planning approaches, to expect the whole world to return to pre-industrial, rural lifestyles and standards of living has been widely regarded as highly impractical, and to most people, undesirable. It would probably be impossible at current population levels. While Deep Ecology may be more 'organic', it tends not to be creative – one of the fundamental drives in the evolution of both nature and human society (Jantsch, 1980).

3. ENVIRONMENTAL PROTECTION

The dominance of the frontier economics paradigm began to weaken in the 1960s, especially after the publication of Rachel Carson's book, *Silent Spring* (1962). The recognition of the pollution problem in the polarized context of frontier economics versus the nascent deep ecology schools led to the perception of the necessity to make compromises, or tradeoffs; the perception of 'Ecology versus Economic Growth' became freshly explicit.

'Environmental impact statements' were institutionalized in some industrial countries. Their purpose was to provide a rational means for assessing the costs and benefits of development activities before they began. In actuality, statements often were added on after project planning and design were well along, so that the late-coming environmental concerns usually ended up being perceived as 'anti-development'. This accounts for much of what might be called the 'negative, or defensive agenda' in environmental politics and management. It is termed negative because it institutionalized an approach that focussed on *damage control*: on repairing and setting limits to harmful activity. Rather than focussing on ways to *improve* both development actions and ecological resilience, this approach was inherently defensive or *remedial* in practice. It has also been described as the 'end-of-the-pipe' or 'business-as-usual, plus a treatment plant' approach. To use a medical analogy, 'land doctoring' is practiced rather than 'land health'.

Economic analysis is still based on the neoclassical model of the closed economic system; the principal strategy of this paradigm is to *legalize the environment as an economic externality*. 'Optimal pollution levels' are defined, more by short-term economic acceptability, and therefore, politics, than by what is necessary for the maintenance of ecosystem resilience. 'Command-and-control' regulatory approaches are relied upon to attain such levels. Pollution dispersal continues to be a common approach to amelioration, even when it creates yet larger, more costly problems down the road (e.g., international transport of acid precipitation). The prescription of new technological solutions to mitigate pollution problems (e.g., expensive smokestack 'scrubbers') has also become part of this strategy.

Separate 'Environmental Protection' agencies or ministries are created and given responsibility for setting the limits, and in some cases, cleaning up after limits are exceeded. But they are not responsible for planning development activities in ways that do not pollute or impair necessary ecological functions, or that facilitate ecological functions at the same time as making use of them.

Relatively small parcels of common property sometimes were converted to state property to be set aside for preservation or conservation as national parks and wilderness reserves. A more pervasive conceptual tenet of this path, however, is the neoclassical belief in the privatization of property as a principal solution to overuse of resources. Garrett Hardin's classic allegory of *The Tragedy of the Commons* (1968) has been widely accepted by researchers and development practitioners as a basis for this prescription. Common property regimes are associated with 'inevitable' resource degradation. This became the dominant perspective from which social scientists view natural resource issues.

The 1972 Stockholm Conference signaled the internationalization of the problem of environmental disruption. While it is quite unfair to say that the conceptual framework for Stockholm and its follow-up (such as the creation of UNEP, and the Cocoyoc Conference in 1974) was exclusively of the 'remedial' focus described above, the predominant practical consequences were still in this mode. UNEP has no operational power and no responsibility for truly changing the ways in which development activity is organized and measured. It is an information-gathering agency, ensconsed in Nairobi, far from the corridors of power, financial resources, and decision making.

The perception of unaffordability and unfairness is at least in part due to the fact that the environmental protection approach is basically a modest variation on the 'frontier economics' paradigm of development. Constraints to activity are added, the effects of which are often interpreted as keeping the rich rich and the poor poor. Because economic analysis seeks only limited, monetary-based types of information, and ecological benefits are difficult to quantify, environmental management in this variation of the model only shows up as added costs. Development activities that are ecologically benign or even beneficial are rarely recognized as such. The impacts of pollution on human health, the aesthetic quality of the environment, and rare wild species are often the prime 'environmental' concerns of industrial country governments; for this reason, some economists have claimed that it is mainly the concern of the industrial middle class. Developing country governments often have seen environmental concerns, especially pollution and land/wildlife protection, as the interests of the elite class of rich countries, and contrary to their needs and interests. Somewhat paradoxically, governments do usually bow to local elite groups when they resist land reform measures that might be useful in addressing some of their resource problems.

4. RESOURCE MANAGEMENT

The publication of the Club of Rome's global systems dynamics modeling effort, *The Limits to Growth* (Meadows et al., 1972) was another landmark. This report, along with subsequent modeling attempts such as the U.S. *Global 2000 Report to the President* (CEQ, 1980), was widely vilified because it projected a future of 'doom and gloom' based on linear extrapolation of trends without considering the positive potential of technological change, resource substitution, and price mechanisms. But many of the threats predicted in early modeling efforts in fact remain serious, despite the fact the one often reads statements that the doom and gloom scenarios have been 'vanquished'. Non-governmental and international organizations, such as the International Union for the Conservation of Nature and Natural Resources (IUCN) and the UN, prepared the World Conservation Strategy (IUCN, 1980) and the World Charter for Nature (UN, 1982). The Tropical Forestry Action Plan (WRI, 1985) was launched (and has since been widely criticized, even by some of its creators, for making the problem worse by focusing on 'industrial' forestry more than communities and biological diversity (Winterbottom, 1990).

Resource Management is the basic theme of reports such as the Brundtland Commission's Our *Common Future* (WCED, 1987), the Worldwatch Institute's annual *State of the World*, and the World Resources Institute's biannual *World Resources* reports. It involves both a fairly natural theoretical extension of neoclassical economics and a substantial change in practice. Thus, it might be termed 'evolutionary', rather than 'revolutionary'. The basic idea is to incorporate all types of capital and resources – biophysical, human, infrastructural, and monetary – into calculations of national accounts, productivity, and policies for development and investment planning. Climate and the processes regulating it are coming to be regarded as a fundamental, vital resources to be managed under this paradigm. The interdependence and multiple values of various resources are taken into greater account (e.g., the role of forests as watersheds, affecting hydropower, soil fertility and agricultural productivity, climate regulation and even fisheries productivity). Future rationales for parks or reserves will focus more on their genetic resource and climate regulation values. Resource managers view the stabilization of population levels in developing countries and reductions in the per capita consumption (via increased efficiency) in the industrial nations as absolutely essential to achieving sustainability. Again, these resources are intended for potential use by humans; in fact, that is what the term 'resource' implies.

'Global Commons' resources, such as the atmosphere and its ozône layer in particular, climate, biodiversity, and oceanic resources, have emerged as issues for which the prevailing legal, economic, political, and institutional structures and concepts are completely inadequate. As a result, several new initiatives in global commons law have taken hold, with several more possible. [2]

Another paradox is that while the poor are harmed more by both pollution and resource degradation than are the rich, the poor's immediate survival priorities usually supersede their environmental quality interests. The political economy and the practical concerns of environmental management in developing countries are quite different from those of industrial nations. Resource depletion is often felt more severely than pollution effects, but those most affected have had little means of generating meaningful change. This is starting to change in some countries, (e.g., Brazil and India) where as in Eastern Europe, new movements for greater political freedom are starting with 'environmental' causes (Bandyopadhyay and Shiva, 1988). These are of course buttressed by greater interest from international quarters – NGOs, the media, politicians – and modern communications technology.

Concern for the environment no longer implies that one is necessarily anti-development. In fact, sustainable development depends on it. Though there is considerable rhetoric to this effect, it is proving difficult for many to grasp its operational significance, and to make the necessary decisions to

[2] Previous efforts included: The Antarctica Treaty (now being renegotiated), the Convention on the International Trade of Endangered Species (CITES), the stalled Law of the Sea, the Nile Waters Agreement, and the U.S.–Canada Boundary Waters Treaty. Recent measures include the 1988 Montreal Protocol on Ozone and subsequent efforts to strengthen it, and an agreement on the International Trade of Hazardous Wastes. Other possibilities include an 'International Law of the Atmosphere', a 'Biodiversity Conservation Agreement', recognition of World Court jurisdiction by the nations of the UN Security Council, etc.

change business-as-usual. It is all too easy to fall into the conventional, polarizing language of the frontier economics versus deep ecology debate. The neoclassical imperative of economic growth is still seen as the primary goal of development, but sustainability is viewed as a necessary *constraint* for 'green' growth (Pezzey, 1989).

Much work is being done to integrate understanding of the economy of nature with the economy of markets, and to improve the UN System of National Accounts accordingly (e.g., the subject of several papers from the World Bank's Environment Department and reports by the World Resources Institute and UNEP). Calculations of *Hicksian income*, which is by definition sustainable (Hicks, 1946), need to incorporate natural, or non-man-made capital as well as man-made economic resources such as labor, money, infrastructure.

This approach has also been called the '*Global Efficiency*' paradigm (W. Sachs, 1988). Its core program depends on new technologies to increase energy efficiency in particular and resource conservation in general, and the 'polluter pays principle' of internalizing the social costs of pollution, rather than mandating particular clean-up technologies (Kapp, 1950, 1971; Beckerman, 1975/90; OECD, 1975). Correcting incentive systems in order to harness market forces for efficient environmental management is a major theme; tradable emissions permits are a prime example. Much of the work is focussed on 'getting the prices (of all resources) right'. *In essence, ecology is being economized.*

5. ECO-DEVELOPMENT

"The existence of tradeoffs between environmental management and economic growth can not be denied, but their pervasiveness and intensity have been overrated, to the detriment of a search for the best of two worlds."

Ignacy SACHS, 1984b

'Eco-Development' (e.g., Riddell, 1981; Glaeser, 1984; Sachs, 1984a, b) more explicitly sets out to restructure the relationship between society and nature into a 'positive sum game' by reorganizing human activities so as to be synergetic with ecosystem processes and services, as opposed to the back-to-nature 'simple symbiosis' advocated by deep ecologists. 'Eco-' signifies both 'economic' and 'ecological', since both words come from the same Greek root. The use of 'Development' rather than 'Growth', 'Management' or 'Protection' connotes an explicit reorientation and upgrading of the level of integration of social, ecological and economic concerns.

Eco-Development would expand the boundaries of the system considered under Resource Management. The model of the closed economic system is replaced with the 'biophysical economics' model of a thermodynamically

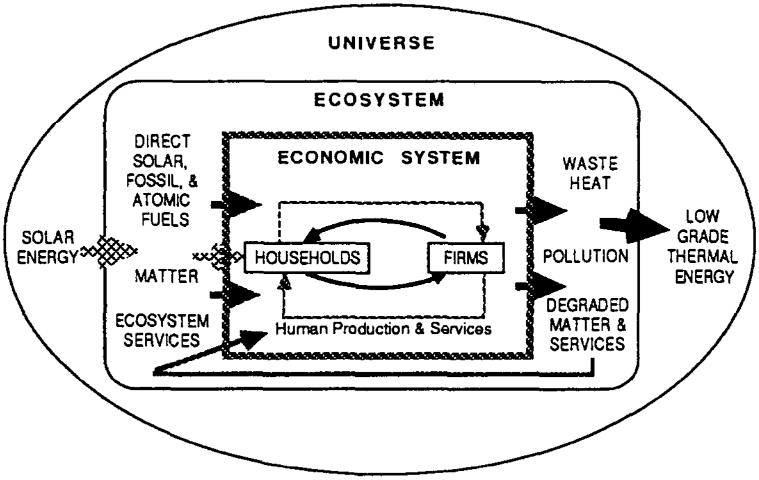

Fig. 2. Economic production from a biophysical perspective. A continuous input of high-quality/low entropy fuels, materials of varying entropy ('natural' resources), and ecosystem services enter the economic system from the larger ecosystem. The economy then uses the fuels to upgrade the natural resources, driving the circular flow between households and firms in the process. The fuel, materials, and services are degraded and returned to the ecosystem as low quality, high entropy heat and matter and impaired ecosystem process functioning. [Colby (1990a), modified from Hall et al. (1986) and Daly (1977).]

open economy embedded within the ecosystem: biophysical resources (energy, materials, and ecological processing cycles) flow from the ecosystem into the economy, and degraded (non-useful) energy and other by-products (pollution) flow through to the ecosystem (Fig. 2). It would attempt to move from polluter pays to 'pollution prevention pays', explicitly restructuring the economy according to ecological principles 'to reduce this 'throughput' to sustainable levels.

The distinction between growth in *biophysical* scale and *economic* growth and development is fundamental. [3] Decoupling them would in effect make actual systems of economic production and consumption operate closer to the ideal of the neoclassical circular model of the environmentally closed economy. While recognizing the impossibility of 'angelizing' the economy (Daly, 1977), [4] Eco-Development would stride purposefully toward the ideal of maintaining throughput at a sustainable level while achieving growth in

[3] A measure of biophysical *scale* or throughput is per-capita resource consumption times population, while *economic* activity is usually measured by the flow of currency.

[4] Due to the physical laws of thermodynamics and the complementarity of input factors, there are energy and physical resources embodied in all labor and man-made capital. Maintenance of the status quo alone requires energy and materials. See: Daly, 1977; Costanza, 1980; Gever et al., 1986; Hall et al., 1986.

economic welfare. It would pursue not just efficiency as it is conventionally thought of, but also synergies gained from designing agricultural and industrial processes to mimic the logic of, and where possible, actually use ecosystem processes. Examples of *ecological engineering* (Mitsch and Jørgensen, 1989) include constructed wetlands and in situ aquifer purification for wastewater processing, integrated pest management, multi-cropping and agro-forestry, and turning the unused byproducts of one production process into the inputs for another (Sachs and Silk, 1988). New fields such as agroecology, industrial ecology, and ecological engineering are based on this type of logic.

Eco-development requires longer term management of adaptability, resilience, and uncertainty, to reduce the occurrence of 'surprises' caused by crossing over unknown ecological thresholds. Ecological uncertainty needs to be incorporated into economic modeling and planning mechanisms; current techniques of risk management are of limited use in complex, tightly coupled systems where discontinuous change becomes more likely (Perrow, 1984; Perrings, 1987). Tradable emissions (pollution) permits, an economic tool derived from the polluter pays principle, do not adequately incorporate ecological uncertainty and social equity issues. They not only create a market for 'bads', they also create new property regimes, as in the right to pollute. Once new property rights have been created (a politically sticky allocation problem in its own right), they are very difficult to take away. [5] Given the extreme uncertainties involved in calculating sustainable levels of pollution, or even resource harvest, it is likely that permit levels would need to be changed.

From the Eco-Development perspective, one of the most significant attitude changes modern society needs is to give up the notion that people have a right to do whatever they have done in the past (business as usual). *Gradually* ecologizing tax codes, by increasing taxes on resource extraction and polluting activities, while simultaneously decreasing taxes on other activities that should be encouraged (labor, savings, investment, recycling resources, increasing efficiency, protection of ecosystem functions, etc.) can be a more flexible as well as socially more equitable means of attaining sustainability than tradable pollution rights (Colby, 1990b).

Eco-development also attempts to incorporate the social equity and cultural concerns raised in the various schools of deep ecology. Greater recognition is given to indigenous knowledge and experience in the manage-

[5] This is demonstrated by the empirical difference between environmental valuation as calculated by the 'willingness to pay' method versus the 'willingness to accept' techniques of environmental economics (Knetsch and Sinden, 1984; Knetsch, 1989).

ment of human-ecosystem interactions. Ecologically sound common property regimes would be maintained and perhaps replicated (Berkes, 1989; Bromley and Cernea, 1989). [6] Eco-Development thus moves on from economizing ecology to *ecologizing the economy, or whole social systems*. From the conflict between anthropocentric versus biocentric values, it attempts to synthesize *ecocentrism*: refusing to place humanity either above nature or below it.

Parallel to the rise of the 'systems analysis' schools of thinking used in Resource Management came another systems approach to planning and action for social systems, which recognized the limitations of centralized planning (Ackoff, 1974; Passmore and Sherwood, 1978; Vergara et al., 1980). There have been several variations on this 'soft synthesizing systems' approach, some more directly focussed on the integration of ecological and developmental goals than others (see especially, Hawk, 1979, 1984; Bandurski et al., 1986; Caldwell, 1988). A basic commonality between them is the idea that planning should be embedded in the total environment of the systems being planned for, including all of the parties affected (stakeholders).

The controversial 'Gaia Hypothesis' (Lovelock, 1979) is the inspiration for many ideas about the relationship between human activity and nature (including justifications of both Deep Ecology and Frontier Economics). This theory postulates that the Earth is a self-organizing, self-regulating living system in which life itself actively influences the environmental conditions which sustain it. (It has been shown that this does *not* require purposeful consciousness, as critics of the hypothesis have complained.) Lovelock (1988) has proposed a new science of '*geophysiology*', based on the marriage of biology, geochemistry, and atmospheric sciences. Much research that should prove very useful – on climate change, for instance – has been spawned as a result of ideas inspired by this hypothesis. Work on the theory of 'co-evolutionary development' of humans and nature (Norgaard, 1988) is attempting to bridge the new social/self-organizing/gaia systems theories.

CONCLUSIONS: POSSIBILITIES FOR CONVERGENCE?

In many cases, behavioral factors (be they individual, organizational-institutional, or political) are more important than economic and technological factors in influencing societal actions (Allison, 1971). There is a tendency to

[6] Such as sustainable extractive forest reserves, rather than clear-cutting for timber, cattle, and short-term cropping; careful common management of tribal drylands such as by the nomadic Samburu of Kenya; and the involvement of local peoples in the management and benefit-sharing of national parks and eco-tourism, as with the Maasai in Kenya, or Luangwa Valley in Zambia.

view calls for change, whether behavioral or technological, as threats. However, the post-WWII 'economic miracles' of West Germany and Japan were based on such radical changes, not just on the mythical hard-working nature of those cultures. They were forced to completely renew their economic infrastructure with investments in new, state-of-the-art technological production systems, as well as innovative ways of organizing the social factors of production. It is likely that by restructuring along the lines of eco-development, companies and nations will develop new comparative advantages that will help to make the most adaptable more competitive and prosperous in the long run, rather than less so, as is frequently feared today. Some developing countries might even be able to 'leapfrog' over the 'environmental protection' phase to a much more sustainable, as well as self-defined, state of development.

Fig. 3 depicts the progression in how economics has considered three types of concerns: allocation, distribution, and scale (Foy and Daly, 1989). Since the late 1800s, they have been seen as separate and conflicting, with a fundamental battle raging between allocative and distributive economics, while biophysical issues were neglected. But neither free market nor socialist economies have used the environment sustainably (Redclift, 1987). Perhaps a major part of what is needed for Eco-Development to emerge is a new economic synthesis that re-integrates all three types of concerns. Ecological Economics would thus appear to be more like Classical Economics than the three intermediary economic paradigms, albeit utilizing many of their more sophisticated, powerful techniques and concepts (Bandurski, 1973; Goodland and Ledec, 1987; Martinez-Alier, 1987).

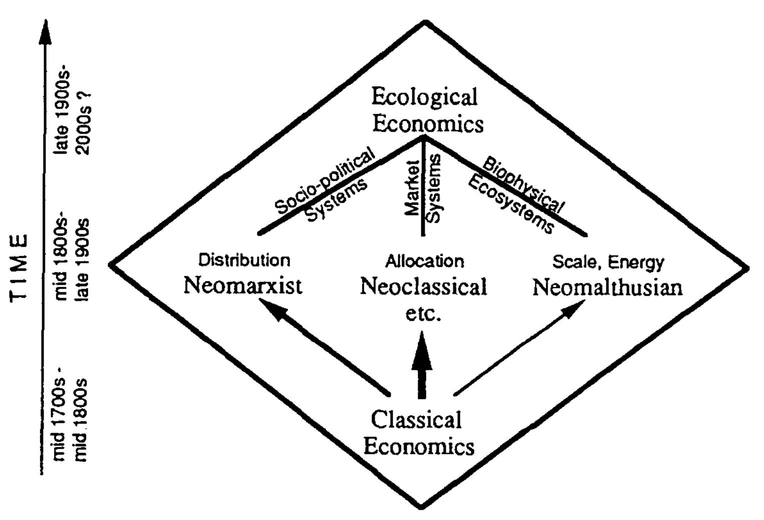

Fig. 3. Evolution of Economic Paradigms. [Colby, (1990a).]

Paradigms of the relationship between environmental management and development are in a period of flux. The defensive (remedial) agenda is breaking down because of its ineffectiveness in dealing with the negative consequences of unmodified frontier economics and development. The serious push at the more 'neutral' (resource management, systems analysis) agenda very recently has begun to get under way. The widespread perception at this time is still one of tradeoffs between environment and development.

However, this is a pernicious and unnecessary assumption. There are great economic and social benefits to be obtained from fully integrated approaches to environmental management. The mislabeling of various societal messes as 'environmental' problems is in many cases what helps to perpetuate them, because it enables professionals to conceive of them as 'externalities' to be solved, cleaned up, or managed by different people from those who were responsible for creating the messes, rather than as evidence of a faulty system of logic by which society makes its choices (Miller, 1985). It also helps keep debates about 'sustainable development' unnecessarily polarized, preventing workable resolutions from emerging.

Still on the fringes are small but growing pockets of advocacy for the more positive approach, be they through the 'synthesizing-systems' planning methodologies, or the contextual, philosophical and values-based approaches of what are today some leading edges of science. The co-evolutionary approach would require inclusion of all user groups, or stakeholders, in the development of future environmental management and development strategies.

It should be remembered that the five paradigms presented here (summarized in Fig. 1 and Table 1) are not separate species. As is appropriate in times of great change, there is some fluidity between them. No single approach has the best answer to every type of environmental management or development problem. As the newer paradigms evolve, they incorporate much of the older ones.

It is hypothesized here that three sets of conditions may combine to provide the necessary and sufficient forces for convergence to a paradigm along the lines of eco-development more rapidly than sometimes seems politically expedient to advocate at this time: (1) the unprecedented degree of threat of global changes in the ozone layer and climate issues, (2) widespread problems of resource depletion/degradation, and (3) the easing of the military and ideological competition between the superpowers, which has opened the possibility of redefining the meaning of national security to include ecological as well as economic and military concerns (Mathews, 1989; Myers, 1989; Renner, 1989)

Time might appear to be on the side of ecodevelopment. On the other hand, it may be that paradigms are impervious to evidence, institutions and societies too difficult to change, and the adherents to each will go on talking past each other, avoiding the real discussions and conflicts that are necessary to ultimately achieve a synthesis.

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