80

World Bank Discussion Papers

Environmental Management in Development

The Evolution of Paradigms

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Abstract

The importance and the methodologies of environmental management, and its relationship to human development, are in a period of dramatic change. Conceptions of what is economically and technologically practical, ecologically necessary, and politically feasible are rapidly being altered. Implicit in such changing strategies are differing philosophies of human-nature relationships.

For centuries, a usually implicit debate has prevailed between what have come to be called "economics" and "development" on one side, and the "preservation of nature" and "ecology" on the other. In the past quarter century, as environmental management has become an increasingly explicit and significant matter requiring the attention of governments, corporations, communities, and individuals, this dichotomy has begun to break down. The resolution of this debate involves much more than ecology and economics; it includes different approaches to the organization of social and production systems, orientations toward the past and the future, and philosophies of science and epistemology.

Societies are beginning to have serious discussions about "sustainable development." Many different ideas are emerging, from a wide range of disciplines, about what environmental management and sustainable development entail. Five broad, 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 each prescribes different solutions, strategies, technologies, roles for economic sectors, culture, governments, and ethics, etc.

Each paradigm actually encompasses several schools of thought, not always in complete agreement, and there are also overlaps between them. The paper explores the distinctions, connections, and implications of these five paradigms for the future of environmental management in development.

I. Introduction

The range of environmental problems perceived to be major threats to human welfare has expanded considerably over the past two decades, from pollution issues at local, regional and then international scales, to widespread natural resource depletion and degradation, to truly global concerns such as climate change and the ozone layer (see Table 1). The subject of "environmental management"[1] and its integration with "development"[2] has therefore become a major concern and challenge for a growing number of people, businesses, and governments of the world. While this is not a new subject, the level of concern and sense of urgency has reached new heights, and presently there is widespread discussion, a myriad of new proposals, commitments of resources, and programs of action. Examples include the Montreal Protocol on Ozone, the publication of the Brundtland Report, *Our Common Future* (WCED, 1987), the international agreement over the disposal of hazardous wastes; the Intergovernmental Panel on Climate Change, the furor over deforestation in the Amazon, the creation of a central Environment Department and four regional technical environmental divisions in the World Bank, growing cooperation between environmental NGOs and international agencies to create and coordinate action agendas, and a burgeoning of articles on redefining "national security" to incorporate the needs of environmental/resource quality and stability in addition to economic and military interests (e.g., Mathews, 1989; Myers, 1989; Renner, 1989).

With all this political, organizational, scientific, and public activity, the subject of how mankind is to integrate environmental management with concerns about economic and social development in order to create and ensure a future for civilization is, sixteen years after the groundbreaking 1972 Stockholm UN Conference on the Human Environment, once again a major arena of debate. Not unrelated to changes in the types and scale of environmental threats and the new initiatives mentioned above, the practices of environmental management and economic development planning, and the theoretical constructs on which they rest, are in a period of major revision. The outcome of this evolutionary process is particularly important because, in the words of the Assistant

1 *Environmental Management*: the field that seeks to balance human demands upon the Earth's natural resource base with the natural environment's ability to meet these demands on a sustainable basis.

2 *Development*: a process of progressive societal (therefore involving equity and political issues) and economic transformation, the major objective of which is the satisfaction of human needs and aspirations, usually achieved by increasing productive potential (growth) and equality of opportunity (WCED, 1987).

TABLE 1. Evolution in the Perception of Serious Environmental Problems

1970 (MIT Study)	1982 (Råttvik Conference, see Smil, 1987))	1988 (Blueprint for the Environment)	Compiled 1988 (Worldwatch, ICSU, IIASA, WCED, UNEP)
Carbon dioxide Thermal pollution	CO2/ Greenhouse Gases, Sea Rise	Greenhouse gases/ Global Warming	Global Climate Change, Sea Rise
Atmospheric Particles			
Jet-induced Cirrus clouds			
Supersonic Transport impact on the ozone layer		Depletion of Ozone layer by CFCs	Atmospheric Ozone Concentration Changes (decreases in upper, increases in lower)
Mercury Oil in the ocean Coastal Eutrophication	Ocean Pollution in general	Ocean Pollution in general	Regional Seas Pollution Oil Spills Estuarine/Coastal Eutrophication
DDT (pesticides)	Hazardous chemicals	Toxic substances, Solid Waste	Biocide residues Toxic Wastes and International "Trade"
	The spread of man-made mutant genes		
	Tropical Deforestation Loss of Biodiversity	Tropical Deforestation Loss of Biodiversity/ Habitat	Tropical Deforestation, Loss of Biodiversity/ Habitat
	Acid Rain/ Deposition	Acid Deposition	Acid Deposition, Trans-boundary, Multimedia pollution
	Nuclear Winter		
		Fresh Surface- and Groundwater Pollution	Fresh Water Quality and Quantity
		Population Growth	Population Growth
		Environmental Degradation in Developing Countries	Marginalization of poor, especially indigenous cultures and women
		Wasteful, harmful use of Energy	Inefficient use of Energy
		Soil Loss	Soil Deterioration, Loss, Desertification,Salinity
		Poor Public Lands Management (US)	Poor Land Use policies in general
			Disruption of Ecological/ Biogeo-chemical processes
			Urban growth

Secretary of the Smithsonian Institution, Thomas Lovejoy (1988), "most of the great environmental struggles will be won or lost in the 1990s. . . I am utterly convinced. . . that by the next century it will be too late."

At both operational and theoretical levels, there have been many developments since the Stockholm Conference which portend major changes in the way societies will think about the management of the relationship between nature and human activity in the future. Most of these advances have yet to be institutionalized into governments' and development agencies' policy and planning systems. In many respects, the Brundtland Commission said little that was not said at Stockholm, though perhaps it was said with more widespread participation and urgency. The ideas — that "sustainable development"[3] is necessary, that it requires careful management of the biophysical-geochemical resources and processes of the planet — are now in good currency once again, however. This brings with it both some threats and some major opportunities.

II. A Taxonomy of the Relationship Between Environmental Management and Development

All human activity, economic and socio-cultural, takes place in the context of certain types of relationships between society and the bio-physical world (the rest of nature). "Development" necessarily involves a transformation of these relationships. For instance, agriculture, of any sort, is a form of environmental management, but the types of agriculture implemented may reflect very different underlying conceptions of the relationship between nature and humans, and what "environmental management" means. As societies have evolved or developed, so has this relationship. Sometimes it evolved in ways that might be construed as mutually beneficial and ecologically sustainable. At other times or places, people exacted benefits by attempting to manage nature to improve their chances of survival and quality of life, in ways which have reduced local ecosystems' capacities to provide them in the future.

[3] *Sustainable Development:* (1) "development that meets the needs of the present without compromising the ability of future generations to meet their own needs. ...A process of change in which exploitation of resources, the direction of investments, the reorientation of technology development, and institutional change are all in harmony and enhance both current and future potential to meet human needs and aspirations" (WCED, 1987, p. 43, 46).
(2) a process in which qualitative development is maintained and prolonged while growth in the biophysical scale of the economy becomes increasingly constrained by the capacity of the socio-ecosystem to perform over the long run two essential functions: to regenerate raw material inputs and to absorb waste outputs of the human economy (Daly, 1989c).

This was not too important when such activities took place on a scale that was minor compared to that of nature's own. When populations were small and new frontiers could always be found, people could move on to a new arena when they had exhausted the local capacity of the land to support their activities, and the land would then have time to regenerate itself. Between 1950 and 1986, however, the scale of the world population doubled, from 2.5 to 5.0 billion, while the scale of gross world product and world fossil fuel consumption each quadrupled (Daly, 1988). In this century, world population has tripled, and the world economy has expanded to 20 times its size in 1900 (Speth, 1989). Matter and energy flows — the physical presence of the economy within the ecosphere — were not negligible in 1900, but they now rival in magnitude the flow rates of many natural cycles and fluxes. This is having major effects on the stability of the biogeochemical and physical processes that support life, human and otherwise, on this planet. The result is a new political pseudo-consensus that societies can no longer operate as if economics[4] and ecology[5] were two separate disciplines, with no need to learn from each other. It is probably not yet a truly practical consensus. Without more powerful approaches, and the courage to implement them, the concept of "sustainable development" may prove to be politically unsustainable, subject to yet another period of disillusionment, backlash, or simple disinterest.

If one takes a slightly longer perspective on this "reborn" consensus, it is easy to see that it is more than just the second wind of a process that began in the 1960s. With a considerably longer view, and the idea of the evolution of the relationship between man and nature in mind, one can see that this relationship has taken on a very specific character, in the Western world at least, since the time of the scientific revolution, and developed to its present state in that context. Going back even further in time, or by looking at other societies, one encounters other kinds of relationship between man and nature. Each society, in fact, has had its own relationship with nature. There even exist "ecological" accounts of history, with the thesis that the downfall of certain civilizations may have been more related to what today are

4 *Economics*: (1) the study of allocating the resources available to society in a way that maximizes social well-being (common neoclassical definition). (2) "the wise and legitimate government of the house for the common good of the whole family ... extended to the government of the great family, the State." (Rousseau, 1755, quoted in Bandurski, 1973).

5 *Ecology*: (1) the study of the interrelationships between living organisms and their biological, physical, geological, chemical, and geographic environment (reductionist; McNaughton and Wolf, 1979); or
(2) the study of the structure and function of nature (holistic; Odum, 1953).

called "environmental problems," than to the typical historical accountings of military give and take between societies (Cronon, 1983). Some studies of the Mediterranean and Mayan civilizations have provoked thought in this vein (Weiskel, 1989).

Peoples' views on their relationship with nature is one of the most important aspects of any strategy for human development, though they are very often implicit. Since this relationship is at the root of each of the seemingly distinct fields of "environmental management," "economics," and "development," its evolution is fundamental to current discussions and the future practice of "sustainable development." Societies' fundamental ideas about the relationship between human activity and nature are now in a period of major flux. The term "nature" is used here purposefully to represent one "side" of this relationship, rather than "environment," as the latter is itself a term that has evolved as a consequence of a particular worldview on the relationship between man and nature. In other words, it is the result of one of the very paradigms that are in flux, and as such is a particular conceptual representation of nature which is also evolving.

There are many ways of describing this fundamental relationship and how different social conceptions of it translate to or impact on practical management. Five basic "paradigms"[6] of management of the relationship between humans and nature, or of "environmental management in development," are proposed here. Each paradigm is driven by different assumptions about human nature and activity, about nature itself, and the interactions between nature and humans. 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, of course.

Many of these differences will be highlighted for purposes of distinction. However, it is important to emphasize that these paradigms are not completely distinct or unrelated. Because some aspects are shared between two or more of the paradigms presented, the reader may feel that some of the distinctions made are overdrawn. In part

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6 *Paradigm*: (1) a criterion for choosing problems ... that can be assumed to have solutions. Other problems are rejected as metaphysical, as the concern of another discipline, or sometimes as just too problematic to be worth the time; (2) the entire constellation of beliefs, values, techniques, and so on shared by members of a given community, or one element in that constellation, the concrete puzzle-solutions which, employed as models or examples, can replace explicit rules as a basis for the solution of the remaining puzzles of normal science; (3) not the same as shared rules; the existence of a paradigm need not even imply that any full set of rules exists (Kuhn, 1970). (4) a worldview or mode of perception; a model around which reality is organized (Berman, 1981).

this is true, in part it is evidence of the transitional stage of the debate about just what sustainable development and environmental management entail. All too often, the implications of changing conditions and innovations in thought in the field have not been explored; all variations are viewed by the dominant paradigm as belonging in a single basket of strange thoughts. This is why "environmentalism" and environmental management can look so confusing to "non-environmentalists" — but it is nowhere near as monolithic as the latter tend to believe; just as economics is nowhere near as monolithic as many assume. This is what makes the debate about just what "sustainable development" means so interesting — and what makes greater clarity so very important.

Certain approaches *are* probably more appropriate to different problems or issues than others. Concepts and techniques from all five paradigms will be necessary for long into the future; what is definitely changing is the dominance or relative degrees of emphasis the different approaches are given. At least in part due to shortcomings in the previously dominant approaches, some aspects of the paradigms have evolved out of the others, retaining many of their predecessors' features within an expanded framework. It should also be noted, of course, that there are still disagreements and *many* schools of thought within each general paradigm presented. This paper will identify the core differences between the paradigms and begin to explore their implications.

Figure 1 provides the titles proposed for the five paradigms, and attempts to depict graphically the nature of the "evolutionary" relationships between them. Table 2 provides a summary of the distinctions between them, along the dimensions mentioned above. It is also worth noting that within the basic dimension of dominant perceived threats, one could construct a sub-list of particular problems or risks and then a whole additional matrix of the "solutions" preferred by each of the paradigms (see Colby, 1990a, pp. 194-198). Following Table 2 is a more detailed discussion of each paradigm and the concepts raised in the table.

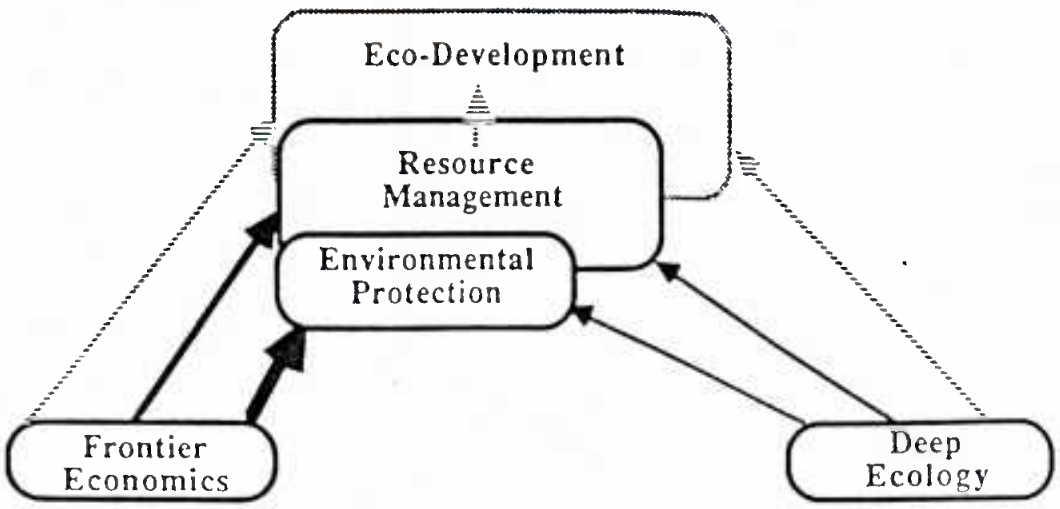

FIGURE 1. Evolutionary Paradigms Diagram.

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 and integration of social, ecological and economic systems in the definition of development and organization of human societies. Non-solid lines indicate the hypothesized future.

TABLE 2. Basic Distinctions Between Five Paradigms of Environmental Management in Development ©M.E. Colby 2/90

Paradigm> Dimension	*Frontier Economics*	*Environmental Protection*	*Resource Management*	*Eco-Development*	*Deep Ecology*
Dominant Imperative:	"Progress," as Infinite Economic Growth and 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 Social Systems" 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: esp. Poor)	Taxpayers (Public at Large)	"Polluter Pays" (producers & consumers) (Poor)	"Pollution Prevention Pays" Income-index Envir. Taxes	Avoid costs by foregoing development
Responsibility for Development & Management	Property Owners: Individuals or State	Fragmentation: Development decentralized Management centralized	Toward Integration across multiple levels of gov't. (e.g., fed./state/local)	Private/Public Institutional Innovations & Redefinition of Roles	Largely Decentralized but Integrated design & mgmt.
Environmental Management Technologies and Strategies:	Industrial Agriculture: High Inputs of Energy, Biocide, & Water; Monocultures, Mechanized Production Fossil Energy Pollution Dispersal Unregulated Waste Disposal High Population Growth "Free Markets"	"End-of-the-Pipe" or "Business as Usual Plus a Treatment Plant" Clean-up. "Command and Control" Market Regulation: Some Prohibition or Limits, Repair, & Set-asides. Focus on Protection of Human Health, "Land Doctoring" Envir. 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 Scale Reduction, Agro-forestry, Low Input Agriculture, Extractive Forest Reserves Population Stabilization & Enhanced Capacity as AM	Stability Management Reduced Scale of Mkt Economy (inc. Trade) Low Technology Simple Material Needs Non-dominating Science Indigenous Tech. 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 & Eco-system Process Design; Integration of Social, Economic, & Ecological Criteria for Technology; Trade & Capital flow regulation based on Community Goals & Mgmt; Land Tenure & Income Redistrib.; Geophysiology?	Grassroots Bioregional Planning Multiple Cultural Systems Conservation of Cultural & Biological Diversity Autonomy
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?
	Frontier Economics (F.E.)	Environmental Protection (E.P.)	Resource Management (R.M.)	Eco-Development (E.D.)	Deep Ecology (D.E.)

A. Frontier Economics

"Frontier economics" is the term used by economist and systems theorist Kenneth Boulding to describe the approach that prevailed in industrial countries until 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 development and consumption of these benefits, in the form of various types of pollution and ecological degradation (Boulding, 1966). 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 predominant economic thinking, because it was believed to be *infinite* in extent, while neoclassical economics was chiefly concerned with the allocation of those resources perceived to be *scarce* (Daly, 1989a). Thus, according to this view, there is no explicit biophysical "environment" to be managed, since it is 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."

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, (Figure 2) was widely accepted (Georgescu-Roegen, 1971). This posed little problem as long as the rate of demand for natural resources and ecosystem services did not exceed nature's capacity to provide them. Since this capacity was assumed to be infinite, for all practical purposes, the issue of *scale* of total resource flow relative to total resource stocks was not considered important (Daly, 1989b). 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 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 limit production and human opportunity.

Sometimes economic theory blocks out ecological reality, not to mention its impact on economic reality — but sometimes it is economists, not their theory, who

narrow their "practical" concerns within a theoretical framework which might be sufficient to handle many ecological problems if properly applied. It is a paradox of economics that "value" is generated by creating scarcity; depleting and degrading resources increases their measured value, but it usually hurts people, the economy, and the functionality of the ecosystem on which they rest. This paradox results from a narrow definition of efficiency within modern economics' *exchange* theory of value; only resources that are considered scarce must be used efficiently, so that non-scarce items inexorably become scarce, and therefore valuable. Meanwhile the people and economies whose survival/ sustainability depends on the *use* of those resources become increasingly vulnerable.

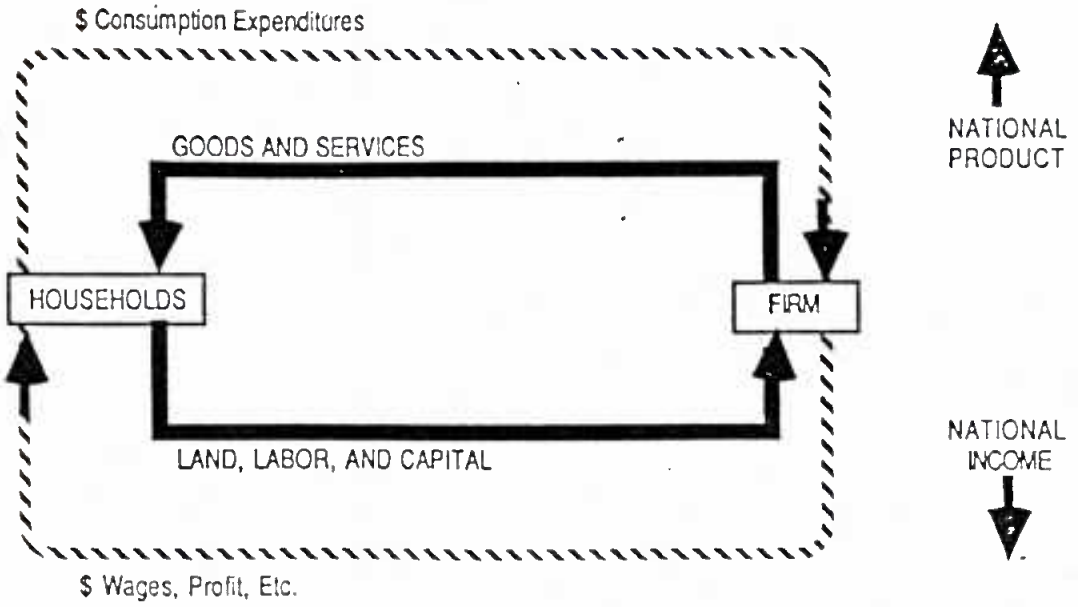

FIGURE 2. Neoclassical Circular Flow Model of Economic Production.

Households sell or rent land, natural resources, labor, and capital to firms in return for rent, wages, and profit (factor payments). Firms combine the factors of production to produce goods and services in return for consumption expenditures, investment, government expenditures, and net exports. (Modified from Hall et al, 1986; and Heilbroner and Thurow, 1981.)

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. The relationship between human activity and nature under this management paradigm thus can be seen as *unilaterally oriented (anthropocentric)*. From "nature's perspective," the relationship may have been characterizable as *zero-sum*, or *negative*; humans benefitted at the expense of other species and natural ecosystems.

This type of relationship between society and nature is common to both relatively decentralized, capitalist economies and centrally-planned, marxist economies. They differ in strategies for organizing development, such as in the type of property regime promoted as most efficient and/or desirable, responsibility for governance and design of activity, and how the income from production is to be distributed, but the underlying worldviews about the roles of people and nature, and their ultimate goals, are much the same. Both capitalism and communism have visions of infinite economic growth and human progress.

Many technologies that have been used for "development" could thus be seen, with a minor adjustment in view, as 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 negative 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, and plant—herbivore/plant—plant interactions with fossil fuel energy, irrigation, man-made chemical "pesticides," and specialized monocultures of genetic hybrid crops. 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. They have been in no small way encouraged by not just the example and teachings, but also the direct policies prescribed for them by the leaders and policy-makers of industrialized nations and international development and financial institutions. Of course, such prescriptions were not necessary intentionally harmful; they arose due to the implicit, often unconscious assumptions made about the relationship and interdependence between human activity and nature. Unfortunately, the hidden effects were built into the policies. This Frontier Economics approach was sometimes justified as a minor evil,

"necessary" during the pre- and early-industrial stages of development, as was rapid population growth, in order to achieve a more advanced state. Such population growth then became a reason for yet more resource consumption and pollution. It is believed that damage, if it is even perceived, can easily be repaired where necessary, after development has proceeded to some point where explicit environmental management can be afforded (see "Environmental Protection"). The vision is one where infinite technological progress and economic growth would eventually provide affordable ways to mitigate environmental problems (and others, such as equity). 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 processes (after Westman, 1977. "ecosystem services," such as nutrient and water cycling, water and air filtration, regulation of climate and atmospheric gases) that support all life and protect its health.

One major problem with this philosophy arises from an important difference in vulnerability to ecological degradation between temperate and tropical ecosystems, and the types of "environmental" problems they face. The resource depletion and ecological destruction going on in tropical nations is in many cases irreversible on a human time scale, unlike the pollution problems which dominated environmental concerns in the industrial countries (at least until very recently; the ozone and global warming issues may be irreversible). In the late 1980s, most developing nations have come to see that they are damaging their own future prospects by pursuing development strategies and policies that are unsustainable, though they often feel that they have no choice. A vicious circle of poverty and ecological destruction has been set up, often as a direct result of "development," with a unifying theme of increasing marginalization of people and the land on which they live. Natural resources and ecological services are now becoming "scarcer," and so economic practice must incorporate them.

B. 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. In many regards, it is a reaction to many of the consequences of the dominant paradigm, and can be seen as a fundamentally different value/ethical system (Figure 3). 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 socioeconomic activity, with particular emphasis on ethical, social, and spiritual aspects that have been downplayed in the dominant economic worldview. 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 (see Vol. 18, No. 4/5 (1988) of the British journal, *The Ecologist*). At any rate, neither is economic theory anywhere near as unified and consistent as its advocates or its critics are wont to assume. This name actually comes from one school of thought within the philosophical spectrum of "Green Politics," which draws eclectically on various schools such as the modern science of systems ecology; 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 (which some have termed "social ecology").

Deep ecologists promote merging an understanding and appreciation of some of the more technical, scientific aspects of systems ecology with a non-anthropocentric, "biocentric," or "harmonious" view of the relationship between man and nature, which often means putting man under nature, the reverse of the frontier economics hierarchy. Among the basic tenets are intrinsic "biospecies equality" (the Convention on the International Trade of Endangered Species, or CITES, signed by over one hundred nations, is sometimes considered a step toward the achievement of this goal); major reductions in human population; bioregional autonomy (reduction of economic, technological, and cultural dependencies and exchanges to within integrous 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 (as well as many systems analysts of the resource management and eco-development paradigms) see technological fixes as usually leading to larger, more costly, more intractable problems — not exactly a desirable form of "progress."

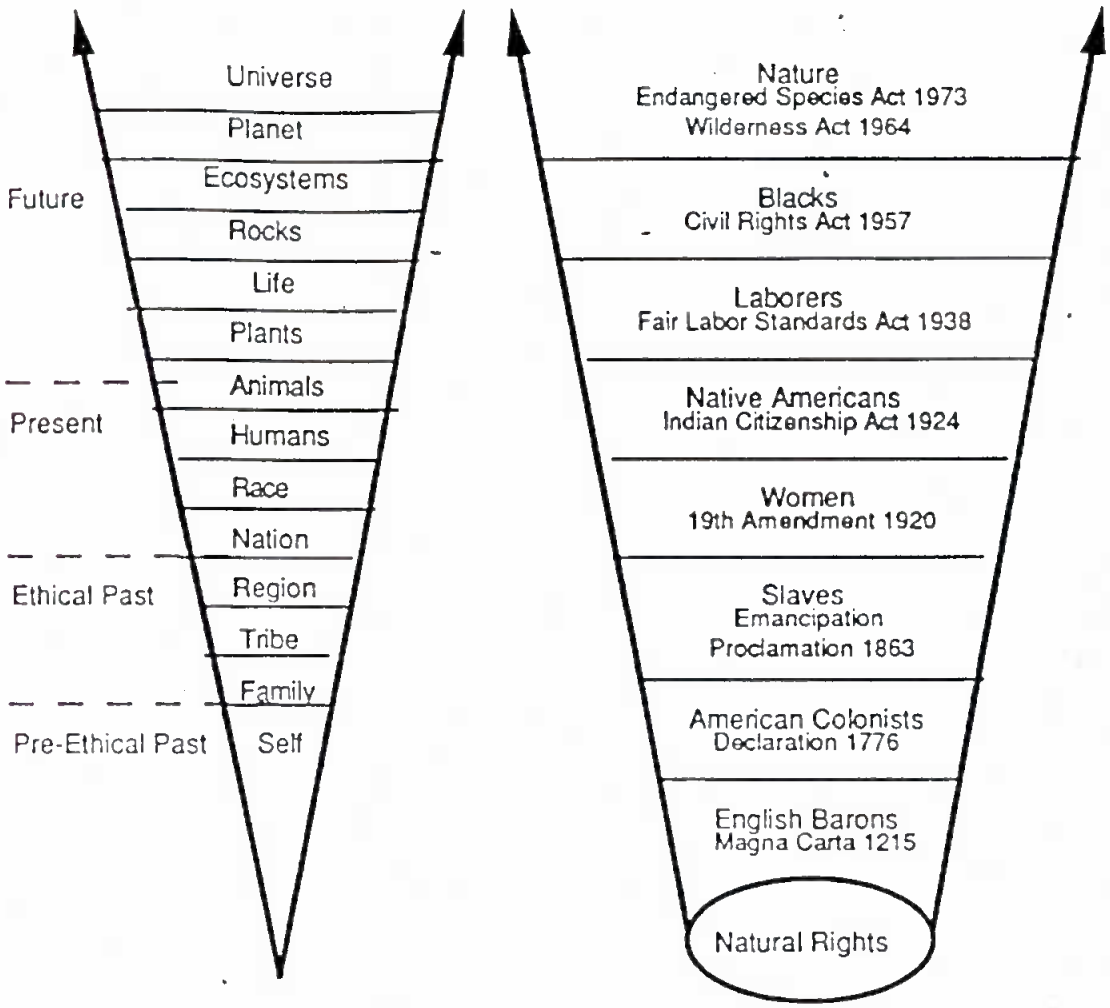

FIGURE 3. The Evolution of Ethics and The Expanding Concept of Rights.

Discussions of "sustainable development" suggest that "Future Generations" should be added to the top of the right-hand figure. (modified from Nash, 1989, pp. 5, 7)

The application of this philosophy would result in radical changes in social, legal and economic systems, and definitions of "development." Its advocates promote major changes in the quality and extent of human modification of nature, recognizing the mutual dependence and need for cooperation between humans and nature.

While *some* of these principles can actually be of use in future development planning approaches, the extreme — 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. Even if everyone wanted to, this would probably be impossible at current population levels and rural land degradation. The extreme imperative is of an anti-growth "Eco-topia," of a constrained "harmony with nature." While this may be organic, it tends not to be creative — one of the fundamental drives in the evolution of both nature and human society. Table 3, comparing this worldview directly with Frontier Economics, is modified from the book *Deep Ecology: Living as if Nature Mattered* (Devall and Sessions, 1985).

TABLE 3.

Dominant Economic Worldview	vs. Deep Ecology Worldview.
Dominance over nature	Harmony with nature; symbiosis
Natural environment is a resource for humans	All nature has intrinsic worth; biospecies equality
Material/economic growth for growing human population	Simple material needs, serving a larger goal of self-realization
Belief in ample resource reserves	Earth "supplies" limited
High technological progress and solutions	Appropriate technology; non-dominating science
Consumerism, Growth in consumption	Do with enough; recycling
National/centralized community	Minority traditions/ bioregions

C. Environmental Protection

The dominance of the frontier economics paradigm began to weaken in the 1960s, especially after the 1962 publication of Rachel Carson's book, *Silent Spring*. By the end of that decade, pollution was a major concern in the industrialized nations. Scientists began to study "environmental problems," usually related to pollution or the destruction of habitats and/or species. 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 constrained perception of "Ecology *versus* Economic Growth" became freshly explicit.

"Environmental impact statements" were institutionalized in some industrial countries as a rational means to assist in weighing 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 is the beginning of what might be called the takeover of the "negative, or defensive agenda" in practical environmental management policies and actions, though the assumptions and values implicitly underlying it go much further back in time.

By "negative," it is not meant that the environmental protection approach explicitly set out to harm the environment. On the contrary, environmental protection and therefore, management, was now a much more explicit enterprise than it was during most of history, and this was certainly a "positive" development. It is termed negative because it institutionalized an approach that focussed *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, concerned mainly with *ameliorating* the effects of human activities. 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." As in human medicine, remedial approaches are usually much more expensive than prevention. Economic analysis is still based on the neoclassical model of the closed economic system (Figure 2).

Perhaps the principal strategy this paradigm is to *legalize the environment as an economic externality*. "Command-and-control" regulatory approaches are relied upon in this paradigm to set limits on pollution or other damages. "Optimal

pollution levels" were defined, more by short-term economic acceptability, and therefore, politics, than by what was necessary for the maintenance of ecosystem resilience (admittedly, in part due to the fact that ecologically appropriate levels were/are not known, and even the definition of resilience is still debated by ecologists). The limits enacted were thus often arbitrary from a scientific- ecological point of view. Pollution dispersal continued to be a common approach to amelioration, even when it created yet larger, more costly problems down the road, such as international transport of acid precipitation. In keeping with the dominant paradigm of separation of issues and fragmentation of responsibility in government, separate "Environmental Protection Agencies" were created. They were responsible for setting the limits, and in some cases, cleaning up after limits were exceeded, but they were not responsible for planning development activities in ways that did not pollute or impair necessary ecological functions, or better still, that facilitate ecological functions at the same time as taking advantage of them. As many pollution problems grew, the after-the-fact, clean-up nature of this type of management grew (e.g., the clean-up of the North American Great Lakes and the United States' Superfund), as did the prescription of new technological solutions to mitigate pollution problems (e.g., expensive smokestack "scrubbers").

In this approach, 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" has been widely accepted by researchers and development practitioners as a basis for this prescription (Hardin, 1968). Common property regimes are associated with "inevitable" resource degradation. This has become the dominant perspective from which social scientists view natural resource issues. However, "the Hardin metaphor is not only socially and culturally naive, it is historically false" (Bromley and Cernea, 1989). What were actually *open access* property regimes with the stereotypical "tragic" consequences, were lumped together with *common* property regimes, under which specific usage rights and duties apply to a finite group, and from which others are excludable. Scores of common property regimes which have proven ecologically sustainable have been identified, on all continents (e.g., Berkes, 1989). Unfortunately, it is difficult to determine the potential for replicating them, as in many cases, the processes of "development" have changed once sustainable cultures so that ecologically viable systems of usage rights and duties may no longer be socially or economically stable.

The Stockholm UN Conference on the Human Environment in 1972 signaled the internationalization of the problem of environmental disruption, and therefore, the subject of explicit management. While it is quite unfair to say that the conceptual framework of the organizers of 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. Most developing countries have been slow to implement comprehensive and effective protective legislation, planning and enforcement, partly because they believed they could not afford it (in the neoclassical sense, excluding the externalities) and partly because it is perceived as unfairly restricting their development potential. 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 rich, elite interest groups when they resist land reform measures that might be useful in addressing some of the problems. Another paradox is that the poor are harmed more by both pollution and resource degradation than are the rich.

This 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, and even that was at least in part thrust on developing countries by industrial nations. 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. Impacts of excessive environmental depletions (resource exploitation) or insertions (pollution) are considered to be "externalities" to the economy. They are dealt with after they occur, if at all, and usually paid for by the public at large, in the forms of quality of life degradation and/or increased taxes. The ecosystem in general is seen as external to the economy. The impacts of pollution on human health and the aesthetic quality of the environment 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. Resource depletion and ecosystem services are still not perceived in policy-making circles as serious limiting factors, because of an

unbridled faith in technological progress and substitution. The very use of the term "environmental" as a label for these types of problems belies how small the change in attitudes which underlie the approach really are. Under a different set of assumptions about the relationship between man and nature, they might be more properly called "economic," "resource," or perhaps most appropriately, "development" problems.

The interaction between human activity and nature can still be seen as negative from nature's perspective, hence the dichotomous perception of "environment versus development." The basic purpose of this interaction is still unilateral or anthropocentric. Setting aside national parks and cleaning up of pollution are still done primarily for human benefit, whether health- or aesthetically-oriented. Economists still focus almost exclusively on the market economy. Little understanding of "nature's economy" or the "survival economy" enters into economic analysis or development planning. The former is the ecology of resource processes, such as the stocks and flows of nutrient cycles, ecosystem services, throughput processing abilities of different ecosystems, and the interdependence of ecosystems and climate (see Worster, 1977; Hall et al, 1986; Perrings, 1987), while the latter consists of the various human activities which do not enter into any market statistics but nonetheless support hundreds of millions of people's lives (e.g., Chambers, 1987).

D. Resource Management

The survival priorities of the poor usually supersede their environmental quality interests. In terms of actual health effects, the impacts of degraded environmental quality are probably most severe on the poor, however. The political economy and the practical concerns of environmental management in developing countries are quite different from those of industrial nations because resource depletion is often felt more severely than pollution effects, and it is the poor who are most affected. Hence, in some developing countries such as India, "ecology movements" have risen from the lower classes (Bandyopadhyay, Jayanta and Vandana Shiva, 1988). This is one of the major reasons for the emerging shift to from Environmental Protection to "Resource Management."

Resource Management is the basic theme of reports such as the Brundtland

Commission's *Our Common Future*, the Worldwatch Institute's annual *State of the World*, and the World Resources Institute's annual *World Resources* reports. It involves both a fairly natural theoretical extension of neoclassical economics and a substantial change in practice —therefore, 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. It directly contradicts the frontier economics assertion that natural resource exhaustion is not a matter of concern. Pollution can even be considered a "negative resource" (causing natural capital degradation), rather than as an externality. Climate and the processes regulating it may become regarded as a fundamental, vital resources to be managed under this paradigm. Future rationales for parks or reserves may focus more on their genetic resource and climate regulation values. Again, these resources are intended for potential use by humans; that is what the term "resource" implies. The interdependence and multiple values of various resources will be 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).

Global systems dynamics modelers began in the early 1970s to model not just the resources of capital and labor, but also the interactive supply and demand of other natural resources, including energy, valuable metals, fisheries, forests, soils, and water, which were perceived as becoming scarcer, and the existence of "negative" resources such as pollution. The publication of the Club of Rome's *The Limits to Growth* in 1972 was a landmark in this regard. This report, along with subsequent modelling attempts such as the U.S. *Global 2000 Report to the President* in 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. These "systems analysis" arguments then languished in policy-making circles in the early 1980s, amid a resurgent political climate of economic and technological optimism, and faith in free markets and trade growth. Meanwhile, the debt crisis in developing countries were so acute that, rather than implementing even defensive or remedial Environmental Protection, the debt trap sometimes led to increased rates of extraction and destruction of natural resources, in an attempt to pay off debt and meet the immediate needs of rapidly growing populations (George, 1988).

Outside of major policy and decision-making circles, work continued along the lines of the systems analytical framework. Methodologies, monitoring, and documentation improved, particularly with regard to resource depletion, population pressure, and the circular links with poverty. In addition to ecology, other interdisciplinary fields such as the study of living systems and self-organizing systems developed more rigorous systems modeling methods. Many of the threats predicted in earlier modeling efforts have in fact come true, despite the fact the one often reads statements that the doom and gloom scenarios have been "vanquished." "Global Commons" resources, such as the atmosphere in general and the ozone layer in particular, climate variation, biodiversity, and oceanic resources, have emerged as issues for which current legal, economic, political, and institutional structures and concepts are completely inadequate. 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.

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 (1980) and the World Charter for Nature (1982). Many more conferences were held. Collaborative efforts such as the Tropical Forestry Action Plan were launched (WRI, et al, 1985). It was argued that increasing efficiency of resource use, through conservation, wise management, and policies that integrated economic and ecological principles, along with ever-relied-upon promises of technological advances, would prevent disaster and ensure that "*The Global Possible*" (Repetto, 1986) would be achieved.

New initiatives in global commons law have already taken hold, with several more possible.[7] The combination of greater resource depletion, pollution, continued population growth, rising energy costs, climatic changes, land destruction, and high debt burdens have created economic and social conditions in developing countries that are much worse than they were ten, or in parts of Africa, even twenty years ago. These conditions seriously threaten possibilities for economic growth and prosperity, not to mention survival, for large

7 Previous efforts included: The Antarctica Treaty, 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. Contemporary measures include the 1988 Montreal Protocol on Ozone and subsequent efforts to strengthen it, International Trade of Hazardous Wastes, a renegotiated Antarctica Treaty. 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.

numbers of people. The new discipline of "risk management," whereby the magnitude and probability of various threats are analyzed so that they can be prioritized for action according to their degree of danger to society, is now a major aspect of environmental management (Kleindorfer and Kunreuther, 1986).[8]

Concern for the environment no longer implies that one is anti-development; in fact, sustainable development depends on it. It is understood that the scale of human activity is so large that it now affects nature as much as nature affects man, and these impacts feed back on the quantity and quality of human life that is achievable. The neoclassical imperative of economic growth is still perhaps the primary goal of development, but sustainability is viewed *as a necessary constraint for green growth* (Pezzey, 1989).

Despite the fact that *ecology* and *economics* come from the same Greek root — *oikos*, meaning "house" — the sciences of ecology and economics have different concepts of what *production*, *capital*, *health*, *resource*, etc. mean. 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 Working Papers by 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. Perhaps even more significant, ecosystem processes, rather than just stocks of physical resources, need to be considered as resources and capital which should be conserved — as well as used more effectively through new technology. The approach is still anthropocentric at its core; all this concern for nature is based on the fact that hurting nature is beginning to hurt economic man. Thus, the instrumental economic paradigm prevails, only it is enlarged to encompass some basic ecological principles in an attempt to maintain ecosystem/life support system stability for the support of sustainable development.

This approach has been called the "Global Efficiency" path (W. Sachs, 1989). Management strategies that will probably be implemented on a large scale include energy efficiency in particular and resource conservation (or efficiency improvement) in general, restoration ecology, ecosystem and social health monitoring, 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,

8 The World Bank hosted its own conference on risk management and industrial development in October, 1988.

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. *In essence, ecology is being economized.* Much of the work is focussed on "getting the prices (of all resources) right."

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 (decisions). When they are fully internalized, they can be conceived of as "resource problems," but this too has limitations, some of which will be discussed below. The characteristics of problematic situations of practice, which increasingly can be seen in the myriad "problems" of development, are frequently mismatched with the nature of technical-economic rational logic and its tools on which professionals have come to rely. This leads to the need for a new, mutually positive synthesis of development and management of human-nature interactions for the future.

E. 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, 1984.

Eco-Development is perhaps the paradigm for the longer term future. It involves a larger, more discontinuous shift in thinking and practice than either Environmental Protection or Resource Management, though again, it can be said to follow eventually from the limitations inherent to those paradigms. It 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. It sees most development activity as a form of management of this relationship; environmental management, economic development, and socio-ecological development might virtually become semantic

distinctions for the same subject: the integrated coevolution of conscious civilization and nature. "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 in planning.

Eco-Development would expand the system boundaries considered under Resource Management, just as Environmental Protection did for Frontier Economics, and as Resource Management is now doing for Environmental Protection. The model of the closed economic system is replaced with the "biophysical economics" model of a thermodynamically 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 back out to the ecosystem (see Figure 4). It would attempt to move from polluter pays to "pollution prevention pays" by restructuring the economy according to ecological principles to reduce this "throughput."

Such decoupling of growth in biophysical scale (as measured by per capita resource consumption times population) from economic growth and development (as measured by the flow of currency) 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 (Figure 2). The potential for decoupling biophysical throughput from economic growth remains a hotly debated issue (see Costanza, 1980; Gever et al, 1986; Hall et al, 1986). Ultimately, there are limits, 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. But there is also room for great improvement, not just in efficiency as it is conventionally thought of, but in terms of synergies gained from designing agricultural and industrial processes to mimic (and to use) ecosystem processes (e.g., turning the unused byproducts of one production process into the inputs for another; see Figure 5). Ecosystem-specific differences in the area of rate limitations on the physical flow of matter and energy through the economy are important in determining sustainable throughput levels. This "carrying capacity," always difficult to determine, is affected by an interacting mix of factors, including the capacities of ecosystems to regenerate new resources and assimilate wastes, and the technologies employed to enhance these capacities — the production of which may.or may not decrease local or distant ecosystem capacities.

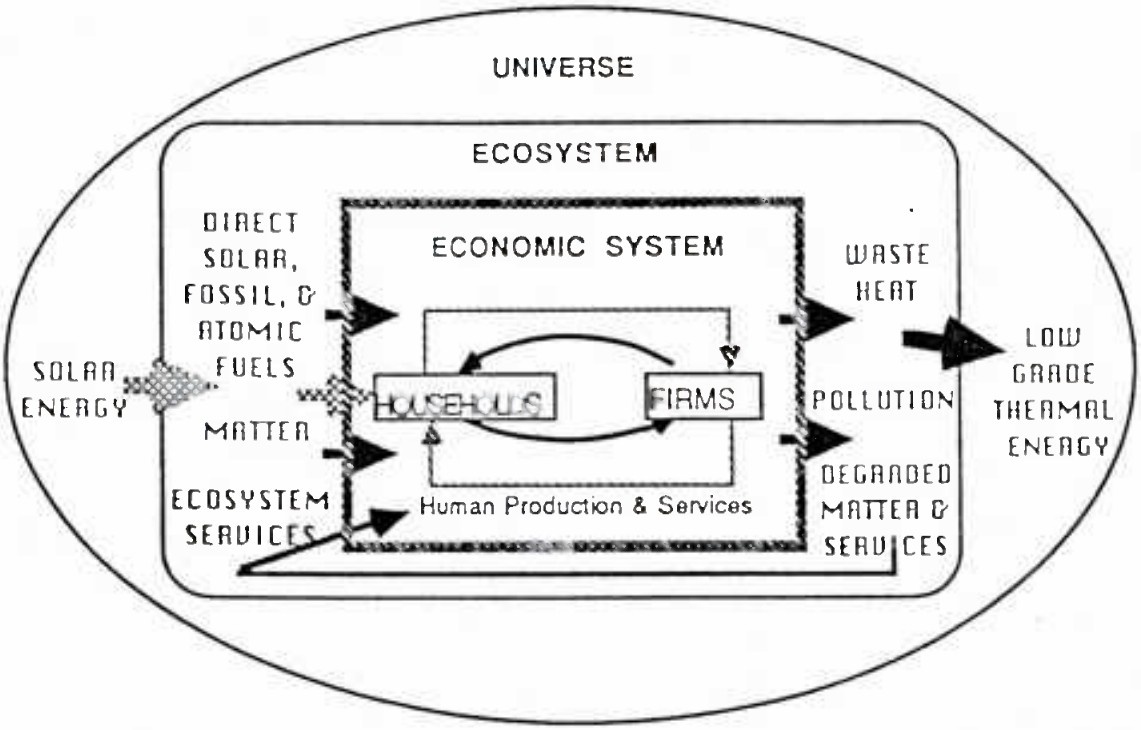

FIGURE 4. Economic Production from a Biophysical Perspective.

A continuous input of high-quality/low entropy fuels, varying entropy material ("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.)

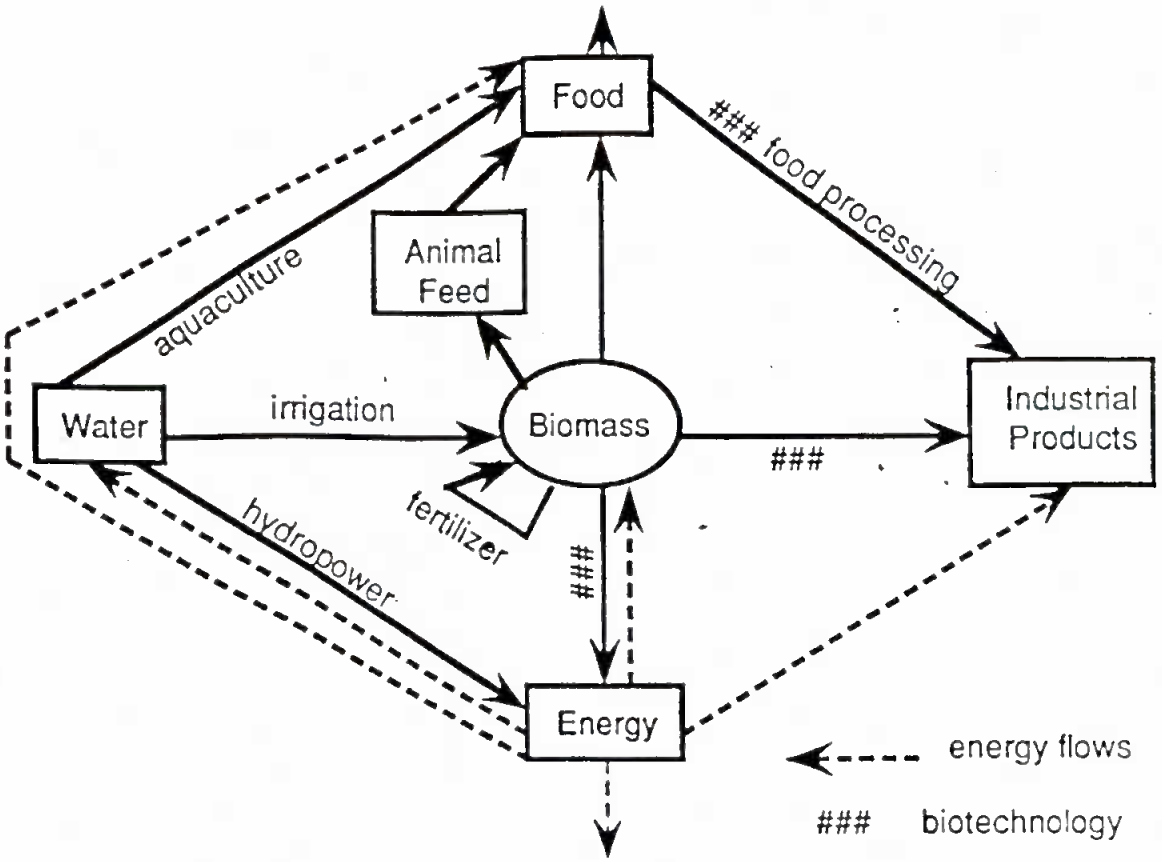

FIGURE 5. A Rural Agro-Industrial System Design.
(modified from Sachs and Silk, 1988.)

This is my interpretation of what Herman Daly's "steady-state" economics (Daly, 1977) is about, though it might be worth debating whether the term "steady-state," accurate in its physical meaning, is too misleading a label in terms of the economic and developmental consequences to be useful in the everyday political world. For most people, unused to the distinction between biophysical growth and economic growth, and not understanding that it doesn't necessarily mean stagnation, "steady-state" is not a creativity-inspiring goal. But this is crucial for development; people must have a vision of a desirable future which inspires them to create it. "Steady-flow," as hinted at in Leopold's *Round River* (1953), would be perhaps less problematic politically and less restrictive psychologically.

In addition to reliance on efficient, clean, renewable energy sources, sustainable development might be based more on increasing the information intensiveness, community consciousness, and experiential quality of economic activity, rather than on increased material-energy intensiveness.

Eco-development would also attempt to incorporate many of the social equity and cultural concerns raised in the various

schools of deep ecology. In *Sustainable Development: Exploring the Contradictions*, Michael Redclift (1987) argues that if the work of the Brundtland Commission is to be taken seriously, the direction of the development process itself must be redirected to give greater emphasis to indigenous knowledge and experience. Other major problems of the economic paradigm that still need to be resolved are the impacts on sustainability of time scales and discount rates, and integrating returns on different types of investments (e.g., financial, ecological, and social).

Eco-Development would thus move 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 (as in frontier economics, environmental protection, and resource management), or below it (deep ecology). The goal is to integrate the ecological relationships among people and nature in communities, among communities sharing ecoregions, and among ecoregions cooperating to sustain the shared ecosphere of the planet (Tokar, 1988, p. 139). Recognizing the aspirations of all, placing equal value on ecology and creativity, is essential.

Eco-development requires even longer term management of adaptability, resilience, and uncertainty, to reduce the occurrence of nonlinear ecological surprises caused by crossing over unknown ecospheric stock, flow-rate, and process thresholds. Ecological uncertainty needs to be incorporated into economic modeling and planning mechanisms; risk management (trying to figure out how much can be gotten away with) is not sufficient (Perrow, 1984). The Resource Management strategy of the polluter pays principle, and methods for implementing it such as tradable pollution permits, do not incorporate ecological uncertainty and social equity issues well at all. Tradable emissions permits not only create a market for "bads," they also create a new property regime, 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; this is demonstrated by the difference between environmental valuation as calculated by the "willingness to pay" method versus the "willingness to accept" techniques of environmental economics under the Environmental Protection paradigm (see Knetsch and Sinden, 1984; Knetsch, 1989). Given the extreme uncertainties involved in calculating sustainable levels of pollution, or even resource harvest, it is highly possible that permit levels would need to be changed, which could be very difficult. 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.) might be a more flexible as well as socially more equitable means of attaining sustainability (Colby, 1990b). The true costs of development would be fully integrated, allocated socially and internationally, perhaps according to cumulative benefits, ecological uncertainty, and means (ability to pay). Sources on the theories and strategies for Eco-Development include Riddell (1981), Glaeser (1984), Sachs (1984a, 1984b), Norgaard et al (1987), Norgaard (1988), and Colby (1990a, 1990c).

Environmental management and development under Eco-Development will sometimes still involve "trade-offs," but with better accounting of the true values of functioning natural systems to economies, and more learning about the opportunities for synergy between ecological and economic systems, this necessity will decrease. Eco-development would make explicit social, ecological, *and* economic criteria for the development and use of technology and production systems: e.g., renewable, clean energy sources and energy conserving techniques; integrated pest management and low input agriculture; agro-forestry; appropriate uses of biotechnology). In so doing, eco-development attempts to provide a *positive*, interdependent vision for both human development and nature. Asking "how can we create ecologically?" rather than "how can we create? and then how can we remedy?" leads one toward the use of ecologically sound common property regimes and indigenous knowledge (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).

Parallel to the rise of the "systems analysis" schools of thinking used in Resource Management came another approach to planning and action which recognized the limitations of centralized planning (Ozbekhan, 1969; Ackoff & Emery, 1972; Ackoff, 1974; Passmore and Sherwood, 1978; Vergara et al, 1981). There have been several variations on this "synthesizing systems" approach, some more directly focussed on the integration of ecological and developmental goals than others (see especially, Hawk, 1979, 1984). A basic commonality between them is the idea that planning ought to be embedded in the total environment of the systems being planned for, including all of the parties affected (stakeholders). In order to achieve improved conditions for both the system being directly planned for *and* its environment, global systems awareness must be coupled with local responsibility for

action. This direct involvement of all concerned parties in the setting of goals, planning of means, and sharing accountability and benefits, is why decentralization is required, and what makes the process of "planning" more effective (Sagasti, 1978). Interdependent autonomy, which may seem like an oxymoron, is promoted.

An early attempt to apply a synthesizing systems type of planning for environmental management was the International Joint Commission (IJC) of the U.S. and Canada's "Ecosystem Approach" to resolving environmental disputes along the 4000 mile border between those two nations. Though the "systemic design" aspect is sometimes limited by the dispute resolution character of the IJC's charter, the 1909 Boundary Waters Treaty (Caldwell, 1988), the IJC now explicitly uses a stakeholder, positive-sum perspective in its approach. It is working on developing the ability to monitor and manage for ecosystem health, rather than for the doctoring of ecosystem dis-ease (Bandurski et al, 1986).

Related to the idea of ecosystem health, James Lovelock (1979, 1988) is the father of the controversial "Gaia Hypothesis" that the Earth is a self-organizing, self-regulating living system in which life actively develops and maintains the environmental conditions which sustain it. (This does NOT require purposeful consciousness.) Lovelock has proposed a new science of "*geo*physiology," 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 generated by this hypothesis.

Thus, the positive vision of eco-development is for integrated, co-evolutionary development of humans and nature (Norgaard et al, 1987; Norgaard, 1988). The idea of co-evolution comes from studying the evolution of complex ecosystems with a high degree of species-specific symbiosis, or mutual dependence (e.g., tropical rainforests and coral reefs). Its application to the theory of environmental management and development is based on the recognition that man and nature are not nearly so separate as Western philosophy and approaches to governance have supposed. In fact, all human cultures have been altering ecosystems for millenia, while nature simultaneously exerted evolutionary pressure on human biology and on social systems. In the past few decades, however, humans have succeeded in altering ecosystems to a far greater extent, and in the process, have begun to degrade their capacity to function effectively. Eventually, perhaps quite soon given the strong likelihood of accelerating, discontinuous changes in the ozone layer and climate, the circle will close, leading to a "natural" degradation of human civilizations' functioning capacities. Table 4 is a summary

of some major distinctions between Resource Management and Eco-Development.

TABLE 4.

Major Differences Between the Resource Management and Eco-Development Paradigms.

Resource Management	Eco-Development
Economize Ecology	Ecologize Economy/ whole Social System
Global Efficiency/Growth Imperative	Co-development, Nature & Humans
Nature as resource for man; Man manages nature	Ecocentric ? Man manages self first, then nature
Resource Degradation/Depletion, Poverty	+ Ecological Uncertainty, Global Change; Poverty & Affluence
Change SNAs to reflect resource depletion & defensive expenditures	+ Ecological Economics — 2nd Law Thermodynamics, different assumptions about "Eco-Reality"*
Polluter pays to internalize social costs; Tradable emissions permits; Policies to Get Prices Right	Pollution *prevention* pays; Environmental taxes & policies to ecologize entire economy/social system, Reduce biophysical throughput to sustainable levels
Freer Trade; Privatize everything, including Global commons	Ecologically Regulated Trade; Common Property regimes too
Incremental planning forward, assume current goals	Idealized redesign; set community goals & plan backwards (participatory)

*Critical Assumptions about Eco-Reality such as: the role of ecosystem services & processes in economy/ life support; substitution and complementarity; systems and signals; time, uncertainty, and external effects; entropy, scale, and sustainability; renewability and discount rates (Colby, 1990a, 1990c).

* posición crítica a las concepciones que representa la perspectiva del "desarrollo sostenible" p.e Goodland"

III. Changing Conceptions of National Security

"Environmental stress" has become a major source of political tension and military action in the world. Amongst the several ecological threats which may force a redefinition of "national security" are:

- growing numbers (millions per year) of "ecological refugees," often mistaken as political or military refugees, in many countries (Jacobson, 1988).

- the very real possibility of regional conflicts over resources, particularly water, in the coming decades. (e.g., in the Middle East, where water shortages are becoming a more serious threat to peace than conflict over access to the region's petroleum; Myers, 1989).

- the possibility of reaching the limits of the proportion of the Earth's net primary productivity (photosynthesis) that may be safely expropriated by man, perhaps sometime in the next half century as the world population doubles once again (Vitousek, et al, 1986).

- discontinuous global climate variations causing disruptions in the world's most productive agricultural zones.

- major health crises due to ozone layer damage -- even if safe replacement products could be sweepingly introduced immediately, due to lags of decades between emissions and upper atmosphere effects.

- the broad-scale loss of biodiversity and *in situ* genetic resources, particularly of the tropical rain forests and coral reefs, whose true economic and ecological values (as well as aesthetic and intrinsic) are unknown and underappreciated but certainly vast.

Past concepts of national sovereignty are no longer sufficient for a world altered by ever-increasing interdependence among nations on economic, ecological, and security fronts (Lebel & Hane, 1989). At the same time, major geopolitical forces (demilitarization of the East-West superpower conflict, directly in the North and indirectly in the Southern proxies) may complement an accelerating political will to divert attention and resources to this highly-needed redefinition. Additionally, another record-breaking summer in Washington, DC or drought in the U.S. bread basket will probably do much to accelerate the political feasibility of such a redefinition. The much-heralded, if tenuous, "resolution" of the East-West Cold War may free up vast financial, scientific/engineering, and diplomatic resources that could be redeployed to eventually lead to a resolution of a more

significant North-South "Silent Resource War" which has been brewing for a long time, but whose expression was hardly allowed due to the self-absorption of the North in its East-West ideological and geopolitical conflict. Even if this does not translate to more direct transfer of resources to the South (desperately needed), if it were to lead to a redefinition of development and massive restructuring of the industrial economies along the lines of the resource management and/or eco-development paradigms, this would give the South more freedom to utilize its natural resources sustainably for its own development, rather than for simple export to Northern markets. It could also allow far more equable forms of collaboration and a search for new economic roles for all nations to play in creating an integrated, sustainable relationship between civilization and nature, which would benefit all concerned.

IV. Possibilities for Convergence

It is easy to think of environmental management as a remedial cost. However, there are great economic and social benefits, not just environmental ones, that would accrue, particularly from the types of changes that a redefinition of development along the lines of good resource management and/or ecodevelopment would help promote. In many cases, institutional and both individual and organizational behavior factors are more important than the economic ones cited in preventing the development of more ecologically sound economies. One of the major factors contributing to the "economic miracles" of post-war West Germany and Japan is that fact that they were forced to completely rebuild their economic infrastructure with new, state-of-the-art technological production systems, as well as innovative ways of organizing the social factors of production. While the United States had almost no competition in the first couple decades after the war because its production systems had not been destroyed, they eventually suffered in the newly competitive world marketplace of the 1970s and 80s, at least in part because their technological as well as social production systems were outdated. Change is often resisted due to behavioral and cultural inertia, despite economic imperatives. It is possible that by restructuring along the lines of eco-development, companies and economies might develop new comparative advantages that will help to make those that are quickest to adjust more competitive and prosperous in

the long run, rather than less so, as is frequently heard 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.

Figure 6 below 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 virtually ignored by both. But neither free market nor socialist economics is sustainable. 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 providing much more sophisticated, powerful techniques and concepts (Martinez-Alier, 1987). While this synthesis has yet to be achieved, work on Ecological Economics is underway (e.g., the International Society for Ecological Economics and its journal).

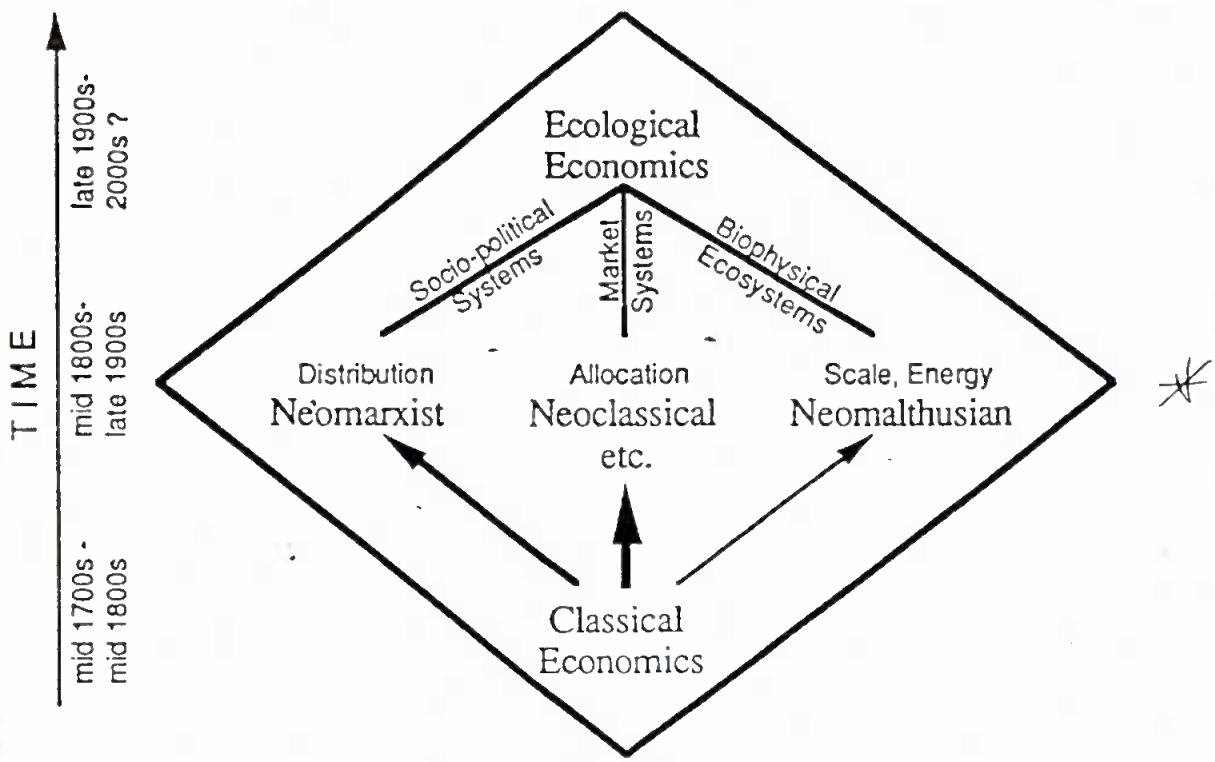

FIGURE 6. The Evolution of Economic Paradigms.

V. Conclusions

So, paradigms of the relationship between environmental management and developmentare in a period of flux. The defensive (remedial) agenda is breaking down, in no small part 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, politically. 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.

Figure 1 and Table 2 provide a working summary of the five paradigms of the relationship between environmental management and development. It should be remembered that the paradigms presented here are not separate species. As is appropriate in times of great change, there is an increasing amount of fluidity between them. No single paradigm has the best answer to every type of environmental management or development problem. As the newer paradigms evolve, they incorporate much of the older. There are also two types of evolution entwined in this discussion: that of the historical *evolution of the concepts and tools* within the particular paradigms, presented here somewhat artificially as separate, for purposes of distinction, and that of the historical *progression in the dominance of their use.* If the paradigms are thought of as separate populations, rather than species, it may be seen that each is evolving through changing "selective pressures" imposed by different and changing *user groups* and *problems.* Depending on the user group and the problem(s) they are concerned with, each paradigm is influenced differently by the introduction of new ideas. In addition, the user groups themselves are also evolving in the context of both their paradigms and their perceived problems (or realities), which feeds back to both the evolution of the paradigms and of their use.

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. It is possible that the growing sense of alarm about global climate change and ozone layer disruption may cause a more rapid evolution from Resource Management to Eco-Development than it is

politically expedient to advocate at this time. The co-evolutionary approach would require inclusion of all user groups, or stakeholders, in the development of future environmental management and development strategies.

It is hypothesized here that three sets of conditions may combine to provide the necessary and sufficient forces for a synthesis or convergence to a paradigm along the lines of eco-development: (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. The path to such a synthesis may involve evolutionary learning and cross-over between the paradigms presented here, or it may occur as a more revolutionary change to one of these five (or yet another) becoming predominant in its own right. Widespread political paralysis which will prevent effective cooperation and institutional innovations of the magnitude needed to meet the great challenges of the coming decades may be the result if some synthesis does not surface as a vision for the future development of both industrial and developing societies. 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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