International Society for Ecological Economics
Internet Encyclopaedia of Ecological Economics

Sustainability and Sustainable Development

Jonathan M. Harris

February 2003

I. SUSTAINABLE DEVELOPMENT: DEFINING A NEW PARADIGM

In 1987 the World Commission on Environment and Development sought to address the problem of conflicts between environment and development goals by formulating a definition of sustainable development:

Sustainable development is development which meets the needs of the present without compromising the ability of future generations to meet their own needs.

– World Commission on Environment and Development, 1987

In the extensive discussion and use of the concept since then (see e.g. Holmberg, 1992; Reed, 1997; Harris et al., 2001), there has been a growing recognition of three essential aspects of sustainable development:

* Economic: An economically sustainable system must be able to produce goods and services on a continuing basis, to maintain manageable levels of government and external debt, and to avoid extreme sectoral imbalances which damage agricultural or industrial production.

* Environmental: An environmentally sustainable system must maintain a stable resource base, avoiding over-exploitation of renewable resource systems or environmental sink functions, and depleting non-renewable resources only to the extent that investment is made in adequate substitutes. This includes maintenance of biodiversity, atmospheric stability, and other ecosystem functions not ordinarily classed as economic resources.

* Social: A socially sustainable system must achieve fairness in distribution and opportunity, adequate provision of social services including health and education, gender equity, and political accountability and participation.

These three elements of sustainability introduce many potential complications to the original, simple definition of economic development. The goals expressed or implied are multidimensional, raising the issue of how to balance objectives and how to judge success or failure. For example, what if provision of adequate food and water supplies appears to require changes in land use that will decrease biodiversity? What if non-polluting energy sources are more expensive, thus increasing the burden on the poor, for whom they represent a larger proportion of daily expenditure? Which goal will take precedence?

In the real world, we can rarely avoid trade-offs, and as Norgaard points out, we can maximize only one objective at a time: 'it is impossible to define sustainable development in an operational manner in the detail and with the level of control presumed in the logic of modernity' (Norgaard, 1994, p. 22). The strongly normative nature of the sustainable development concept makes it difficult to pin down analytically.

Despite these complications, the three principles outlined above do have resonance at a common-sense level. Thus there is ample justification for the elucidation of a theory of sustainable development, which must have an interdisciplinary nature. Drawing on economic, ecological, and social perspectives, we can identify some of the main themes that are integral to the construction of a new paradigm:

* Economic sustainability requires that the different kinds of capital that make economic production possible must be maintained or augmented. These include manufactured capital, natural capital, human capital, and social capital. Some substitutability may be possible among these kinds of capital, but in broad terms they are complementary, so that the maintenance of all four is essential over the long term.

* The conservation of ecosystems and natural resources is essential for sustainable economic production and intergenerational equity. From an ecological perspective, both human population and total resource demand must be limited in scale, and the integrity of ecosystems and diversity of species must be maintained. Market mechanisms often do not operate effectively to conserve this natural capital, but tend to deplete and degrade it.

* Social equity, the fulfillment of basic health and educational needs, and participatory democracy are crucial elements of development, and are interrelated with environmental sustainability.

Taken together, these observations suggest new guidelines for the development process. They also require modifications to the goal of economic growth. Economic growth in some form is required for those who lack essentials, but it must be subject to global limits and should not be the prime objective for countries already at high levels of consumption (see e.g. Daly, 1996). In terms of sustainability, a moderate level of consumption, together with strong social institutions and a healthy environment, represents a better ideal than ever-increasing consumption (Durning, 1992). Sustainability, however, is more than limits on population or restraint in consumption - though these are important. It means that the choice of goods and technologies must be oriented to the requirements of ecosystem integrity and species diversity as well as to social goals. Elements of all three perspectives – economic, ecological, and social – are essential to an understanding of the requirements for sustainability.

II. THE ECONOMIC PERSPECTIVE

From the point of view of neo-classical economic theory, sustainability can be defined in terms of the maximization of welfare over time. (This is assumed to be human welfare – the claims of the non-human world arise when we consider the ecological perspective.) Most economists simplify further by identifying the maximization of welfare with the maximization of utility derived from consumption. While this may be criticized as an oversimplification, it certainly includes many important elements of human welfare (food, clothing, housing, transportation, health and education services, etc.) and it has the analytical advantage of reducing the problem to a measurable single-dimensional indicator.

A formal economic analysis then raises the question of whether sustainability has any validity as an economic concept. According to standard economic theory, efficient resource allocation should have the effect of maximizing utility from consumption. If we accept the use of time discounting as a method of comparing the economic values of consumption in different time periods, then sustainability appears to mean nothing more than efficient resource allocation – a concept already well established in economics.

One line of criticism of this reductionist approach to sustainability centers on the use of discounting. At a discount rate of 10%, the value of *1 million one hundred years from now is the same as a mere *72 today. Thus it would apparently be justifiable to impose costs of up to *1 million on people in the year 2100 in order to enjoy *72 worth of consumption today. By this logic, much resource depletion and environmental damage could be considered acceptable, and even optimal, according to a criterion of economic efficiency.

The problem is that the use of a discount rate implicitly imposes a specific choice regarding the relative welfare of present and future generations. Howarth and Norgaard have shown that the choice of a discount rate is equivalent to a choice of allocations among generations (Howarth and Norgaard, 1993). Use of a current market discount rate gives undue weight to the preferences of current consumers. When we consider issues such as soil erosion or atmospheric buildup of greenhouse gases, where the most damaging impacts are felt over decades or generations, this creates a strong bias against sustainability. Thus to achieve intergenerational equity, we must either impose a low discount rate or some kind of sustainability rule regarding resource use and environmental impacts. Cline (1992), for example, has suggested the use of a discount rate of 1.5% for balancing long-term costs and benefits of global climate change abatement.

A related issue concerns the concept of natural capital. Soils and atmospheric functions are aspects of natural capital, which consists of all the natural resources and environmental services of the planet. In the neo-classical view, there is no special reason to conserve natural capital. The 'Hartwick rule', a well-known principle derived from work by Hartwick (1977) and Solow (1986), states that consumption may remain constant, or increase, with declining non-renewable resources provided that the rents from these resources are reinvested in reproducible capital. This rule does not require maintenance of any particular stock of *natural* capital.

The essential assumption involved in the Hartwick/Solow approach is that of *substitutability* of different types of capital. If, for example, we cut down forests but build factories, we are better off provided the economic value of the new industrial plant exceeds the economic value of the lost forests. Daly's view is based on the opposite assumption, that 'man-made and natural capital are fundamentally complements and only marginally substitutes' (Daly, 1994, p. 25). If natural capital has a special and unique importance, then neo-classical economic efficiency will not suffice for sustainability.

The issue may be posed terms of *weak* and *strong* sustainability. Even in the neo-classical perspective the principle of *weak sustainability* is appropriate. In this approach, sustainability requires that the total value of manufactured plus natural capital remain constant over time. El Serafy has pointed out that in order to assess this value, there must be a full accounting for natural capital depletion (El Serafy, 1993, 1997).

A *strong sustainability* approach is based on the idea that substitutability between natural and manufactured capital is limited. Rather, the two are seen as complements -- factors that must be used together to be productive. For example, a fleet of fishing boats is of no use without a stock of fish. In the case of critical natural capital (Pearce and Warford, 1993, p. 53) -- for example essential water supplies -- substitutability is close to zero. While it may be possible, for example, to compensate for some water pollution with purification systems, life and economic activity is essentially impossible without access to water. The strong sustainability approach implies that specific measures distinct from the ordinary market process are necessary for the conservation of natural capital. It also implies limits on macroeconomic scale. The economic system cannot grow beyond the limitations set by the regeneration and waste-absorption capacities of the ecosystem.

The distinction between weak and strong sustainability is discussed in Daly (1994). Strong sustainability is defended by Daly (1995) and criticized by Beckerman (1994, 1995), who rejects the concept of sustainability in general. A defense of weak sustainability is offered by El Serafy (1996), while Common (1996) argues that the distinction between weak and strong sustainability is invalid. Limitations of the weak sustainability concept are discussed by Gowdy and O'Hara (1997).

Costanza and Daly (1992) suggest that a minimum necessary condition for sustainability can be expressed in terms of the conservation of natural capital. This policy goal leads to two decision rules, one for renewable and the other for non-renewable resources. For renewables, the rule is to limit resource consumption to sustainable yield levels; for non-renewables the rule is to re-invest the proceeds from non-renewable resource exploitation into renewable natural capital. Following these two rules will maintain a constant stock of natural capital. To maintain a constant per capita stock of natural capital also requires a stable level of human population, a factor which Daly has emphasized elsewhere (Daly 1991).

The rules suggested by Costanza and Daly for natural capital conservation are rough guides rather than precise theoretical principles. Nicholas Georgescu-Roegen, whose pathbreaking work *The Entropy Law and the Economic Process* outlined the dependence of the economic system on biophysical systems, argued that it is ultimately impossible to maintain a constant stock of natural capital, since all planetary resources will eventually degrade or be used up according to the Second Law of Thermodynamics (Georgescu-Roegen 1971). But at a more practical level he proposed an approach similar to Costanza and Daly's, reasoning that 'the enormous disproportionality between the flow of solar energy and the much more limited stock of terrestrial free energy suggests a bioeconomic program emphasizing such factors as solar energy, organic agriculture, population limitation, product durability, moderate consumption, and international equity' (Georgescu-Roegen 1993; see also Cleveland and Ruth 1997).

Toman (1992) proposes that the difficulty in defining sustainability may be resolved by recognizing that some issues can be appropriately dealt with through neo-classical market efficiency, while others require the application of

Ciriancy-Wantrup's (1952) concept of a 'safe minimum standard' approach to protect essential resources and environmental functions. He suggests that the criteria of possible severity and irreversibility of ecological damages should be used to decide which theoretical framework is more appropriate. This perspective implies that criteria other than the strictly economic – in particular, principles drawn from the science of ecology – should be applied to problems of long-term sustainability.

III. THE ECOLOGICAL PERSPECTIVE

Common and Perrings (1992) have suggested that the economic perspective of 'Solow-sustainability' needs to be complemented by an ecological approach of 'Holling-sustainability', following the work of Holling (1973, 1986) on the resilience and stability of ecosystems. Unlike economists, whose models provide no upper bound on economic growth, physical scientists and ecologists are accustomed to the idea of limits. Natural systems must exist subject to the unyielding laws of thermodynamics, and the science of population ecology has explored the implications of these laws for living organisms. 'Two of the fundamental axioms of ecological and evolutionary biology are that organisms are exuberantly over-productive, and that limits set by time, space, and energy are inevitably encountered' (Holling, 1994). In an ecological perspective sustainability must involve limits on population and consumption levels. These limits apply to all biological systems. While humans may appear to evade them for a time, they must ultimately accept the boundaries of a finite planet.

However, this simple assertion of limits does not fully capture the contribution of ecologists to the discussion of sustainability. What Holling identifies as a third axiom of ecology has even more significant implications. The third axiom 'concerns processes that generate variability and novelty' – the generation of genetic diversity and the resultant processes of evolution and change in species and ecosystems.

Genetic diversity gives rise to *resilience* in ecosystems. Resilience is the 'bounce-back' capacity that enables a system to respond to disturbances or damage. A forest ecosystem, for example, may recover from a pest infestation through an increase in the population of predators that control the pest, an expansion of species unaffected by the pest, or possibly a development of pest resistance in affected species. The patterns of response will be widely variable, but the essential integrity of the ecosystem will be preserved. The key to resilience is the existence of a wide variety of species, interacting with each other and providing a reservoir of genetic forms that provide the potential to adapt to changing conditions.

For the ecologist, sustainability should be defined in terms of the maintenance of ecosystem resilience. This view of sustainability is clearly different from the human-centered conceptions put forward by the World Commission on Environment and Development and the consumption-based principles proposed by economic theorists. Common and Perrings suggest that 'the concepts of Solow-sustainability and Holling-sustainability are largely disjoint. This implies that there may be no close relationship between economic efficiency and ecological sustainability' (1992, p. 7). In order to achieve ecological sustainability, it is likely to be necessary to modify current consumption preferences and production techniques which, while efficient in economic terms, threaten the ecological resilience of planetary systems.

IV. THE SOCIAL PERSPECTIVE

Advocates of sustainable development, as noted above, recognize the social component of development as an essential part of the new paradigm. A 'human development' approach emphasizing issues of basic needs and equity is well grounded in the history of economic theory. Anand and Sen (1996) point out that concerns for these dimensions of economic development start with the earliest economic theorists, and contrast the human development approach to the wealth maximization approach that has dominated modern economics.

Basic needs and equity in development have been the focus of the United Nations Development Programme's series of Human Development Reports. In addition to calculating the Human Development Index, which offers a different measure of development success from per capita GNP or GDP, the Human Development Reports focus each year on a different aspect of social and economic development, such as democratic governance (1993), gender inequity (1995), and poverty (1997).

While the HDI does not explicitly include any environmental measures, the 1994 report discussed the relationship between sustainability and equity, arguing that 'the concept of sustainable development raises the issue of whether present life-styles are acceptable and whether there is any reason to pass them on to the next generation. Because intergenerational equity must go hand in hand with intragenerational equity, a major restructuring of the world's income and consumption patterns may be a necessary precondition for any viable strategy of sustainable development' (UNDP, 1994).

The issue of environmental sustainability is intertwined with that of poverty and inequity. The causative relationship runs both ways – increased poverty and loss of rural livelihoods accelerates environmental degradation as displaced people put greater pressure on forests, fisheries, and marginal lands. Lipton (1997) and Scherr (1997) emphasize the relationship between population growth, social, conditions, and resource degradation. Reed (1997) notes that the social component of sustainability includes issues of distributional equity, provision of social services, gender equity, population stabilization, and political accountability and participation.

The relationship of the human development paradigm to sustainability is discussed by Haq (1995) and Chambers (1992). Interrelationships between development, population growth, and environmental sustainability are prominent in the exposition of human development concepts by Sen (2000).

V. A SYNTHESIS OF PERSPECTIVES

The principles which emerge from this tripartite discussion of sustainability include:

* The conservation of natural capital is essential for sustainable economic production and intergenerational equity. Market mechanisms do not necessarily operate effectively to conserve natural capital, but may tend to deplete and degrade it.

* From an ecological perspective, both population and total resource demand must be limited in scale, and the integrity of ecosystems and diversity of species must be maintained.

* Practices consistent with sustainable development must remedy social inequities and environmental damage, while maintaining a sound economic base.

* Social equity, the fulfilment of basic health and educational needs, and participatory democracy are crucial elements of development, and are interrelated with environmental sustainability.

Taken together, these principles clearly suggest new guidelines for the development process. They also require a modification of the goals of economic growth (Arrow et al., 1995). The principles of sustainability imply new goals and policies in all major areas of economic development, including:

* *Population*: Theorists of sustainable development have generally rejected the concept of unlimited growth, whether of population or of economic production. Even if a specific carrying capacity for humans is difficult to identify, resource and environmental constraints will eventually be reached, if they have not been already. A sustainable society must ultimately imply a stable level of population. Thus population policy must become a central element of economic development. Scherr (1997) suggests that maintaining environmental integrity depends on slowing rates of population growth in the developing world, and that policies to so require a focus on social equity and women's rights.

* *Agriculture*: The need to feed an expanding population at higher per-capita levels of consumption is straining global soil and water systems (Harris and Kennedy, 1999; Pinstrup-Andersen and Pandya-Lorch, 1998). A transition to more sustainable agricultural systems requires changes on both the production and consumption sides. On the production side, current high-input techniques which are leading to serious soil degradation and water pollution and overdraft must be replaced by organic soil rebuilding, integrated pest management, and efficient irrigation. This in turn implies much greater reliance on local knowledge and participatory input into the development of agricultural techniques (Pretty and Chambers, 2000). On the consumption side, both limits on population growth and greater equity and efficiency in food distribution are of central importance given probable resource limitations on production.

* *Energy*: Both supply limits and environmental impacts, in particular the accumulation of greenhouse gases, mean that it will be necessary to accomplish a transition away from fossil fuels well before 2050 (MacKenzie, 1996; IPCC, 2001a, b). A non-fossil energy system would be significantly more decentralized, adapted to local conditions and taking advantage of opportunities for wind, biomass, and off-grid solar power systems. This is unlikely to occur without a major mobilization of capital resources for renewable energy development in countries now rapidly expanding their energy systems (Johansson and Goldemberg, 2002).

* *Industry*: As the scale of global industrial production increases several-fold over current levels, which themselves represent a quadrupling over 1950 levels, it is apparent that 'end-of-pipe' pollution control not be adequate. The concept of 'industrial ecology' implies the restructuring of whole industrial sectors based on a goal of reducing emissions and reusing

materials at all stages of the production cycle (Frosch and Gallopoulos, 1989; Frosch, 1992; Ayres and Ayres, 1996; Socolow, 1994). Corporate reform and 'greening', as well as a broad cooperative effort between corporations and governments, will be needed to achieve goal.

* *Renewable Resource Systems*: World fisheries, forests and water systems are severely over-stressed. With even greater demands on all systems expected in the next century, all levels of institutional management must be urgently reformed. Multilateral agreements and global funding are needed to conserve transboundary resources; national resource management systems must be shifted from goals of exploitation to conservation and sustainable harvesting; and local communities must be strongly involved in resource conservation (UNEP, 2000, 2002; UNDP et al., 2000).

Each of these areas poses challenges that are social and institutional as well as economic. The social component of sustainability is not just an idealized goal, but also a necessity for achieving the economic and ecological components. Existing institutions of all kinds, including corporations, local and national government, and transnational organizations, will have to adapt to the requirements of sustainable development if all the problems which motivated the development of concept are not to grow worse. Democratic governance, participation, and the satisfaction of basic needs are thus an essential part of a new sustainable development synthesis.

References

Anand, Sudhir and Amartya K. Sen (1996), *Sustainable Human Development: Concepts and Priorities*, United Nations Development Programme, Office of Development Studies Discussion Paper Series.

Arrow, Kenneth et al. (1995), 'Economic Growth, Carrying Capacity, and the Environment', *Science* **268**, 520-521.

Ayres, Robert U. and Leslie W. Ayres (1996), *Industrial Ecology: Closing the Materials Cycle*, Cheltenham UK: Edward Elgar.

Beckerman, Wilfred (1994), 'Sustainable Development: Is it a Useful Concept?' *Environmental Values* **3**, 191-209.

Beckerman, Wilfred (1995), 'How Would You Like Your "Sustainability", Sir? Weak or Strong? A Reply to My Critics', *Environmental Values* **4**, 169-179.

Chambers, Robert (1992), 'Sustainable Livelihoods: The Poor's Reconciliation of Environment and Development', Chapter 7 in Paul Ekins and Manfred Max-Neef eds., *Real-Life Economics: Understanding Wealth Creation*, New York: Routledge.

Ciriancy-Wantrup, S.V. (1952), *Resource Conservation*, Berkeley: University of California Press.

Cleveland, Cutler J. and Matthias Ruth (1997), 'When, Where, and by How Much do Biophysical Limits Constrain the Economic Process?' A Survey of Georgescu-Roegen's Contribution to Ecological Economics', *Ecological Economics* **22**, 203-223.

Cline, William R (1992) *The Economics of Global Warming*, Washington DC: Institute for International Economics.

Common, Mick (1996), 'Beckerman and his Critics on Strong and Weak Sustainability: Confusing Concepts and Conditions', *Environmental Values* **5**, 83-88.

Common, Mick, and Charles Perrings (1992) 'Towards an Ecological Economics of Sustainability', *Ecological Economics* **6,** 7-34.

Daly, Herman E. (1991), *Steady State Economics*, 2nd ed., Washington, D.C.: Island Press.

Daly, Herman E. (1994), 'Operationalizing Sustainable Development by Investing in Natural Capital', in AnnMari Jansson et al. eds., *Investing in Natural Capital: The Ecological Economics Approach to Sustainability*, Washington, D.C.: Island Press.

Daly, Herman E. (1995), ‘On Wilfred Beckerman’s Critique of Sustainable Development’, *Environmental Values* **4**, 49-55.

Daly, Herman E. (1996), *Beyond Growth: The Economics of Sustainable Development*, Boston, Massachusetts: Beacon Press.

Durning, Alan (1992), *How Much is Enough? The Consumer Society and the Future of Earth*. Worldwatch Environmental Alert Series, ed. Linda Starke, New York: W.W. Norton.

El Serafy, Salah (1993), ‘The Environment as Capital’, in Ernst Lutz ed., *Toward Improved Accounting for the Environment: An UNSTAT-World Bank Symposium*, Washington, D.C: The World Bank.

El Serafy Salah (1996), ‘In Defence of Weak Sustainability: A Response to Beckerman’, *Environmental Values* **5**, 75-81.

El Serafy, Salah (1997), ‘Green Accounting and Economic Policy’, *Ecological Economics* **21**, 217-229.

Frosch, Robert A. (1992), ‘Industrial Ecology: A Philosophical Introduction’, *Proceedings of the National Academy of Sciences* **89**, 800-3.

Frosch, Robert A. and Nicholas E. Gallopoulos (1989), ‘Strategies for Manufacturing’, *Scientific American* **261** (3), 94-102.

Georgescu-Roegen, Nicholas (1971), *The Entropy Law and the Economic Process*, Cambridge, Massachusetts: Harvard University Press.

Georgescu-Roegen, Nicholas (1993), ‘Energy and Economic Myths’, Chapter 4 in Herman E. Daly and Kenneth N. Townsend eds., *Valuing the Earth: Economics, Ecology, Ethics*, Cambridge, Massachusetts: MIT Press.

Gowdy, John, and Sabine O’Hara (1997), ‘Weak Sustainability and Viable Technologies’, *Ecological Economics* **22**, 239-247.

Harris, Jonathan M., Timothy A Wise, Kevin P. Gallagher, and Neva R. Goodwin eds. (2001), *A Survey of Sustainable Development: Social and Economic Dimensions*, Washington, D.C.: Island Press.

Harris, Jonathan M. and Scott Kennedy (1999). ‘Carrying Capacity in Agriculture: Global and Regional Issues’, *Ecological Economics* **29**, 443-461.

Hartwick, J.M. (1977), ‘Intergenerational Equity and the Investing of Rents from Exhaustible Resources’, *American Economic Review* **66**, 972-974.

Haq, Mahbub ul (1995), *Reflections on Human Development*, New York: Oxford University Press.

Holling, C.S. (1973), 'Resilience and Stability of Ecological Systems', *Annual Review of Ecological Systems* **4**,1-24.

Holling, C.S. (1986), 'The Resilience of Terrestrial Ecosystems: Local Surprise and Global Change', in W.C. Clark and R.E. Munn eds., *Sustainable Development of the Biosphere*, Cambridge, U.K.: Cambridge University Press.

Holling, C.S. (1994), 'An Ecologist View of the Malthusian Conflict', in Kerstin Lindahl-Kiessling and Hans Landberg eds., *Population, Economic Development, and the Environment*, New York and Oxford: Oxford University Press.

Holmberg, Johan ed. (1992), *Making Development Sustainable: Redefining Institutions, Policy, and Economics*, Washington, D.C.: Island Press.

Howarth, Richard B. and Richard B. Norgaard (1993), 'Intergenerational Transfers and the Social Discount Rate', *Environmental and Resource Economics* **3**, 337-58.

Intergovernmental Panel on Climate Change (2001a), *Climate Change 2001: The Scientific Basis*, New York: Cambridge University Press.

Intergovernmental Panel on Climate Change (2001b), *Climate Change 2001: Impacts, Adaptation, and Vulnerability*, New York: Cambridge University Press.

Johansson, Thomas B. and José Goldemberg eds. (2002), *Energy for Sustainable Development: A Policy Agenda*, New York: United Nations Development Programme.

Lipton, Michael (1997), 'Accelerated Resource Degradation by Agriculture in Developing Countries? The Role of Population Change and Responses to It', in Stephen A. Vosti and Thomas Reardon eds., *Sustainability, Growth and Poverty Alleviation: A Policy and Agroecological Perspective*, Baltimore: Johns Hopkins University Press.

MacKenzie, James J. (1996), *Oil as a Finite Resource: When will Global Production Peak?* Washington, D.C: World Resources Institute.

Norgaard, Richard B. (1994), *Development Betrayed*, London: Routledge.

Pearce and Warford (1993), *World Without End: Economics, Environment, and Sustainable Development*, New York and Oxford: Oxford University Press.

Pinstrup-Andersen, Per, and Rajul Pandya-Lorch (1998) 'Food Security and Sustainable Use of Natural Resources: A 2020 Vision', *Ecological Economics* 26, 1-10.

Pretty, Jules, and Robert Chambers (2000) ‘Towards a Learning Paradigm: New Professionalism and Institutions for Agriculture’, in Jonathan M. Harris ed., *Rethinking Sustainability: Power, Knowledge, and Institutions*. Ann Arbor, Michigan: University of Michigan Press.

Reed, David ed. (1997), *Structural Adjustment, the Environment and Sustainable Development*, London: Earthscan Publications.

Scherr, Sara J. (1997), ‘People and Environment: What is the Relationship between Exploitation of Natural Resources and Population Growth in the South?’ *Forum for Development Studies* (1), 33-58.

Sen, Amartya, (2000), *Development as Freedom*, New York: Alfred A. Knopf.

Socolow, Robert et al (1994), *Industrial Ecology and Global Change*, New York and Cambridge, UK: Cambridge University Press.

Solow, Robert M. (1986), ‘On the Intertemporal Allocation of Natural Resources’, *Scandinavian Journal of Economics* **88**, 141-149.

Toman, Michael A. (1992), ‘The Difficulty in Defining Sustainability’, *Resources* **106**, 3-6.

United Nations Development Programme (1990-2002), *Human Development Report*, New York: Oxford University Press.

United Nations Development Programme, United Nations Environment Programme, World Bank, and World Resources Institute (2000), *World Resources 2000-2001: People and Ecosystems: The Fraying Web of Life*, Washington, D.C.: World Resources Institute.

United Nations Environmental Programme (2000), *Global Environmental Outlook 2000: UNEP’s Millennium Report on the Environment*, London: Earthscan Publications, 1999.

United Nations Environmental Programme (2002), *Global Environmental Outlook 3: Past, Present and Future Perspectives*, London: Earthscan Publications, 2002.

World Commission on Environment and Development (1987), *Our Common Future*, New York: Oxford University Press, 1987.