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Natural Resource Degradation: Policy, Economics and Management

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NATURAL RESOURCE DEGRADATION
POLICY, ECONOMICS AND MANAGEMENT

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GATEKEEPER SERIES

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Natural Resource Degradation Policy, Economics and Management

The following paper briefly discusses recent progress in economics research on natural resource degradation in Third World countries, the current gaps in our understanding of this problem and the research needs for the future. Although the emphasis will be on economics research, policy-relevant research from other disciplines will be reviewed where appropriate. The discussion will concentrate mainly on national and sectoral policy issues as they relate to the management of key natural resources and resource systems - e.g., tropical forests, water resources, wetlands, drylands and arable soils.

1. Current Progress

In the 1980s natural resource degradation in the Third World received increasing recognition as a key economic development issue by donor agencies, Third World governments and the general public in all countries. Sustainable and efficient management of the natural resource base is now perceived to be an important condition for 'sustaining' development efforts in the Third World. Concerted research efforts in resource and environmental economics in the Third World are considered essential to progress in developing appropriate policies to control natural resource degradation.

Important research initiatives that have contributed to the economic analysis of natural resource degradation include efforts to analyze the aggregate economic cost of degradation, especially advances in 'resource accounting' methods; the impact on the environment of economic policies, particularly pricing policies for natural resource products or resource-based activities; the effects of 'user incentives', e.g. common property rights, land tenure and distribution, intra-household division of labour, perceptions of risk, degree of participation in decision-making, etc., on the way individuals manage the resources available to them; and improvements in the methodology of economic valuation of environmental impacts, in terms of appraising both the benefits of environmental preservation and the costs of degradation.

2. Tropical Forests

Tropical deforestation has become a key global concern. Natural closed broadleaved forests in tropical countries are estimated to cover 1.26 billion hectares (ha). Approximately 7.1 million ha of this forest area were being cleared annually in the early 1980s.

with 4 million ha deforested in Latin America alone.¹ Perhaps most worrying is that deforestation is occurring with little regard to long-term management of the forests. For example, on a world scale, operational management of tropical forests for sustainable production of timber is negligible.²

The cost of forest conversion and degradation can be high. For example, in Indonesia, the forgone cost in terms of timber rentals from converting primary and secondary forest land is in the order of US \$625-750 million per annum. With logging damage and fire accounting for additional costs of US \$70 million, this would represent losses of around US \$800 million annually. The inclusion of forgone minor forest products would raise this cost to US \$1 billion per year. In addition, the loss of timber on sites used for development projects could be another US \$40-100 million.³ The total cost of the depreciation of the forest stock would include not just the cost of conversion but also the cost of timber extraction and forest degradation. One study estimated this total cost for Indonesia to be around US \$3.1 billion in 1982, or approximately 4% of GDP.⁴ However, this estimate must be considered a lower bound, as it does not include the value of the loss of forest protection functions (e.g., watershed protection, micro-climatic maintenance) and of biodiversity. The latter may particularly be important in terms of option and existence values - i.e., values reflecting a willingness to pay to see species conserved for future use or for their intrinsic worth - which could translate into future payments that the rest of the world might make to Indonesia to conserve forest lands.

There is now sufficient economic evidence linking the tropical deforestation problem to economic policies. Too often, the pricing and economic policies of countries with tropical forests distort the costs of deforestation:

- i. the 'prices' determined for tropical timber products or the products derived from converted forest land do not incorporate the lost economic values in terms of forgone timber rentals, forgone minor forest products and other direct uses (e.g., tourism), disrupted forest protection and

¹ Food and Agricultural Organization (FAO) of the United Nations [1988]. An Interim Report on the State of Forest Resources in the Developing Countries, Forest Resources Division, Forestry Department, FAO, Rome, Italy.

² D. Poore. [1989]. No Timber Without Trees: Sustainability in the Tropical Forest, Earthscan Publications, London, 1989.

³ D.W. Pearce, E.B. Barbier and A. Markandya. [1990]. Sustainable Development: Economics and Environment in the Third World. Edward Elgar, London, ch. 5.

⁴ R. Repetto, M. Wells, C. Beer and F. Rossini [1987]. Natural Resource Accounting for Indonesia, World Resources Institute, Washington DC.

other ecological functions, and the loss of biological diversity, including any option or existence values.

- ii. even the direct costs of harvesting and converting tropical forests are often subsidized and/or distorted, thus encouraging needless destruction.

For example, in the Brazilian Amazon subsidies and other policy distortions are estimated to have accounted for at least 35% of all forest area altered by 1980 through tax incentives for capital investment (e.g., industrial wood production and livestock ranching); rural credits for agricultural production (mechanized agriculture, cattle ranching and silviculture); subsidized small farmer settlement; and export subsidies.⁵ Similarly, in Malaysia and Indonesia, government policies to encourage the switching from the export of raw logs to processed timber products have led to substantial losses in timber rents, the establishment of inefficient processing operations and accelerated deforestation. Equally problematic has been the allocation of timber concession rights, leasing agreements and the incentives for reforestation.⁶

There is also evidence of non-economic policy distortions contributing to extensive deforestation.⁷ Formal property law and titling regulations often ensure that clearing of land is a prerequisite for guaranteeing claims to frontier forest landholdings. Given the insecurity of many frontier tenure regimes, private individuals and firms often excessively clear forest lands in order to safeguard their tenuous claims to holdings and to 'capture' agricultural rents. As the capacity of many governments to 'manage' vast tracts of publicly owned tropical forests is often minimal, encroachment into forest reserves and protected lands are not controlled. At the same time, proper consideration of customary land tenure arrangements and access claims by indigenous forest dwellers and users is often lacking in government decisions to allocate forest land or determine titling.

⁵ J.O. Browder [1985]. Subsidies, Deforestation, and the Forest Sector in the Brazilian Amazon, World Resources Institute, Washington DC.

⁶ R. Repetto and M. Gillis (eds.) [1988]. Public Policies and the Misuse of Forest Resources. Cambridge University Press, Cambridge and Pearce Barbier and Markandya, op. cit.

⁷ H. Binswanger [1989]. Brazilian Policies that Encourage Deforestation in the Amazon, Environment Department Working Paper No. 16, World Bank, Washington DC; Browder, op. cit.; Pearce, Barbier and Markandya, op. cit.; and D. Southgate, R. Sierra and L. Brown [1989]. The Causes of Tropical Deforestation in Ecuador: A Statistical Analysis, LEEC Paper 89-09, London Environmental Economics Centre, London.

Existing economic research on tropical deforestation is only just beginning to yield valuable insights. The literature is still confined to specific case studies with a narrow geographic focus. The following general research priorities are required:

- i. further analysis of the total economic value of tropical forests, including existence and option values;⁸
- ii. extending the analysis of public policy distortions, both economic and non-economic, to more geographical areas (e.g., Africa), as well as continually up-dating and broadening existing analyses;
- iii. instigating multi-disciplinary research into complex socio-economic issues surrounding deforestation, such as the linkages among land clearing, tenure security, rural population pressure, and the factors determining agricultural rents on converted forest lands; and
- iv. exploring economic aspects of international agreements and timber trade policies to protect tropical forests, including debt-for-nature swaps and compensatory flows to countries forgoing exploitation of their tropical forests.

3. Wetlands

Since 1900, over half of the world's wetlands may have disappeared. The United States alone has lost an estimated 54% (87 million ha) of its original wetlands, of which 37% has been lost to agricultural development, 8% to urban development and 5% to other conversions.⁹ The total area and status of tropical wetlands are still unknown, but the available evidence suggests that the pattern of wetland conversion in Third World countries may be similar to that of the United States - and perhaps proceeding at even a faster rate in some regions.

Natural wetlands perform many important functions for humankind - storm prevention, flood and water flow control, nutrient and waste absorption and so forth. Wetlands can also be used for recreation and water transport, and their diverse resources can be directly exploited for fishing, wildlife products, wood products and water supply. When properly measured, the total economic value of a wetland's ecological functions, its services and its resources may exceed the economic gains of converting the area to an alternative use. Some economic studies have valued the

⁸ For further elaborations on these values and the broad approach to be taken see D.W. Pearce [1990] "Economic Values and Tropical Forests", in D.W. Pearce and J.J. Warford, Environment and Economic Development in the Third World, forthcoming.

⁹ E. Maltby [1986]. Waterlogged Wealth: Why Waste the World's Wet Places? Earthscan Publications, London, p. 90.

benefits of temperate wetlands.¹⁰ But to date, little analysis of tropical wetland benefits has been undertaken. The methodology for economic valuation of tropical wetlands is relatively straightforward, although more sophisticated techniques of contingent valuation, travel cost method and hedonic pricing are difficult to apply in most developing regions.¹¹

The lack of sufficient studies of the economic value of tropical wetland benefits, including the benefits derived from local communities dependent on the natural wetlands, means that wetland conversion in tropical wetlands will proceed in Third World countries as long as the economic gains from conversion - mainly for agricultural purposes - exceed the direct costs of drainage, clearing and other 'reclamation' expenditures. As arable land becomes scarce in Third World countries, it is likely that subsidies and distortions to reduce the direct costs of wetland conversion may reach levels similar to those in OECD countries in the 1950s-70s.¹² Efforts by IUCN, the Ramsar Convention Bureau and the International Waterfowl and Wetlands Research Bureau to co-operate on methodologies for wetland management, particularly in the hitherto neglected Third World, are welcomed. But the relevance of such efforts in affecting government development decisions and planning will depend crucially on improving and extending the economic evaluation of tropical wetlands. The following general research priorities are required:

- i. initiating more functional assessments of the ecological relationships of tropical wetlands, especially their hydrological functions, which should lead to more analyses of the total economic value of tropical wetlands, ensuring a wide geographical spread and covering different ecological systems (e.g., freshwater, mangrove swamps, etc.);

¹⁰ For a review, see R.K. Turner [1988]. "Wetland Conservation: Economics and Ethics", Chapter 9 in D. Collard, D. Pearce and D. Ulph (eds.), Economics, Growth and Sustainable Development: Essays in Memory of Richard Lecomber, The MacMillan Press, London, pp. 121-59 and S. Farber and R. Constanza [1987]. "The Economic Value of Wetland Systems", Journal of Environmental Management 24:41-51.

¹¹ E. Barbier [1989]. Economic Evaluation of Tropical Wetland Resources: Applications in Central America, London Environmental Economics Centre. One interesting study of the economic benefits of a tropical wetland can be found in D. Thomas, F. Ayache and T. Hollis [1989]. "Use Values and Non-Use Values in the Conservation of Ichkeul National Park, Tunisia", forthcoming in Environmental Conservation.

¹² D. Baldock [1984]. Wetland Drainage in Europe: The Effects of Agricultural Policy in Four EEC Countries. International Institute for Environment and Development and the Institute for European Environmental Policy, London.

- ii. extending the analysis to cover public policy distortions, both economic and non-economic, as they impact on wetland conversion in Third World countries; and
- iii. instigating multi-disciplinary research into the socio-economic relationships of local communities dependent on tropical wetlands for their livelihoods and the benefits derived from wetland use.

4. Drylands

The term 'drylands' is usually applied to all arid and semi-arid zones, plus areas in the tropical sub-humid zone subject to the same degradation processes that occur on arid lands. Accounting for about one third of global land and supporting a population of 850 million, the world's drylands are rapidly being degraded through population growth, over-grazing, cropping on marginal lands, inappropriate irrigation and devegetation.¹³ The process of dryland degradation is often referred to as 'desertification', where the productive potential of the land is reduced to such an extent that it can neither be readily reversed by removing the cause nor easily reclaimed without substantial investment.¹⁴

There are few economic studies of the costs of dryland degradation. The 1984 UNEP study on the status and trends of desertification estimated a global cost of US\$ 26 billion annually from lost agricultural and livestock productivity. The annual cost of degradation in Canada's prairie region is estimated to be US\$ 622 million.¹⁵ However, substantial work on the costs of dryland degradation in developing regions has yet to be conducted, even though the problems there are believed to be more severe than those encountered in temperate areas.

Even further behind - and more controversial - is the analysis of the effects of economic and resource management policies on dryland degradation in Third World countries. This is often attributed to the superficial identification of the causes of desertification and to the frequently poor identification of the causes of the failures of dryland projects.¹⁶ Although the majority of 'causes' are attributable to population growth and natural events, dryland degradation is also symptomatic of an

¹³ J. Dixon, D. James and P. Sherman [1989]. The Economics of Dryland Management, Earthscan Publications, London and M. Mortimore [1989]. Adopting to Drought: Farmers, Famines and Desertification in West Africa, Cambridge University Press, Cambridge.

¹⁴ R. Nelson [1988]. Dryland Management: The "Desertification" Problem, Environment Department Working Paper No. 8, World Bank, Washington DC.

¹⁵ Dixon, James and Sherman, op. cit.

¹⁶ Nelson, op. cit.

agricultural development bias that distorts agricultural pricing, investment flows, R & D, and infrastructure towards more 'favored' agricultural land and systems.¹⁷ Where drylands 'development' is encouraged, it is usually through the introduction of large-scale commercial agricultural schemes that can conflict with more traditional farming and pastoral systems.

The complexity of social, economic and environmental relationships is formidable. Not enough is often known about dryland farming and pastoral systems; open access use and common property resource rights; land tenure regimes and security; the distribution of wealth and income; and coping strategies under the presence of variable climatic conditions, frequent drought, market instability, political conflicts and other factors influencing risk and uncertainty. A common misperception is that the extension of private property rights, commercial agriculture and markets will 'automatically' solve dryland management problems in the long run. At the same time, not all dryland farmers and pastoralists, even in the most distant and resource-poor regions, are totally isolated from agricultural markets. Virtually all subsistence households require some regular market income for cash purchases of some agricultural inputs and basic necessities; many farmers and pastoralists provide important cash and export crops. As a result, alterations in market conditions - whether from changes in policies, climatic conditions, R & D innovations, or other factors - do have a significant impact on the livelihoods of rural groups in dryland areas. Understanding the responses to these changing market conditions is a crucial aspect of the dryland management problem. For example, a study of gum arabic production in Sudan indicates that fluctuations in the real price of gum and its price relative to those of other agricultural crops have had important impacts on farmers' cropping patterns, diversification strategies and decisions to re-plant gum - with important consequences for Sudan's gum belt.¹⁸

The crucial research priority is to analyses of the extent of dryland degradation and to develop more appropriate technologies for improving farming and pastoral systems. The following general research priorities in economics are also required:

- i. initiating more case studies of the economic costs of dryland degradation in developing regions, and policy-related causes of the problem;
- ii. extending the analysis to cover public policy distortions, both economic and non-economic, as they impact on dryland management in Third World countries, e.g., the impact of prices on rainfed cropping, land management and agricultural

¹⁷ E. Barbier [1989]. "Sustaining Agriculture on Marginal Land: A Policy Framework", Environment 31:13-40.

¹⁸ IIED and IES [1989]. Gum Arabic Rehabilitation Project in the Republic of Sudan: Stage I Report, IIED, London.

extensification, the prices of livestock products on rangeland stocking rates, fuelwood prices on wood harvesting and own-production, input subsidies on soil conservation, land acquisition, tenure arrangements and regulations on land management, and so forth.

- iii. instigating multi-disciplinary research into the socio-economic relationships of local communities and their livelihood systems, e.g. farming and herding relationships, agro-forestry developments, tenure arrangements, insurance mechanisms and so forth.¹⁹

5. Irrigation

From 1950 to the mid-1980s, cropland under irrigation increased by over 3% annually, from 94 to over 270 million ha. Around 18% of the world's cultivated land is irrigated, producing 33% of the total harvest. The equivalent of US\$ 250 billion has already been spent to expand irrigation capacity in the Third World, and an additional US\$ 100 billion is expected to be spent between 1985 and 2000. Two thirds of the world's irrigated lands are in Asia, where 38% of additional food production through the year 2000 is anticipated to come from existing irrigated areas and 36% from newly irrigated areas.²⁰

Virtually all irrigation developments in the Third World are through public investments, which are heavily subsidized. Distributional considerations, political concerns and common perceptions of water as a 'free good' have generally led to charges well below costs of supply. Revenues collected from farmers in most Third World countries often cover only 10-20% of the building and operating costs of irrigation systems, usually failing to cover just operation and maintenance (O & M) costs

¹⁹ Given the 'disenfranchisement' of many dryland sub-populations (e.g., traditional pastoralist societies) in basic economic and social policy decisions affecting dryland management and resource allocation, some approaches may need to go beyond 'pure research' and propose mechanisms and institutional reforms for enhancing the participation of these communities in dryland management decisions. See, for example, C. Lane [1990]. Land for Pastoralists: Sustainable Development on the Drylands, IIED, London.

²⁰ R. Repetto [1986]. Skimming the Water: Rent-Seeking and the Performance of Public Irrigation Systems, World Resources Institute, Washington DC.

alone.²¹ The result can be inefficient and poorly maintained irrigation networks, rent-seeking behavior by farmers, misallocation and wasteful use of water and unnecessary investments in major surface water developments, such as dams and large-scale irrigation networks. The environmental impacts can be significant:

- i. the disincentive to conserve water can lead to problems of water logging, salinization and water scarcity; and
- ii. irrigation investments and infrastructure, including dams, can lead to extensive external costs in form of displacement of local communities, loss of agricultural and forest lands, and alterations in river hydrology, in fishing and wildlife industries and in erosion and sedimentation rates.

For example, in India 10 million ha of irrigated land have been lost through waterlogging and 25 million ha are threatened by salinization, and in Pakistan 12 million ha are waterlogged and 5 million ha are saline.²² Agricultural irrigation in Java accounts for about 47% of the total potential water resources available and 75% of the dry season/year flow. Given the expected future demands in all uses of water, the poor cost recovery and inefficiencies in irrigation (average efficiencies are 10-35% and hardly exceed 30% in most areas for both wet and dry seasons), water scarcity is becoming a chronic problem.²³ In Tunisia, an ex post analysis of the large-scale Ghezala irrigation project to take into account disruptive hydrological and other environmental impacts on the neighboring Ichkeul National Park and surrounding areas reveals that these costs contribute to making the project economically unviable.²⁴

The following research priorities in economics are suggested:

²¹ Repetto, op. cit.; D. Julius and A. Alichbusan [1988]. Public Sector Pricing Policies: A Review of Bank Policy and Practice, mimeo, World Bank, Washington DC; and L. Small, M. Adriano and E. Martin [1986]. Regional Study on Irrigation Service Fees: Final Report, Asian Development Bank, Manila. Charging for irrigated water is feasible only where volumetric metering is possible (e.g., tubewell and pumped schemes); however, where this is not possible (e.g., gravity fed systems and canal irrigation), indirect charges can be levied through land and crop taxes.

²² Repetto op. cit.

²³ World Bank [1988] Indonesia - Java: Water Resources Management Report, World Bank, Washington DC.

²⁴ D. Thomas [1989]. Irrigation and Drainage Development Adjacent to the Ichkeul National Park, Tunisia, Department of Geography, University College London, London.

- i. conducting more case study analyses of how current charges and cost-recovery efforts in irrigation impact on water use and the environment, how these impacts can best be mitigated, and the feasibility of changing water pricing structures and supply options;
- ii. improving and extending cost-benefit analysis and appraisal methodology for assessing the environmental and social impacts of hydrodams and large-scale irrigation networks;²⁵
- iii. conducting multi-disciplinary research efforts into the impact of irrigation on land tenure arrangements, water use access and rights, cropping patterns and yields, income and wealth distribution and other socio-economic concerns; and
- iv. conducting more comparative analyses of the economic returns of different irrigation scheme design options - public versus private schemes, the viability of self-help and medium-size alternatives, and so forth.

6. Land Degradation and Soil Erosion

Soil erosion and land degradation are not confined just to drylands and other marginal lands; the problem is pervasive throughout all agricultural systems, degraded forest lands, public and privately owned lands, and large and small holdings in the Third World. Moreover, soil erosion results from all forms of land degradation - over-cropping, devegetation, deforestation, over-grazing and so on. To simplify and limit the discussion, this section will discuss the problem of soil erosion and land degradation mainly in the context of erosion of farm cropland.

Reliable estimates of soil erosion are difficult. Little long-term monitoring of soil erosion from farmers' plots has occurred in Third World countries, aggregation and extrapolation from the few studies that do exist are fraught with complications. Regional - let alone national and international - comparisons should be treated with caution. Estimates of erosion based on the universal soil loss equation (USLE) and modified USLEs adapted for tropical conditions still face many difficulties, as do methods involving Geographical Information Systems (GIS). To go further and analyze the impacts of erosion on crop yields or the impacts of runoff and sedimentation on 'off-site' economic activities is even more difficult in Third World countries. Particularly frustrating is that the declining trends in crop yields attributable to erosion are hard to substantiate, given that erosion impacts are often inseparable from the effects of climatic variations, relative price changes, changing cropping patterns, input mixes and labor use strategies, etc.

²⁵ A major research effort financed by the ODA, with case studies in six Third World countries, has been launched as a result of the International Workshops on Hydro-Power Dams in the Tropics and Sub-Tropics.

Not surprisingly, very few empirical studies of the aggregate economic costs of soil erosion have been attempted. However, some recent efforts indicate that these costs could be substantial. For example, in Mali current net farm income foregone from soil erosion is estimated to be US\$ 4.6 to 18.7 million annually, and current plus future foregone income due to one year's soil erosion is estimated to be US\$ 31 to 123 million (4-16% of agricultural GDP). In Java, the on-site costs of soil erosion in upland areas is estimated to be around US\$ 320 million annually (3% of agricultural GDP), with additional off-site sedimentation costs of US\$ 25 to 90 million.²⁶

Designing appropriate policy responses to control soil erosion and land degradation is again hampered by the data limitations and the lack of microeconomic analyses of farmers' responses to erosion and incentives to adopt conservation measures. The limited evidence that does exist suggests that relationships - such as the effects of agricultural input and output pricing on farm-level erosion - are complex and difficult to substantiate. Nevertheless, there are some indications that subsidies for non-labor inputs, notably inorganic fertilizers, can artificially reduce the costs to farmers of soil erosion and, on more resource-poor lands, substitute for manure, mulches and nitrogen-fixing crops that might be more appropriate. On the other hand, the inaccessibility of inorganic fertilizers - e.g., shortages caused by rationing cheap fertilizer imports - can actually lead to sub-optimal application and encourage farming practices that actually increase land degradation. Similarly, the relationship between erodibility and profitability of different cropping systems needs to be carefully analyzed, particularly in relation to changing relative prices of different crops and changes in real producer prices and incomes over time. More complex incentive effects arise from the relationships between erosion and the availability of labor, off-farm employment, population pressure, tenure and access to frontier land, the development of post-harvesting capacity and other complementary infrastructure and the availability of credit at affordable interest rates.²⁷

²⁶ J. Bishop and J. Allen [1989]. The On-Site Costs of Soil Erosion in Mali, Environment Department Working Paper No. 21, World Bank, Washington DC; and W. Magrath and P. Arens [1987]. The Costs of Soil Erosion on Java - A Natural Resource Accounting Approach, World Resources Institute, Washington DC.

²⁷ E. Barbier [1988]. The Economics of Farm-Level Adoption of Soil Conservation Measures in the Uplands of Java, Environment Department Working Paper No. 11, World Bank, Washington DC; E. Barbier [1989]. Economics, Natural Resource Scarcity and Development: Conventional and Alternative Views, Earthscan, London, ch. 7; IIED and IES, op. cit.; M. Mortimore [1989]. The Causes, Nature and Rate of Soil Degradation in the Northernmost States of Nigeria and An Assessment of the Role of Fertilizer in Counteracting the Processes of Degradation, Environment Department Working Paper No. 17, World Bank, Washington DC; and D. Southgate [1988]. The Economics of Land Degradation in the Third World, Environment Department Working Paper No. 2, World Bank, Washington DC.

A tentative conclusion is that there are often strong economic incentives determining farmers' decisions to invest in soil conservation. Farmers will generally not modify their land management practices and farming systems unless it is in their direct economic interest to do so. Such modifications are expensive and may involve risk. Unless soil erosion is perceived to be a threat to farm profitability, or alternatively unless changes in land management lead to at least some immediate economic gains, farmers will be less willing to bear these substantial costs. In addition, the more productive or profitable the land use, the more farmers will be willing to maintain and invest in better land management and erosion control practices. Higher productivity and returns will also mean that farmers can afford to maintain terraces and other conservation structures and to continue with labor-intensive erosion control measures. On the other hand, poorer farmers dependent on low-return cropping systems, such as maize or cassava, may be aware that soil erosion is reducing productivity but may not be able to afford to adopt conservation measures. At the other extreme, farmers with very profitable crops that are extremely erosive, such as temperate vegetables on steep upper volcanic slopes with deep topsoils, may not consider soil conservation measures if their returns do not appear to be affected by soil erosion losses. Unfortunately, in most developing regions, we still do not understand sufficiently the economic and social factors determining these incentives for soil conservation.

Calls for improved R & D and extension for soil conservation technologies and appropriate cropping systems, as well as investments in more infrastructure and credit expansion, are virtually mandatory these days. Complementary policy measures will also be necessary, however. To assist this effort, the following general research priorities in economics are required:

- i. working with soil scientists and others to initiate more case studies of the economic costs of soil erosion and land degradation in developing regions, and policy-related causes of the problem;
- ii. initiating more microeconomic research into the responses of farmers to erosion and their incentives to adopt soil conservation, which should complement multi-disciplinary research into the socio-economic relationships of local communities and their livelihood systems.
- iii. extending the analysis to cover public policy distortions, both economic and non-economic, as they impact on land management in Third World countries, e.g., the impact of changes in relative agricultural prices and real producer prices, subsidies of inputs and their distribution and marketing, labor use and constraints (including intra-household) tenure arrangements, land titling, use and access, and so forth.

7. Conclusion

This paper has reviewed briefly the existing economics research into natural resource degradation in Third World countries and its relevance for policy. The research priorities suggested for economics are necessarily general: with most natural resource problems we are not even at the state of 'optimal ignorance' on economic-environmental interactions to begin designing appropriate policy responses. In the face of such uncertainty, we should be humble in our policy prescriptions. Even the standard economic tool of 'improved pricing policy' should be invoked with caution. In most Third World countries, there is still very little empirical understanding of the linkages from price changes to agricultural supply and demand responses to natural resource effects. On the other hand, substantial policy distortions affecting natural resource management do exist, and it is necessary to discern these impacts and to correct the causes as best as possible.

For all the resource degradation problems discussed, there is a need for substantive and extensive analysis of the implications of various macroeconomic, trade and sectoral policies for the resource base. Alternative policy options that explicitly take into account the resource constraints of the most vulnerable economic groups need also to be properly formulated and analyzed. At the micro level, there is a need for more analysis of the economic costs of environmental impacts. Micro-level analysis of natural resource allocation decisions at the village or farmer level is also required, as is monitoring of the impacts of policy decisions and investment programs at this level. Although some of this information is sometimes available from research stations, independent, project and provincial studies, it needs to be coordinated and reviewed consistently at the national level to assist policy and investment decisions.

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Economics, Natural-Resource Scarcity and Development: Conventional and Alternative Views. Earthscan Publications Limited, London, 1989. (£29.95)

The history of environmental and resource economics is reviewed, then using insights provided by environmentalism, ecology and thermodynamics, Barbier begins the construction of a new economic approach to the use of natural resources and particularly to the problem of environmental degradation. With examples from the global greenhouse effect, Amazonian deforestation and upland degradation on Java, Barbier develops a major theoretical advance and shows how it can be applied. This book breaks new ground in the search for an economics of sustainable development.

David W Pearce, Edward B Barbier and Anil Markandya,

Sustainable Development: Economics and Environment in the Third World, Edward Elgar Publishing Limited, London 1989 [in press].

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The authors attempt to give some structure to the concept of sustainable development and to illustrate ways in which environmental economics can be applied to the developing world. Beginning with an overview of the sustainable development concept, the authors indicate its implications for discounting and economic appraisal. Core studies on natural resource management are drawn from Indonesia, Sudan, Botswana, Nepal and the Amazon.

David W Pearce, Anil Markandya and Edward B Barbier

Blueprint for a Green Economy, Earthscan,
September 1989, £6.95 (Second Printing)

This book by the London Environmental Economics Centre was prepared as a report for the Department of Environment, as a follow up to the UK government's response to the Brundtland Report. Here it stated that: '...the UK fully intends to continue building on this approach (environmental improvement) and further to develop policies consistent with the concept of sustainable development.'

The book attempts to assist that process.

Gordon R. Conway and Edward B. Barbier

After the Green Revolution:
Sustainable Agriculture for Development
Earthscan, London 1990 (available in April)

The Green Revolution has been successful in greatly improving agricultural productivity in many parts of the developing world. But these successes may be limited to specific favourable agro-ecological and economic conditions. This book discusses how more sustainable and equitable forms of agricultural development need to be promoted. The key is developing appropriate techniques and participatory approaches at the local level, advocating complementary policy reforms at the national level and working within the constraints imposed by the international economic system.

David W. Pearce and R. Kerry Turner

Economics of Natural Resources and the
Environment, Harvester-Wheatsheaf, London and
Johns Hopkins University Press, Baltimore,
1989.

This is a major textbook covering the elements of environmental economics in theory and practice. It is aimed at undergraduates and includes chapters on sustainable development, environmental ethics, pollution taxes and permits, environmental policy in the West and East, recycling, and optimal resource use.

IIED/UCL LONDON ENVIRONMENTAL ECONOMICS CENTRE

The London Environmental Economics Centre is a joint initiative of IIED and the Department of Economics of University College London. It has been funded by core contributions from the governments of Sweden, Norway and the Netherlands.

The Centre has as its main objectives:

- Research into environmental problems of less developed countries from an economic standpoint;
- Dissemination of research and state of the art environmental economics through publication, public and professional address and specialist conferences;
- Advice and consultancy on specific issues of environmental policy.



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