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Environmental Management and Development in the South: Prerequisites for Sustainable Development

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Introduction

In the 1980s environmental degradation in the South received increasing recognition as a key economic development issue by governments, aid agencies and the general public in all countries. This rather recent 'discovery' that excessive resource mismanagement, depletion and degradation do indeed impose high costs on developing economies has been slow in coming. Perhaps one reason has been that these costs have been difficult to assess. The impacts of environmental degradation often occur *externally* to any market system and involve complex processes of ecological-economic interaction. Both the economic *causes* and *effects* of environmental degradation are difficult to discern and analyze in developing countries.

Moreover, much excessive degradation of the environment and natural resources in developing countries results from individuals in the market place and by governments not fully recognizing and integrating environmental values into decision-making processes. If markets fail to reflect adequately environmental values, *market failure* is said to exist. Where government decisions or policies do not fully reflect these values, there is policy or *government failure*. Throughout the developing world, the existence of poorly formulated input and output pricing policies, insecure land titling and registration, tax thresholds and rebates, cheap and restricted credit facilities, overvalued exchange rates and other policy distortions, has exacerbated problems of natural resource management. By failing to make markets and private decision makers accountable for forgone environmental values, these policies may contribute to market failure. At worst, the direct private costs of resource-using activities are subsidized and/or distorted, thus encouraging unnecessary environmental degradation.[2]

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[1] I am grateful to Bruce Aylward, Joshua Bishop, Joanne Burgess, Johann Holmberg and Anil Markandya for their constructive comments. All errors and omissions are of course mine alone.

[2] For a recent review of the economics of environmental degradation in developing countries see Barbier (1991).

The following paper argues that sustainable and efficient management of natural resources is crucial to developing economies. These economies, especially the lower-income countries, are highly dependent on primary production as the foundation of long-term, sustainable economic development. Successful exploitation of primary production - agriculture, fishing, forestry and minerals - in turn depends on efficient and sustainable management of the resource base supporting primary productive activities. Moreover, as developing countries industrialize and as their populations concentrate in urban settlements, the role of the environment in assimilating waste products and providing life-support amenities will become increasingly important. Protection and conservation of key natural systems and important ecological functions will also be essential, not only in terms of their potential value for recreation and tourism but also because these systems and functions may provide valuable support and protection for economic activity and human welfare.

Poverty, Environment and Degradation

Given the presence of both high levels of poverty and environmental degradation in developing countries, it is tempting to conclude that poverty *causes* environmental degradation. However, recent evidence suggests that poverty-environmental linkages cannot be reduced to simple unidimensional cause-effect relationships (Jagannathan 1989; Barbier 1989; Conway and Barbier 1990; Pearce and Warford 1991). There are numerous complex factors that influence poor peoples' perceptions of the environment and their behaviour towards natural resource management. These range from the economic distortions arising from policy and market failures, to underlying labour and capital endowments and constraints, to access to alternative employment and income-earning opportunities, to institutional and legal factors such as tenure or access security, property rights and delivery systems. Often what is perceived to be a *direct* link between poverty and environmental degradation proves to be an *indirect* link under careful analysis. Public policies and other factors often affect the incentive structures and redirect capital and labour flows between sectors and regions, with adverse consequences for the poor and their ability or willingness to manage resources sustainably (Jagannathan 1989).

As poor people have little or no access to capital and must rely on family or low-skilled labour for earning income, it would seem economically perverse that they would degrade any 'natural capital' at their disposal. Many studies have revealed that poor people and communities are often acutely aware of the essential role of natural resources in sustaining their livelihoods, and equally, of the costs and impacts of environmental degradation.[3]

[3] On indigenous knowledge and views of the role of natural resources in the livelihood security of the poor, see Chambers (1988), Richards (1985) and Wilson (1988).

This would suggest that, *ceteris paribus*, there exist tremendous *incentives* for the poor to manage and sustain the stock of natural capital at their disposal in order to maintain or enhance both their immediate and future livelihood options. Where they choose to degrade their environment - and there may be rational grounds for doing so under certain circumstances - it is because changing economic and social conditions have altered the incentive structures of the poor, including perhaps their control over or access to essential resources. Often increased 'immiserization' is an outcome, or part of the 'cumulative causation' process, that is symptomatic of the subsequently observed poverty-environment 'trap'.

Thus from an economic perspective, simply observing that poor people are 'driven' to degrade the environment - even when this appears to be the case - is not helpful. Designing appropriate policy responses to alleviate problems of poverty and environmental degradation therefore requires careful analysis of the *determinants* of individual behaviour. Such an analysis would clarify the factors leading them to degrade their environment, their responses to environmental degradation and the incentives required to induce conservation.

Where further analysis reveals that poverty is not the direct 'cause' of environmental degradation, designing appropriate policy responses will nevertheless be affected by poverty's indirect role. The response of poor people and communities to incentives encouraging sustainable resource management may be affected by special factors influencing their behaviour, such as high rates of time preference induced by greater risk and uncertainty over livelihood security, labour and capital constraints, insecure tenure over and access to resources, imperfect information and access to marketed inputs and a variety of other conditions and constraints (Barbier 1989b and 1990b).

Moreover, the poor are not a homogenous group. The work of Lipton (1983 and 1988) highlights how the 'ultra' or 'core' poor, other poor and the non-poor in developing countries all differ in terms of demographic, nutritional, labour-market and asset-holding characteristics.[4] A recent study in Malawi highlights how the poor and the 'core' poor face different incentives and constraints in combatting declining soil fertility and erosion, which is a serious problem afflicting smallholder agriculture (Barbier and Burgess 1990). Some of the results of the study are indicated in Box 1.

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[4] The exact numbers and composition of poor and ultra-poor will obviously vary by country and region; however, as an approximate indication Lipton (1988) suggests that the ultra-poor can be defined as those at significant risk of income-induced caloric undernutrition and the poor as those with sufficiently low income to be at risk of hunger but not undernutrition, with the former usually falling in the bottom 10-20% income category (e.g., the 'poorest quintile').

BOX 1 WOMEN, POVERTY AND LAND DEGRADATION, MALAWI

A. Smallholder Poverty Profile, Malawi

	Core Poor	Other Poor	Non-Poor
Sex of head of household (% female)	42	34	16
Number of labour days/year - per household	532	606	762
Average land holding (ha) - per household	0.39	0.73	1.76
Agricultural services - % using fertilizer	9	16	35
- maize yield (1000 tn/ha)	1.2	1.3	1.4

B. Fertilizer Use by Household Type, Blantyre Agricultural Development Division, Malawi

Total Households	883			
Gender of Household head	Male		Female	
	No.	%	No.	%
	556	63.0	327	37.0
Fertilizer Farmers	208	37.4	90	27.5
Non-Fertilizer Farmers	348	62.6	237	72.5

C. Credit Disbursement and Input Use to Smallholders, Malawi

	83/84	84/85	85/86	86/87	87/88	88/89	89/90
Seasonal Loans ('000 Malawi Kwacha)	11460	15555	19065	18283	26871	42211	57075
No. of Beneficiaries ('000)	180	212	208	206	243	301	315
Women as % of Beneficiaries	15.0	16.2	19.4	25.4	29.8	24.8	29.9

D. Adoption of Soil Conservation, Ntcheu Rural Development Project, Malawi

ACTIVITY	TARGET (1)	ACHIEVEMENT (2)	(1/2) %
Farm Plans	M: 8 W: 2	M: 3 W: 0	37.5 0.0
Contour Marker Ridges	M: 600 W: 300	M: 232 W: 42	38.7 14.0
Composting	M:1500 W:1000	M:1051 W: 156	70.1 15.6
Manuring	M:4500 W:2500	M:3347 W:1002	74.4 40.1
Alley Cropping	M: 170 W: 80	M: 30 W: 14	17.6 17.5
Buffer Strips	M: 8 W: 2	M: 3 W: 0	37.5 0.0
Raised Boundaries/Paths	M: 200 W: 100	M: 321 W: 199	160.5 199.0
Gully Reclamation	M: 80 W: 20	M: 104 W: 20	130.0 100.0
Farmer Training	M: 500 W: 220	M: 157 W: 245	31.4 111.4

Notes: M: Men W: Women.

Source: Table A from World Bank, Malawi - Country Economic Memorandum: Growth Through Poverty Reduction, Washington DC, 1989, Table III.B.1; Tables B,C and D from E.B. Barbier and J.C. Burgess, Malawi - Land Degradation in Agriculture, Report to the World Bank Economic Mission on Environmental Policy, Malawi, London, July-August 1990.

In Malawi, female-headed households make up a large percentage (42%) of the 'core-poor' households. They typically cultivate very small plots of land (< 0.5 ha) and are often marginalised onto the less fertile soils and steeper slopes (> 12%). They are often unable to finance agricultural inputs such as fertilizer, to rotate annual crops, to use 'green manure' crops or to undertake soil conservation. As a result, poorer female-headed households generally face declining soil fertility and lower crop yields, further exacerbating their poverty and increasing their dependence upon the land. The special constraints and needs of poor female-headed households must be carefully considered when designing economic policies to alleviate poverty and control land degradation. Otherwise, an important sub-set of the rural population will not respond fully to policy measures and incentives to improve environmental management, and the problem of land degradation may continue unmitigated.

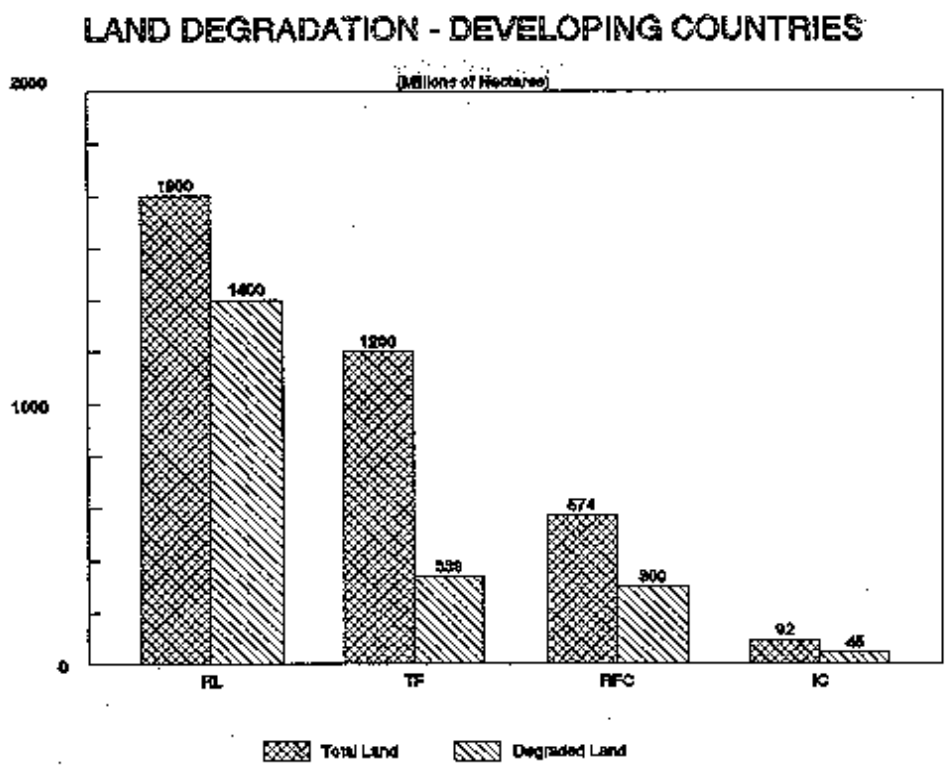
In confronting poverty-environmental degradation problems, policy makers are therefore faced with difficult challenges. On the one hand, existing policy and market failures may distort the incentives faced by all individuals for managing environmental assets efficiently and sustainably, suggesting that public policies are a legitimate means of ensuring that these distortions are corrected. This is reinforced by the important role that resources often play in the livelihoods of the poor. In other words, efficient and sustainable resource management may be an important *prerequisite* for ensuring livelihood security and avoiding any poverty-environment trap rather than a *by-product* of efforts to improve incomes. On the other hand, designing appropriate policies to alleviate poverty and reduce environmental degradation is not an easy task. In many instances, our knowledge and analysis of the linkages between policy changes at the sectoral or macro level and their effects on the incentives facing diverse groups of poor people in a variety of differing ecological, economic and social circumstances is simply not adequate. This reinforces the urgent need for more research and policy analysis of this kind.

Land Degradation, the Poor and Ecologically Fragile Areas

Whatever the complex factors driving poverty and environmental degradation, recent evidence does suggest that the task for policy makers in reducing poverty and environmental degradation is becoming increasingly intractable.

A major problem facing developing countries is the scale of land degradation that is currently occurring. Figure 1 highlights this problem: in recent decades nearly 80% of rangeland and dryland forest areas, 30% of tropical forest and around half of all rainfed and irrigated cropland in developing countries are classified as degraded.

Figure 1



Notes: RL = Rangeland and dry forest, excluding deserts and cropland.
TF = Total tropical forest in developing countries; degraded portion indicates land that has been deforested since 1960.
RFC = Rainfed cropland in current production.
IC = Irrigated cropland.

Degraded lands are lands that have been seriously degraded by environmental destruction or abuse.

Source: Derived from H.J. Leonard, "Overview - Environment and the Poor: Development Strategies for a Common Agenda", in H.J. Leonard et al., Environment and the Poor: Development Strategies for a Common Agenda, Transaction Books, New Brunswick, 1989.

Although there are few studies of the overall economic costs of land degradation to developing economies, Box 2 presents selective estimates from a few low-income countries. These estimates all indicate that the costs of land degradation as forgone income are significant in terms of the overall gross domestic product (GDP) of developing countries, and particularly in terms of agricultural earnings.

Land and renewable resources are the basic capital assets of many developing countries, and as will be discussed below, it is the poorer economies of the world that are particularly dependent on 'natural' capital for their development efforts. Excessive land degradation in developing countries only serves to hamper the future earning potential of these economies - and where such degradation is irreversible or can only be reversed at considerable cost - reduces the future economic opportunities available to them.

BOX 2 ESTIMATED COSTS OF LAND DEGRADATION IN SOME DEVELOPING COUNTRIES

A. Indonesia - Costs of Forest Degradation and Soil Erosion a/
(1973 Rupiah Billion)

Period	Average Annual GDP	Average Costs of Forest Depreciation	Average Costs of Soil Erosion b/	Total Costs of Degradation	Average Share of GDP
1971-84	9427	557	78	635	6.9%

B. Burkina Faso - Costs of Dryland Degradation c/
(1988 CFAF billion)

Period	Fuelwood Losses	Livestock Losses	Cereal Losses	Total Damage Costs	Share of GDP
1988	46.7	10.0	15.3	72.0	8.8%

C. Mali - On-Site Costs of Soil Erosion d/
(1988 CFAF billion)

Period	Forgone Current Farm Income	Forgone Future Farm Income	Total Forgone Income	Share of National GDP	Share of Agricultural GDP
1988	1.32	8.95	10.28	1.7%	4.4%

D. Malawi - On-Site Costs of Soil Erosion e/
(1988 Malawi Kwacha million)

Period	Forgone Current Gross Margins	Forgone Future Gross Margins	Total Forgone Gross Margins	Share of National GDP	Share of Agricultural GDP
1988	18.4	160.2	178.6	4.8%	14.6%

Notes: a/ From R. Repetto, W. Magrath, M. Wells, C. Beer and F. Rossini, *Wasting Assets: Natural Resources in the National Accounts*, World Resources Institute, Washington DC, 1989.

b/ Java only.

c/ From D. Lallement, *Burkina Faso: Economic Issues in Renewable Resource Management*, Agricultural Operations, Sahelian Department, Africa Region, World Bank, Washington DC, 1990.

d/ From J. Bishop and J. Allen, *The On-Site Costs of Soil Erosion in Mali*, Environment Department Working Paper No. 21, World Bank, Washington DC, 1989. Note that only the most conservative base case estimates of soil erosion costs are indicated. The upper range estimates for these costs amount to 16% of Mali GDP.

e/ From J. Bishop, *The Cost of Soil Erosion in Malawi*, Malawi Country Operations Division, The World Bank, Washington DC, 1990. Note that only the most conservative base case estimates of soil erosion costs are indicated. The upper range estimates for these costs amount to over 30% of Malawi GDP.

A more worrying trend in developing economies is the concentration of the poorest groups in 'ecologically fragile' zones - areas where environmental degradation or severe environmental hazards constrain and even threaten economic welfare. As indicated in Box 3, around 470 million, or 60 percent of the developing world's poorest people, live in rural or urban areas that can be classified as 'ecologically fragile'.[5]

Nearly two thirds of the developing world's poorest people do not live in areas of high agricultural potential, but are found in more 'marginal' agricultural and 'peripheral' urban areas. The less favourable agricultural lands, with lower productivity potential, poorer soils and physical characteristics and more variable and often inadequate rainfall, are easily prone to land degradation due to overcropping, poor farming practices and inadequate conservation measures.

The result is that **the economic livelihoods and welfare of the poorest income groups in low potential areas are at greater risk from increasing environmental degradation.** It is this risk combined with the impact of public policies, institutions and investments on the economic incentives that the poorest face that may have the most profound - and often perverse - effects on the willingness and ability of the poorest groups to counteract degradation.

Another major 'poverty reserve' in developing countries is peripheral urban areas, or 'squatter' settlements (see Box 3). Recent evidence from West Java and Nigeria confirms that the informal employment sector and settlements around urban and semi-urban settlements are often the preferred 'open access resource' for the poor (Jagannathan 1989). Although precise estimates of how many of the 1.3 billion urban dwellers in developing countries live in 'squatter' settlements are scarce, it is common for between 30-60 percent of the population in large cities to live either in illegal settlements or in tenements and cheap boarding houses. In smaller urban centres of less than 100,000 inhabitants - which contain about three quarters of the developing world's urban population - the proportion of people living in illegal settlements may be smaller than in the large cities. However, the proportion living in areas with inadequate infrastructure or services may be as high or even higher in small compared to larger urban centres (Cairncross, Hardoy and Satterthwaite 1990).

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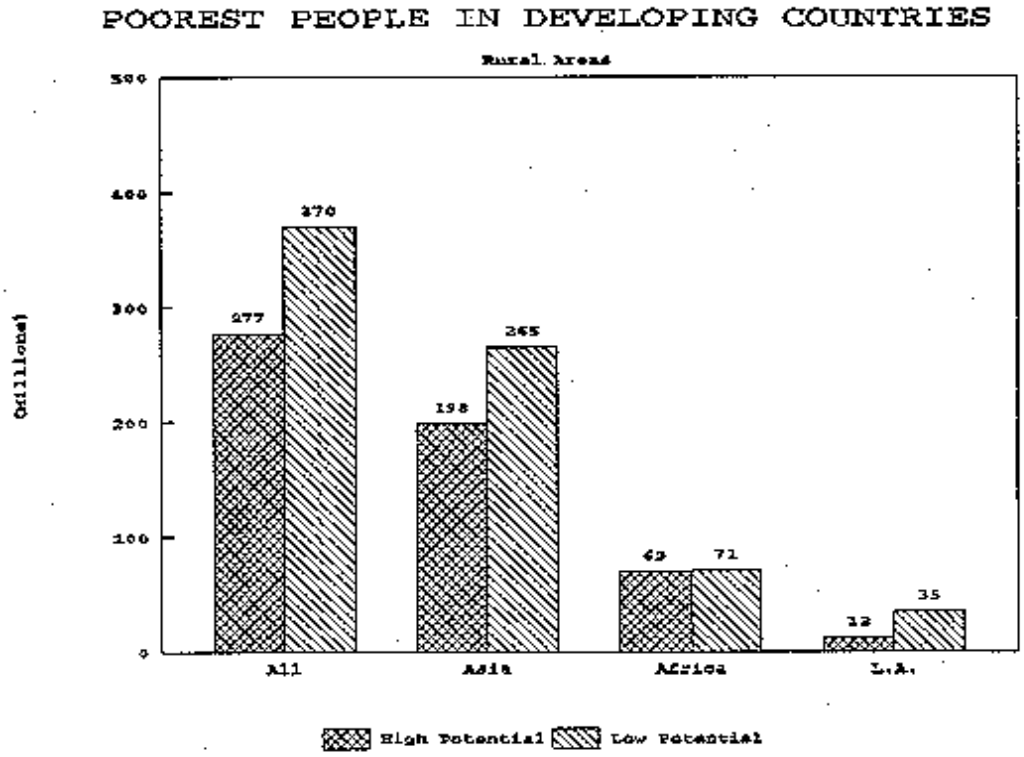
[5] In commenting on the data presented by Leonard (1989) in Box 3, Kates (1990) argues that it is too simplistic to equate all land of low agricultural potential and squatter settlements with 'areas of high ecologically vulnerability'. Thus "while there is good reason to expect an increasing geographic segregation of the poor onto the threatened environments, both the purported distribution of the hungry and the actual state of environmental degradation needs to be examined much more carefully."

The result is that the economic welfare of a substantial, and growing, number of the poorest urban dwellers is threatened by the environmental hazards and health risks posed by pollution, inadequate housing and poor sanitation, water and other basic infrastructure services.[6]

[6] Further examples of the impact of urban environmental problems and sub-standard living conditions on the welfare of the urban poor can be found in Hardoy and Satterthwaite (1989) and Hardoy, Cairncross and Satterthwaite (1990).

BOX 3. THE POOREST OF THE POOR AND ECOLOGICALLY FRAGILE AREAS

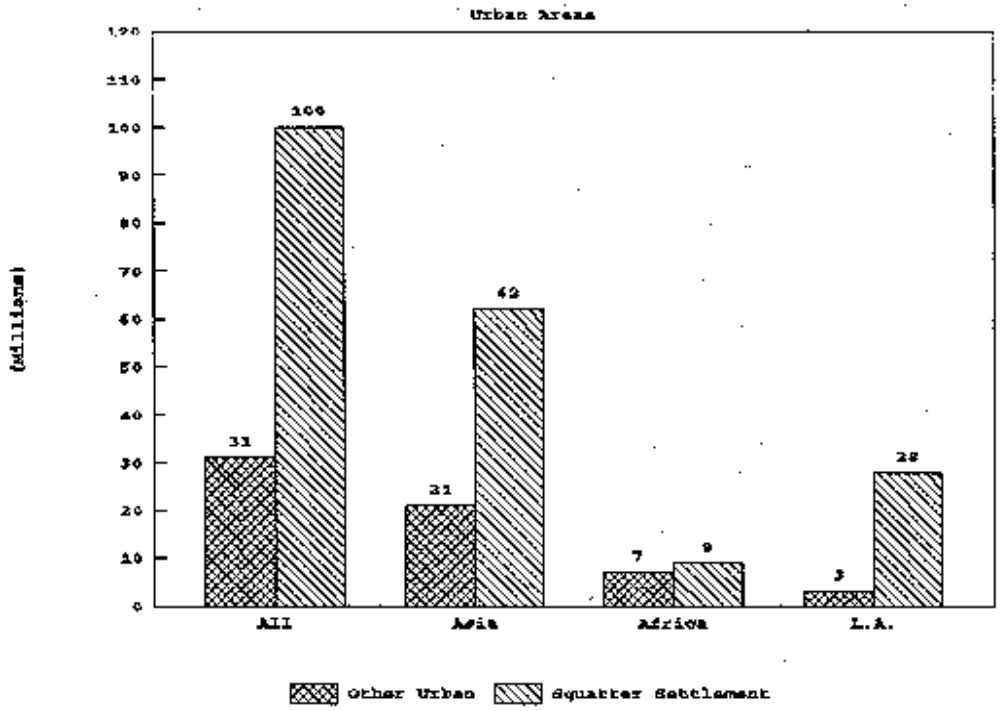


Notes: High Potential = High potential agricultural lands; i.e., highly productive, favourable agricultural lands that are either irrigated or have reliable and adequate rainfall, as well as generally high or potentially high soil fertility.

Low Potential = Low potential lands; i.e., resource-poor or marginal agricultural lands, where inadequate or unreliable rainfall, adverse soil conditions, fertility and topography limit agricultural productivity and increase the risk of chronic land degradation.

The 'poorest people' are defined as the poorest 20 percent of the population in developing countries.

POOREST PEOPLE IN DEVELOPING COUNTRIES



Notes: The 'poorest people' are defined as the poorest 20 percent of the population in developing countries.

Source: Derived from H.J. Leonard, "Overview - Environment and the Poor: Development Strategies for a Common Agenda", in H.J. Leonard et al., Environment and the Poor: Development Strategies for a Common Agenda, Transaction Books, New Brunswick, 1989.

The concentration of the poorest groups in developing countries in 'ecologically fragile' areas suggests that it is the welfare of the poorest in developing economies that is at the greatest risk from continued environmental degradation. As argued by Kates (1990), throughout the developing world the poor often suffer from three major processes of *environmental entitlement* loss:

* the poor are *displaced* from their traditional entitlement to common resources by development activities or by the appropriation of their resources by richer claimants;

* the remaining entitlements are *divided* and reduced by their need to share their resources with their children or to sell off bits and pieces of their resources to cope with extreme losses (crop failure, illness, death), social obligations (marriages, celebrations) or subsistence; and

* the resources of the poor are *degraded* through excessive use and by failure to restore or to improve their productivity and regeneration - a process made worse by the concentration of the poor into environments unable to sustain requisite levels of resource use.

As a result of these processes, the economic livelihoods of the poor become even more vulnerable to the risks posed by environmental degradation, and their ability and willingness to manage resources sustainably may become even more constrained.

Moreover, Box 3 indicates that the poorest groups in the relatively more affluent developing regions of Latin America and Asia are even more concentrated in ecologically fragile areas than the poorest 20% in Africa. This would suggest that the problem does not easily disappear with economic growth and rising national income.

In short, whether poverty is directly, or only indirectly, the 'cause' of environmental degradation seems less relevant a concern when compared to the implications of pervasive environmental degradation for the livelihoods of the poor. This is the real 'poverty-environment' link that should be the focus of development efforts. If poverty alleviation is an ultimate aim of economic development, then efficient and sustainable environmental management is a necessary means for achieving this goal.

Resource Dependent Developing Economies

If governments of developing economies are to be convinced that sustainable and efficient management of their resource base is essential to economic development, not only do they have to be convinced of the economic costs of environmental degradation in terms of forgone income and the resulting welfare implications for the poorest groups but they must also see the role of natural resources in supporting the economy as a whole.

Annex A produces several tables that indicate the high degree of *resource dependency* of many low and lower middle income developing countries. Many of these economies are directly dependent on natural resource products for the overwhelming majority of their exports (see Tables A-1 and A-2). In most cases, export earnings are dominated by one or two commodities. Resource dependency has been a feature of these economies over the past 25 years, and for most low-income countries, has remained a persistent feature since the mid-1960s. More of the lower middle income economies have reduced their resource dependency with time, but this is clearly a long term process. Careful management of the natural resource base may be necessary to maintain the 'capital' required for this transition and to achieve long term development goals. Running down the natural resource base today through inefficient and unsustainable exploitation could jeopardize development efforts by reducing future export earning potential, as well as needlessly wasting current earnings.

The failure to manage resources efficiently and sustainably today also increases vulnerability to the economic stresses imposed by external debt. External debt as a percentage of the gross national product (GNP) and debt servicing as a proportion of GNP and exports have risen substantially in virtually all low and lower middle income resource-dependent economies (see Tables A-3 and A-4). For these economies the ability to meet debt repayments and to induce further economic development will depend on the continued successful exploitation of their natural resource bases. Without sustainable management, the debt burden may severely constrain development efforts.

The resource base in poor resource-dependent economies is far from static. Although comparison of land classifications across countries is fraught with difficulties, the most notable change over the last fifteen years in most economies is the decline in forest area and the increase in cropland (see Tables A-5 and A-6). Much of the forest land has presumably been lost to agricultural conversion, with fuelwood and fodder gathering a factor in some areas and depletion for timber operations important in major producing countries. Some empirical explorations of the causes of deforestation, particularly from frontier agriculture expansion, are discussed further below.

Expansion of cropland clearly appears to follow the classic agricultural extensification pattern (see Tables A-7 and A-8). Particularly in low income resource-dependent economies, low levels of fertilizer use and yield changes suggest very little agricultural intensification, with the notable exception of Indonesia, Sri Lanka and to some extent Kenya, Benin, Ghana, Nigeria and Zambia. A worrying trend in some poor Sub-Saharan economies is the fall in agricultural yields, particularly for cereals. Many other economies show substantial yield increases only because yields were abysmally low in the mid-1970s. Some economies that have increased agricultural intensification - for example Indonesia, Sri Lanka and Kenya - also face rapid population growth and severe constraints on cropland

availability, as indicated by extremely low levels of cropland per capita. In general, most of the low-income resource-dependent economies have long since extended cropland beyond their stock of favourable land with good chemical and physical properties for agriculture. Those countries that do still have 'excess' favourable land face difficulties in cultivating it, as much of this land occurs in areas with climates and growing season (e.g. arid/semi-arid zones) that prevent or severely constrain rainfed cultivation.

Cropland use and productivity in resource-dependent lower middle income economies follow similar patterns as in the low income economies (see Table A-8). In general, fertilizer use and yields and yield changes appear higher in the lower middle income compared to the low income economies, suggesting a slightly higher level of agricultural intensification. However, in common with the low income countries, many lower middle income economies also display low cropland availability per capita and a low ratio of favourable to total cropland. Climatic conditions again limit cultivation of much of the 'excess' favourable land in the North African and Middle Eastern countries, whereas social, economic and climatic constraints on frontier agricultural expansion also limit exploitation of the additional favourable land available in the South American countries. Clearly, much cultivation of marginal - or ecologically fragile - land occurs in resource-dependent lower middle income economies.

Thus the continuing dependence of most of the world's poorest economies on their resource base should give environmental management a high priority as a development concern. This is particularly the case given that past economic policies and investments have led to rapid changes - frequently with adverse economic consequences - in resource stocks and patterns of use. Demographic trends have often worsened the relationship between population and resource carrying capacity in many regions. Continuing agricultural extensification into marginal lands have increased the susceptibility of economic systems and livelihoods to environmental degradation.

As pointed out elsewhere, a re-appraisal of demographic and agricultural policies to take into account the new realities of resource-carrying capacity constraints and the need to improve the potential of marginal lands while sustaining the productivity of high potential lands is required (Conway and Barbier 1990; Barbier 1989b; FAO 1990; Leonard *et al.*; Pearce 1991; Repetto 1987; Repetto and Holmes 1983). With regard to population-environment linkages, one useful approach is to view the role of population growth in terms of increasing the 'scale' of human demands on limited natural systems (Foy and Daly 1989). As will be discussed in the following sections, rethinking public policies for developing countries is also a necessity.

Public Policies and Natural Resource Management

As discussed above, market and policy failures are at the centre of many of the environmental degradation problems facing developing countries. *Market failures* exist when markets fail to reflect fully environmental values. The presence of open access resource exploitation and public environmental goods, externalities (e.g. pollution, nonmarketed environmental services), incomplete information and markets (e.g. uncertainty, lack of formal market mechanisms) and imperfect competition all contribute to market failure. Usually some form of public or collective action, involving regulation, market-based (economic) incentives or institutional measures, is required - provided that the costs of correcting market imperfections do not exceed the potential welfare benefits. *Policy failures* occur when the policy interventions necessary to correct market failures are not taken, or over-correct or under-correct for the problem. They also occur when government decisions or policies are themselves responsible for excessive environmental degradation. For example, environmental damage may arise because economic policies and interventions in developing countries are designed primarily to promote economic growth or to improve income distribution, with little regard for their consequences for the environment.

The result of market and policy failures is a distortion in economic incentives. That is, the private costs of actions leading to environmental degradation do not reflect the full social costs of degradation, in terms of the environmental values forgone. There are several reasons for this outcome:

First, the market mechanisms determining the 'prices' for natural resources and products derived from conversion of natural resource systems *do not automatically take into account wider environmental costs*, such as disruptions to ecological functions, assimilative capacity, amenity values and other environmental impacts or forgone option and *existence values* - i.e. the value of preserving certain natural environments, species and resources today as an 'option' for future use or simply because their 'existence' is valued. Nor do market mechanisms account for any *user cost* - the cost of forgoing future direct or indirect use benefits from resource depletion or degradation today.

In addition, even the direct costs of harvesting resources or converting natural resource systems *are often subsidized and/or distorted by public policies*. As a result, individuals do not face even the full *private costs* of their own actions that degrade the environment. Unnecessary and excessive degradation ensues.

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

(Browder, 1985). In addition, government-financed investment programmes - for road-building, colonial settlement and large-scale agricultural and mining activities - may *indirectly* be contributing to deforestation by 'opening up' frontier areas that were previously inaccessible to smallholders and migrants.

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 economic losses, the establishment of inefficient processing operations and accelerated deforestation (Repetto and Gillis, 1988). Throughout Southeast Asia the allocation of timber concession rights and leasing agreements on a short time scale, coupled with the lack of incentives for reforestation, have contributed to excessive and rapid depletion of timber forests. In the Philippines, the social gains from logging old-growth forest was found to be negative (around - US$130 to - US$1175 per hectare), once the social costs of timber stand replanting, the costs of depletion and off-site damages were included (Paris and Ruzicka, 1991).

There is also evidence of *non-economic* policy distortions contributing to excessive deforestation (Binswanger 1989; Browder 1985, Pearce, Barbier and Markandya 1990 and Southgate, Sierra and Brown 1989). 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 clear excessive amounts of 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 is 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.

Finally, many large-scale public investment projects and programmes, such as hydroelectric dams, irrigation schemes, commercial agricultural development schemes, road building, and so on, have significant environmental impacts. Some of these impacts may impose additional costs on society. Given such costs, to appraise the net benefits of the investment project or programme in terms of its *direct* costs and benefits alone would be a misrepresentation of its economic net worth to society. The *forgone net benefits* associated with any environmental impacts must also be included as part of the opportunity costs of the development investment.

In recent years, many advances have been made in applying economic valuation techniques to analyzing the environmental impacts of investment projects and programmes in developing countries (Anderson, 1987; Dixon *et al.*, 1988; Bojo, Maler and Unemo, 1988; Gregersen *et al.*, 1987). Frequently, appraisal of the environmental impacts of major public investments has shown

that the investments should be modified, and in some cases should not proceed at all. Box 4 summarizes an analysis of the net benefits of the Hadejia-Jama'are floodplain in Northern Nigeria, which is under threat from upstream irrigation development investments, such as the Kano River Project. The analysis shows that the economics benefits of the floodplain system are considerable, and the opportunity cost of diverting water to upstream developments would be high.

BOX 4. COMPARATIVE BENEFITS OF FLOODPLAIN AND UPSTREAM DEVELOPMENT, NIGERIA

In northeast Nigeria, an extensive floodplain has been created where the Hadejia and Jama'are rivers combine to form the Komadugu Yobe river which drains into Lake Chad. The Hadejia-Jama'are floodplain provides essential income and nutrition benefits in the form of agriculture, grazing resources, non-timber forest products, fuelwood and fishing for local populations. The wetlands also serve wider regional economic purposes, such as providing dry-season grazing for semi-nomadic pastoralists, agricultural surpluses for Kano and Borno states, groundwater recharge of the Chad Formation aquifer and 'insurance' resources in times of drought. In addition, the wetlands are a unique migratory habitat for many wildfowl and wader species from Palaearctic regions, and contain a number of forestry reserves. The region therefore has important tourism, educational and scientific potential.

However, in recent decades the Hadejia-Jama'are wetlands have come under increasing pressure from drought and upstream and downstream water developments. Upstream developments are affecting incoming water, either through dams altering the timing and size of flood flows or through diverting surface or groundwater for irrigation. Increased demand for water downstream for irrigated agriculture may lead to diverting water past the wetlands through construction of bypass channels. Intensified human use within the floodplain itself, notably wheat irrigation, is also putting pressure on the wetlands.

An analysis was conducted, comparing the net economic benefits of 14 agricultural crops, fuelwood and fishing in the Hadejia-Jama'are floodplain with the returns to an upstream water development, the Kano River Project:

Comparison of Present Value Net Economic Benefits, Kano River Project Phase I and Hadejia-Jama'are Floodplain, Nigeria

(N7.5 = US$1, 1989/90)

Per Hectare a/	(8%, 50 yrs)	(8%, 30 yrs)	(12%, 50 yrs)	(12%, 30 yrs)
HJF (N/ha)	1276	1176	872	846
KRP (N/ha)	233	214	158	153
Per Water Use b/				
HJF ($N/10^3m^3$)	366	337	250	242
KRP ($N/10^3m^3$)	0.3	0.3	0.2	0.2

Notes: a/ Based on a total production area of 730,000 ha for Hadejia-Jama'are floodplain (HJF) and a total crop cultivated area of 19,107 ha in 1985/86 for the Kano River Project Phase I (KRP).

b/ Assumes an the annual average river flow into Hadejia-Jama'are floodplain (HJF) of 2549 Mm^3 and an annual water use of 15,000 m^3 per ha for the Kano River Project Phase I (KRP).

Source: E. Barbier, W. Adams and K., Kimmage (1991). Economic Valuation of Wetland Benefits: The Hadejia-Jama'are Floodplain, Nigeria, LEEC Paper DP 91-02, London Environmental Economics Centre, London.

The economic importance of the wetlands suggests that the benefits it provides cannot be excluded as an opportunity cost of any scheme that diverts water away from the floodplain system. When compared to the net economic benefits of the Kano River Project, the economic returns to the floodplain appear much more favourable. This is particularly the case when the relative returns to the Project in terms of water input use is compared to that of the floodplain system. The result should cause some concern, given that the existing and planned water developments along the Hadejia-Jama'are river system, such as the Kano River Project, will continue diverting water from the floodplain.

The Challenge for Public Policies: 'Optimal Ignorance'

If public policies are to be re-directed to achieve efficient and sustainable management of natural resources in developing countries, then clearly major changes are required. Economic valuation of the environmental impacts arising from market and policy failures is essential for determining the appropriate policy responses. Often, however, insufficient data and information exist to allow precise estimation of the economic costs arising from market and policy failures. In most cases, cost estimates as orders of magnitude and indicators of the direction of change are sufficient for policy analysis. (See, for example, the case studies in Pearce, Barbier and Markandya 1990 and the discussion of tax and regulation policies in developing countries in Anderson 1990).

However, with many natural resource problems in developing countries we are not even at this state of 'optimal ignorance' to begin designing appropriate policy responses. In the face of such uncertainty we should be humble in our public policy prescriptions. Even the standard economic tool of 'improved pricing policy' should be invoked with caution. In most developing countries there is little empirical understanding of the linkages from price changes to short and long term supply and demand responses to natural resource impacts. The situation is complicated by the presence of underemployment, informal and incomplete markets, labour and capital constraints, and above all, the problem of widespread poverty. Thus we are often ignorant of the impact of public policies on the economic incentives faced by individual producers and households for managing natural resources, particularly in the case of the poorest groups who are on the 'margin' of the formal economic and social systems.

This problem occurs frequently in the economic analysis of *dryland degradation*. 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. Yet these areas are being asked to support increasing numbers of the world's poorest people. 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.

As Box 2 indicates, there are few economic studies of the costs of dryland degradation. 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 reasons behind the failures

of dryland projects (Nelson 1988). Although the majority of 'causes' are attributable to population growth and natural events, dryland degradation is also symptomatic of an agricultural development bias that distorts agricultural pricing, investment flows, R & D, and infrastructure towards more 'favoured' agricultural land and systems (Barbier 1989b). 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 their 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 (IIED/IES 1990; Barbier 1990). Even though it is economically profitable *and* environmentally beneficial to grow gum, it is only when these economic incentives are properly dealt with by the government will rehabilitation of the important gum belt of Sudan take place.

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. Designing appropriate policy responses to control soil erosion and land degradation for all types of cropland in developing countries 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-labour 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 labour, 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 (Barbier 1988; Barbier 1989a, ch. 7; Barbier and Burgess 1990; Mortimore 1989; Southgate 1988).

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 labour-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.

Nor do we appreciate fully the special role of women and female-headed households in economic-environment linkages. Women's relationship with the environment is not just confined to the poverty link. Even in those households that are not classified as poor the women are active participants in agricultural and

household production. Thus, *womens' use, perception, knowledge and management of the land* can be contrasted to that of men across all households. For example, a detailed study of the effects of agricultural commercialisation among smallholders in the Zomba district of the southern region of Malawi emphasises how the type of crops cultivated differ between men and women (Peters, Herrera and Randolph 1989). Female-headed households on average cultivate maize on 90% of their land and rarely grow any cash crops, whereas men grow maize on 81% of their land with the remainder mostly under the cash crop tobacco.

Women confront a multitude of *constraints* that are non-existent or less binding for men which hinder economic opportunities and improved land management (Becker 1990). For example, both men and women may be constrained in adopting new maize varieties as they require relatively intensive fertilizer inputs as compared to traditional maize. However, female-headed households often have extremely low income and are unlikely to be able to raise sufficient financing from their own sources or to obtain credit to purchase hybrid maize and fertilizer (see Box 1). Large labour demands on women within the household - such as child bearing and rearing, fuel and water collection, cooking, land preparation, planting and weeding, further limits their ability to undertake sound land management - constructing ridging along contours, building bunds, maintaining buffer strips, planting trees and so on. Off-farm employment opportunities for women to supplement farm income may also be constrained by gender discriminations in the labour market; for example, male labour is usually preferred to female labour for wage employment on tobacco estates.

Smallholders in Malawi appear aware of the problems posed by persistent soil erosion - especially farmers cultivating steep slopes who frequently cite problems of run-off and declining yields. Extension advice on how to deal with the problems posed by soil erosion mainly reaches more prosperous, male farmers who are credit club members. Extension messages tend to be very general and are not customized to the needs and requirements of women, particularly the labour and other economic constraints they face. This is indicated in the relatively poor adoption of soil conservation measures by female as opposed to male farmers (see Box 1).

An equally important challenge for economic analysis in the future is to examine the causes of large-scale land use changes and resource degradation, such as those indicated for resource-dependent economies in Annex A. Thus clearing forest land for agriculture is thought to be the major cause of tropical deforestation. A number of economic studies have been launched, particularly in Latin America, to analyze the main factors inducing people to settle in and to clear 'frontier' forest lands for agriculture.

For example, Binswanger (1989) and Mahar (1989) make the case for the role of subsidies and tax breaks, particularly for cattle ranching, in encouraging land clearing in the Brazilian Amazon.

However, more recent analyses by Schneider *et al.* (1990) and Reis and Margulis (1990) emphasize the role of agricultural rents, population pressures and road building in encouraging small-scale frontier settlement. In Northern Brazilian Amazon, the total road network (paved and unpaved) increased from 6,357 to 28,431 km over 1975-88. A simple correlation between road density and the rate of deforestation shows that as road density increases, the rate of deforestation increases in larger proportions (Reis and Margulis 1990). Schneider *et al.* argue that these factors encouraging frontier agriculture - 'nutrient mining' - far outweigh the more publicized impacts of fiscal incentives for cattle ranching. A statistical analysis by Southgate, Sierra and Brown (1989) of the causes of tropical deforestation in Ecuador indicates that colonists' clear forest land not only in response to demographic pressure but also to 'capture' agricultural rents and to safeguard their tenuous legal hold on the land.

Although there are an increasing number of case studies examining the factors behind tropical deforestation and agricultural frontier expansion, there have been few attempts to explore these linkages through statistical analysis. One such analysis by Palo, Mery and Salmi (1987) for 72 tropical forest countries identified a strong link between tropical deforestation and population density, population growth and increased food production. A study by Capistrano (1990) and Capistrano and Kiker (1990) examined the influence of international and domestic macroeconomic factors on tropical deforestation.[7] The econometric analysis indicates the role of high agricultural export prices in inducing agricultural expansion and forest clearing, as well as the influence of domestic structural adjustment policies, such as exchange rate devaluation and increased debt servicing ratios. Comparative analysis of 24 Latin American countries also highlights the strong but indirect relationship between population pressure and frontier expansion - increasing numbers of urban consumers raise the demand for domestic production and hence for agricultural land - and the countervailing role of increased agricultural productivity and yield growth in slowing agricultural expansion (Southgate 1991). A statistical analysis by Burgess (1991), covering all tropical forest countries, confirms the relative importance of frontier agricultural expansion (represented by an index of food crop and meat production) and debt-servicing on tropical deforestation. Increases in domestic roundwood (representing both industrial use and fuelwood) and GNP per capita also had significant but much

[7] Capistrano (1990) and Capistrano and Kiker (1990) use changes in timber production forest area as a proxy for total deforestation. Although the authors argue that there is a close correlation between average area of closed broadleaved forest and timber production forest area, there are many tropical forest countries where industrial logging is not a significant source of overall deforestation. Thus their analytical results are more relevant to the deforestation of tropical timber production forests than to overall tropical deforestation.

smaller positive impacts. Surpisingly, population had a slightly negative effect on deforestation.[8]

Clearly, both microeconomic analysis of individuals' behaviour influencing and responses to environmental degradation and macroeconomic analysis of the broader economic-environmental linkages affecting degradation will be required if coherent and effective public policies for natural resource management in developing countries are to be designed and implemented.

Conclusion

This paper has argued that efficient and sustainable natural resource management has a vital role to play in economic development and poverty alleviation. Improved economic analysis of both the impacts and the causes underlying environmental degradation will become crucial in the years ahead. Substantial policy distortions and market failures affecting natural resource management in developing countries do exist, and it is necessary to re-orient public policies to correct for these distortions as best as possible. However, we should also be cautious in advocating 'sweeping' policy changes. For many environmental problems in developing countries, we are not even at the state of 'optimal ignorance' to begin advocating new policy directions. More difficult is the problem of 'political will'; even when the economic evidence is clear and the policy direction self-evident, short-term political and economic interests in developing countries may predominate - especially when powerful special interest groups have a vested interest in maintaining the *status quo*.

Further economic analysis of the relationship between natural resource management and economic development is required. There is a need for substantive and extensive analysis of the implications of various macroeconomic, trade and sectoral policies for management of the resource base. Alternative policy options that explicitly take into account the resource constraints of the most vulnerable economic groups also need 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 the required information is sometimes available from research stations, independent, project and provincial studies, it needs to be

[8] The results of Burgess (1991) indicating that annual increments in population is *negatively* correlated with deforestation conflicts with the earlier findings by Palo, Mery and Salmi (1987). Clearly, further work needs to be undertaken to examine the explicit relationship between population growth, population density and deforestation.

coordinated and reviewed consistently at the national level to assist policy and investment decisions.

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ANNEX A

Table A.1

LOW INCOME ECONOMIES WITH HIGH EXPORT CONCENTRATION IN PRIMARY COMMODITIES a/

	Contribution of Primary Commodities to Total Exports b/	Export Share in 1980/81	Export Share in 1965	Main Export Commodities b/ 1		2	
	over 90%						
Uganda ($280)	100	100	100	Coffee	95.6%	Tea	0.3% c/
Eq. Guinea ($410)	100	91	NA	Cocoa	34.4%	Coffee	3.1%
Sao Tome & Pr. ($490)	99	100	NA	Cocoa	95.5%	Copra	1.8%
Ethiopia ($120)	99	99	99	Coffee	53.8%	Hides	15.3%
Rwanda ($320)	99	99	100	Coffee	75.5%	Tea	10.8% c/
Yemen PDR ($430)	99	NA	94	NA		NA	
Zambia ($290)	98	99	100	Copper	83.0%	Cobalt	5.4%
Burkina Faso ($210)	98	85	95	Cotton	32.6%	Livestock	26.8% e/
Nigeria ($290)	98	99	97	Petroleum	87.3%	Cocoa	4.7%
Liberia ($450) c/	98	98	97	Iron Ore	63.4%	Rubber	16.1% e/
Ghana ($400)	97	98	98	Cocoa	51.1%	Gold	20.3%
Mauritania ($480)	97	99	99	Fish	65.8%	Iron Ore	33.3%
Niger ($300)	96	98	95	NA		NA	
Somalia ($170)	95	99	86	Meat	39.7%	Banana	34.5%
Zaire ($170)	93	94	92	Copper	35.8%	Coffee	11.2% e/
Sudan ($480)	93	99	99	Cotton	30.3%	Livestock	24.4%
Togo ($370)	92	85	97	Phosphate	36.2%	Cotton	12.6%
Comoros ($440)	92 c/	86 e/	NA	Cloves	41.7%	Vanilla	33.3% c/
Lao PDR ($180)	90	100 e/	NA	Timber	51.7%	Electricity	19.0%
	over 80%						
Chad ($160)	89 c/	96 e/	97	Cotton	69.4%	Hides/Skins	3.8% e/
Myanmar ($210) c/	89	81 d/	NA	Rice	32.7%	Teak	32.2% e/
Guinea-Bissau ($190)	87 c/	71 d/	NA	Cashewnut	73.3%	Groundnut	6.7% c/
Guyana ($420)	87 c/	NA	NA	NA		NA	
Madagascar ($190)	84	92	94	Coffee	26.6%	Cloves	5.7%
Malawi ($170)	83	93	99	Tobacco	62.8%	Tea	10.3%
Burundi ($240)	83	96	95	Coffee	82.6%	Tea	5.0%
Kenya ($370)	83	88	94	Coffee	26.2%	Tea	21.9% c/
Tanzania ($160)	81	86	87	Coffee	31.4%	Cotton	12.7%
	over 70%						
Maldives ($410)	77 c/	70 e/	NA	Fish	57.1% c/		
Benin ($390)	74	96	95	Cotton	13.4%	Fuel	9.4%
Indonesia ($440)	71	96	96	Petroleum	40.0%	Rubber	5.0%
Mali ($230)	70	83	97	Cotton	36.9%	Livestock	29.0%
	over 60%						
C.A.R. ($380)	60	74	46	Diamonds	40.9%	Coffee	18.9%
	over 50%						
Sri Lanka ($420)	57	79	99	Tea	25.9%	Rubber	7.0% c/

Notes: a/ Low-income economies are those with per capita incomes of $545 or less in 1988. US dollar figure af country listed indicates GNP per capita in 1988. b/ Contributions to the value of total merchandise exp 1988, unless indicated. c/ 1987 value. d/ 1981-83 average value. e/ 1984 value.

Source: Based on various editions of the following World Bank documents: World Development Report; Trends in Developing Countries; Commodity Trade and Price Trends; African Economic and Financial Data.

Table A.2

LOWER MIDDLE INCOME ECONOMIES WITH HIGH EXPORT CONCENTRATION IN PRIMARY COMMODITIES a/

	Contribution of Primary Commodities to Total Exports b/	Export Share in 1980/81	Export Share in 1965	Main Export Commodities b/ 1		2	
	over 90%						
Bolivia ($570)	97	100	95	Gas	40.1%	Tin	13.9%
Papua N.G. ($810)	95	100	90	Gold	37.7%	Copper	28.9%
Ecuador ($1120)	93	93	98	Petroleum	44.8%	Fish/Shrimp	19.0%
	over 80%						
Yemen A.R. ($640)	89	49	100	Oil	93.7%		
Honduras ($860)	89	89	96	Bananas	39.0%	Coffee	21.0%
Congo ($910)	89	94	37	Oil	71.6%	Timber	15.6%
Cote d'Ivoire ($770)	88	90	95	Cocoa	25.7%	Coffee	13.1%
Cameroon ($1010)	88	97	94	Petroleum	48.9%	Coffee	12.2%
Paraguay ($1180)	88	NA	92	Cotton	10.3%	Timber	2.5%
Chile ($1510)	85	90	96	Copper	48.4%	Agriculture	13.2%
	over 70%						
Panama ($2120)	79	91	98	Petroleum	31.7%	Banana	17.9% d/
Peru ($1300)	78	83	99	Copper	12.9%	Zinc	8.8%
Senegal ($650)	75	81	97	Fish	26.9%	Groundnut	14.8%
Colombia ($1180)	75	72	93	Coffee	30.2%	Oil	17.0%
Syria ($1680)	75	NA	90				
Egypt ($660)	74	92	80	Oil	64.4%	Cotton	6.5%
Dominican Rep. ($720)	74	81	98	Nickel	31.2%	Sugar	20.5%
El Salvador ($940)	71	63	83	Coffee	60.6%	Fish	3.5% c/
	over 60%						
Guatemala ($900)	62	71	86	Coffee	34.8%	Bananas	7.6%
Zimbabwe ($650)	60	63	85	Tobacco	21.5%	Gold	13.1%
Costa Rica ($1690)	60	68	84	Coffee	30.4%	Banana	18.8%
	over 50%						
Malaysia ($1940)	55	80	94	Rubber	9.8%	Palm Oil	8.4%
Jordan ($1500)	53	57	81	Minerals	38.6%	Food	10.2%
Brazil ($2160)	52	59	92	Soya	9.4%	Coffee	6.8%
Morocco ($830)	50	72	95	Ph. Acid	16.8%	Phosphate	13.3%

Notes: a/ Lower middle income economies are those with per capita incomes of $2160 or less in 1988. US dollar figure after each country listed indicates GNP per capita in 1988. b/ Contributions to the value of total merchandise exports in 1988, unless indicated. c/ 1987 value. d/ 1984 value.

Source: Based on various editions of the following World Bank documents: World Development Report; Trends in Developing Economies; Commodity Trade and Price Trends; African Economic and Financial Data.

Table A.3

DEBT AND DEBT SERVICE RATIOS IN RESOURCE DEPENDENT LOW INCOME ECONOMIES a/

	External Total Debt as Percentage of GNP b/		Debt Service as Percentage of GNP		Debt Service as Percentage of Exports	
	1970	1988	1970	1988	1970	1988
over 90%						
Uganda (100)	7.3	34.3	0.5	1.0	2.9	14.0
Eq. Guinea (100)	140.2 c/	120.1	NA	NA	6.0 c/	28.5
Sao Tome & Pr. (99)	54.3 d/	146.0	NA	NA	4.7 d/	251.0
Ethiopia (99)	9.5	50.6	1.2	4.3	11.4	37.4
Rwanda (99)	0.9	25.5	0.2	0.7	1.5	9.6
Yemen PDR (99)	83.5 d/	199.4	NA	10.8	5.1 d/	46.5
Zambia (98)	37.5	116.7	4.6	4.9	8.0	14.2
Burkina Faso (98)	6.6	43.4	0.7	2.0	7.1	11.9
Nigeria (98)	4.3	102.5	0.7	7.0	7.1	25.7
Ghana (97)	22.9	44.6	1.2	4.0	5.5	20.6
Mauritania (97)	13.9	196.2	1.8	11.9	3.4	21.6
Niger (96)	5.0	66.0	0.4	5.6	4.0	32.6
Somalia (95)	24.4	185.2	0.3	0.4	2.1	4.9
Zaire (93)	9.1	118.0	1.1	2.8	4.4	6.9
Sudan (93)	14.8	74.6	1.7	0.6	10.6	9.5
Togo (92)	16.0	81.6	1.0	7.0	3.1	18.3
Comoros (92)	94.3 c/	94.4 e/	NA	NA	1.9 d/	3.2 e/
Lao PDR (90)	50.2 c/	153.5	NA	1.8	12.6 c/	143.5
over 80%						
Chad (89)	9.9	33.2	0.9	0.7	4.2	2.7
Myanmar (89) c/	25.3 d/	45.7 e/	NA	NA	20.3 d/	59.2 e/
Guinea-Bissau (87)	118.4 d/	271.0 e/	NA	NA	0.0 d/	92.0 e/
Madagascar (84)	10.4	192.7	0.8	9.3	3.7	39.0
Malawi (83)	43.2	85.9	2.3	4.6	7.8	19.8
Burundi (83)	3.1	69.8	0.3	3.3	2.3	25.1
Kenya (83)	26.3	58.5	3.0	5.7	9.1	25.3
Tanzania (81)	20.7	140.1	1.6	3.0	6.3	17.8
over 70%						
Maldives (77)	71.6 c/	44.2	NA	NA	16.9 c/	5.9 e/
Benin (74)	15.1	49.3	0.7	1.0	2.5	5.4
Indonesia (71)	30.0	61.7	1.7	11.5	13.9	39.6
Mali (70)	71.4	100.8	0.2	2.5	1.4	14.2
over 60%						
C.A.R. (60)	13.5	53.3	1.7	1.1	5.1	5.9
over 50%						
Sri Lanka (57)	16.1	61.6	2.1	4.8	11.0	17.6

Notes: a/ Percentage figure after each country listed indicates contribution of primary commodities to total exports. Low income economies are those with GNP per capita of $545 or less in 1988. b/ Total debt includes public, publicly guaranteed and private nonguaranteed debt. c/1980 value. d/1984 value. e/ 1987 value.

Source: Based on World Bank, World Development Report 1990 and World Bank, Trends in Developing Economies 1989.

Table A.4

DEBT AND DEBT SERVICE RATIOS IN RESOURCE DEPENDENT LOWER MIDDLE INCOME ECONOMIES a/

	External Total Debt as Percentage of GNP b/		Debt Service as Percentage of GNP		Debt Service as Percentage of Exports	
	1970	1988	1970	1988	1970	1988
over 90%						
Bolivia (97)	49.3	114.9	2.5	5.6	12.6	32.9
Papua N.G. (95)	33.4	64.2	4.8	15.6	24.5	30.9
Ecuador (93)	14.8	94.2	2.2	5.7	14.0	21.4
over 80%						
Yemen A.R. (89)	35.1 c/	41.7	NA	3.4	1.3 c/	16.0
Honduras (89)	15.6	68.3	1.4	7.2	4.9	28.6
Congo (89)	46.5	205.0	3.4	13.1	11.5	28.7
Cote d'Ivoire (88)	19.5	135.1	3.1	12.4	7.5	31.9
Cameroon (88)	12.6	27.0	1.0	4.6	4.0	27.0
Paraguay (88)	19.2	36.4	1.8	5.0	11.8	24.6
Chile (85)	32.1	79.3	3.9	7.9	24.5	19.1
over 70%						
Panama (79)	19.5	81.2	3.1	0.2	7.7	0.2
Peru (78)	37.3	56.1	7.0	1.3	40.0	8.7
Senegal (75)	15.5	63.6	1.1	5.2	4.0	19.3
Colombia (75)	22.5	42.1	2.8	8.0	19.3	42.3
Syria (75)	10.8	25.0	1.7	2.6	11.3	21.1
Egypt (74)	22.5	126.7	4.8	4.4	38.0	16.6
Dominican Rep. (74)	23.9	77.3	2.7	5.8	15.3	14.4
El Salvador (71)	17.3	31.5	3.1	3.3	12.0	18.8
over 60%						
Guatemala (62)	6.5	28.3	1.6	4.5	8.2	27.2
Zimbabwe (60)	15.5	37.3	0.6	8.2	2.3	27.9
Costa Rica (60)	25.3	89.2	5.7	7.7	19.9	19.9
over 50%						
Malaysia (55)	10.8	56.3	2.0	16.5	4.5	22.3
Jordan (53)	22.9	94.0	0.9	19.6	3.6	31.9
Brazil (52)	12.2	29.6	1.6	4.5	21.8	42.0
Morocco (50)	18.6	89.8	1.7	6.5	9.2	25.1

Notes: a/ Percentage figure after each country listed indicates contribution of primary commodities to total exports. Lower middle income economies are those with GNP per person of $2160 or less in 1988. b/ Total debt includes public, publicly guaranteed and private nonguaranteed debt. c/ 1980 value.

Source: Based on World Bank, World Development Report 1990 and World Bank, Trends in Developing Economies, 1989.

Table A.5

LAND USE CHANGES IN RESOURCE DEPENDENT LOW INCOME ECONOMIES, 1975-87 a/

	Total land area 1987 ('000 km2)	Land use ('000 km2) and % change since 1975-77							
		Cropland		Pasture		Forest		Other b/	
		85-87	%	85-87	%	85-87	%	85-87	%
Uganda (100)	200	67	21.4	50	0.0	58	-7.9	25	-21.3
Eq. Guinea (100)	28	2	0.0	1	0.0	13	0.0	12	0.0
Ethiopia (99)	1,101	139	1.4	451	-1.1	275	-3.5	236	5.9
Rwanda (99)	25	11	18.6	4	-27.3	5	-5.5	5	1.8
Yemen PDR (99)	333	1	9.2	91	0.0	15	-6.1	226	0.4
Zambia (98)	741	52	3.8	350	0.0	293	-3.0	46	18.3
Burkina Faso (98)	274	31	19.4	100	0.0	68	-8.1	75	1.3
Nigeria (98)	911	313	3.8	210	0.8	146	-17.0	243	7.5
Ghana (97)	230	29	5.5	34	-2.8	84	-7.7	84	8.4
Mauritania (97)	1,025	2	0.0	393	0.0	150	-0.9	481	0.3
Niger (96)	1,267	35	32.0	93	-8.4	25	-19.1	1113	0.5
Somalia (95)	627	9	3.0	289	0.0	89	-5.3	241	2.0
Zaire (93)	2,268	66	8.2	92	0.0	1756	-1.9	353	8.7
Sudan (93)	2,376	125	1.8	560	0.0	471	-6.2	1220	2.4
Togo (92)	54	14	1.0	2	0.0	14	-26.3	24	25.3
Lao PDR (90)	231	9	5.9	0	0.0	1	-11.1	6	6.7
Guinea-Bissau (87)	28	3	15.8	11	0.0	11	0.0	3	-11.9
Chad (89)	1,259	32	4.0	450	0.0	131	-5.7	647	1.0
Madagascar (84)	582	31	8.5	340	0.0	149	-9.7	62	28.1
Malawi (83)	94	24	4.3	18	0.0	44	-13.2	8	272.2
Burundi (83)	26	13	5.3	9	6.3	1	9.6	3	-32.8
Kenya (83)	567	24	5.6	37	-1.0	37	-7.5	469	0.4
Tanzania (81)	886	52	2.9	350	0.0	425	-2.7	58	21.6
Benin (74)	111	18	3.3	4	0.0	37	-12.0	51	9.5
Indonesia (71)	1,812	211	8.1	440	0.0	180	0.1	868	1.3
Mali (70)	1,220	21	4.6	300	0.0	86	-4.5	814	0.4
C.A.R. (60)	623	20	5.1	30	0.0	358	-0.3	215	0.0
Sri Lanka (57)	65	19	-1.0	4	0.0	17	-2.2	24	2.5

Notes: a/ Percentage figure after each country listed indicates contribution of primary commodities to total exports. Low income economies are those with GNP per capita of $545 or less in 1988. b/ Other land includes uncultivated land, grassland not used for pasture, built-on areas, wetlands, wasteland and roads.

Source: World Resources Institute/UNEP/UNDP, World Resources 1990-91.

Table A.6

LAND USE CHANGES IN RESOURCE DEPENDENT LOWER MIDDLE INCOME ECONOMIES, 1975-87 a/

	Total land area 1987 ('000 km2)	Land use ('000 km2) and % change since 1975-77							
		Cropland		Pasture		Forest		Other b/	
		85-87	%	85-87	%	85-87	%	85-87	%
Bolivia (97)	1,084	34	3.0	268	-1.2	558	-1.3	224	4.5
Papua N.G. (95)	453	385	8.9	1	-18.5	383	-0.5	65	3.0
Ecuador (93)	277	26	1.4	49	61.5	121	-19.6	81	14.9
Yemen A.R. (89)	195	14	0.3	70	0.0	16	0.0	95	0.0
Honduras (89)	112	18	5.9	25	8.3	36	-18.5	33	18.5
Congo (89)	342	7	2.7	100	0.0	212	-0.9	22	9.1
Cote d'Ivoire (88)	318	36	22.4	30	0.0	69	-42.1	183	31.2
Cameroon (88)	465	70	7.2	83	0.0	250	-4.2	63	11.2
Paraguay (88)	397	22	71.2	192	26.0	166	-20.4	18	-25.2
Chile (85)	749	56	4.0	119	1.7	87	0.0	487	-0.8
Panama (79)	76	6	4.5	13	8.3	40	-7.0	17	11.3
Peru (78)	1,280	37	12.8	271	0.0	694	-3.5	278	8.1
Senegal (75)	193	52	0.6	57	0.0	59	-4.2	24	3.7
Colombia (75)	1,039	53	3.2	398	7.3	515	-5.5	73	1.5
Syria (75)	184	56	1.3	83	-3.1	5	16.2	40	25.3
Egypt (74)	995	25	-7.5	0	0.0	0	0.0	970	0.2
Dominican Rep. (74)	48	15	13.2	21	0.0	6	-3.1	7	-18.9
El Salvador (71)	21	7	8.9	6	0.0	1	-35.4	6	-1.0
Guatemala (62)	108	18	10.2	14	7.9	41	-16.4	36	17.4
Zimbabwe (60)	387	28	9.1	49	0.0	199	0.0	111	-2.0
Costa Rica (60)	51	5	6.1	23	34.1	16	-22.9	6	-16.4
Malaysia (55)	329	44	3.1	NA	NA	152	-0.3	167	57.9
Jordan (53)	89	4	5.5	6	0.0	134	0.0	6	0.0
Brazil (52)	8,457	767	22.7	1670	6.4	5604	-4.2	415	0.3
Morocco (50)	446	84	9.0	209	7.7	52	0.2	101	-17.9

Notes: a/ Percentage figure after each country listed indicates contribution of primary commodities to total exports. Lower middle income economies are those with GNP per capita of $2160 or less in 1988. b/ Other land includes uncultivated land, grassland not used for pasture, built-on areas, wetlands, wasteland and roads.

Source: World Resources Institute/UNEP/UNDP, World Resources 1990-91.

Table A.7

CROPLAND USE AND PRODUCTIVITY IN RESOURCE DEPENDENT LOW INCOME ECONOMIES a/

	Cropland ha ('000 ha) 1987	Cropland ha per capita 1989	Fertilizer use (kg/ha) '85/87	Fertilizer use % change b/	% Yield changes '76-78 to '86-88 Cereals	% Yield changes '76-78 to '86-88 Roots	Favorable land index c/
Uganda (100)	6,705	0.38	0	0	6	29	8.8
Eq. Guinea (100)	238	0.53	0	0	NA	-12	9.1
Ethiopia (99)	13,930	0.30	4	100	22	-9	105.9 d/
Rwanda (99)	1,120	0.16	1	100	0	-12	8.1
Yemen PDR (99)	119	0.05	13	86	12	12	2753.8 d/
Zambia (98)	5,208	0.64	16	33	19	3	11.4
Burkina Faso (98)	3,140	0.36	5	67	34	18	206.9 d/
Nigeria (98)	31,335	0.29	10	400	43	6	28.5
Ghana (97)	2,870	0.20	10	150	12	6	9.7
Mauritania (97)	199	0.10	7	0	47	45	14723.1 d/
Niger (96)	3,540	0.51	1	0	-2	-10	1362.5 d/
Somalia (95)	933	0.13	3	-25	76	-5	366.2 d/
Zaire (93)	6,690	0.19	1	-50	15	8	18.2
Sudan (93)	12,478	0.51	4	-33	-24	-24	599.3 d/
Togo (92)	1,431	0.43	7	250	-1	-24	19.3
Lao PDR (90)	901	0.23	2	200	66	3	4.1
Guinea-Bissau (87)	335	0.35	1	0	42	14	0.0
Chad (89)	3,205	0.58	2	0	20	25	966.5 d/
Madagascar (84)	3,067	0.26	4	33	2	5	71.7
Malawi (83)	2,377	0.29	17	70	-9	-28	46.2
Burundi (83)	1,332	0.25	2	100	5	-4	5.0
Kenya (83)	2,420	0.10	46	109	4	20	252.4 d/
Tanzania (81)	5,230	0.20	9	50	34	-18	57.0
Benin (74)	1,840	0.40	37	95	10	9	12.3
Indonesia (71)	21,220	0.12	100	270	45	26	35.5
Mali (70)	2,076	0.23	15	200	26	-3	1674.0 d/
C.A.R. (60)	2,005	0.71	1	0	48	58	39.9
Sri Lanka (57)	1,887	0.11	106	116	49	50	25.9

Notes: a/ Percentage figure after each country listed indicates contribution of primary commodities to total exports. Low income economies are those with GNP per capita of $545 or less in 1988.
b/ Percentage change in annual average fertilizer use since 1975/77.
c/ Index denotes (favorable land/total cropland)*100, where favorable land denotes land with good chemical and physical properties relevant for crop fertility and management, as defined by the fertility capability classification (FCC) system.
d/ Much of the favorable land in these countries occur in areas with climates and growing seasons (eg. arid/semi-arid zones) that prevent or severely constrain rainfed cultivation.

Source: World Resources Institute/UNEP/UNDP, World Resources 1990-91.

Table A.8

CROPLAND USE AND PRODUCTIVITY IN RESOURCE DEPENDENT LOWER MIDDLE INCOME ECONOMIES a/

	Cropland ha ('000 ha) 1987	Cropland ha per capita 1989	Fertilizer use (kg/ha) '85/87	% change b/	% Yield changes '76-78 to '86-88 Cereals	Roots	Favorable land index c/
Bolivia (97)	3,399	0.48	2	100	19	-12	254.3
Papua N.G. (95)	386	0.10	30	50	5	0	NA
Ecuador (93)	2,646	0.25	34	8	7	-35	75.6
Yemen A.R. (89)	1,360	0.18	13	86	2	46	184.7 d/
Honduras (89)	1,785	0.36	19	36	54	121	35.2
Congo (89)	679	0.35	5	25	15	18	0.0
Cote d'Ivoire (88)	3,640	0.30	9	-36	14	29	3.8
Cameroon (88)	6,995	0.64	7	133	13	7	27.6
Paraguay (88)	2,176	0.52	5	400	20	10	493.1
Chile (85)	5,580	0.43	46	130	90	44	79.6
Panama (79)	575	0.24	58	35	30	10	28.0
Peru (78)	3,725	0.17	43	13	30	15	362.1
Senegal (75)	5,225	0.73	4	-56	15	8	59.7
Colombia (75)	5,318	0.17	81	65	11	9	95.0
Syria (75)	5,630	0.47	42	180	41	28	15.2
Egypt (74)	2,560	0.05	347	85	18	31	817.9 d/
Dominican Rep. (74)	1474	0.21	47	-8	33	-1	30.8
El Salvador (71)	733	0.14	111	-26	11	39	34.5
Guatemala (62)	1,865	0.21	62	24	20	43	25.1
Zimbabwe (60)	2,769	0.29	56	8	-6	29	32.2
Costa Rica (60)	526	0.18	166	31	13	-11	16.0
Malaysia (55)	4,380	0.26	154	126	2	6	6.5
Jordan (53)	414	0.10	34	113	126	39	716.9 d/
Brazil (52)	77,500	0.53	49	20	32	5	29.2
Morocco (50)	8,462	0.35	36	57	39	22	107.1 d/

Notes: a/ Percentage figure after each country listed indicates contribution of primary commodities to total exports. Lower middle income economies are those with GNP per capita of $2160 or less in 1988. b/ Percentage change in annual average fertilizer use since 1975/77. c/ Index denotes (favorable land/total cropland)*100, where favorable land denotes land with good chemical and physical properties relevant for crop fertility and management, as defined by the fertility capability classification (FCC) system. d/ Much of the favorable land in these countries occur in areas with climates and growing seasons (eg. arid/semi-arid zones) that prevent or severely constrain rainfed cultivation.

Source: World Resources Institute/UNEP/UNDP, World Resources 1990-91.

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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