GUIDELINES FOR APPLYING ENVIRONMENTAL ECONOMICS IN DEVELOPING COUNTRIES

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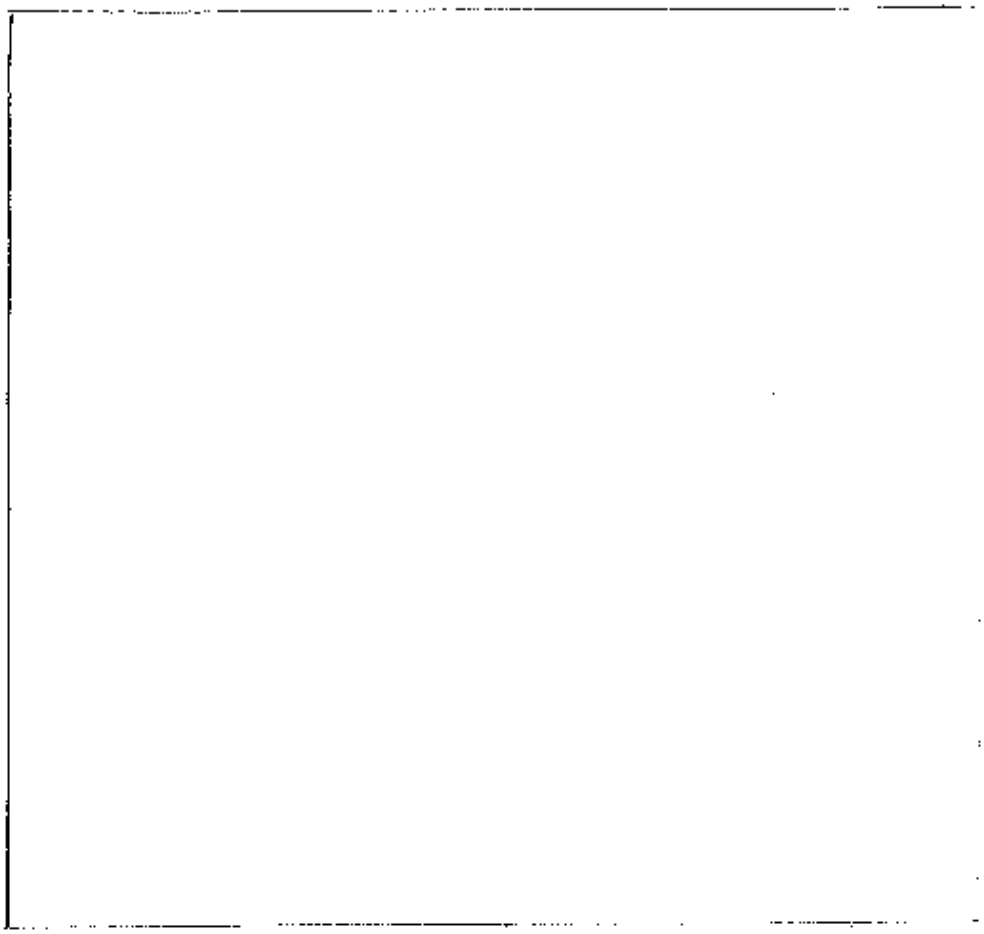

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This **Gatekeeper Series** is produced by the London Environmental Economics Centre (LEEC). This Centre was established in 1988 and is a joint venture by the International Institute for Environment and Development (IIED) and University College London (UCL). Its aims are the furtherance of policy relevant research in the field of environmental and natural resource economics, particularly in the context of developing countries.

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INTRODUCTION

These guidelines are intended to support the use of economic analysis in assessing environmental problems in developing countries. They have been written for an audience familiar with the language of economics, as a practical introduction to applied environmental economics. The guidelines are in three parts: The first section deals with the assessment of natural resource endowments, trends and potential problems, with a focus on defining economy-environment links and the valuation of environmental degradation. Section II reviews the market failures underlying many environmental problems, including causes, consequences and alternative policy responses. Section III reviews the impact of public policy on the environment, including the effects of regulation, economic policy, public investment and institutions. Illustrations and examples throughout this report are drawn primarily from previous LEEC publications.

Some concept of sustainable development is implicit to environmental economics. Whether or not a particular environmental phenomenon is considered to be a problem, as well as assessment of its magnitude, will depend on how the concept is defined. For a discussion of the various points of view and their ethical and theoretical underpinnings, the reader is referred to *Sustainable Development: Economics and Environment in the Third World*, by Pearce, Barbier and Markandya, Earthscan, London, 1990.[1] Regardless of the concept adopted, economic analysis of environmental change is usually justified by the simple observation of significant physical deterioration in a resource of obvious economic importance.

I. ASSESSING RESOURCE ENDOWMENTS AND PROBLEMS

Environmental assessment begins with a description of natural resource stocks and flows, expressed in terms of quantitative physical indicators. These describe the state of natural and environmental resources and trends in their use or depletion. Indicators may be reported on their own, or used in the construction of physical accounts, with conceptual rather than quantitative links to the economy. Physical indicators may also be used as input data for valuing the economic impacts of environmental degradation, based on explicit links between natural resources, economic production and consumption. Valuation is a crucial step in resource accounting exercises, which attempt to estimate the depreciation of natural capital on a regional or national level, or aggregate welfare losses due to environmental damage.

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[1] For a briefer treatment of the concept of sustainable development, see the following LEEC papers: Barbier 1987 (offprint no. 1), Turner and Pearce 1990 (Discussion Paper 90-01), Barbier and Markandya 1989 (Discussion Paper 89-01), Pearce 1989 (Gatekeeper Series 89-01).

A. Physical Indicators

Various indicators may be used to describe the physical state of the environment and trends in the use or depletion of natural resources. Such indicators may be expressed in terms of resource stocks or flows. Typical physical indicators include measures of **air and water quality**, such as suspended particulates or the incidence of respiratory or gastro-intestinal disorders; **waste management**, reflected by industrial emissions and effluent levels, or by energy efficiency; **land degradation**, revealed by soil erosion and deforestation; **ecology**, including species population, diversity and reserved areas; and **non-renewable resources**, measured in terms of known reserves and rates of extraction. Physical indicators are fundamental to environmental analysis, in economic or any other terms, hence the establishment of a reliable physical data base should be a high priority.

Physical indicators may be used in the construction of comprehensive physical accounts, to track changes in the natural resource endowment of a given area over time. Measurement of resource stocks may be difficult, but some quantification of trends and flows is required in order to carry out an accounting of net additions and subtractions. Physical measures of depletion rates are important indicators of degradation. Aggregation of physical data should coincide with standard units of economic analysis, by adopting existing administrative boundaries wherever possible, rather than devising incompatible geographic units based on ecological features. Where physical data are not available on an aggregate or country-wide level, useful analysis can often be carried out with localized information obtained from specific research sites or project areas.

B. Valuing Resources

Analyses of environmental degradation frequently consider economic impacts only in very broad terms. Ultimately some attempt must be made, however, to correlate marginal changes in resource endowments with economic activity and social welfare. This must be done carefully, since links between the economy and environmental change are often indirect, wide ranging and slow to appear. The definition of physical links between the environment and the production and consumption of marketed goods and services is thus the crucial first step in an economic assessment of environmental trends.

Once physical stocks and flows are accounted for and links to economic activity have been determined, it may seem relatively straight-forward to value the economic contribution of environmental resources and functions. In practice, however, valuation is often difficult because many goods and services provided by the environment are not traded in markets. Moreover, even where markets for resources do exist they are often distorted.

The economic value of most natural resources includes direct and indirect use values, option and non-use values. Price data are usually available for only part of the direct use value of a resource, namely the marketed goods and services obtained from it. In the case of a tropical forest, for example, information on prices might be limited to commercially exploitable timber. Non-marketed goods and services can also have significant value. In areas of tropical forest, this would include a wide range of non-timber products collected and consumed directly by indigenous populations. A forest may also have important indirect

uses, eg. protection of watersheds and maintenance of a stable climate. It may also be valued for its potential to provide certain goods and services at some time in the future (option value). Finally, a forest may have a cultural or existence value, for which some people would be willing to pay although they have no intention of ever visiting the forest itself (non-use value).[2]

The total economic value of a resource is the sum of all use and non-use values. In practice, the estimation of the various components of total economic value can be quite complicated. A common technique employed is the "production function" approach, which treats environmental goods and services as inputs or factors contributing to the production of marketed output. This approach relies on explicit linkages between environmental quality and economic production, which may not always be well documented.

An alternative to the production function approach is to estimate "damage costs" imposed by economic activity, in terms of reduced environmental quality, negative health impacts of pollution, or clean-up costs. This approach is particularly useful where there are significant externalities associated with the use of natural resources (see section III.B). Damage costs may also be expressed in terms of alternative uses forgone, such as the value of wildlife habitat, watershed protection, non-timber products and other forest values forgone due to clear-cut logging. Few studies of damage costs have been conducted on a regional or national scale, but local estimates of damage costs may often be found in project and consultancy reports, especially those concerned with pollution abatement, soil conservation and flood control.

Other techniques employed to assess use and non-use values of environmental goods and services include hedonic pricing, contingent valuation, travel cost, replacement cost and indirect substitute cost, among others. A variety of methodologies used to value environmental impacts are described and illustrated in detail in *Environmental Policy Benefits: Monetary Valuation*, by Pearce and Markandya, OECD, Paris, 1989.

Where data are available, historical price trends can be used as a rough indicator of resource scarcity, with some provisos. While nominal price data are readily available, the choice of deflator can be problematic. Moreover, resource prices tend to be quite volatile, hence long-run price trends will give the most meaningful results. Market prices may fail to incorporate certain use and non-use values, as well as environmental damage costs, and may be further distorted by market imperfections and/or economic policy. Alternative indicators of resource scarcity include marginal production costs and resource rents, but these also present certain methodological difficulties. Neither indicator typically reflects environmental costs, while both may be distorted by market and policy failures. Data are also less readily available.

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[2] The different values derived from natural resources will vary in importance to particular firms and agencies, depending on their relative ability to capture the associated economic benefits. The fact that certain values can be measured may be of little practical relevance, if the lack of clear property rights or a viable market prevents potential buyers and sellers from making a deal.

C. Resource Accounting

Resource accounting attempts to evaluate on a national level changes in natural resource endowments, aggregate damage costs and "defensive" expenditures undertaken in response to environmental degradation and pollution. The usual goal is to adjust or revise indicators of national economic performance so that they reflect environmental trends, for use in macroeconomic analysis and planning.

Once a resource has been valued in terms of its direct and indirect uses, as well as non-use values, depreciation may be calculated as the change in the value of natural capital stocks over an accounting period, net of physical additions, subtractions and price changes. It may thus be used as a means of estimating the net product of economic activities which rely heavily on natural resource inputs and services. Recent case studies of watershed degradation in Java and of deforestation in Indonesia rely on resource accounting to indicate the economic cost of natural resource depletion (Pearce, Barbier and Markandya 1990). These studies reveal that aggregate economic growth, as measured by per capita GDP for example, is reduced significantly when the depletion of natural capital is taken into account.[3]

More sophisticated analysis is required to estimate the aggregate social welfare losses arising from inefficient use of natural resources, based on the concept of an optimal rate of use or depletion of natural resources. The latter may prove difficult to determine empirically, however, especially where non-marketed goods and services are concerned, as both marginal benefit and marginal cost functions must be specified.

II. MARKET FAILURE

A frequent cause of environmental degradation in developing countries is the failure of markets to reflect the full value of natural resources. Markets fail where there are (1) open access exploitation or public goods, (2) externalities or other non-marketed goods and services, (3) uncertainty or a lack of mechanisms to hedge risk, or (4) imperfect competition.

Market failure usually justifies some form of public or collective action, provided that the cost of correcting market imperfections does not exceed the potential welfare benefits. Public intervention to redress market failure may involve regulation, economic incentives or institution-building. These responses are provided by local, national or international authorities depending on the location of the market failure. In the following section we review the four market failures listed above, discuss their environmental and economic consequences, and identify alternative policy solutions.

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[3] Data for compiling resource accounts are rarely available on a national level. Extrapolation from sectoral or microeconomic analyses must be carried out with extreme care.

A. Open Access and Public Goods

Environmental problems often arise where there are common pool resources or public goods. Both types of resources are **non-excludable**; i.e. they are available to all who wish to consume them. Public goods are also **non-rival**; i.e. consumption by one user does not impinge on the quantity or quality of consumption by others. Public goods will be under-supplied by the market, since the costs incurred by any private producer exceed the benefits they might obtain. Common pool resources, on the other hand, are **rival**, i.e. exploitation by one user impairs the consumption of others. When the cost of excluding potential users or of coordinating joint use is high, common pool resources may be subject to **open access** exploitation. Open access refers to the un-managed exploitation of a resource by multiple users. Because each user suspects that others would benefit from any exercise of self-restraint (**free-riding**), all users rush to consume the resource as fast as possible.

Open Access

Fisheries are a classic example of how ineffective management of common pool resources leads to open access exploitation. Like many naturally occurring goods that are initially abundant, fish stocks become scarce as the intensity of fishing rises with human population and technological improvements. If rights of access are not clearly defined, limited and enforced, too many users will attempt to maximize their short-run income, to the detriment of future productivity. Concern about the increasing scarcity of fish is overcome by the fear that restraint would only benefit other users, who might capture today any fish thrown back for tomorrow.

Similar conditions and outcomes prevail in many loosely or ineffectively managed rangelands, forests, wetlands and other natural environments in developing countries, most of them in the public domain. Open access problems also lie behind many international environmental disputes, affecting resources such as watersheds, ocean fisheries, air and water quality, the ozone layer and tropical forests. Trans-boundary resource problems persist because of inadequate legal instruments and institutions at an international level. Where potential benefits to the international community exceed the cost to national governments of improving management, however, there may be scope for subsidy via aid flows.

Regulatory approaches to the open access problem stress enforcement of property rights, through limits on exploitation such as licensed quotas, closed seasons, etc. Quotas may be tradeable, or subject to review on a regular basis. Management of common pool resources may be undertaken by government alone, or in collaboration with local user groups, which are often better placed to define regulations or to administer incentives and dispute resolution schemes than central authorities. Management systems for common pool resources usually involve the exclusion of some potential users, hence explicit attention to equity effects is important.

Short concessions for renewable resources with long growth cycles create incentives similar to open access. Logging concessions with a shorter term than tree growth cycles, for example, will discourage the protection and regeneration of growing stock, and may lead timber companies to minimize harvest costs by practising destructive clear-cutting of forests.

Concessions for the use of renewable resources should therefore be phased to coincide with natural growth cycles, with provision for extension and sale of use rights.

Public Goods

Many benefits provided by natural ecosystems are essentially public goods, including genetic resources, potable water supplies and clean air. While such public goods themselves may be subject to open access exploitation, this does not imply a management problem so long as their use is truly non-rival. Problems arise when the resources which provide such environmental goods and services are subject to open access exploitation, threatening the supply of the public goods that they produce.[4] Collective action is often necessary to preserve such resources, but the free-rider problem indicates that the marketplace will not meet the need; government intervention is therefore usually required.

Provision of environmental public goods may be achieved by mandating minimum quality standards (eg. for air and water), or by reserving natural areas which contain important resources or supply important environmental services. Alternatively, side-payments may be used to establish privileged groups, who will perceive a net financial benefit in the production of a public good.

B. Externalities and Non-marketed Goods and Services

Externalities most often attract attention when they take the form of costs arising in a process of production or consumption which are not reflected in the market prices of the relevant goods and services. Typically these costs affect third party "victims," who lack means to obtain compensation. Externalities may be positive as well, in which case a benefit is enjoyed without payment to the producer. Externalities persist due to the absence of markets in which such costs and/or benefits may be valued and exchanges made. Negative externalities imply that the level of production and/or consumption of the relevant good or service is excessive, while positive externalities suggest the opposite. Table 1 presents some examples of positive and negative externalities, including sources, effects, analytical approaches and alternative policy responses.

The economic importance of other non-marketed goods and services is also frequently neglected, including a number of products collected, processed and consumed directly by rural producers (eg. game meat, medicinal plants, fuel and construction materials). Such products and activities often make significant contributions to economic welfare and should not be neglected when planning investments that affect "undeveloped" areas. Typically the very poor rely most heavily on non-marketed subsistence production.

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[4] Public planners frequently neglect the value of environmental public goods, although they support and protect economic activity, because these goods are not marketed (see Section B).

Table 2. Typical environmental externalities

Externality and source	Uncompensated effects	Analysis and valuation	Common policy responses
Air pollution (industrial, commercial and automotive emissions)	Respiratory ailments	Medical treatment costs; days of work lost	Emissions standards or taxes; restricted licenses to pollute; subsidize control
Water pollution (industrial, commercial and private effluent)	Diverse health effects (poisoning, genetic damage); destruction of fish stocks	Medical treatment costs; days of work lost; reduced fish production; potable water treatment costs	As above
Soil erosion (deforestation, agriculture)	Siltation and sedimentation of reservoirs, irrigation infrastructure, river channels, ports and harbours; destruction of fisheries; increased flood damage; reduced ground water recharge; reduced reliability of river flows	Reduced hydro-electric and irrigation capacity and useful life; increased dredging costs; reduced fish production; flood damage costs; increased water supply costs	Increase land rent/tax and timber stumpage fee/tax; subsidize soil and water conservation
Watershed protection (natural and plantation forest, reserves)	Protection of above	As above (damage costs avoided)	Modify relative returns to perennial versus annual crops (subsidy or tax); subsidize protection of watersheds
Water regulation (wetland, mangrove swamps)	Natural waste recycling and water purification; maintenance of water flows; protection from storm surge	As above (damage costs avoided)	Remove implicit and explicit subsidies for draining and filling wetland; subsidize conservation

The challenge posed by externalities is often simply identifying them, since they usually occur as unintended, indirect and diffuse consequences of production and consumption activities. Most externalities occur locally, although some are international in scope (eg. the emission of "green house" gases implicated in global warming, acid rain and depletion of the earth's ozone layer). Poorer victims of negative externalities (or poor producers of positive ones) are most likely to need public assistance in obtaining compensation.

The ideal response to an externality is to "internalize" costs and benefits affecting third parties, so that market prices will reflect the full social costs and benefits of production and consumption. Practical solutions may appeal to the **polluter pays principle**, which states that the firm or agency responsible for an externality should bear all expenses associated with clean-up or compensation, such that any external cost is reflected in the private costs of production or consumption (Pearce 1989). An exception to the polluter pays principle may be appropriate where polluters are many and isolated but victims are few (eg. soil erosion on upland farms resulting in siltation of a hydroelectric facility). In such cases it may be preferable to subsidize private conservation efforts.

More often the policy response to negative externalities such as pollution is regulation by means of fixed standards (eg. maximum levels of emissions or effluent). Such an approach ignores differences in the costs of pollution control among industries and firms. An alternative approach involves creation of permit systems, which recognize a "right to pollute" in certain industries. Permits may be designed as tradeable instruments, on the assumption that market mechanisms will allocate pollution rights among firms according to the relative costs of conservation. Both quantitative standards and market-based systems imply significant monitoring and enforcement costs. The latter may also require the development of new jurisprudence and damage claim procedures.

C. Uncertainty and Risk

The neo-classical market model assumes perfect information, but risk and uncertainty violate this assumption. Risk implies that the relative likelihood of alternative outcomes is known, while uncertainty is akin to ignorance -- expected outcomes are totally obscure. Market failure occurs where there are no mechanisms for hedging risk, or if absolute uncertainty (which cannot be hedged) prevails. Under such circumstances individuals and firms will tend to curtail their investment. Society as a whole, on the other hand, can pool and diversify risk, which suggests that it will prefer a higher level of investment. Uncertainty and risk thus drive a wedge between private and social rates of time preference.

Households and private firms in developing countries face many risks and considerable uncertainty about market trends and future government policy. This leads them to discount at a very high rate the potential returns from conservation or improvement of environmental assets. The private sector will therefore consume natural resources rapidly, with little investment in sustainable methods of production. From a social perspective, the resulting environmental degradation will be excessive.

Many developing countries lack markets and institutions in which producers can hedge or pool risk. Producers of non-traded goods and small-scale operators are particularly

susceptible. Unlike larger firms, which may have access to sophisticated futures markets and insurance policies, most small-scale producers cannot easily insure themselves against the risk of fluctuating prices, drought or other exogenous shocks. In addition, lack of access to formal credit sources frequently forces subsistence producers to borrow in informal markets, where interest rates are much higher. Case studies of land degradation in Botswana, Java, Sudan and Nepal highlight the role of uncertainty and risk, much of it related to the high cost of informal credit, in reducing farmers' propensity to invest in land improvements (Pearce, Barbier & Markandya 1990). Institutional responses to these problems may include the development of marketing cooperatives, extension of credit at affordable interest rates, crop insurance programs or international buffer stock/price stabilization schemes with the technical ability and economies of scale necessary to pool producer risk or to cover exposure in existing markets.

Uncertainty over renewal of tenure agreements, threats of expropriation and the perceived unwillingness or inability of public authorities to protect private property may also discourage private investment in sustainable production, or encourage rapid exploitation of resources. Property rights issues may be addressed through land redistribution programs, land titling, fixed term leases, limits on the frequency and/or magnitude of rent hikes, and protection of tenants from arbitrary eviction. If such institutional interventions are impractical, economic incentives such as tax relief, extension of rural credit or direct subsidies to encourage investment by farmers may offer an alternative. Countering a distortion in the private discount rate by direct subsidy is a crude method, however, and the impact on relative prices must be carefully considered before implementing such schemes. Often a more practical approach is to improve the delivery of informal rural credit and to remove distortions in formal credit systems that direct scarce resources away from resource-improving investments.

D. Imperfect Competition

Monopolies, oligopolistic cartels and monopsonies violate the neo-classical assumption of perfect competition. The lack of competition typically leads to levels of production and supply below the social optimum, a transfer of welfare to the monopolist or monopsonist, and a deadweight loss to society. Monopolies or monopsonies in natural resource markets are often considered benign precisely because they lead to conservative use of resources, in order to maximize scarcity rents. Tax and regulatory instruments can be used to ensure that monopolistic scarcity rents accrue to society, although public intervention more often creates conditions of imperfect competition that dissipate resource rents.

Lack of competition in agricultural markets often results from the creation of commodity marketing boards, acting as monopsonist buyers. Resulting environmental impacts may be ambiguous, as depressed prices for farm products can keep marginal lands out of cultivation, but may also reduce farm incomes and thus deter investment in conservation. Without government restrictions, however, monopolies are unlikely to arise in markets for local agricultural products, which are characterized by many small-scale producers. On the other hand, collusion among a small number of firms controlling access to land, capital, fertilizer, machinery or other inputs may result in monopolistic pricing. Another common scenario is the creation of public monopolies in agricultural inputs, causing price distortions and restricted supply. Poorer farmers needing inputs for land improvements might be excluded,

whereas 'progressive' farmers willing to invest in mechanized irrigation of dry-land areas and conversion of forest areas and wetlands might benefit -- to the detriment of the environment.

At the international level, states have often tried to manipulate prices of traded products, through producer cartels or commodity agreements. Little thought has been given to the implications of such arrangements for the underlying resource base. However, the growing concern in developed nations over threats to biodiversity and other ecosystem services originating in developing countries may generate new opportunities for international agreements between producers and consumers, such as the recent International Tropical Timber Agreement.

III. PUBLIC POLICY AND THE ENVIRONMENT

Public policy affects the environment in a number of ways. The preceding section illustrates how policy may be used to correct for market failure. The discussion below concerns policies unrelated to environmental market failure, which nonetheless influence the use and allocation of resources directly or indirectly. Environmental damage may arise inadvertently from economic and social policies originally designed to promote efficiency or equity objectives. Damage may also result from government restrictions on political and social expression, or from the use of government policy by officials for private or political gain. Four areas of government intervention are defined: regulation, economic policy (macroeconomic and sectoral), public investment and institutional policy.

Analysis of environmental impacts may reveal that the net welfare effects of a policy measure are negative. This often occurs when the policy adversely affects the use of resources, with few compensating growth or equity benefits. Alternatively, analysis may reveal that net welfare benefits would have been greater if a policy had been adjusted to account for impacts on natural resources. This is often the case when the environmental impacts of a policy are incidental to its primary objective.

A. Regulation

Regulations covering the production and consumption of a wide range of goods and services can affect environmental quality by distorting demand and supply conditions for natural resources. Trade restrictions often have the most significant effects: quantitative restrictions on grain imports, for example, may result in higher local grain prices and thus encourage encroachment by farmers on marginal lands or environmentally sensitive areas. Other regulations with environmental impacts include pollution controls and emission standards, licensing and permit laws, concession terms, tenancy arrangements, etc. The effect of regulation on the use of natural resources may be indirect and ambiguous, hence the need for careful scrutiny of existing and proposed measures. In Indonesia, for example, regulations governing pesticide use in rice production were modified in 1987, after increased pest outbreaks in successive seasons were linked to problems of excessive pesticide use (Pearce, Barbier & Markandya 1990).

B. Economic Policy

Macroeconomic, trade and sectoral adjustment policy can alter incentives governing the use of natural resources by altering aggregate demand, as well as by distorting the relative prices of natural resources and related goods and services. Because the exploitation of natural resources is a relatively large component of economic output in many developing countries, almost any economic policy or price distortion may be suspected of having environmental effects. Figure 1 outlines some typical linkages between economic policy and the environment. As a rule, however, the analysis of economic policy for possible environmental impacts must be undertaken on a case-by-case basis.

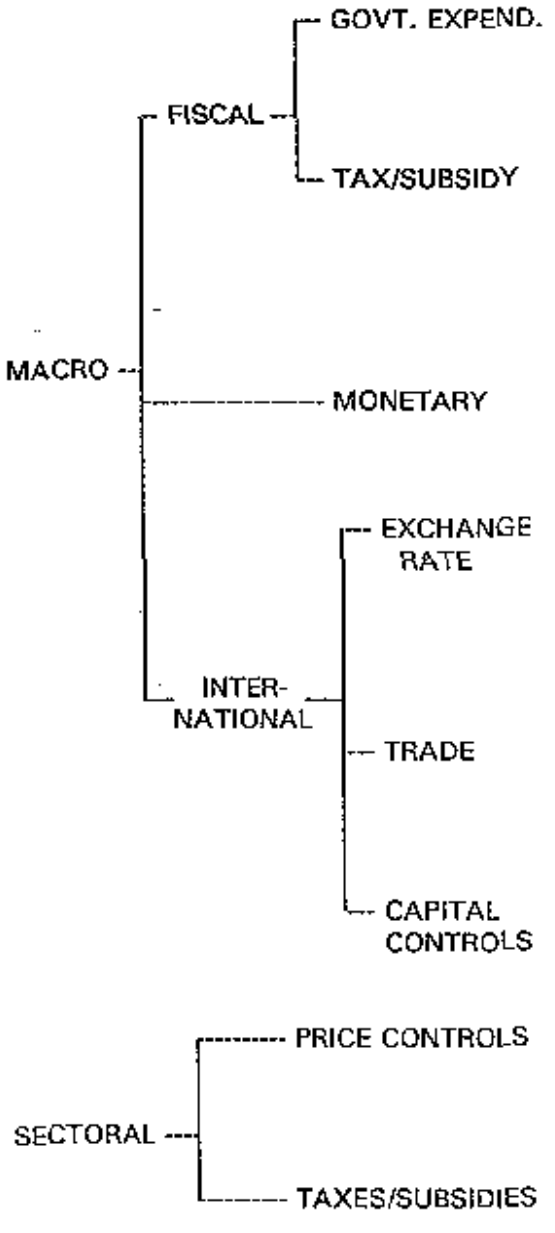
Ideally, sectoral or microeconomic policy should aim to bring market prices into line with the estimated marginal social costs and benefits of natural resource use, accounting for all environmental market failures described above. In practice, however, limitations on data and research capacity usually require that initial efforts concentrate on determining the **direction** in which prices must move to reflect these social costs and benefits. On the macroeconomic side, even a qualitative assessment of the potential environmental impacts of policies designed to modify aggregate demand, counter fiscal deficits or address balance of payments problems may suggest minor adjustments to limit environmental damage, thus improving the contribution of macroeconomic policy to sustainable development. Lessons from one country are rarely transferable, hence analysis should be pursued on a country-specific basis. The environmental impacts of **structural adjustment**, or of a large burden of **foreign debt**, are particularly difficult to generalize.

C. Public Investment

Public investment programmes may be analyzed in much the same way as fiscal policy regarding subsidies. Growth and equity objectives must be weighed against possible negative environmental impacts. Often the latter only become apparent after project completion, usually due to inadequate assessment of environmental impacts during project formulation. In general, project evaluation and cost-benefit analysis should consider not only the direct benefits and direct costs of public investment, but also the opportunity cost of foregoing alternative uses of natural resource inputs and the possible loss of important environmental services.

The analytical approach used to extend project appraisal to include environmental impacts has been well developed (see Pearce, Barbier and Markandya 1990). Formal pre-project assessments of environmental impacts are still often superficial in practice, however, despite a substantial and growing literature documenting the negative consequences of failing to take account of such impacts. This is partly because environmental impacts are often subtle, indirect, slow to reveal themselves or difficult to measure. Another reason may be that environmental costs associated with public investment programmes are usually not borne by the funding or supervising agencies, which have little incentive to incorporate such costs in their project appraisal and evaluation procedures.

Figure 1. Economic policy and potential environmental impacts



Publicly funded agencies can protect biologically unique areas; public infrastructure (roads and dams) may encourage land uses that degrade fragile areas.

Multi-sector instruments can alter general demand conditions and thus use of resources; eg. income tax breaks may encourage speculation in land and/or unnecessary conversion of natural areas; "polluter pays" taxes and user fees can reduce waste and air/water pollution.

Tied-credit analogous to subsidies; credit rationing and interest rate hikes may reduce demand, but can also discourage conservation investment.

Devaluation increases prices of imported inputs (eg. pesticides, logging equipment), while increasing profitability of exports (eg. crops and timber); environmental impacts will depend on the nature of the resource and product affected.

Import/export taxes and quotas have effects similar to devaluation but on selected commodities only; may alter relative returns to environmentally destructive versus benign products.

When used to prop up over-valued currency, similar to revaluation of exchange rate.

May stimulate or retard environmentally damaging production; depends on nature of resource and products affected.

Usually indirect impact via changes in demand, but may alter choice of inputs/outputs: eg. incentive subsidies to livestock production may promote deforestation; fertilizer subsidies may retard adoption of soil conservation; pesticide subsidies may increase negative health effects of agro-chemical run off, etc.

D. Institutions

The most important form of institutional weakness with negative environmental consequences is the failure to establish and/or enforce clearly defined rights of access, tenure and control over productive resources. Producers must be sure that they will enjoy the fruits of conservation or investment before they will undertake it. Where such assurance is lacking, producers will be tempted to extract the maximum profit from resources in the short term. This usually results in the rapid depletion of the resource, under open-access exploitation. As discussed above, such tenure problems frequently arise in subsistence agriculture, fisheries, forestry and the use of pastoral resources.

Policy responses to tenure problems may include police action to enforce existing rights, the creation of formal title or licenses, or the establishment of autonomous common property management schemes. The appropriate response will vary with the particular characteristics of the resource and the institutional context. Where the capacity of central institutions and agencies for enforcing land tenure claims is low, it may be preferable to reinforce indigenous resource management systems. These issues are discussed in a study of Botswana, which reviews the various laws and regulations governing the allocation of grazing lands, arable lands and water rights (Pearce, Barbier & Markandya 1990).

Other institutional factors contributing to environmental damage include political failings such as a lack of participatory mechanisms and public accountability, or rent-seeking behaviour on the part of public servants. Politics lies outside the subject matter of these guidelines, but technical factors resulting in inefficient bureaucratic procedures and conflicting or mismatched responsibilities can also have important effects on the use of natural resources.

A common structural failure is the definition of institutional authority along sectoral or geographic lines that do not correspond to the range and types of environmental problems. Many developing countries distribute responsibility for environmental affairs among a number of public agencies, creating serious problems of coordination. Examples may include a lack of policy coordination between agricultural and environmental departments over pesticides or fertilizer policy, or conflicting local government policies on the management of resources straddling administrative boundaries. In many cases all that is needed is clear delineation of areas of authority, or improved institutional linkages where there are geographical or sectoral overlaps affecting the use of natural resources.

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The London Environmental Economics Centre (LEEC) is now known as the Environmental Economics Programme, at the International Institute for Environment and Development. The former name dates from 1987 when the Centre was established by IIED and the Economics Department of University College, London.

Today, all environmental economics staff and research projects are based at IIED where the Programme has become a core area of Institute activity.

The Environmental Economic Programme conducts economic research and policy analysis for improved management of natural resources and sustainable economic growth in the developing world.

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