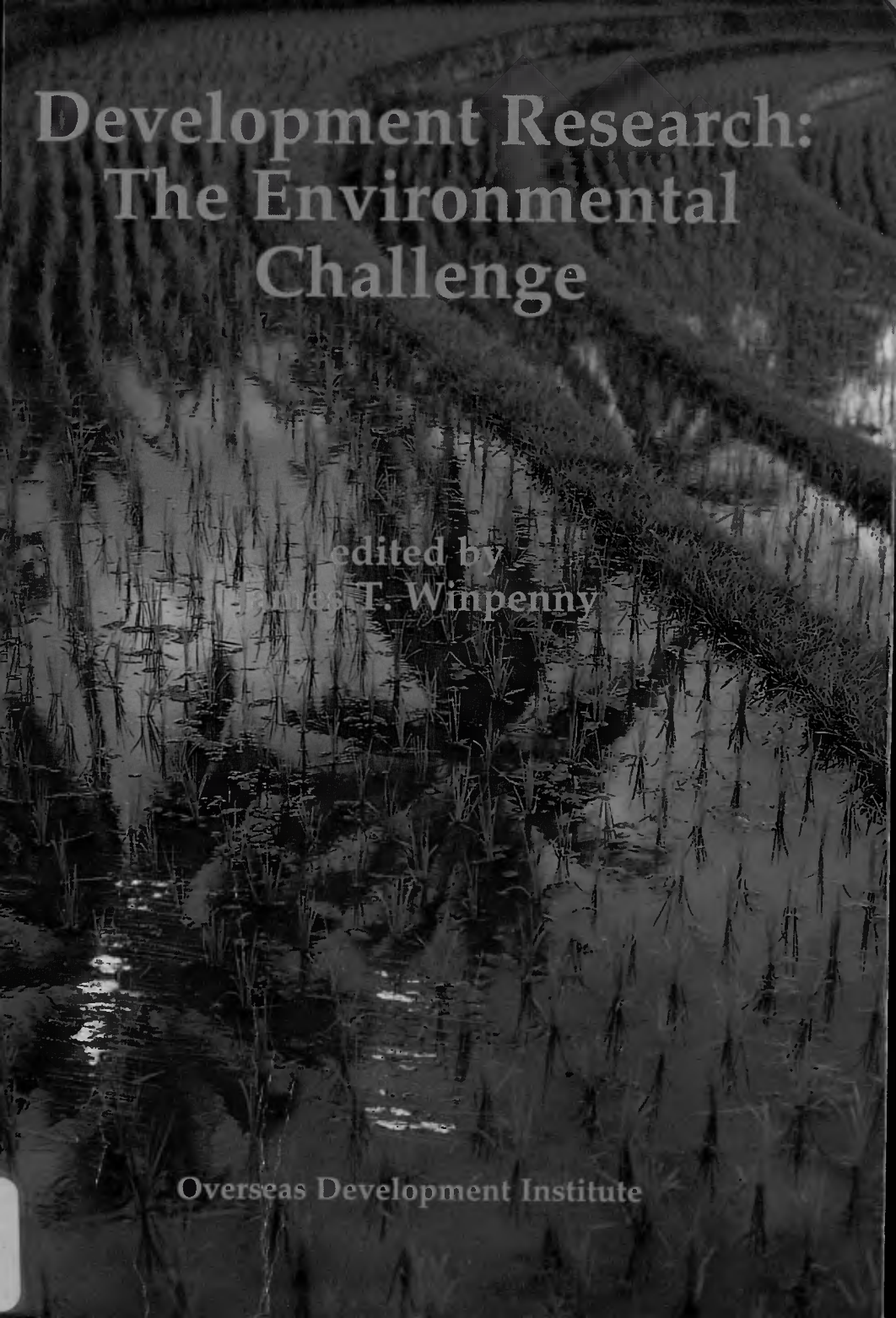
Development Research: The Environmental Challenge



edited by

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Acknowledgements

The chapters in this book were originally presented as papers at an ODI Conference on 'The Environment, development and economic research' held in London in March 1990. The financial assistance of the Overseas Development Administration towards the cost of the Conference and for this publication is gratefully acknowledged. Colleagues at ODI have been generous with their time and assistance. I would particularly thank Nidhi Tandon and Michèle Low for help in organising the Conference, and Patsy de Souza for preparing the text of this book. Readers can thank Margaret Cornell for her usual invaluable editorial contribution.

James T. Winpenny
November 1990

British Library Cataloguing in Publication Data:
Winpenny, James Thomas, 1941-
Development research: the environmental challenge
1. Environment. Research
I. Title
333.7072

ISBN 0 85003 141 9

Printed on Re-cycled paper.

Printed and typeset by the Russell Press Ltd., Nottingham.

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I. INTRODUCTION

1: Introduction and Overview
J.T. Winpenny

The chapters in this collection were originally presented as papers at a Conference on 'The Environment, Development and Economic Research', held at the Overseas Development Institute in March 1990. Its object was to draw up an agenda of research topics on environmental issues relevant to students and practitioners of economic development. The organisers deliberately mixed environmental specialists with those with a more general interest in development, in the hope that the two groups would challenge each other in a professionally rewarding way.

Some of this 'creative tension' is evident in the structure of this book. Several of the papers are followed by shorter pieces which are reactions to, or elaborations on, the original arguments by writers with a different *locus standi* on the issues. This introductory section reviews some of the main points emerging from the collection. Detailed research proposals are left for the final chapter.

International Issues

Ahmad in effect provides an 'environmental overlay' to the normal agenda of international North-South issues. He promotes population to the head of the list of concerns, which also includes changes in production processes (for example, more efficient use of natural resources and energy, and more recycling) and methods of transferring technology from private firms to developing country users. He reminds us of the massive sums that are being suggested

to finance world conservation projects, alternative energy development, and the implementation of protocols and agreements on chlorofluorocarbon reduction, control of greenhouse gas emissions, and the protection of bio-diversity. It is a moot question whether the international political will currently exists to transfer sums of this size, and what institutions and policy conditions would be necessary to make effective use of such flows.

Lankester describes ways in which the British ODA is responding to environmental issues. He finds the concept of sustainable development still lacking sufficient operational value. As a development practitioner he calls for more understanding of the links between poverty, population and environmental degradation. Environmental studies should, in his view, rest on a sound base of economic analysis, but the existing methodology needs to be developed and extended to remain plausible in this important area.

Macroeconomic Policies

Hansen notes that an increasing proportion of aid is being offered in association with structural adjustment programmes that lead to changes in key economic variables. Changes in the prices of outputs and inputs, taxes, the size and balance of public spending programmes and the exchange rate can intimately affect environmental behaviour. So far aid agencies have paid little heed to these effects, still less manipulated them.

Contrary to a popular view, structural adjustment programmes are not necessarily bad for the environment and, on balance, may even have positive effects. Moving input prices closer to their economic level, by, for instance, removing subsidies, is often beneficial to the environment. Hansen stresses that much depends on *which* export crop is stimulated by a devaluation, and *which* spending programme or subsidy is affected by public spending cuts. The general message is that adjustment programmes should be closely scrutinised for their potential environmental impact, and that trade-offs might be identified and fine-tuning of the programmes carried out to modify or highlight certain of their elements in the interests of the environment.

Killick also stresses the beneficial *potential* of structural adjustment programmes. They are normally introduced in the midst of great economic uncertainty and instability. Inasmuch as they provide a better framework for planning and policy-making, and improve

confidence in the future, they can help environmental policy formation. They also support market mechanisms, which can be manipulated in the interests of environmental policy. He warns, however, that too much emphasis on short-term export successes may run counter to the sound management of natural resources.

Natural Resources

The recurring themes in Barbier's overview of natural resources degradation are: the importance of valuing resource use and measuring the costs of environmental degradation; recognising and correcting distortions in government policies; and understanding — and then working on — the set of incentives facing private environmental users. These themes are explored in relation to tropical forests, wetlands, drylands, irrigated agriculture and soil erosion.

The argument for proper valuation is reinforced by Prance, writing of tropical forests. He refers to the growing number of studies of the economic value of standing forest, especially for the supply of minor, non-timber products. These values can easily exceed the commercial worth of felled timber. Shepherd switches the focus of discussion to tropical dry forests, an ecosystem which is much more important than humid forests for life support, as well as having important global climatic effects. She argues that the management of dry forests is important in various ways for people dependent on them, but that they will do little to solve urban fuelwood shortages. However, some of the models of 'participatory management' being worked out for such dry forests may have relevance to the management of humid tropical forests.

Turner believes that much conversion of wetlands happens because of ignorance about their true ecological and other functions, and a failure to put economic values on their services. Apart from greater attention to valuation, he urges that project appraisal should include actual compensatory projects to restore environmental functions lost during development.

Questions of property rights, tenure, and incentives for good management are explored by Toulmin in the context of Sahelian drylands. She argues that local resource management depends on users having some stake in the resources and a voice in how they are used. The attempt to increase the power of the central government, for example, through nationalisation, has had the

paradoxical result of creating a local power vacuum, since central governments are too weak to fulfil a proper role, and traditional local structures have been enfeebled. She points to the growth of the 'responsibilisation' movement, aimed at decentralising power over resource use.

Soil erosion is the problem that has probably received most attention in studies of the environments of developing countries. Belshaw, Blaikie and Stocking remind us that it is too simple to treat it as a narrow technical problem, since its causes lie in its wider socio-economic context. This paper reviews the great variety of interventions possible in soil conservation, and warns of a failure syndrome caused by the ignorance of external 'experts' of the concerns and motives of the very people who are supposed to benefit from the projects.

Tiffen highlights another common reason for non-sustainable growth, namely poor management of complex systems and the neglect of essential maintenance. She argues that financial and institutional weaknesses go far to explain the variable performance of irrigated agriculture. Poor cost recovery from water users and the lack of autonomy on the part of irrigation agencies are emphasised, as well as the more familiar under-pricing of water.

Urban Problems

Despite 'urban bias', Satterthwaite believes that the environmental problems of poor cities have received short shrift from researchers and policy-makers. He alleges that most of our perceptions about this issue stem from work on the largest cities, and have concerned problems preoccupying more affluent societies — such as air pollution and industrial effluent — when the supply of safe water and sanitation is more important to everyday health. He urges greater understanding of the main environmental problems as perceived by the poor urban resident, and recognition of the differential impact of problems on the various socio-economic groups, which prevents safe generalisation.

Social and Gender Dimensions

One socio-economic group which is particularly sensitive to environmental quality is, of course, women. As householders and mothers — but to an important degree as producers too — they are

amongst the first to experience the effects of environmental change and suffer it in their persons through malnutrition, declining returns to food production, more time spent getting fuel and water, coping with their own and their children's illnesses, etc. Davidson sets out the case for 'empowerment', starting with understanding of women's viewpoint, and enabling them to put across their concerns to influence relevant *mores*, projects and policies.

Bio-diversity

The questions 'who benefits, who loses'? should perhaps be the text for all future environmental research projects. McNeely attacks the same theme in his paper on bio-diversity. In seeking reasons for the rapid loss of biological diversity he stresses the importance of separating gainers and losers, and likewise for conservation projects. Better management of bio-diverse resources will depend on improving the distribution of costs and benefits, and on devising better bargains between the various parties. He suggests a role for economic valuation, cost-effectiveness, and international willingness-to-pay.

Barrett probes the controversial role of economics in bio-diversity further, with reference to distribution, ethics and fairness to future generations. His view is that it is inadequate to draw up a balance sheet of all costs and benefits and decide on the basis of aggregates; only the payment of actual compensation (from gainers to losers, from the present to future generations) will make a real impact on the problem.

Energy

Energy consumption is a vital factor in both global problems and local environmental concerns such as deforestation and air pollution. Anderson presents a scenario in which, whatever may happen to consumption in the OECD countries, the use of conventional energy sources in developing countries continues to rise in the long term. Thus the co-operation of developing countries is vital to international efforts to curb global warming. He distinguishes two categories of problem: firstly, local air pollution, acid rain, etc. where the effects are local or regional; and secondly, global greenhouse problems. The former can, he suggests, be tackled by taxes and other market devices. The latter could be addressed

by applying a carbon tax whose yield would, amongst other things, finance research and development for alternative energy sources and technologies. The 1990 Gulf crisis supervened after this paper was written and it is too soon to assess its impact on Anderson's analysis; but it would, if anything, reinforce the longer-term case for energy taxation and research into alternatives.

Goodman points to evidence of the adaptability of the world's energy economy to drastic changes in energy prices such as those of the 1970s. He believes that developing countries could make substantial economies in their use of energy, provided they could raise the sizeable funds necessary for installing energy-efficient end-use equipment. On this point, the discussion loops back to Ahmad's discussion of technology transfer and international funding mechanisms.

Economic Valuation

Most of the papers mentioned so far require changes of various kinds in the methodology used to approach environmental issues, especially in the choice of development projects. The final group of papers address the question of economic valuation. In the project context, Dixon points out that economic valuation techniques are well-known but their application is stymied by uncertainty about the physical relationships linking environmental causes and effects. Non-quantifiable effects also limit the scope of valuation exercises. He notes that in developing countries most progress in valuation has been achieved with the simpler techniques, which require the fewest assumptions and the least data. Winpenny goes further, arguing that the valuation of externalities has actually not proceeded very far in developing countries, compared with on-site effects, for example, of soil erosion.

El Serafy takes up the valuation issue in the context of national income accounting. It is important for policy-makers to receive the right signals about economic performance. In countries relying on the production and export of finite national resources like oil or minerals, the depletion of stocks is usually treated as current income, thus exaggerating the underlying rate of economic growth. The point has been made more generally; the extraction of renewable resources such as timber, or farming methods causing soil erosion, are analogous to depleting capital for the sake of current output, and income should be offset by a capital depletion

item. El Serafy urges that adjustments to national accounts should proceed as soon as possible, rather than waiting until all the methodological and data problems have been resolved.

Three of the most insistent themes in this collection are: firstly, the need for a better understanding of why people (environmental users) act as they do; secondly, how they can be given incentives to manage their environments in a more sustainable manner; thirdly, how environmental resources can be valued in economic terms, in the cause of devising more rational projects and policies.

II. INTERNATIONAL ISSUES

2: International Policies to Respond to Global Environmental Threats: An Economic Perspective

Yusuf J. Ahmad

Introduction

International policies to respond to global environmental threats are on a rising curve of public scrutiny and interest. What these policies should address, their options and their efficiency are all becoming major items on the economic, no less than the political, agenda at the highest levels. In developed and developing countries alike there is a growing concern at the grass-roots level about what is perceived as a rapidly deteriorating situation. It is this public concern that is pushing governments and industry to take a second hard look at natural resources management and problems connected with the quality of the environment.

It has been said that ecology is entering the corridors of power. If this is so, it is not as yet reflected in the elaboration of effective international policies. There is no evidence that the financing needs of the biosphere or the emergence of such global problems as the depletion of the ozone layer, the threat of climate change, the loss of bio-diversity, the international disposal of hazardous wastes, are receiving attention in a competent and orderly manner. The necessary political will, it seems, has yet to emerge.

There is little difference in informed circles on the need for effective and urgent action. There is even less dissent on the need to begin forging a focused global response to global concerns. What is awaited in sustained progress is defining the policy means to fashion the global response. Sadly, the compelling reality of the

consequences of natural resources and environmental degradation has yet to find expression in realistic and repairing policy frameworks.

This is not to minimise the difficulties that must be faced. The problems that have emerged cannot be solved by cosmetic actions. They need responses covering a wide spectrum of leverage points including trade, finance, technology, social, economic and political policies. The existing problems will no doubt increase and become even more complex in the future. But it will be reckless to allow the difficulties to deter or delay prompt action. As current developments in the USSR and Eastern Europe continue, the threat of global armed conflict and nuclear annihilation is receding. Unfortunately, the threat of an environmental catastrophe is not. There is universal evidence that the global inheritance is being degraded and destroyed by gross mismanagement of resources, transboundary pollution and global environmental deterioration.

Compromise Strategies

Viewed from an economic perspective, what are needed are compromise strategies to deal with a contemporary predicament: how to reconcile the need for economic growth with the equally pressing need to maintain and, if possible, enhance the natural delicate balance which lies at the heart of that growth.

The present world population of 5.2 billion is expected to double, or even reach 12 billion, in the next three or four decades. Today's population uses up 40% of the planet's photosynthetic productivity. The doubled population is expected to consume 80% of that productivity — a daunting prospect which will take us to the brink of the planet's resource and sink capacities. But the increased population will also need accelerated economic activity, including an ever increasing application of technology to natural resources, to meet its needs. Economic activity in the Third World, the focal point for most of the population increase, would have to be increased by a factor of 10-15 to meet (a) the basic human needs of the burgeoning population, (b) their legitimate aspirations for rising living standards and (c) reduction of levels of absolute poverty. This translates into a huge new burden on the biosphere which is already under substantial pressure.

If we pursue the paths of development followed so far, renewable and non-renewable resources would be mined, fossil fuel use

increased by several times the present figure which is already high, and pollution increased well beyond the threshold levels acceptable to planetary balances. Soil erosion would cause the loss of no less than one-third of the planet's productive land by the end of the century.[1] The net economic loss due to desertification is currently estimated at $26 billion per year. According to studies carried out under the Montreal Protocol[2] the depletion of the ozone layer — at current rates — is likely to cause 44 million cases of skin cancer and 800,000 deaths. Many scientists are convinced that we are now embarked on the most systematic mass extinction of plants and animals in over 60 million years. Water use in itself, if it keeps increasing at the level of this century, could become a serious constraint to economic development in the near future. The timeframe for these changes is not hundreds of years; they will take place within the next 40 or 50 years. The prospect of environmental bankruptcy and the brinkmanship on which mankind appears set must make us pause and reflect on the survival options available.

What must be sought are new international policy frameworks based on global partnership. Countries of the world may not have a common past but they certainly share a common future in the security and well-being of which they have a critical stake. The challenge is to take unified — and timely — actions to contain resource-management and environmental problems. These problems are found to be so pervasive and widespread as to appear almost like a seamless web. If response policies are to prevent or forestall the foreclosing of options for future generations they must be based on an *understanding* of present problems and a *recognition* of potential ones. Equally, they must have an appreciation of the magnitude of the dangers and of the requirements for financial and other resources, as well as analysing the benefits to be gained. They must go beyond the commonplace but must also be practicable and readily acceptable. The problems will not be solved by a modest commitment of resources or of resolve: they need structural changes, which cannot avoid being painful.

The emergence of the planetary problems has raised far-reaching questions as to the adequacy of international response policies and, above all, the mechanisms for international co-operation. Are these mechanisms able to deal with the vexed issues of cost sharing and priorities? Is there a system to deal with the high consumerism in the industrial world and the poverty in the developing one in an equitable and responsible manner? Politically difficult and

economically burdensome compromises must be reached on the kind of economic growth that is sustainable in the stressed and highly fragile environment of today and how the benefits and dis-benefits are to be shared.

Strategy Components

The compromise strategies needed to move to a more sustainable order require a number of building blocks.

Population policy

The first and foremost of these is a realistic population policy. Experience has shown that what is needed is not so much to *facilitate* a demographic transition as to *motivate* one, which is a much more difficult exercise. The lesson from all over the globe is clear: that setting a basic standard of living and providing more education and a greater say to women with respect to child-bearing are the essential instruments of an effective policy. It is surprising that international strategies are not more centrally focused on these objectives and their chains of causation.

Production processes

Population policies are, however, by definition long-term. In the short term, effective compromise strategies will require a change in production processes. These processes must: (a) use natural resources more efficiently and carefully; (b) take energy efficiency as one of their guiding principles, and (c) make a serious attempt to recycle wastes.

It is not that the technologies are not known. The technology exists — thanks largely to the efforts of industry — to lower carbon emissions substantially, and also to increase the efficiency of electric motors 40-fold. Fluorescent bulbs can reduce energy demand for lighting by 75%. As compared with today's average of 20 mpg, the automobile industry is now looking at standards of 75 mpg and to experimental electrical models. In fact, it is currently possible to increase energy efficiency in most industrial and many actively industrialising countries by as much as 25%. The technologies have been developed and demonstrated in several countries including Japan (where fuel efficiency for steel production increased by 70%

during the past three decades), the Federal Republic of Germany, Sweden and others. But a consistent and coherent policy package needs to be developed on the basis of the proven economies that are possible. This is not only desirable but compelling in view of the fact that the Third World is likely to quadruple its energy use in a few decades. The development of non-fossil fuel supplies — for example wind, solar, geothermal, hydro and biomass energy — is currently linked to the rise and fall in oil prices. This is short-sighted. Response policies dictate that fossil fuels should be taxed heavily, reafforestation projects financed more generously, and new energy sources developed more systematically.

Recycling of wastes is a key component of these processes. Along with a significant decrease in raw material inputs, there must be a slowing down of wasteful output through process efficiency and recycling. Historical experience shows that it is possible to make significant advances in recycling aluminium, steel, paper and glass. The potential for gains in this field are enormous. UNEP's low-waste and no-waste technology programme provides many examples where the developing countries, especially the rapidly industrialising ones, could adapt such technologies to improve their competitive position.

Technology transfer

Change in production processes depends critically on the development and transfer of technology. There are two aspects to be considered. First, the pivotal role of technology in the containment of planetary problems. It is now generally recognised that the delicate planetary balances are in jeopardy, and some of them probably already breached. An effective response must be based on a clear acceptance of global interdependence and a shared sense of responsibility. If developing countries are to accept that responsibility and make legally binding commitments to minimise or negate damages, the scale of which is not of their making, it is equitable for them to receive in return equally binding commitments on the transfer of technology and defrayment of the incremental costs.

Complications have arisen from the fact that advanced, and in particular new and emerging, technologies are in the custody of industry and not governments. Industrial conglomerates have spent considerable amounts of money in developing them. Their natural

desire is to protect their investments and to obtain maximum returns from them. Hence the problems that arise from patents, royalty payments, proprietary rights, etc. These problems need examination and elaboration of ways to solve them.

Second, transfer of technology plays a basic role in securing sustainable development in the Third World. Sustainable development must be based on the effective and systematic integration of economic development with environmental protection. The key to that integration lies in appropriate and environmentally sound technology and its transfer to developing countries. This raises two important considerations: (i) the importance of technology transfer to developing countries, and (ii) the initiation of an international programme in this field.

(i) *Importance to developing countries.* Experience since the Second World War has shown that the selection and use of appropriate technology must be given high priority in the quest for agricultural and industrial sustainability. In this context, it is worthwhile to identify technologies appropriate for the self-help of developing countries and for the pressing issues of natural-resources management and economic growth. Research has produced many new technologies that are far less harmful to the environment than they were twenty or even ten years ago. It is also now possible to calculate the long-range consequences of technology, but at the same time there is a tendency to accept technological determinism. It should no longer be a question of sitting back and seeing where technology is taking us; it should now be a question of using science and technology to take us where we want to go. Appropriate Technology is often defined in terms of the labour and capital endowments of a country or a region, but this definition is too narrow. Appropriateness must be assessed on three-dimensional criteria with environmental and social aspects no less important than the economic ones.

The emerging agricultural technologies, most notably biotechnology, show certain encouraging features. Preliminary studies indicate that the new technologies have in general a benign impact on the environment and natural resource base for two reasons. First, most of them are expected to increase productivity and thus reduce the pressures on natural resources to meet future agricultural and food needs. Second, most of them are biological and informational and not mechanical and chemical (which has caused so much damage in the past). Some (but not all) of them

may also provide the potential for reducing costs and capital requirements (per unit of output) at the producer level.

The selection of an appropriate technology from amongst the different alternatives available is not an easy task. In their agricultural and food production the developing countries face different physical endowments of natural resources, customary and traditional agro-economic practices, patterns of cropping, institutional settings, credit systems, expertise levels, and social attitudes that are relevant to choosing a technology that is environmentally sound and conducive to the development strategy in operation. Success will depend upon the extent to which a reconciliation of the conflicting claims is achieved. A dilemma arises. On the one hand, the technology must be adapted to the conditions of the country; but organisational and institutional arrangements within the different sectors should also be modified to use the technologies, especially the new and emerging ones.

(ii) *An international programme of work* is long awaited in this critical area. It could have the following components:

- dialogue and active co-operation with industry, particularly in the newly industrialising countries of the Third World, to help in R and D efforts to develop and introduce processes and products that will lead to significant and rapid reduction in the energy and raw material content of every unit of production;
- dissemination of information and transfer of technological options to developing countries where substantial economies are involved;
- identification of opportunities and constraints in attempting to achieve breakthroughs in innovative technologies that are careful of resources and environmentally sound;
- investigation and research into what is involved in a transition to recycling of materials and closed-system approaches to resource and energy conservation;
- finally, there is the need for encouragement of low-waste and no-waste technologies.

Development activities

Development activities constitute interventions in nature, the consequences of which are often not clearly known or assessed. Many of them could be synergistic in their impact, others

irreversible. It is not surprising that many of the projects undertaken, even now, by bilateral aid donors and multilateral financing agencies are perverse in their impact on resource conservation and environmental quality. Project design and implementation must be improved and made sensitive to environmental concerns.

Environmental assessments of the type now being introduced by the World Bank for regional and sectoral programmes as well as for project-specific planning should be a routine part of project design. They should continue throughout the project cycle in order to minimise environmentally negative impacts. Improving the institutional capability of the country concerned should also be an important policy objective. It has been suggested that if, within a particular sector, a number of projects are initiated which may on balance have an adverse impact on environmental quality or natural resources management, it could be useful to introduce compensatory projects which need not conform to financial orthodoxy. This seems a sound idea which could be pursued by aid agencies.

It must be added, however, that although projects are important, a more weighty responsibility rests on public policies (macroeconomic, fiscal, physical, sectoral, investment, resource planning) pursued by governments. Countless activities are undertaken daily (as a result of incorrect incentives, subsidies, taxes, levies, exchange controls, exemptions and the like) which tend to destroy the natural resource base and environmental well-being. In sum, the impacts of these policies may well be greater than the havoc wrought by misguided projects.

There is also a third, and more potent, cause of environmental degradation. This relates to complex *political* realities: the distribution of income and wealth, system of land tenure, institutional bias in favour of the powerful and the rich, location of political power in a society, etc. In the field of natural-resources management and environmental use powerful vested interests have tended to play an adverse role. Landlords, large farmers, traders, middlemen and political activists are among those who mine the natural capital, exploit the global commons, pollute without internalising the costs, deplete the ozone layer with impunity for their rapid economic expansion. One-tenth of the world's population emits 91% of the greenhouse gases. This is a hard reality

which must be tackled with political will if environmental problems are to be met effectively.

Financial needs

It is implicit in the issues discussed above that there is now a serious lack of funding for the proper maintenance of the environment. Moving to action will require new sources of financing and innovative mechanisms for identifying, launching, and supporting activities to protect the environment.

The issue has assumed political overtones touching upon such questions as the 'conditionality' and 'additionality' of development assistance. As far back as 1975, the UN General Assembly adopted resolution 3362 (5-VIII) which reads in part:

> Concessional financial resources to developing countries need to be increased substantially, their terms and conditions ameliorated and their flow made predictable, continuous and increasingly assessed so as to facilitate the implementation by developing countries of long-term programmes for economic and social development.

These considerations are of particular relevance in dealing with the global environmental problems arising today. Financing is likely to be a central issue of the 1992 Conference on Environment and Development.

The assessment of financing needs consists of two parts. There is the need to provide financing to developing countries in order to undertake national sustainable development programmes effectively or to cover what may be called their unmet conservation needs. According to the UN Development Programme and the World Resources Institute International Conservation Financing Project Report[3] these needs will amount to roughly $20-$50 billion per year for the next decade. The World Watch Institute identifies six categories of expenditures, namely, protecting top soil and crop land, re-foresting the earth, population control, energy efficiency, renewable energy development and reducing Third World debt, and estimates that they will need total additional expenditures rising from $46 billion in 1990 to $149 billion in the year 2000. By then the greater proportion of these expenditures ($85 billion) would be related to energy needs. Although multilateral and bilateral financial flows could meet some of these requirements, new and innovative financial mechanisms will be called for, for both

qualitative and quantitative reasons. The conservation financing initiatives, and especially the International Environmental Facility and ECOVEST (a pilot investment fund for sustainable resource use), as recommended in the WRI Report, deserve careful consideration.

Secondly, there are the financial requirements to meet the emerging planetary problems. No accurate or even approximate estimate of the finances required to meet the different scenarios of abatement or containment have emerged so far. The most advanced are estimates of what the developing countries would need to accept the discipline of the Montreal Protocol. These range from $3 to $6 billion spread over the period 1990-2008 (when the 10-year grace period envisaged for developing countries from the general implementation date of 1998 would expire).[4] There are rough estimates for dealing with greenhouse gases (leading to climate change and global warming); the figure of $26 billion has been mentioned. The cost of a Convention on Bio-diversity is being worked out at a technical level which will be subject to political bargaining later.

It is interesting to examine the negotiations relating to the Montreal Protocol from the point of view of the international policy framework and the mechanisms of international co-operation currently available. The developing countries consider that the financial transfers necessary to enable them to accept the discipline of the Montreal Protocol should have the following four basic desiderata. First, the assistance should be *additional* to the current flows and sources of funds for economic development programmes, and should not reflect a shift in emphasis from the least developed countries to the semi-industrialised ones, who are the major users of chlorofluorocarbons, the main contributors to the damage to the ozone layer. Second, with an existing debt of over $1.3 trillion, the assistance should be on concessional terms, i.e. largely grants or highly *concessional* loans, and not be subject to conditionalities such as structural adjustment programmes. Third, *all* incremental costs incurred should be covered. Finally, it follows that there is a need to establish a *new Fund* with a single focus on ozone protection and not financing mechanisms subsumed under existing multilateral and bilateral financing arrangements.

The first two points above have received a large measure of agreement, although there is no consensus. Opinion on the subject of incremental costs is divided as to whether all such costs or only

certain *agreed* ones are to be met from international sources. But this is not likely to be a major divisive issue. What is more important is to reach a framework agreement (taking account of the total costs involved) on the types of financing mechanisms which could be put in place quickly. It has not been possible to estimate all the costs involved. The country-specific studies which are being undertaken in 16 developing countries, at the instigation of the UN Environmental Programme, could clarify the position but the first preliminary study in India has shown that small variations in assumptions could produce misleading estimates. It has therefore been suggested that it may be worthwhile to proceed with rollover planning and financing periods of 3 years starting from 1990. One estimate of the requirements for the first 3 years is $260 million.

The institutional structure of the financial transfers is a much more critical matter. The developing countries strongly support the idea of a Fund established with a financial and a technical secretariat under the overall supervision and control of the Contracting Parties to the Montreal Protocol as the most appropriate arrangement to reflect global responsibility. Others are of the opinion that financial mechanisms involving existing channels of multilateral and bilateral assistance could be adequate. UNEP has been exploring with the World Bank, UNDP and the UN Industrial Development Organisation ways of implementing activities generated by a Fund or funding mechanisms. Should the contributions to the Fund or funding mechanisms be voluntary or mandatory? UNEP considers that this question is not important, so long as they are assessed on the basis of the 1986 level of CFC consumption or the UN scale of assessment.

These issues may not seem of crucial importance but they are illustrative of the type of hurdles that must be overcome in political negotiations. The net position is that unless a mechanism for the transfers is identified, the carefully constructed regime of the Montreal Protocol is in danger of falling apart.

Conclusion

Compromise strategies should make it possible to conclude that economic growth need not be curtailed. But development must take a new course that will pay attention to the environment and allocate adequate resources for its proper maintenance. Success lies in carrying over to the future a portfolio of assets (no less than the

stock inherited from the past) which will include not only man-made and natural capital (e.g. quality and quantity of water, clean air, fertility of soils, forest cover, etc.) but also the critical biochemical cycles, the resilience of ecosystems and other natural balances without which the quality of life cannot be sustained. It is these latter elements of the portfolio of assets that need strong policy focus. To this end a number of policy options, as discussed, are open. One set relates to the totality of resources to be set aside for environmental maintenance, another set to the appropriate mix of regulations, incentives and safeguards necessary in each separate case of environmental concern. These options must be resolved in advance through international policy. It is too late to continue with crisis management.

Notes

1. See M. Kassas and Y.J. Ahmad, *Desertification: Financial Needs for the Biosphere*. London: Hodder and Stoughton, 1987.
2. United Nations Environment Programme, Protocol to the Vienna Convention for the Protection of the Ozone Layer, Montreal, 16 September 1987, which provides for phasing out ozone-depleting chemicals.
3. *Natural Endowments: Financing Resource Conservation for Development*. Washington, DC: World Resources Institute, September 1989.
4. Background material submitted to the Working Group organised for the meeting of the Contracting Parties to the Montreal Protocol, London, June 1990.

3: The Role of British Aid

Tim Lankester

This chapter aims to give a brief outline of the donor perspective on this book's theme and, in particular, the perspective of the British Government and the Overseas Development Administration (ODA).

Environmental problems are everywhere. The most remote rural area of a developing country may be plagued by soil erosion and deforestation, threatening three vital necessities of rural subsistence: food, fodder and fuel. The rapidly burgeoning cities and towns of the developing world are increasingly threatened by pollution — of air and water.

There are regional environmental problems. One country's actions affect another country's environment. Thus, in an area of the world where the ODA is heavily involved, deforestation in the Himalayas is blamed, at least in part, for serious flooding in Bangladesh. And, of course, there are global environmental problems. With the considerable help of the media we are all now familiar with the awesome threats to the planet of global warming, holes in the ozone layer and the loss of bio-diversity. It is not my intention to dwell on the nature of all of these environmental problems — but rather to note, as many others have done, their diversity, ubiquitousness and scale.

What I would like to emphasise at the outset is the importance the British Government attaches to finding solutions to environmental problems. Margaret Thatcher has spoken eloquently of our having a 'repairing lease' on the planet. Her speech to the

UN General Assembly in November 1989 left no doubt of the government's commitment that Britain will contribute in full measure to the international effort required.

So far as the ODA is concerned, we recognise all too well that we must promote sustainable development and not simply narrowly measured economic growth. The ODA has a particular concern to alleviate poverty, and the poor sadly often suffer the most from environmental degradation. That gives the ODA an important additional reason for tackling environmental problems.

Sustainable development — and here I am using the term in the sense of environmentally sustainable development — is, of course, not just a matter of sifting out environmentally damaging projects. Sustainable development is a concept that must permeate the whole range of government policies, institutional arrangements and the shape and content of public sector investment programmes. However worthy, it is an elusive concept to tie down. We can often recognise what it is not, without being quite able to define what it is. But maybe definition is not so important. After all we cannot define money at all precisely, but we recognise its importance in macroeconomic management. Our concern at the ODA is to make sustainable development operational in developing countries — at the local and national level — and, conversely, not to promote unsustainable development. The last thing we want is for sustainable development to be just a slogan. The aspiration of sustainable development needs to be given a sharp cutting edge.

We are confident at the ODA that we are moving in the right direction. Thus, for example, in our project work, we have worked hard to raise awareness of environmental issues amongst our own project managers and appraisal teams. The ODA has introduced a *Manual of Environmental Appraisal* with an associated training course. These set out the issues for project managers and help them to assess when they need to call in specialist technical help.

The British Government is also acutely concerned about global environmental problems. Clearly a co-operative international effort is required to tackle these. Probably the largest global problem looming is climate change arising from greenhouse gas emissions. Developing countries are likely to be the first to suffer the adverse effects of climate change and the associated rise in the sea level, so we have a shared interest in solving the problem.

We believe there is scope for some switching of international assistance to help deal with environmental problems, especially

where the particular investment is clearly in the recipient country's own interest. The most obvious example is investment in energy efficiency. But we also accept that there will have to be additional assistance — especially to deal with those environmental problems whose solutions will primarily or significantly be of global benefit.

Like other donors, the ODA is greatly expanding assistance to the forestry sector, which is, of course, highly relevant to concerns about climate change. We are also helping developing countries plan how to phase out chlorofluorocarbons, in particular by financing a major strategic study for the Government of India. We are also redoubling our efforts on energy efficiency. Rapid population growth is linked to many environmental problems, and here too the ODA is redoubling its efforts.

The second point I would like to emphasise is the importance the British Government attaches to getting the economics right. Of course, we have to have good science, and we need to support good science with good economics. Why is economics so important in all of this? Let me offer three reasons.

First, thinking about development has its roots in economics, and development writing and ideas have been dominated by economists. This is not to say that there cannot be development without economists (though there will certainly be economists without development), but I wager that as long as countries aspire to development, economists will be trying to help. In some quarters there is still antagonism between environmentalists and economists and, dare I say it, between environmentalists and developmentalists. As a development practitioner — I hope a sustainable development practitioner — I find that antagonism unacceptable. It is vital that economists and environmentalists do not go off down separate tracks, rarely communicating with each other — but instead forge through serious debate and rigorous thought a unified intellectual framework.

The second reason why economics is important is the vital role of government policies, and in particular economic policies, in determining behaviour which in aggregate determines/will determine the environment in which national and world populations live. Thus, for example, the level, and structure, of energy prices can have an enormous impact on the demand for power and hence on the environmental damage wrought by the various ways currently available of generating electricity. Similarly,

land tenure policies and incentives for forest clearance can produce deforestation on a massive scale.

The third reason is the need to find least-cost solutions to environmental problems. Local environmental problems in developing countries need least-cost solutions because these are poor communities with very scarce resources. Global environmental problems, such as global warming, need least-cost solutions because the problems are on such a massive scale: in the absence of least-cost solutions, countries will find themselves unable to bear the resource costs (and even with them it is going to be highly difficult).

I was struck recently by some calculations from the United States of the costs of market-based systems of tradeable permits to limit pollution as compared with traditional regulatory approaches: the costs of the regulatory approaches were up to six times those of the market-based systems. This is only one example, but it does indicate the possible cost savings from the right policies.

In my three reasons for the importance of economics I have not mentioned valuation. That is because I regard valuation as a means to an end. Quantification, and where possible valuation, of environmental impacts is important in the design of policies and of least-cost solutions, and also in project appraisal. But the real value of economics lies in the conceptual tool kit it provides. The analysis of the causes of man-made environmental degradation and the design of solutions are the heart of the matter.

This is not to suggest that economic analysis can be conducted in isolation. In the environment field as in other fields a multi-disciplinary approach is usually essential.

Research Priorities

Donors have always given high priority to research as a vital source of new ideas for improving the development prospects of the Third World. Certainly the ODA has. A wide range of research has been supported — not only in economics, but also multi-disciplinary research in natural resources, engineering, health and population, education, and the social and institutional aspects of development. Our increased awareness of environmental problems gives an important added impetus to the research effort.

Donors are already active in promoting research in the area of economics and the environment. The ODA is heavily involved in the following ways, among others:

- we have funded a major study in Nepal of the matrix of government policies that would best stem natural-resource degradation;
- we have supported a number of research projects in the forestry sector. Examples are a study to identify an effective management strategy for tropical rain forest in Sierra Leone and a study of small farmer tree growing in East Africa;
- we have commissioned from the Overseas Development Institute an 'environmental guide for economists' — which we hope will very soon be providing sound practical advice to our economists as they undertake project design and appraisal;
- and, in the area of global warming, we have funded a study of the relative cost-effectiveness of different ways of reducing carbon dioxide emissions in developing countries.

It is important that all those active in the area co-ordinate their efforts. Co-ordination is unglamorous and time-consuming, but we do have the mechanisms to organise it. The DAC Working Party on Environment and Development and the OECD Environment Directorate play important roles in this.

The priority now is to get the research agenda right — given the importance of the environmental problems, the limited research capacity, the need to avoid low priority work and, of course, the need to avoid duplication of effort.

The purpose of this book is to take stock of what research work has already been done, to identify the most important gaps in our knowledge and to indicate a research agenda for the next few years. Many donors often feel they are working in the dark when commissioning research. I would dare to suggest that finding money for good research is the least of our problems. Three specific research areas seem a priority to the ODA.

The first is the relationship between poverty and environmental degradation. In some circumstances in developing countries poverty is said to be a prime cause of environmental mismanagement. But in what circumstances will raising living standards be conducive to better environmental management? More work needs to be done in this area if we are fully to understand the operational meaning of sustainable development.

My second suggestion is the relationship between population and environmental degradation. Rapidly increasing populations seem to mean that we need to run ever faster in order to stand still — and may make a sustainable improvement in living standards highly elusive. But is rapid population growth entirely the villain of the piece? The ODA has commissioned an initial think-piece on this topic, but I suspect that we need some hard empirical work to help us formulate policy prescriptions.

My third suggestion is more wide-ranging — namely, research to develop the tools of economics to analyse environmental impacts. I was interested to hear recently of a World Bank research proposal to extend, and go beyond, cost-benefit analysis in order to address environmental issues better. We need more work of this sort.

Tom Stoppard, the playwright, tells a story about a Nobel prize-winning theoretical physicist who keeps a horseshoe on his wall. His colleagues are bewildered that a rational, thinking scientist should display an object of superstition. One finally puts the point to him, 'Surely you do not believe a horseshoe can bring you good luck?' 'No', he replies, 'but they tell me it works even if you don't believe it.' Sustainable development gives us the opposite problem. We do believe in it, but we are not quite sure yet if and how it works.

III. INFLUENCE OF MACROECONOMIC POLICIES

4: Macroeconomic Policies: Incidence on the Environment

Stein Hansen

Environment-Economy Interactions: Limits to Growth

We cannot destroy resources, we can only convert or dissipate them. As a consequence, the economy is not separate from the environment in which we live. Everything is an input into everything else. Therefore, the way in which we manage our economy has an impact on the environment, and environmental quality has an impact on the performance of the economy. This is a fundamental fact that we often overlook, not only when we act as individual consumers and producers, but also when macro-level decisions are made.

Microeconomics centres on the concept of the optimal scale of single activities and would limit the scale of an activity to the point where its marginal costs equal its marginal benefits. If every micro activity has an optimal scale then presumably an optimal scale for the aggregate of micro activities also makes sense.

Suppose we take it as an actual possibility that there are serious limits to world resources. Then a steady development of more for everybody, coupled with a more and more equal distribution of goods and services, cannot persist. Something will have to yield. It is implicit in many hopeful views on the future of mankind that the greedy craving for economic growth will give way to an altruistic willingness to share and share alike. This could certainly lead to a rather dramatic final outcome in which a maximum number of people, all equally near starvation level, would drop dead

simultaneously. It becomes somewhat difficult to see how the danger of such a catastrophe could be reduced by increasing the speed at which one approaches it.[1]

The microeconomic emphasis on optimal allocation is widely accepted and can be likened to optimally allocating a given amount of weight in a boat. But once the best relative location of weight has been determined, there remains the question of the absolute amount of weight the boat should carry, even when optimally loaded. Optimally loaded boats will sink under too much weight — even though they may sink optimally![2] Such thoughts simply reflect the idea that the macroeconomy is an open sub-system of the ecosystem and is totally dependent upon it.

The above remarks portray 'limits to growth' in a simplified way by introducing some sort of absolute 'maximum population-carrying capacity' of our total resource base. This assumption may be somewhat loosened, but not eliminated, by assuming that people have the ability to utilise resources more or less efficiently. Population-carrying capacity can be increased by investment and technology, and decreased by consumption and depletion of the resource base.[3] Another possibility — by analogy to what happens in a closed fishing lake when it becomes 'overpopulated' — is that the small, poor and many somehow 'eat' the big and more demanding out of existence so that many can survive on very little.

Such unpleasantnesses should be at the core of the political debate over so-called sustainable development, i.e. how to ensure that per capita well-being will increase over time while measures are taken so that significant reductions in absolute poverty result. Since we cannot have an impossible world, something else will happen. It is a reasonable axiom that actual history will be consistent.[4]

National Income Accounting and the Environment

The fundamental definition of income in accounting and economic textbooks is the maximum amount that the recipient could consume in a given period without reducing the amount of possible consumption in a future period.[5] This concept encompasses not only current earnings but also changes in asset positions. Depreciation accounts reflect the fact that, unless the capital stock is maintained and replaced, the possibilities of future consumption will inevitably decline.

In line with this, economic growth is defined as an increase over time in the level of real Gross National Product (GNP) per capita. GNP is measured from the established national income accounts which value man-made assets such as plant and equipment as productive capital, their depreciation being charged against the value of national production. This practice recognises that a consumption level maintained by drawing down the stock of capital exceeds the sustainable level of income.

But this treatment of capital depreciation in conventional national income accounting does not extend to natural resource depletion. A country could exhaust its mineral resources, cut down its forests, erode its soils, pollute its aquifers, and hunt its wildlife and fisheries to extinction, but measured income (i.e. GNP) and growth during the same period would not be affected as these assets disappeared. However, in subsequent periods economic growth, as conventionally measured, would decline and eventually come to a halt, as the basis for growth was eroded.

This asymmetric treatment of man-made and natural resources in the economic growth index (i.e. GNP derived from conventional national income accounts) ignores the loss of natural resources and the services they provide. Policy-makers — especially in developing countries dependent on natural resources — can therefore get very misleading signals regarding the performance of the economy they govern. Temporary improvements in consumption can be purchased by permanent losses in wealth and productive capacity, thus obstructing the scope for sustaining the consumption level into the future.[6] Failure to extend this broader concept of depreciation to the capital stock embodied in natural resources is a major omission and inconsistency.

Attempts to incorporate environmental issues within national accounting systems can be traced back to the early 1970s. One school of thought originated in the United States in 1972.[7] Another which originated in Norway in 1974 attempted to develop the accounts for natural and environmental resources in a separate physical accounting framework.[8]

The physical approach has the advantage that it is not based on assumptions about economic valuation that could be debatable. Furthermore, reasonably accurate relationships can be estimated between, for example, the output of pollutants and the activities of industries and households, by using a combination of econometric approaches. And in some cases a physical input-output matrix can

be constructed to calculate the overall consequences of changes in the composition and level of final demand on several aspects of the environment.

This has recently been done as part of Norway's follow-up to the World Commission on Environment and Development in the so-called SIMEN project. A physical accounts emission model has been attached to a multi-sectoral macroeconomic growth model in order to analyse possible development paths for the Norwegian economy and the extent to which these developments will influence the goals of energy and environmental policies; in particular, emissions into the atmosphere. The model has proved promising in studying the extent to which different taxation strategies could be used to achieve environmental goals, and at the same time trace the impacts on economic growth and some distributional indicators.[9]

The monetary approach, while instructive, faces conceptual and empirical problems before Gross Domestic Product (GDP) and Net Domestic Product (NDP) can be replaced with more sustainable GDP and NDP in accordance with the theoretical economic income concept. One approach that might be pursued to meet this requirement in the case of economic activities that mine exhaustible resources is to calculate a division of the receipts from the activity into an income component available for consumption and a capital component to be invested ultimately in renewables so as to sustain the income component indefinitely.[10]

As an interim step it is suggested that a set of satellite accounts, linked with the System of National Accounts (SNA), can be constructed to deal with environmental issues.[11] Such accounts could be in physical or monetary terms or both. In addition to issues such as those addressed by the Norwegian SIMEN project described above, such accounts could be used in estimating a natural resource balance sheet and working towards a measurement of sustainable income.[12] Clearly, the attainment of a widely acceptable and operational measure of sustainable income is some way off. Nevertheless, such efforts are likely to be less demanding than those required for a full physical accounting framework, and the rewards from knowing the maximum amounts that can be consumed by a nation without eventual impoverishment appear attractive.[13]

Such research is of particular importance for the better integration of macroeconomic and physical planning in developing countries. A recent study of the Indonesian economy has shown that the

conventionally measured 6.9% average annual economic growth rate in terms of GDP over the period 1972-84 significantly overstates sustainable growth, due to the depletion of the natural resources capital. A recalculated NDP taking into account the value of natural resource depletion resulted in an average economic growth rate over the same period of only 5.4% (and this probably also considerably overstates the real growth rate because there are other important natural resources that were not accounted for in the study).[14]

The priority attached to this research is manifested through the active work of the Joint UNEP/World Bank Workshops on Environmental and Resource Accounting,[15] and is also an area of focus in, for example, a regional study on economic policies for sustainable development undertaken by the Asian Development Bank in seven Asian countries (the Philippines, South Korea, Indonesia, Malaysia, Nepal, Sri Lanka and Pakistan).[16]

Incidence on the Environment of Economic Adjustments and Stabilisation Measures

Adjustment and programme lending operations by the multilateral development banks and the International Monetary Fund have been developed over the last decade in response to structural macroeconomic and sectoral problems and now constitute as much as 25% of new lending.[17] Before 1986-7, it was exceptional to find linkages between such operations and environmental issues. In 1988, the role of such macroeconomic and sectoral operations in environmental degradation became evident because of their overall volume and their focus on short-term equilibrium, their abrupt contractions of aggregate demand, and their apparent disregard for environmental consequences.[18] Recent World Bank adjustment operations — for instance in Kenya, Côte d'Ivoire, Malawi, Nepal, the Philippines, Tunisia, Pakistan, Morocco, Turkey, and Jamaica — and Asian Development Bank programme lending operations in, for example, the Philippines, Nepal, Fiji, Sri Lanka, Bangladesh, Laos, Indonesia, and Pakistan, include such explicit environmental considerations and measures.

The central questions pertaining to such macro policies and the economic models developed and used by the agencies and

governments in preparation for, and design of, these programmes are as follows:

- Have adjustment operations caused environmental degradation?
- Do their particular policy objectives make them a likely cause of such degradation?
- Do they take enough account of environmental implications?

Three studies have reviewed such operations by the World Bank and the Asian Development Bank and the following answers represent how far our present understanding has progressed:[19]

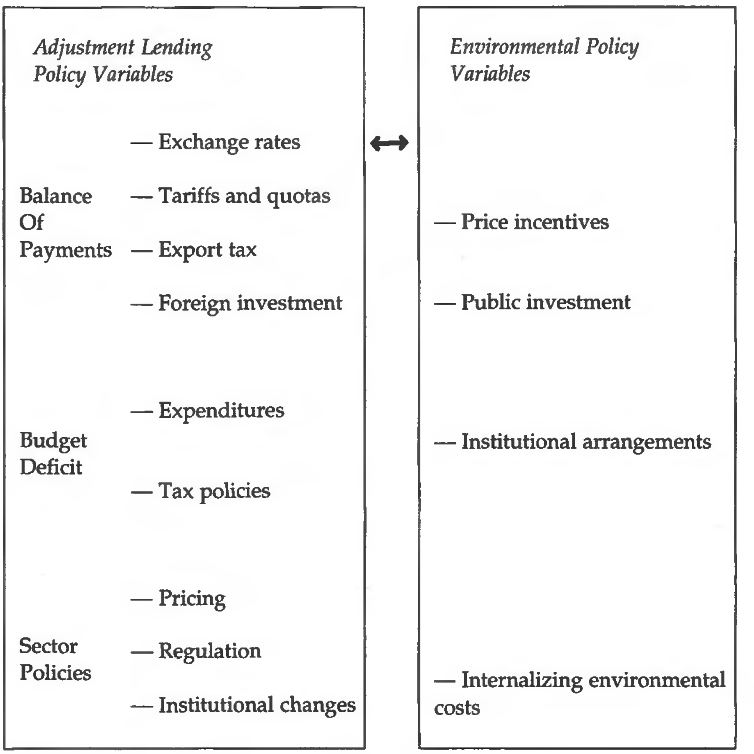
- Far from being a major source of environmental degradation in developing countries, adjustment and programme lending operations appear, on balance, to have a bias in favour of the environment;
- With adequate complementary measures to ensure that they are implemented correctly, the policies can be manipulated to achieve environmental as well as economic objectives.

Figure 4.1 illustrates links between macroeconomic policy and environmental policy variables that may seem obvious today but were not seen that way until very recently.

Findings from reviewing 83 of the World Bank's adjustment lending operations up to 1987/8 and 10 Asian Development Bank programme lending operations since 1987 can be summarised as follows:

(i) The environmental impact of reductions in government spending depends on where and how the cuts are made. While cutting down on allocations to environmental protection and natural resource management is harmful, across-the-board cuts are also likely to reduce road building and hydropower projects, for instance, both of which tend to postpone or stop the opening of access to tropical forests, and thus might have positive environmental impacts. However, where migratory pressures are present the net environmental effect depends on where the migrants end up and what they end up doing there. Where cuts in government spending are linked to cuts in input price subsidies the likely environmental effect is positive. On balance, there appears to be no reason to believe that reductions in government spending are necessarily damaging to the environment.

Figure 4.1: Links between economic policy and environmental policy variables



adapted from Sebastian & Alicbusan, 1989

(ii) Exchange-rate adjustments, i.e. devaluation, manifest themselves through changes in output prices and input prices. The export sector becomes more competitive, while imports become more costly. They are also likely to increase inflation. The effects are discussed below.

(iii) Measures to increase output prices to farmers, for instance, removal of taxes on agricultural products, can have mixed environmental effects. Where such price increases favour tree crops, the environmental effects are largely positive. Where they favour cash and food crops, the chosen cultivation practices and complementary actions determine the net environmental impact.

In general, improved output prices would tend to raise farmer incentives for soil and/or tree conservation, provided that the producers expect the higher prices to be sustained. There are, however, cases where the net effect of such measures stimulates the clearance of fragile marginal tree-covered land for cultivation and where soil fertility may be damaged and erosion increased. There are, on the other hand, also cases where such measures would allow farmers to engage in soil-upgrading measures that increase the carrying capacity of existing cultivable lands.

(iv) Measures to adjust agricultural input prices towards their economic costs tend, in most cases, to benefit the environment by, for example, reducing the uneconomic use of fertilisers, pesticides, insecticides and herbicides, by discouraging the mechanical clearance of marginal land and timber harvesting, and by reducing wasteful use of irrigation water. In many cases, however, this presupposes complementary programme elements in place that protect and cater for the marginalised poor and landless, for example where fertiliser use is far below optimal levels.

(v) Measures to increase energy prices tend to be environmentally beneficial, by promoting conservation of resources and reducing pollutant emissions. They presuppose, however, that the substitute for costlier commercial fuels is not fuelwood harvested for free in open access areas at non-sustainable rates. Changes in relative energy prices have to be accompanied by complementary institutional and regulatory measures to mitigate the potential environmental damage of fossil-fuel burning and the development of hydropower plants.

Aside from recommending much more explicit emphasis on such environmental impacts of macro policy measures in specific country and sector programmes, further research is needed on two fronts. One is to understand the interactions between the formal and informal sectors of the economy, in particular the extent to which poverty as such or economic policies are the culprits causing environmental degradation.[20] We need to know more about the specific incentives that can alter complex behaviour patterns at the household and business level. A second area of needed research is the formulation of policies with predictable environmental consequences. This calls for clarification of the effective channels for transmitting information to those targeted by macro policies and directly affected by the proposed changes in incentives, and a better understanding of how the macroeconomic policies affect different

income and social groups. The task ahead is therefore to devise an analytical framework to integrate the political dimension, technical change, and macroeconomic policies — and their effects on productive activity in the principal sectors of the economy.

Debt Servicing and Resource Extraction

Debt servicing has become critically difficult for many developing countries endowed with tropical rain forest, that are observed to extract from their natural resource base at unsustainable rates. These developments have led observers to link natural resource degradation to the debt crisis in such countries.[21]

Even very simple macroeconomic analysis shows that such conclusions are premature. A country may have borrowed from abroad to expand its production capacity and associated infrastructure faster than would be possible on the basis of domestic savings alone. Such capital imports provide for increased extraction of the natural resources base — for instance, via road developments in the Amazon rain forests — but they could also provide for the import of technologies to secure better management of the same resource base.

For simplicity, let us assume that all imports are production capital and that the country imports all its production capital. Now assume an exogenous event, for example, an increase in international interest rates. In macro terms this means reduced capital accumulation and thus reduced capacity for production by extracting from the renewable resource base. Unless there is a change to a more hazardous forest extraction technology or a reallocation from other domestic sectors to forestry and its related infrastructure as a result of the increased debt-servicing requirements, the outcome would be less pressure on the rain forest. It can thus be seen that there is no simple causal link between the debt crisis and environmental degradation.[22]

These issues can be explored further in a simplified and stylised multi-period theoretical setting to illuminate some important relationships between resource use and credit terms for developing countries with debt problems.[23] For example, if asymmetric information made creditors fear that the debtor countries might default, lending to these countries would become more limited and expensive, and (in a limited-period optimising framework) the short-run pressure on the resource base would be greater.

Exogenous debt relief might, but not necessarily, lead to postponement of resource use, but (in the model framework) not to permanent resource saving. Debt relief, or interest-rate subsidies, tied to resource saving or postponed extraction might have favourable environmental effects when governments that do not intend to service their debt are forced to pursue the same resource extraction policies as honest governments, in order to obtain new loans. In general, however, it may seem that direct transfers, which are tied to the resource extraction policy pursued, are better suited than debt relief for such a purpose; at least such transfers are the only way of implementing resource savings with 'dishonest' governments. In short, it is quite conceivable that adjustment operations could have a greater potential for the achievement of resource conservation goals than debt-for-nature swaps.

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5: Notes on Macroeconomic Adjustment and the Environment

Tony Killick

From an economic perspective, environmental issues can largely be seen in terms of:

- market failures, chiefly in the form of external diseconomies;
- state failures, when government interventions (or failures to intervene) make things worse;
- myopic inter-temporal choices.

The first of these belongs primarily to the domain of microeconomics and, as such, falls outside the remit of this chapter (although the distinction between macroeconomics and microeconomics has become eroded in recent years, with increasing attention paid to supply-side components of economy-wide management). The 'state-failures' aspect is probably one that would have received much less attention ten or twenty years ago but the literature is now replete with warnings — and examples — of the often high costs of such failures in all aspects of economic life, and the appalling ecological degradation in Eastern Europe which is increasingly coming to our attention is a stark illustration of the abysmal failure of central planning in the environmental area.

The myopia problem is that of how to secure individual and collective decisions that give due weight to the future, especially to the interests of future generations, which is what the notion of sustainable development is about. In more technical language, the problem is that of lowering the social rate of discount, so that a

larger weight is given to costs arising in the future. This feeds back into the task of addressing state failures, or of improving the quality of policy decision-making as it affects the environment, including the task of giving *that* a longer time perspective. The task of injecting a longer-term perspective into decision-making is what the literature on planning is about, but that is as unfashionable as warnings of state failures are modish.

In what follows I want to give greater weight than does Stein Hansen's contribution to this volume to the proposition that macroeconomic stability *per se* is favourable to solution of the problems just outlined — but then to introduce some *caveats*. The argument is necessarily rather conjectural, however, because there has so far been little research in this area. The following propositions might be thought of as in the nature of research hypotheses. I mainly have conditions in developing countries in mind but, in principle, they are propositions of more general validity. By stabilisation is meant the steady maintenance of approximate domestic and external balance, resulting in the avoidance of: rapid inflation, major balance-of-payments and debt difficulties, deflationary unemployment and fluctuations in output.

(i) Stabilisation will, more or less by definition, reduce uncertainty, helping to foster confidence in the future. The odds are weighted against future generations when economic instability creates uncertainties so large as to undermine belief that postponement of consumption will actually benefit the future. For example, saving — hence investment in the future — will tend to be discouraged by high inflation. The social rate of discount will be high; the bias will be in favour of consumption now and future costs will be heavily discounted.

(ii) Macro stability is good for the efficient working of markets. In turn, this increases the possibilities of avoiding environmental diseconomies by manipulating prices through the use of taxes (for example, on the 'polluter pays' principle) and by other means, because economic agents are better able to make rational decisions, and demand and supply elasticities will be larger (for instance, because price signals will be clearer and more dependable).

(iii) Successful macro management will reduce the risk of situations in which people experience periods of declining living standards, which cause them to place a very heavy premium on the present as against the future. This could be

related to the present-day situation of a country like Brazil, which is being asked to defer short-term gains in favour of preserving the Amazon forest while at the same time its people continue to suffer major hardships because of the huge claims made upon national savings and export earnings by the cost of servicing their external debts.

(iv) Economic stability creates a policy-making environment more favourable to pro-future decisions. The crisis-driven, day-to-day nature of policy-making in imbalanced economies is strongly antithetical to policy choices in favour of long-run environmental protection and planning. This will be particularly so if economic imbalances induce political instability, further shortening politicians' time horizons.

To the extent that they are valid, these propositions rather strongly support the widespread adoption by developing countries of stabilisation and structural adjustment programmes supported by the IMF and World Bank in the 1980s. Given the special importance for environmental protection of addressing the problem of state failures and of improving governments' abilities to intervene effectively in this area, the focus of these programmes on rationalising policy-making processes is potentially very valuable. These considerations are complementary to Hansen's, which also conclude in favour of the effects of adjustment programmes.

Now some qualifications (which could also be interpreted as research hypotheses):

(a) *Pace* Hansen, the relative shift in production in favour of tradeable goods (chiefly made up of the outputs of the agricultural, mining and manufacturing sectors) and away from non-tradeables (principally various service activities) is liable to be environmentally damaging to some extent, via intensification of cultivation, accelerated depletion of non-renewable assets and greater industrial pollution. As a broad generalisation, non-tradeable services are environmentally friendly since they require only limited material inputs. Note, in relation to this, the strong connection between successful adjustment in developing countries and their success in exporting manufactured goods, as in the East and South-East Asian examples.

(b) The short- to medium-term nature of Fund and Bank programmes (and the shortages of supporting finance which underlie it) can be detrimental by creating pressures for quick results, especially in export industries. Environmental concerns

are liable to be thrust aside in the concern to meet Fund/Bank conditions and targets, of which the accelerated depletion of Ghana's tropical forests provides just one example. Relatedly, the social costs of adjustment — the extent to which it puts poor people at risk — will be more severe when adjustment has to be achieved quickly and this will tend to impart an anti-future bias for reasons analogous to those in (iii) above. This is one aspect of the much wider issue of the relationships between poverty and environmental degradation in developing countries.

(c) In the 1980s much of the policy advice and conditionality of the IMF, the World Bank and bilateral aid donors pushed in the direction of the disengagement of the state from the economy, playing down the role of planning. Pressures for privatisation and deregulation are cases in point. Given the often deplorable past record of such interventions, this orientation was fully understandable. But the fact is that the externalities problem requires substantial state interventions on behalf of the environment. And the long-term nature of environmental tasks requires the adoption of planning in some form, although not necessarily 1970s-style development planning. Although structural adjustment programmes do tackle government failures, they do not necessarily have a focus which is ideal for addressing neglect of environmental protection.

(d) There is a related political-economy point. A shift in the way that economies are run, away from state interventions and towards greater reliance on private enterprise, is not neutral with respect to how *political* systems will work. Different economic systems create different pressure groups, and varying distributions of power. A shift in favour of markets and private enterprise will tend both to create a greater decentralisation of power and (to use a crude shorthand) to distribute it in the direction of capitalists. This, in turn, will make it politically more difficult for governments to act against private sector polluters — a consideration which helps to explain the reluctance of the present British and US administrations to take firm action against industrial polluters.

These latter considerations point up the importance not merely of building specific safeguards against the possible adverse environmental effects of adjustment programmes (as the World Bank has begun to do) but more generally of seeing adjustment in a long-term context, as part of a continuous process of adaptation

to changing circumstances and emerging problems. A longer-term approach implies enhanced levels of financial support. My arguments also imply the desirability of a pragmatic approach to the role of the state and to the possible contribution of planning.

IV. NATURAL RESOURCE DEGRADATION

6: Natural Resource Degradation: Policy, Economics and Management

Edward B. Barbier

This chapter briefly discusses recent progress in economic research on natural resource degradation in Third World countries, the current gaps in our understanding of this problem and the research needs for the future. Although the emphasis is on economic research, policy-relevant research from other disciplines is reviewed where appropriate. The discussion concentrates on *national* and *sectoral* policy issues as they relate to the management of key natural resources and resource systems — for example, tropical forests, water resources, wetlands, drylands and arable soils.

Current Progress

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

Important research initiatives that have contributed to the economic analysis of such degradation include efforts to analyse its aggregate economic cost, especially advances in 'resource accounting' methods; the impact on the environment of economic

policies, particularly pricing policies for natural resource products or resource-based activities; the effects of 'user incentives', for example, common property rights, land tenure and distribution, intra-household division of labour, perceptions of risk, degree of participation in decision-making, etc., on the way individuals manage the resources available to them; and improvements in the methodology of economic valuation of environmental impacts, in terms of appraising both the benefits of environmental preservation and the costs of degradation.

Tropical Forests

Tropical deforestation has become a key global concern. Natural closed broadleaved forests in tropical countries are estimated to cover 1.26 billion hectares (ha). Approximately 7.1 million ha of this forest area were being cleared annually in the early 1980s, with 4 million ha deforested in Latin America alone.[1] Perhaps most worrying is the fact that deforestation is occurring with little regard to long-term management of the forests. For example, on a world scale, the operational management of tropical forests for sustainable production of timber is negligible.[2]

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

into future payments that the rest of the world might make to Indonesia to conserve forest lands.

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

(i) the 'prices' determined for tropical timber products or the products derived from converted forest land *do not incorporate* the lost economic values in terms of forgone timber rentals, forgone minor forest products and other direct uses (for example tourism), disrupted forest protection and other ecological functions, and the loss of biological diversity, including any option or existence values.

(ii) even the direct costs of harvesting and converting tropical forests *are often subsidised and/or distorted*, thus encouraging needless destruction.

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

There is also evidence of *non-economic* policy distortions contributing to extensive deforestation.[7] Formal property law and titling regulations often ensure that clearing of land is a prerequisite for guaranteeing claims to frontier forest landholdings. Given the insecurity of many frontier tenure regimes, private individuals and firms often excessively clear forest lands in order to safeguard their tenuous claims to holdings and to 'capture' agricultural rents. As the capacity of many governments to 'manage' vast tracts of publicly owned tropical forests is often minimal, encroachment into forest reserves and protected lands 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.

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

(i) further analysis of the *total economic value* of tropical forests, including existence and option values;[8]

(ii) extending the analysis of public policy distortions, both economic and non-economic, to more geographical areas (for example, Africa), as well as continually updating and broadening existing analyses;

(iii) instigating multi-disciplinary research into complex socio-economic issues surrounding deforestation, such as the linkages between land clearing, tenure security, rural population pressure, and the factors determining agricultural rents on converted forest lands; and

(iv) exploring economic aspects of international agreements and timber trade policies to protect tropical forests, including debt-for-nature swaps and compensatory flows to countries forgoing exploitation of their tropical forests.

Wetlands

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

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

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

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

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

(ii) extending the analysis to cover public policy distortions, both economic and non-economic, as they impact on wetland conversion in Third World countries; and

(iii) instigating multi-disciplinary research into the socio-economic relationships of local communities dependent on tropical wetlands for their livelihoods and the benefits derived from wetland use.

Drylands

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

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

Even further behind — and more controversial — is the analysis of the effects of economic and resource management policies on dryland degradation in Third World countries. This is often attributed to the superficial identification of the causes of desertification and to the frequently poor identification of the causes of the failures of dryland projects.[16] Although the majority of 'causes' are attributable to population growth and natural events, dryland degradation is also symptomatic of an agricultural development bias that distorts agricultural pricing, investment flows, R & D, and infrastructure towards more 'favoured' agricultural land and systems.[17] Where drylands 'development' is encouraged, it is usually through the introduction of large-scale commercial agricultural schemes that can conflict with more traditional farming and pastoral systems.

The complexity of social, economic and environmental relationships is formidable. Often not enough is 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 and commercial agriculture and markets will 'automatically' solve dryland management problems in the long run. At the same time, not all dryland farmers and pastoralists, even in the most distant and resource-poor regions, are totally isolated from agricultural markets. Virtually all subsistence households require some regular market income for cash purchases of some agricultural inputs and basic necessities; many farmers and pastoralists provide important cash and export crops. As a result, alterations in market conditions — whether from changes in policies, climatic conditions, R & D innovations, or other factors — do have a significant impact on the livelihoods of rural groups in dryland areas. Understanding the responses to these changing conditions is a crucial aspect of the dryland management problem. For example, a study of gum arabic production in Sudan indicates that fluctuations in the real price of gum and its price relative to those of other agricultural crops have had important impacts on farmers' cropping patterns, diversification strategies and decisions to re-plant gum — with important consequences for Sudan's gum belt.[18]

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

(i) initiating more case studies of the *economic costs* of dryland degradation in developing regions, and *policy-related causes* of the problem;

(ii) extending the analysis to cover public policy distortions, both economic and non-economic, as they impact on dryland management in Third World countries, for example, the impact of prices on rainfed cropping, land management and agricultural extensification, the prices of livestock products on rangeland stocking rates, fuelwood prices on wood harvesting and own-production, input subsidies on soil conservation, land acquisition, tenure arrangements and regulations on land management, and so forth.

(iii) instigating multi-disciplinary research into the socio-economic relationships of local communities and their livelihood systems, for example, farming and herding relationships, agro-

forestry developments, tenure arrangements, insurance mechanisms and so forth.[19]

Irrigation

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

Virtually all irrigation developments in the Third World are through public investments, which are heavily subsidised. Distributional considerations, political concerns and common perceptions of water as a 'free good' have generally led to charges well below the costs of supply. Revenues collected from farmers in most Third World countries often cover only 10-20% of the building and operating costs of irrigation systems, usually failing to cover operation and maintenance (O & M) costs alone.[21] The result can be inefficient and poorly maintained irrigation networks, rent-seeking behaviour by farmers, misallocation and wasteful use of water, and unnecessary investments in major surface water developments, such as dams and large-scale irrigation networks. The environmental impacts can be significant:

(i) the disincentive to conserve water can lead to problems of water logging, salinisation and water scarcity; and

(ii) irrigation investments and infrastructure, including dams, can lead to extensive external costs in the form of displacement of local communities, loss of agricultural and forest lands, and alterations in river hydrology, in fishing and wildlife industries and in erosion and sedimentation rates.

For example, in India 10 million ha of irrigated land have been lost through waterlogging and 25 million ha are threatened by salinisation, and in Pakistan 12 million ha are waterlogged and 5 million ha are saline.[22] Agricultural irrigation in Java accounts for about 47% of the total potential water resources available and 75% of the dry season/year flow. Given the expected future demands in all uses of water, the poor cost recovery and inefficiencies in

irrigation (average efficiencies are 10-35% and hardly exceed 30% in most areas for both wet and dry seasons), water scarcity is becoming a chronic problem.[23] In Tunisia, an *ex post* analysis of the large-scale Ghezala irrigation project to take account of disruptive hydrological and other environmental impacts on the neighbouring Ichkeul National Park and surrounding areas reveals that these costs contribute to making the project economically unviable.[24]

The following research priorities in economics are suggested:

(i) conducting more case-study analyses of how current charges and cost-recovery efforts in irrigation impact on water use and the environment, how these impacts can best be mitigated, and the feasibility of changing water pricing structures and supply options;

(ii) improving and extending cost-benefit analysis and appraisal methodology for assessing the environmental and social impacts of hydrodams and large-scale irrigation networks;[25]

(iii) conducting multi-disciplinary research efforts into the impact of irrigation on land tenure arrangements, water use access and rights, cropping patterns and yields, income and wealth distribution and other socio-economic concerns; and

(iv) conducting more comparative analyses of the economic returns of different irrigation scheme design options — public versus private schemes, the viability of self-help and medium-size alternatives, and so forth.

Land Degradation and Soil Erosion

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

Reliable estimates of soil erosion are difficult. Little long-term monitoring from farmers' plots has occurred in Third World countries; aggregation and extrapolation from the few studies that do exist are fraught with complications. Regional — let alone national and international — comparisons should be treated with caution. Estimates based on the universal soil loss equation (USLE)

and modified USLEs adapted for tropical conditions still face many difficulties, as do methods involving Geographical Information Systems (GIS). To go further and analyse the impacts of erosion on crop yields or the impacts of run-off and sedimentation on 'off-site' economic activities is even more difficult in Third World countries. Particularly frustrating is the fact that the declining trends in crop yields attributable to erosion are hard to substantiate, given that erosion impacts are often inseparable from the effects of climatic variations, relative price changes, changing cropping patterns, input mixes and labour-use strategies, etc.

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

Designing appropriate policy responses to control soil erosion and land degradation is again hampered by 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 fertilisers, 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 fertilisers — for instance, shortages caused by rationing cheap fertiliser imports — can 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 analysed, 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.[27]

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.

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

(i) working with soil scientists and others to initiate more case studies of the *economic costs* of soil erosion and land degradation in developing regions, and *policy-related causes* of the problem;

(ii) initiating more microeconomic research into the responses of farmers to erosion and their incentives to adopt soil conservation, which should complement multi-disciplinary research into the

socio-economic relationships of local communities and their livelihood systems;

(iii) extending the analysis to cover public policy distortions, both economic and non-economic, as they impact on land management in Third World countries, for example the impact of changes in relative agricultural prices and real producer prices, subsidies of inputs and their distribution and marketing, labour use and constraints (including intra-household), tenure arrangements, land titling, use and access, and so forth.

Conclusion

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

With respect to all the resource degradation problems discussed, there is a need for substantive and extensive analysis of the implications of various macroeconomic, trade and sectoral policies for the resource base. Alternative policy options that explicitly take into account the resource constraints of the most vulnerable economic groups also need to be properly formulated and analysed. 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 programmes at this level. Although some of this information is sometimes available from research stations and independent project and provincial studies, it needs to be

co-ordinated and reviewed consistently at the national level to assist policy and investment decisions.

Notes

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19. Given the 'disenfranchisement' of many dryland sub-populations (such as traditional pastoralist societies) in basic economic and social policy decisions affecting dryland management and resource allocation, some approaches may need to go beyond 'pure research' and propose mechanisms and institutional reforms for enhancing the participation of these communities in dryland management decisions. See, for example, C. Lane, *Land for Pastoralists: Sustainable Development on the Drylands*. London: IIED, 1990.
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21. Ibid.; D. Julius and A. Alicbusan, *Public Sector Pricing Policies: A Review of Bank Policy and Practice*. Washington, DC: World Bank, 1988 (mimeo); and L. Small, M. Adriano and E. Martin, *Regional Study on Irrigation Service Fees: Final Report*. Manila: Asian Development Bank, 1986. Charging for irrigated water is feasible only where volumetric metering is possible (for example, tubewell and pumped schemes); however, where this is not possible (for example, gravity-fed systems and canal irrigation), indirect charges can be levied through land and crop taxes.
22. Repetto, *Skimming the Water*, op. cit.
23. World Bank, *Indonesia — Java: Water Resources Management Report*. Washington, DC: World Bank, 1988.
24. D. Thomas, *Irrigation and Drainage Development Adjacent to the Ichkeul National Park, Tunisia*. Department of Geography, University College London, 1989.
25. A major research effort financed by the UK Overseas Development Administration, with case studies in six Third World countries, has been launched as a result of the International Workshops on Hydro-Power Dams in the Tropics and Sub-Tropics.
26. 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; and W. Magrath and P. Arens, *The Costs of Soil Erosion on Java — A Natural Resource Accounting Approach*. Washington, DC: World Resources Institute, 1987.
27. E. Barbier, *The Economics of Farm-Level Adoption of Soil Conservation Measures in the Uplands of Java*. Environment Department Working Paper No.11, World Bank, Washington, DC, 1988; E. Barbier, *Economics*,

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7: Tropical Forests
Ghillean T. Prance

In Chapter 6, Dr Barbier presents some of the basic, and alarming, facts about rain-forest economy. It points out the single most important fact: the majority of deforestation is for short-term, non-sustainable projects. For example, much of the deforestation in Amazonian Brazil has been for cattle pasture. Pastures which I have studied sustain less than one cow per hectare for 5 to 8 years and must then be abandoned. Conversion of rain forest to cattle pasture has only been viable because of huge tax incentives and land speculation, rather than because of the value of the meat sold. Many ranches never even brought cattle to market.

Tropical deforestation is often linked to economic policies, rather than to the reality of the potential economic yield of the land. The net present value (NPV) of a good Amazonian cattle pasture has been calculated as $2,960.[1] This is in contrast to an NPV of $6,820 for an extractivist forest at Mishana in Peru,[2] where products are harvested from the original forest. In that area, it was based on the extraction of rubber latex, fruits, medicines and occasional harvest of timber for sale in the markets of Iquitos, Peru. Since 1988, Brazil has no longer given fiscal incentives for the establishment of cattle pasture. However, the principle is still the same and it is most important that we work towards economic policies that are linked to sustainable development.

The work of Peters cited above and several other similar studies show the value of minor forest products. Peters quotes the prices obtained for tropical timber products which do not incorporate the

lost economic value in terms of the disruption of the marketing of minor forest products, tourism, ecological functions, etc. He could well have cited the facts about pharmaceuticals derived from the rain forest. More than 7,000 medicines used in Western practice (25% of the drugs sold by prescription in chemists' shops) contain rain-forest ingredients.[3] How have the rain forests benefited economically from this multi-million dollar annual commerce in pharmaceuticals? As yet, only about 1% of rain-forest plants have been analysed chemically for their usefulness. It is this unknown economy in new drugs, new foods, new fibres, new insecticides, new cosmetics, etc. that is being destroyed for short-term, artificially stimulated economic gain.

A study by Anthony Anderson at Ilha das Oncas in the Amazon Delta region showed that a single family marketed $24,618 worth of products in one year in the markets of Belém, Brazil.[4] This was based on a palm-rich forest where palm fruit, heart of palm, rubber latex, timber, cocoa seeds, shrimp and pigs all featured. This peasant agriculturalist, using an agroforestry system in improved forest with a good ground cover and canopy, made three times the then current (1986) salary of a PhD scientist in the Goeldi Natural History Museum in Belém! The yield of $24,618 is from a system that is sustainable.

Ecotourism is also growing and can be a considerable economic benefit from the rain forest, in Peru, for example. However, absurdities can happen. I had a friend who set up a forest for tourism near Manaus, Brazil. I took a group of my students to identify the trees along his beautiful forest trail beside a crystal clear stream. Legislation required that the 500 metres along the front of any property should be felled to retain title of the property so, even though this area included the stream and the tourist trail, he was forced to cut or lose title. The forest was cut, the trail lost and the stream became a mud-bath because of all the erosion from the forest. This kind of artificial legislation in rain-forest areas is clearly counterproductive.

Research Suggestions

We need much further analysis of the total economic value of tropical forests and this must include many more studies of minor, non-timber, forest products. The other very important area for future research is on existing sustainable management systems such

as that studied by Anderson, including indigenous management systems and new methods of sustainable management. When some indigenous systems have moved into a market economy, they have done better than the replacement systems. Of particular importance is the rehabilitation and sustainable use of the 50% of former rain-forest land that is already destroyed and badly degraded. It is from this area that we should produce timber, fuelwood, charcoal and agricultural crops.

A research priority with which the Royal Botanic Gardens, Kew is already involved is the development and marketing of non-timber products from the rain forest. There are several companies, such as the Body Shop, the food business in the UK and Ben and Jerry's ice cream company in the United States, that are anxious to produce 'green' rain-forest products which they can market from raw material that can be harvested in a sustainable extractivist way. This type of work is in the embryonic stage and needs much more research.

As for ecosystems other than tropical forests, such as wetlands and drylands, a research priority is to balance the use of these different ecosystems against each other and to understand the ecotones between the major regions. This is often where the worst environmental degradation has taken place: for example, the southern fringe of Amazonia in the transition area from rain forest to the savannah or cerrado region of central Brazil. It is pointless advocating the move of all agriculture outside the Amazon region if that merely encourages the total destruction of the biologically extremely important savannas to the south. Research must not only be multi-disciplinary, it must also be across the different ecosystems.

Notes

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3. N.R. Farnsworth and D. Soejarto, 'Potential consequences of plant extinction in the United States on the current and future availability of prescription drugs', *Economic Botany* 39, 1985, pp.237-40.
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8: Tropical Dry Forests
Gill Shepherd

In Chapter 6, Dr Barbier discusses rain forests and drylands (among other subjects), but leaves unidentified as a specific problem the semi-arid and savannah forests which are disappearing even more quickly than the rain forests.

The tropical dry forests are under just as much threat as the rain forests, and are in fact far more extensive. They are mainly to be found today in Africa, but there are also extensive tracts in South Asia, Latin America and of course Australia.

Their Importance

They are important for a mixture of reasons:

(i) In the context of the greenhouse effect, they lock up huge quantities of carbon and give the world a breathing space to develop other technologies.

(ii) While they contribute less moisture to the atmosphere than the rain forests on a per hectare basis, their size, and their presence in lower rainfall areas, makes their moisture contribution of very great importance. When they are removed, the increased albedo effect is apparently marked.

(iii) Semi-arid woodlands support larger numbers of people and domesticated animals per hectare than the rain forests, though the sustainable density is still relatively low. Humans have learned to live from these woodlands by tempering the higher risk option of

semi-arid agriculture with a reliance upon the milk and meat which animals produce from tree-browse.

(iv) Semi-arid woodlands also indirectly support others who live in towns or in higher-rainfall agricultural areas, and who depend on them for fuelwood, poles, and animal products obtained through trade. Recent work by the FAO has also highlighted the major contribution of 'minor forest products' in woodlands to the diets of a wide spectrum of individuals, who obtain them by gathering or by trade. Protein, minerals and vitamins — vital to complement the carbohydrate-rich farm diet — are drawn from the woodlands.

In most areas, of course, dry forests make no contribution to timber exports. Overseas exports from the woodlands are more likely to be gums or other minor forest products, and animal products. For this reason, such woodlands are often overlooked and their contribution within the country where they are sited — and their role in import substitution — may be undervalued.

Yet because such forests occur in more densely populated regions than rain forests, their disappearance may affect people living nearby more severely. It has stronger implications for desertification, and for the supply of urban fuelwood to distant markets.

Sustainability in the Tropical Dry Forests

Those who live in and near the semi-arid woodlands are often eager to manage them sustainably, and may well have been involved in such an activity in the past, particularly if they were mobile herders with an extensive home range patrolled each year.

While the ability of such groups to manage the woodland naturally depends on the nature of the opposition (equitable sharing and restraint are easier among comparable rural groups than between a local management unit and armed urban charcoal burners, for instance), the prospects in general for successful participatory management of semi-arid woodlands are superior to those for rain forests. This is not only because their timber export value is lower and the competition for it consequently less intense, but also because more elaborate management rules for the resource have usually already been devised by local people in the past, because their populations are larger, and resource allocation has needed to be more complex.

Barbier flags the need for research on the causes of deforestation and the relationship between deforestation and land clearance by rural people. We actually already have a good deal of data on this — but it needs to be taken up more in the thinking of the planners.

Deforestation and Rural Woodfuel Needs

In so far as deforestation is the result of woodfuel needs, it springs from *urban*, not *rural* needs.

Rural people are in general sufficiently scattered through the landscape for their fuel needs to be met in perpetuity from the mean annual increment of even unproductive bushland. Only when they and others begin to collect for the far greater and more concentrated needs of urban markets do open areas of bushland begin to be cut to extinction. Similarly, by the time rural people find they have run out of woodfuel, they are probably already planting trees because a shortage of decent poles has forced them to do so years earlier.

The problem has been, and remains, that it is not economic to grow fuel for the urban market in the place where the trees were being cut for that market. Once the trees have gone from remote open areas, we begin to find that they are replaced by trees planted scores or even hundreds of miles away in farms much nearer to towns, so that the reduced transport costs of delivering this wood to urban markets offset the fact that tree-growing is more costly than felling pre-existing bushland trees.

By the same token, really huge urban conglomerations in semi-arid countries (such as Khartoum, Mogadishu, or Nairobi) pose serious supply problems and sooner or later governments have to make a choice between protecting the environment in remote open bushland from further degradation and making alternative provision.

Peri-urban plantations have been shown to be uneconomic many times over, and ultimately big cities have to switch out of biomass use for energy, and use some other fuel such as kerosene. However, most developing country governments are unlikely in the short run to value the environment above the costs of such a substitution, and therefore deforestation and degradation will continue until complete resource depletion or international pressure forces the switch.

Deforestation caused by Land Clearance for Agriculture

While forested land is certainly cleared for agriculture, it is the relationship of the clearers to the land which dictates what happens next. Wherever increased population densities are bringing shifting cultivation to an end and ushering in an era of permanently owned plots, land clearance is actually a highly selective process. Farmers leave in their fields the trees whose timber they value, and as they slowly cut into this capital resource, they replace them with planted trees.

In fallowed areas, trees of value will not be felled if the shifting cultivators are able to move regularly, because it is usually not worth doing so. The situations of devastation are found: where mechanised shifting cultivation takes place (for example, the Central Rangelands of the Sudan); where people have been artificially squeezed into a higher-than-sustainable population density because of political constraints (such as the situation in some of the South African Homelands or in areas of Tanzania under Ujamaa in the past); or where displaced people find themselves leading a hand-to-mouth existence as refugees or evacuees on land they do not own and do not expect to live on for ever.

Land Rights

Such situations are a reminder that a broad understanding of political and economic issues must inform discussions of the need to tackle over-population as part of environmental protection. If higher population densities force a crystallisation of land rights, some population increase may actually increase environmental protection since the stronger and more clear-cut are the group or individual rights over particular tracts of land, the more sustainably will they be managed.

Indeed, where government has actually acquired more land than it can manage itself, which is the case in many developing countries today, devolution to more effective owners should be considered. The precondition is, of course, that local would-be owners, who have to live off the land unlike government officials (or other absentee landlords, for that matter), can be found. Contrary to the received wisdom, such local people often have a far more long-term view of the need for environmental protection than does the state,

with its frequent changes of local officials if not of national-level leaders and policies.

Conclusion and Proposals for Research

The complexity of the problems in the dry forest areas makes it even more imperative to ask, à propos environmental economics, 'Whose economics are we talking about?' There is still so much that planners do not know about the farming systems and decision-making processes of rural people in marginal environments. Yet the attempt is being made to aggregate this ignorance at national if not international level.

Proposal 1: Finding out how to use existing knowledge more effectively

Dr Barbier suggests that what is needed, before good policy-making can take place, is more baseline knowledge in the form of careful microeconomic research. I would add that there is already quite profuse socio-economic data in many of these fields and that the real task is to make planners and natural scientists more aware of them, rather than to collect more data.

Better disciplinary transfer and more effective dissemination of knowledge to developing country planners and decision-makers are vital. Research is needed on the best channels and fora for this, followed by money to make the transfers possible.

Proposal 2: Researching the feasibility of adapting participatory management approaches learned in the tropical dry forests to the tropical moist forests

In the tropical dry forests, community forestry has begun to establish better villager-forester working relationships, upon which community woodland management can in the right circumstances be built. This new body of experience now needs to be applied to the much trickier problems of tropical moist forest management. Here, in addition to greater technical problems, unchallenged and old-fashioned forestry sector styles are part of the problem as well.

9: Identifying Key Land Degradation Issues and Applied Research Priorities

D.G.R. Belshaw, P.M. Blaikie and M.A. Stocking

Introduction

The higher profile given to land degradation, and especially soil erosion, in current debates about the environment, development and economic aid is in part explained by their continual relation to other signs of environmental deterioration: drought, famine, desertification, deforestation. These are the real 'crisis' indicators in developed countries' popular perception of the environment in developing countries. Alarmist prognostications tend to be supported by numerous surveys of the resource base of developing countries.[1] While these may be muted in their wording, the message is essentially the same: land degradation, especially in Africa and South Asia, is extremely serious and threatens the livelihoods of large and rapidly growing populations.

Nevertheless, there are differing views about the seriousness of land degradation and erosion.[2] Quantitative assessment of the magnitude of the processes is itself permeated by errors, scale-factors and ambiguities.[3] Most evidence points to obvious degradation such as gullies occurring in a few well-defined 'hot-spots'. However, a review of the impact of erosion on soil productivity suggests that less obvious forms of degradation such as sheet erosion and loss of organic matter have significant on-site impacts, making the maintenance of yields more difficult and costly.[4]

With few exceptions,[5] almost no economic analysis of land degradation has been accomplished. Indicators related to known economic magnitudes such as Gross National Product via marginal opportunity costs suggest that it may be worthwhile to invest in modest measures to slow degradation rates,[6] but the case made is far from conclusive. The economic costs to Zimbabwe and Ethiopia of losing important plant nutrients through erosion appear to be massive.[7]

There are a number of economic appraisals of soil conservation schemes, twenty of which have been reviewed by Bojo.[8] Hard evidence that measures to combat degradation are worthwhile, however, is lacking from these analyses, from assessments of specific inputs such as labour[9] or from estimates of increases in yields secured by adopting conservation measures.[10] Consequently, in economic terms, the extent to which land degradation is a priority problem is, typically, unclear.

Land degradation in the literature is thus surrounded by uncertainty, amusingly depicted by Thompson:[11]

> The facts, reunited with the uncertainties, now tell us that, if the most pessimistic estimates are correct, the Himalaya will become as bald as a coot overnight and that, if the most optimistic estimates are correct, they will shortly sink beneath the greatest accumulation of biomass the world has ever seen.

This chapter addresses these uncertainties. It looks at ways of explaining the characteristics and causes of degradation as a set of often-competing theories in a chain of explanation, the point of entry to which is not determined by the problem (degradation, erosion) but by the training, position and experience of the observer (social scientist, agricultural engineer, politician, farmer, etc.). The way degradation has been researched and the people who have done it often contribute to the problem as much as the process itself and the persons affected by it. This leads us to review existing classification systems, theoretical frameworks and models in order to assess their utility in understanding the processes and designing counter-measures. From this we show the range of possible intervention packages from standard physical structures through to agro-forestry, and then highlight where we think the major applied research priorities lie.

Land Degradation: Characteristics and Causes

The explanation of the problem of land degradation in a specific case may look at first straightforward, but in the end is usually quite complex. It has to deal both with proximate and ultimate causes, and also accommodate (or judge between) different criteria of what constitutes environmental degradation. Finally, it has to be structured in such a way as to yield clear policy signals.

The idea of a 'chain of explanation' for the process of land degradation has been suggested by Blaikie and Brookfield[12] and elaborated by Blaikie.[13] Figure 9.1 explains the links in the chain (from A through to G). First of all, symptoms are recognised (Box A) — although which are important, and their accurate measurement, is open to a range of uncertainty. The first task, of establishing that degradation is taking place according to explicit socio-economic and physical criteria, provides the starting point. These symptoms are typically: declining and more variable crop yields; increased morbidity and mortality of livestock; sheet and gully erosion; deforestation, and so on. However, to establish this is far from easy. Apart from the technical issues of measurement (see below), there are competing perceptions of what degradation is.

Although physical symptoms and changes may be measured, the social and economic implications may be subject to different judgements. For example, a forest conservator may view the felling of a hardwood forest by shifting cultivators as degradation, while the cultivators may view the tree only as a potential pile of ash and nutrients for their food crops. Bush encroachment may seem to be environmental degradation to cattle-owners but not to goat-herders, and so on. This problem is certainly surmountable — in the direction either of a 'view from above' where scientists and policy-makers adjudicate on how natural resources should be used, or of a more pluralist framework in which competing views of how natural resources are used and of what constitutes 'degradation' can be allowed to co-exist.[14] The policy implications of this choice of conceptual framework are discussed further below.

Box B links the physical changes in land-based natural resources to the economic impact upon land users. The present research focus on the impact of soil erosion on productivity is clearly important here in making the link between the two.[15] In turn, both can be attributed to cumulative land-use practices at that place (e.g. overstocking, insufficient fallow periods).

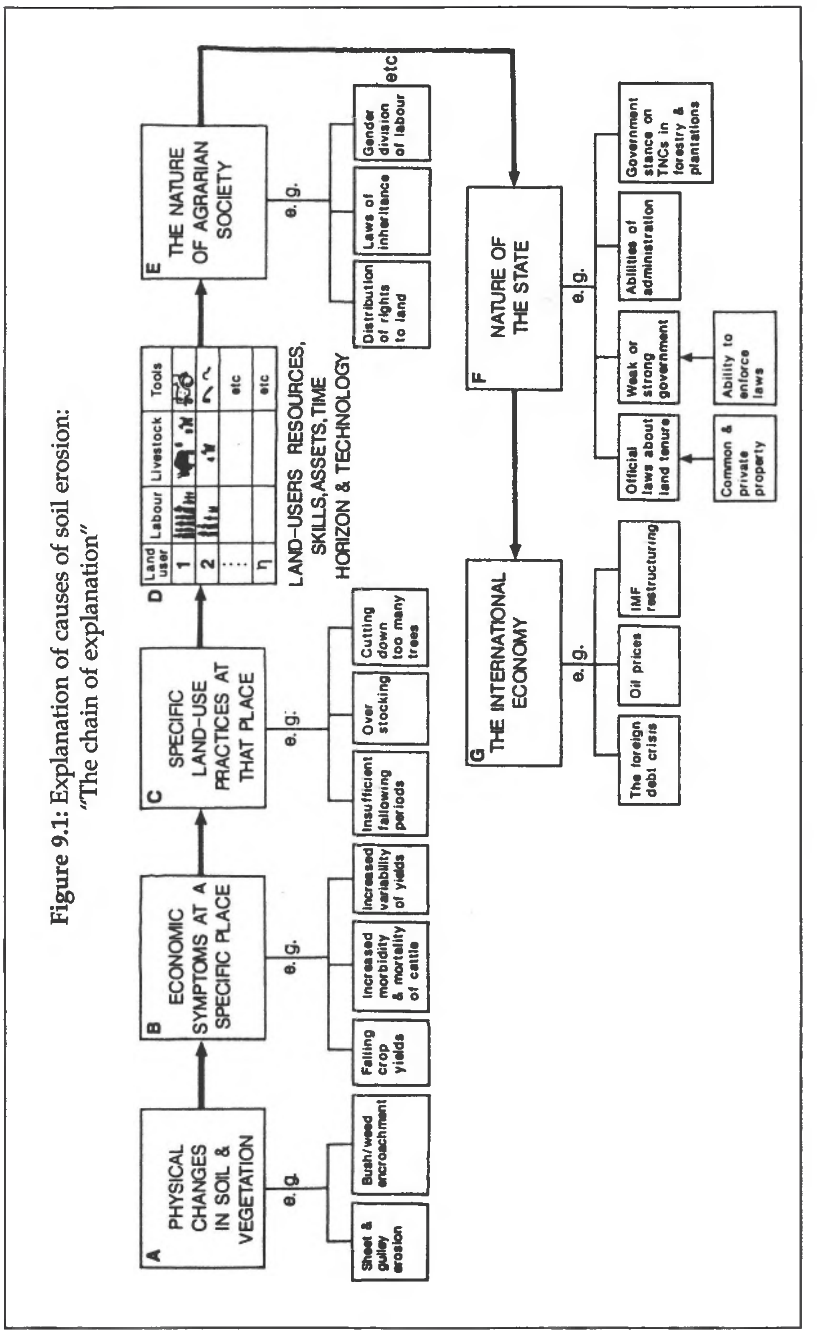


Figure 9.1: Explanation of causes of soil erosion: "The chain of explanation"

The next question is: why does the land user treat the land in this way? Box C deals with the circumstances of the land users themselves, particularly their resources, skills, technology, and the time horizon over which they make land-use decisions. This is probably the most important level of explanation.

Box D represents in simplified form an array of land users with different resources of labour, livestock, tools, capital, etc. Each household applies these resources to earn a livelihood at a particular place. The identification of specific resource scarcities to undertake soil and water conservation (SWC), such as labour in a particular season,[16] cash reserves at the end of the 'hungry gap' or a lack of access to sufficient private lands, usually goes a long way to explaining why small and resource-poor cultivators either cannot afford or cannot risk SWC practices, or, in broader terms, sustainable agriculture.

In other cases, draught power shortages oblige some households (for example in the Communal Areas of Zimbabwe) to plough arable land late and to apply low levels of farmyard manure.[17] Sometimes, a chronic shortage of cash explains persistent under-investment in chemical fertilisers, or the use of dung as fuel rather than fertiliser. The point of a disaggregated household-level analysis is that it can pinpoint resource scarcities which are not experienced across the whole spectrum of agrarian society. Most current SWC practices involve the commitment of resources or opportunity costs in terms of short-run income forgone. Also, farm-level analysis can provide an explanation of the adoption of new, and sometimes problematic, technologies. For example, the introduction of ox-ploughing in Chad and in Mali, or mechanisation in the Sudan, have accelerated serious erosion.[18]

This link in the chain of explanation, then, puts the land user centre-stage and focuses on inter-farm variations in access to resources and their impact on land-use and management decisions. It must also examine the responses and adaptations of different farmers to land degradation itself. Frequently, these do not result in the modification of land-use practice. Blaming the ignorance of land users for this situation is a common reaction by governments and their advisers, but often this is more a result of the latter's own ignorance of the social and economic reasons why land users continue to degrade land.[19] A brief example, from Lesotho, of why farmers adjust to the impact of land degradation in ways *other than* changes in land-use practice can be cited:[20]

> ...under present conditions, the productivity of agricultural land... is so low that the economic conditions of a conventional conservation programme do not adequately exist. Agricultural practices are such that even in the best possible conservation works, the land and the works themselves will continue to erode...

Thus, when a gully appears on a (usually male) farmer's land, it is more cost-effective for him to find employment in the South African mines than to expend his costly and scarce resources patching up land of such low productivity.[21] Remedial action, therefore, is left to women farmers who seldom have sufficient resources of labour or capital to carry out the task. The importance of non-agricultural employment for part-time farming and pastoral households in Africa is crucial in this case in explaining SWC decisions, or lack of them.[22]

The most fruitful opportunities for model-building and causal explanation lie in the fields of farming systems research, applied agricultural economics and anthropological research. Typically, such analyses are omitted altogether in the 'classic' approach to SWC project formulation: problem identification; the planning of control measures; and implementation of the plan. Socio-economic explanation of the problem is thus omitted: FAO[23] recommended a similar set of phases in project formulation, where a well-grounded socio-economic explanation of the problem was assumed (but all too often omitted in practice). Blaikie[24] pointed out the emphases in the classic approach on physical and environmental solutions, and on the 'ignorance' of land users (without explaining their socio-economic circumstances).

However, individual decision-makers and their access to resources must be placed within a broader structural context (Box E). For example, the informal distribution of rights to land outside official land law is often an important consideration. The accepted sexual division of labour and the laws of inheritance, which may tend to exclude women, are two further aspects. Recent work in gender studies applied to agrarian societies has identified important constraints to the available labour time of women, who often carry the major part of the burden of agricultural work, and to the allocation of other resources, particularly cash and purchased agricultural technology, to land and crops under women's control.[25]

Another important issue at this level is the impact of changes to the property regime in which land-use decisions are made.[26] A

continuum from no property, through open access, common pool, common property and private property has been recognised. Both case studies[27] and more empirical economic analysis have highlighted the pressures which common property management institutions currently face. A variety of interlocked factors have tended to reduce the 'mutual assurance' necessary for individuals to forgo income and incur management costs of the commons.[28] This has led to some recommendations for privatisation.[29] The issue has recently received considerable attention. The focus has tended to shift away from defending or attacking pure types of property rights (e.g. common property or private property) to studying the great variety of rights and obligations pertaining to land, vegetation, wildlife and water, and the way in which socio-economic change has affected these. One of the persistent findings of research has been the 'transition of trust'[30] from well-defined management responsibilities in common systems to impersonal and uncertain applications of bureaucratic fiat, and the personal discretion of local state functionaries in matters of land law and restrictions on natural resource use.

A number of writers have identified the causal role of rapid population growth in environmental degradation.[31] Exceptionally rapid population growth may have adversely affected farmers' ability to adopt more intensive but sustainable agricultural and pastoral practices, particularly where the population doubling time is in the order of one generation (as it is in Kenya and Nigeria, for example). Indigenous agricultural adaptation has to be swift. Almost every historical analysis of farming systems in Africa points to a reduction in fallowing periods and a diminution in available land per head of population and livestock. However, few of these writings have addressed the more complex relationships between population, poverty and development. In the environmental literature, for example, it is seldom appreciated that rapid population growth and poverty usually have a reciprocal causal link, and that there are other intervening variables between rapid population growth and its causal role in land degradation.

The ability of the state to intervene in SWC is also crucial to the explanation of land degradation as well as in policy and project formulation. This revolves around the capabilities of the administration at all levels, and the extent to which soil conservation is perceived to affect the economic livelihoods of the most powerful groups represented in government. Where the interests of the most

powerful rural groups have been threatened, effective national conservation policies have been implemented on a highly subsidised basis. South Korea, the Sudan and Zimbabwe are disparate examples: in all three a case can be made that powerful groups were threatened.

The nature of the state is also influential in identifying, controlling and reacting to policy measures which may have positive or negative impacts on degradation. For example, privatisation of tea in Sri Lanka has encouraged rehabilitation of formerly degraded steep lands. Conversely, in Tanzania's Usambara Mountains, low wages and low producer prices for tea have encouraged understorey exploitation of adjacent rain forest for high value spices to the detriment of both the tea lands and the forest.

Last, there are important international effects on land management which are mediated through governments. Foreign debt has led to reduced public expenditure on SWC efforts, and reduced the possibility of importation and/or subsidisation of fertilisers and machinery. Structural adjustment policies may have similar effects. An increase in cash crops may not have a deleterious effect on degradation. However, single-stand planting of some cash crops, such as cotton, tobacco and groundnuts, tends to have low vegetal cover compared with a wider mix of inter-cropped food and cash crops. Single-stand crops grown for sale are more often planted in rows because of the need for mechanisation and standardisation of the harvested crop.[32]

To summarise, it is usually inadequate to ascribe a single cause of degradation. There is a hierarchy of cause, each level of which has to be addressed in an appropriate policy response.

Measurement and Classification of Degradation

Measurement issues

Measurement is central to scientific explanation. Measurement issues centre around:

(i) The frequency/magnitude problem: land degradation processes have extreme variability. Some (e.g. sodication) occur slowly and continuously; others (e.g. landslips) are massive single events, returning to the same site only after thousands of years. Such variability is difficult to accommodate in a sampling design. For example, Walling and Webb[33] show how sampling interval and

the method of interpolation can reduce estimated sediment load of a river to 20% of actual load. There can be considerable underestimation of seriousness of degradation especially for processes that are spatially or temporally very variable;

(ii) Scale problems: measurements of land degradation are extremely scale-dependent. Hydrologists assess this dependency through Sediment Delivery Ratios which describe the proportion of soil eroded at a site which exits from a whole catchment; it can be as little as 1% of catchment net loss. This could mean that a gross measurement of erosion taken for a large area is only one-hundredth the value of the same measurement for a site. Underestimation of the impact of degradation at a single place from catchment measurements or overestimation of sediment delivery into a reservoir based on field measurements are thus possible;

(iii) Data interpretation: similar data often lead to contradictory interpretations. The now-classic maps of suspended sediment yield for Africa based on the work of Strakhov and Fournier, joined more recently by Walling, present differing patterns of denudation and severity. It is difficult to believe they came from the same data base. Observer bias, consciously or subconsciously, can so easily be incorporated into supposedly objective measurement.

The limited value of much measurement has been well demonstrated by Warren and Agnew[34] in the debate over desertification. They cite misleading notions such as the news that 'the deserts are on the march'[35] and that 35% of the earth's land surface is threatened by desertification.[36] Whilst undoubtedly true in limited instances, the views are sensationalist and overdrawn. Measurement, whether directly from fieldwork or indirectly from satellites or rainfall statistics, often leads, they believe, to spurious conclusions and has failed to give unequivocal proof that desertification as a distinguishable process really exists.[37]

Measurements, therefore have to be treated cautiously. Regrettably, they could act as diversions from tackling the problem of degradation.

Types of measurement

Of greatest relevance to this discussion are the attempts to measure the effect of degradation on soil quality and yields, and the resulting economic and financial impacts. However, it must be remembered that these attempts rely on the accuracy and relevance of technical

measures of the process, and for economic assessment on the ability to predict changes over time of the major physical variables such as nutrient or water availability. The experience of models such as EPIC (Erosion-Productivity Impact Calculator)[38] is salutary in this regard. Consisting of eight sub-models including an erosion rate simulation, EPIC attempts to predict yield changes over the long term. Even with the massive data base available in the United States, the model can give wildly variable results. The general lesson is clear: the more sophisticated and complicated the measurement and assessment procedure becomes, the looser is our understanding of the results obtained. Yet, there is the tendency to believe the results from technology-rich measurement; and to play down simpler experience-based assessments.

Different types of measurement should be used in a complementary manner, so that, in each study area, the (usually) few sophisticated estimations of environmental degradation can be supplemented by less accurate but more frequent robust and cheap estimations. Various methods of mapping disparate knowledge about the state of the environment in a particular region are reviewed in ICASLS.[39] In general, methodological problems as well as resource constraints have emphasised that low-cost types of measurement are often more appropriate to developing countries than the others.

Systems of classification

There are a number of systems of classification which attempt to organise and process measurements of land degradation. These can be broadly classified into the following categories:

(i) Degradation/erosion surveys; mapping and classification of actual degree and extent;
(ii) Erosion hazard mapping; the potential, natural and human-induced, for erosion;
(iii) Integrated degradation methods; taking a number of processes and attempting to classify combined effects;
(iv) Classification of the impact of degradation.

Space precludes their assessment here.

To sum up this section, measurement of land degradation is not the objective, unbiased, neutral procedure we might be led to believe. The literature reveals different conclusions derived from the same data, and cries of crisis emanating from the flimsiest

sources. General conclusions can, however, be drawn:

(i) Rates of degradation overall are not high, but specific rates at sites can be very high. Water erosion especially tends to be locationally concentrated;

(ii) High rates occur with poor vegetation. Cover is the major determinant of degradation on agriculturally important land in the tropics;

(iii) Site-specific factors of importance are: steep slopes, a few very erodible soils, locally high rainfall erosivities and the existing state of degradation. Where degradation has already occurred, it is much more likely in the future;

(iv) Anthropogenic factors relate to man's influence on vegetation and the way that soil use and management affect intrinsic soil properties such as rates of humus mineralisation, infiltration, crusting and bulk density.

The question arises as to how far such conclusions need to be refined for particular areas and sites. Techniques exist — erosion hazard mapping, for example. But it is doubtful if they add essential information, without which interventions cannot be designed. Large-scale surveys are likewise of little value. They consume an inordinate amount of time and funds, especially if remote sensing technologies are also applied. The processes being surveyed are site-specific and the impact of each must be related to the intended use of the site. Small-scale surveys can pick up useful differences, but in almost all cases even where dangers have been identified, other, more urgent criteria such as markets, poverty and social need dominate the planning imperative. Do we need to know that the consequence of farming steep slopes because of displacement of peasants from fertile valley soils will lead to 225 tonnes soil loss per hectare in the average year? Will the information help design better conservation systems than simply assessing that erosion will be high because of steep slopes and inappropriate land-use practices? We think not.

The one area where additional efforts at measurement and classification would appear to be potentially fruitful is an assessment of the socio-economic impact of degradation and how far it will prevent land users doing what they want and governments doing what they ought. Non-acceptance of

conservation technologies by the people who are supposed to put them into practice is the single greatest reason for failure of conservation projects (see next section). Occasionally, the technology is itself non-viable; but mostly it is because it is just not economically or financially rational for the land user to put the system into operation. Predicting such impacts would be a major advance in designing systems which match the priorities of land users, rather than of their instigators.

Theoretical Frameworks and Models

Developmental objectives

It is becoming widely recognised that the most intractable problems of land degradation are closely associated with rural poverty. It is in situations of rising human and/or livestock population pressure on the land and low — and falling — levels of productivity that the gains from SWC interventions are insufficient to justify resource allocations which are adequate for the task.

Few studies of land degradation to date have placed it within the broader context of appropriate strategies for the development of the agricultural and rural sector and regional and national economies in the way that the 'chain of explanation' demands. A notable exception is the report of the Ethiopian Highlands Reclamation Study[40] which envisaged effective interventions being made within a four-level hierarchy of decision-making and planning: (i) the farming system; (ii) the agricultural sector; (iii) the level of multi-sectoral rural development; and (iv) the nation which included a significant measure of decentralisation to the regions.

Explicit consideration of negative policy impacts and gaps at each of these levels identified a complex set of policy reforms and investment projects necessary for dealing with a massive and rapidly growing problem. The key recommendations emanating from the study have been incorporated subsequently in higher-level plans for the new administrative and autonomous regions, the agricultural sector and the national food and nutrition strategy.[41] These now await national government and donor agency support as and when improvements in the internal security situation allow.

More generally, the adoption of a multi-disciplinary and multiple objective framework will usually confer greater weight and a sense of urgency to both preventative and remedial interventions aimed

at countering land degradation processes. Thus, in addition to the intended benefits from environmental protection reaching future generations of land users, other short-run developmental objectives can and should be attained simultaneously. These may include protecting or increasing: (i) current marketed surplus from the land resource in question (efficiency gain); (ii) food security for an expanding population (primarily an equity gain but with efficiency gains from disaster relief cost reduction); (iii) rural self- or wage employment (equity gain but with urban overcrowding reduction benefits).

The design of the intervention package would attempt to meet all the developmental objectives. However, it must also explicitly recognise the limits to the implementation capacity of the government (or non-governmental organisation) in the field.

The construction of realistic 'with project' and 'without project' scenarios incorporating effects at the sectoral and national levels is likely greatly to strengthen the financial and economic justifications for such interventions. The apparent trade-offs between environmental and 'economic' objectives (defined in a narrow efficiency sense) are more likely to disappear in such analyses, and the uncertainty about the benefits of investing in anti-degradation measures to be considerably reduced.

Relevant types of economic analysis models

At least five types of economic model, each performing quite distinct tasks, can be distinguished. Only the first of these have been applied to any significant extent to land degradation problems.

(i) The first is concerned with the estimation of efficiency losses in the context of social cost-benefit analyses of project interventions. Work here has focused on the size of the decline in physical crop or livestock output under land degradation, valuing this at current market or shadow prices, calculating the costs of the SWC measures viewed as adequate for the problems and using one or more discount rates to calculate the financial and economic internal rates of return. In poor subsistence communities the value of output is underestimated by using farm-gate rather than retail prices[42] and the costs of famine relief/post-disaster rehabilitation avoided by reversing degradation effects are ignored. Conversely, the ability of poor farm families to bear the short-run costs of physical SWC measures is not assessed;

(ii) The latter gap requires the modelling of farm/*household* systems. Most economic analysis of the benefits of SWC measures to farm households does not employ a wide enough frame of reference. Farm households usually employ an algorithm involving minimum acceptable income or a variety of goals which are traded off between each other. Non-farm employment, and the changing allocation of labour resources within a household (say, between agricultural labouring, handicrafts and farming), may form part of the economic calculus of the household, of which investment and return to conservation may form only a small part. A wider perspective enables the planning team to assess what alternative cultivation techniques or crop/grazing/fodder plant combinations can substitute or supplement physical SWC measures while raising on-farm productivity, employment and population carrying-capacity. Although recent microeconomics research on both farming systems and agro-forestry systems has been incorporating the degradation/conservation dimension,[43] it has not yet replaced the dominant, narrower approaches based on engineering and soil science perspectives;

(iii) Underlying the increasing severity of land degradation one frequently finds unresolved conflicts between major land uses; between pastoralism and dryland farming, for example, or between the latter and established forest reserves. These are usually highly politicised. An unexpected breakthrough in adopting a rational modelling approach is being achieved in a sensitive area of Kenya, following a sectoral review mission.[44] More usually the failure to combine political economy, ecological and economic variables for explanatory and predictive purposes, however, means that governments are deprived of superior multi-land-use solutions. Conflicts can only deepen and the associated land degradation, if it is resolved at all, will be at unnecessarily high cost in terms of reductions in the productivity and social welfare of the — usually very poor — majority of land users;

(iv) and (v) Sub-national planning — defined by functional sector or by geographical area (either multi-regional or a rural-urban dichotomy) — requires the modelling of the economic system if causation is to be understood and successful interventions adopted. A similar argument applies at the level of planning for the national economy. It is rare for land degradation to receive attention as an integral feature at these higher levels. It is more usually 'compartmented off' as the desertification problem or the arid lands

issue. A focus on the growth of population and work forces seems the best way to rectify this omission. The effect of inappropriate macroeconomic policies, such as over-valued exchange rates, on agricultural incentives and productivity has become increasingly obvious in the context of structural adjustment. Very misleading signals are given by domestic commodity *market prices* when one or more macro prices (exchange rates, interest rates, wage rates) are distorted.

Multi-disciplinary frameworks

At the micro level, a more explicit use of systems analysis models seems warranted as a discipline-neutral framework to encourage each discipline to work within a task-force approach to complex analytical and prescriptive tasks. Common training modules in systems analysis for the various disciplines concerned is an important reform which academic institutions should implement.

Alternative Intervention Packages

Broad technical approaches to conservation

It is useful to distinguish between three broad types of intervention:

(i) Prevention: This means not allowing the process of degradation to start. Prevention may also apply to the conditions that determine inadequate vegetation cover. It could, for example, involve pricing policies that encourage crops that give better cover, or crops which give a higher return and hence support greater inputs which, in turn, gives them greater efficiency for raindrop interception;

(ii) Control: Once the process has begun, intervention seeks to minimise its adverse impact.

(iii) Rehabilitation: This requires a high level of technical input or radical restructuring of land use for a period. It is appropriate when the state of degradation has reached such seriousness that only significant injection of external resources can lever environment and society out of the degrading spiral.

Prevention is always better than control. It is cheaper, involves less disruption, and can give significant benefits in other areas. Control is usually needed as a back-up. Rehabilitation is a last resort. Unfortunately we nearly always deal with conservation in exactly

the reverse order, first tackling the costliest interventions with least returns and greatest technical difficulty. Control receives the next priority because the problem is visible and can be dealt with by neat packages of technical inputs. Prevention requires understanding, commonsense, subtlety and vision; regrettably, such qualities are in short supply.

Interventions in control of soil degradation can take many forms, depending on: (i) the type of degradation; (ii) its current seriousness and likely future progression; the (iii) costs and benefits of the intervention to society and the environment, government, aid donor and international relations, implementing agency, land user/household/individual members in society. We can assess the first quite easily. Estimates can be made for the second. But our integration of the third into technical issues is lacking and needs much research and refinement. Nevertheless it is useful to make a preliminary classification and assessment of the principal types of intervention.

Institutional and legal aspects

Institutional responsibility for the control of soil degradation can be complex because of the cross-sectoral nature of the problem and its solution. Sri Lanka in 1986 had 12 ministries and 38 government agencies with statutory responsibility for soil conservation. This illustrates the major difficulty, that degradation and its control crosses sectors; conservation tends to be identified with one particular sector only (a situation common in forestry) or else no one agency has the power to do anything. Nevertheless, there are existing institutions which are considered effective and which could act as models for replication, for example the Department of Conservation and Extension (CONEX) of Southern Rhodesia, which was instrumental in implementing soil conservation as part of a package of extension services, subsidies and advice to commercial agriculture. In Zimbabwe, the Department of Agriculture, Technical and Extension Services (Agritex) continues the tradition and is attempting to widen the scope to small-scale farming — a far greater challenge.

Legislation also has a role — positive or negative. The enforcement of soil conservation in much of British colonial Africa led to considerable disquiet; the independence movement in Tanganyika gained much of its grass-roots political support by

being anti-conservation. Interventionist legislation which sets penalties for specified land-use practices is especially resented where they have been widely practised and upon which people now rely. Examples include the outlawing of shifting cultivation on *vleis* and near watercourses in Zimbabwe, and enforcement of cattle-destocking in Tanzania.

Mechanical preventative and control methods

There are a number of *preventative* practices which go under the general terms of 'conservation tillage[45]' and 'cross-slope barriers': (i) Minimum tillage; (ii) Contour tillage; (iii) Contour ridging; (iv) Tied ridging or basin listing; (v) Lock and spill drains.

Mechanical control involves structures and major earthworks, specifically to control run-off and encourage sedimentation at or near the site. Because they are designed to counter natural, albeit accelerated, processes of degradation, they require continual maintenance. There is some overlap with mechanical preventative methods. The large number of types include: (i) terraces; (ii) waterways; (iii) mechanical barriers; (iv) gully control structures; (v) continuous surface protection.

Biological preventative and control methods

Vegetation is the key to prevention of most forms of degradation. If all soils were continually covered by forest or ground cover, there would be no detachment, transport and net loss of organic matter. Land use makes this practically impossible, but there are ways of maximising vegetation cover and standing biomass. El-Swaify et al.[46] give a useful list of 136 species with potential for erosion control. Specific techniques worth separately identifying include: (i) Cover crops; (ii) Multiple, inter- and relay-cropping; (iii) Crop rotation; (iv) Agro-forestry; (v) Rotational grazing.

Control methods using vegetation rely on the properties of plants to act as live barriers, thereby reducing degradation processes. These technical interventions often require considerable management expertise and knowledge. They include: (i) Grass strips; (ii) Strip cropping; (iii) Trash barriers; (iv) Agro-forestry or farm forestry barriers.

Hillside closure/controlled access/land alienation interventions

This is the common form of rehabilitation which involves radical change of land use. Typically, land is alienated from common use by a village. Food for Work programmes[47] may support the labour input for terracing and tree-planting, and the land is then closed to all uses for an indeterminate period.

Such closures could be necessary in extreme cases, but the dangers must be recognised. First, closure may simply transfer land pressure to adjacent, open land as in the Hifadhi Ardhi Dodo (HADO) soil conservation project in Tanzania.[48] Secondly, resentment can build up between the community that was once dependent on the closed area and the agencies which police the closure. The woodlots planted in the FISC project in Lesotho suffered inexplicable fires in 1989 due, it is thought, to deliberate burning. Thirdly, the intervention is rarely seen as belonging to local people. They do not identify with it and see all responsibility for it resting with government.

Physical land-use planning/watershed development

This embraces the general physical planning approach for whole catchments and watersheds.[49] It assumes that there will be co-operation amongst users in order to locate land uses according to the quality of the land and to position waterways and structures for maximum technical effectiveness. It suffers the same 'technical-fix' problems as single technical interventions, only to a greater degree. Hence it has rarely succeeded where several land users and complex land tenures are involved. SWC interventions must solve a simultaneous equation with both socio-economic *and* technical terms. Frequently, the technical package will have to satisfy a 'good enough' rather than a 'best' criterion because it must incorporate resource, knowledge and institutional constraints faced by the land users themselves.

Farming system/household-level interventions

Projects can be targeted at the farming system to reduce any potential constraint in carrying out conservation works. The most common constraint is labour demand, and several countries (e.g. Sri Lanka, Ethiopia, Brazil) have tried subsidies related to the

opportunity cost of labour. But subsidies set up attitudes of dependency which are not helpful to conservation in the long term. Greater attention to on-farm biological measures supported by short-term food aid has been stressed for Ethiopian smallholder conditions recently.

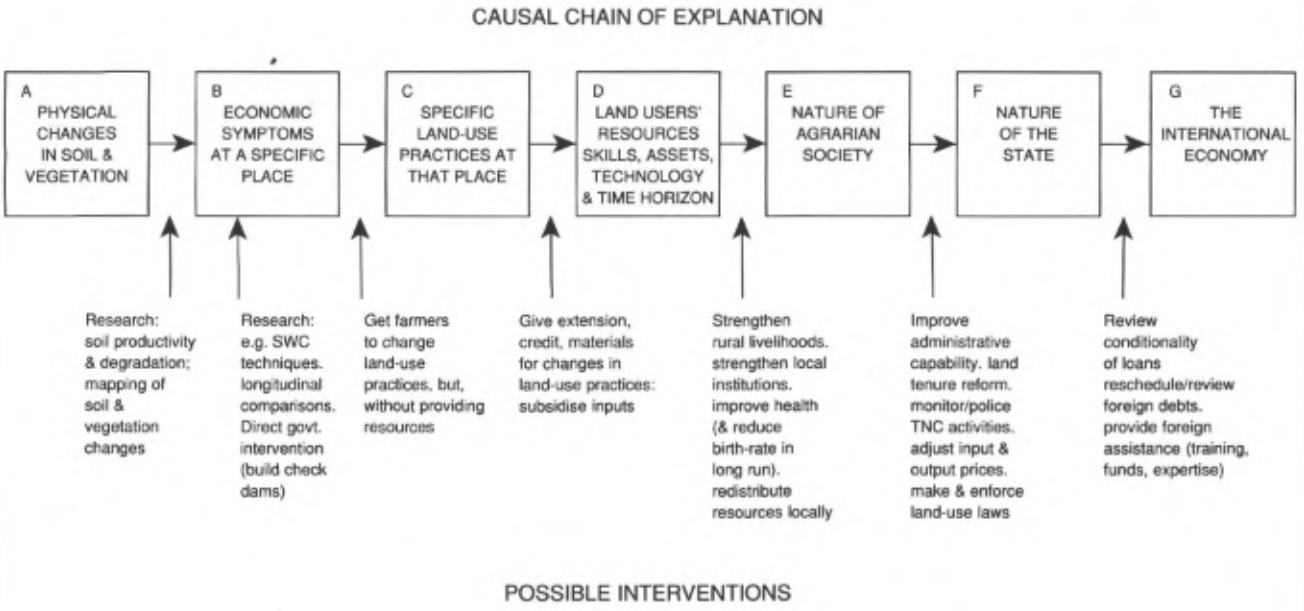
Other interventions into the farming system could unlock constraints in capital, land, expertise, access to resources or education that would have prevented conservation practices. Pricing policies and provision of marketing services can effectively promote certain crops. We do not know of any examples where conservation benefits have been explicitly identified in pricing policy analysis, but there are many cases where erosion has been promoted indirectly by encouraging particular crops such as cotton and tea. Credit systems to buy fertiliser can have conservation benefits in improving vegetative cover. As shown in Zambia, assistance to village industries can promote technical innovations such as improved ox-carts which allow the manuring of fields.

Not all household-level interventions encourage conservation. There is ample evidence that access to tractors in Tanzania has led in parts to the inappropriate extension of arable cropping and gross decline in land husbandry standards. Clearly, there may be many unpredicted effects to be monitored closely.

Current SWC trends

Reij's 'trends'[50] and our additions to them are summarised as: (i) more selective use of subsidies, as in Project *Lutte Anti-Erosive* in Mali; (ii) greater voluntary participation of the local population; (iii) moving from an emphasis on soil conservation to water conservation and water harvesting; (iv) integration of trees and grasses in conservation projects; (v) moving from the catchment approach to a farm/village emphasis with farmers treating their own fields first; (vi) monitoring soil and water conservation activities; (vii) care when transferring successful techniques. The grey literature has many examples of techniques which work in one place but fail in another; (viii) integrating conservation within the development of farm/household systems. Particularly in low-income agriculture, the main thrust for conservation should come from changes in on-farm systems which incorporate conservation goals, especially through enhanced vegetation cover.

Figure 9.2: Interventions related to land degradation causation



Conclusion

Figure 9.2 summarises the many forms and guises of interventions by linking them to the different levels of explanation in Figure 9.1. Usually intervention must be viewed as a package of complementary measures, from the site-specific to the national. It is quite wrong to see land degradation control as solely a package of technical remedies.

The neglected areas in designing suitable interventions would appear to centre around the following themes:

(i) *Improve research:* Low-cost intervention packages have only rarely been the subject of serious research. We need to assess their technical effectiveness (i.e. how much soil is saved; what increase in available water; how much more fertile is the soil?); on-site impact (i.e. increase in yields; potential to rehabilitate land and provide production opportunities); application to strengthening livelihoods (i.e. farming systems research identifying constraints and possible means of alleviation); off-site impacts; and the cost to society of intervention or of doing nothing.

(ii) *Maximise local participation:* This could take several forms: (i) find out what indigenous systems are available and build interventions on these already acceptable techniques; (ii) involve the 'beneficiaries' at all stages; (iii) target approaches which produce immediately perceptible higher yields; (iv) recognise that the problem may be self-adjusting over time; (v) incorporate specific training and extension packages and use locally-trained farmers to train others. Priority should be given to low-cost, replicable packages; use of local materials and knowledge; employment of vegetation rather than structures; and farmer training.

(iii) *Treat incentives warily:* Some material support may be effective. Transport to carry materials, provision of hand tools and removal of innovation risk in the early phase of adoption; support to local craftsmen and community benefits such as wells and clinics are commonly cited. But direct subsidy of conservation works is often counter-productive in the longer term.

(iv) *Monitoring:* Needed urgently everywhere.

(v) *Institutional support and co-ordination:* Multi-sectoral agencies must handle land degradation issues. Co-ordination and exchange of information in order to transfer lessons and develop consistent policies should be strengthened. Donor co-ordination is also important.

Applied research is needed in all these aspects on a broad front that encompasses ecological, economic, agricultural, social and institutional issues. Advances could be made in evaluation methods of, for example, 'best-bet' technologies, and in monitoring the implementation of projects. Research must especially concentrate on the appropriateness and effectiveness of both overall intervention strategies and individual techniques.

Notes

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49. See for example, N. Gil, 'Watershed Development with Special Reference to Soil and Water Conservation', *Soils Bulletin* 44, Rome: FAO, 1979; Sheng, 'Watershed Conservation', op. cit.; and, for small farmers, G.G. Wenner, *Soil Conservation in Kenya*, 6th edn. Nairobi: Ministry of Agriculture, 1980.
50. C. Reij, 'The Present State of Soil and Water Conservation in the Sahel'. Report for the OECD, Club du Sahel and CILSS. Amsterdam: Free University, 1989.

10: Sustainable Resource Management and Project Planning

Mary Tiffen

Before we begin to develop new forms of environmental economics to assess the viability of projects, it is important to diagnose the mistakes that we as economists may have contributed to project planning in the past, and more especially to the planning of projects for the rural sector.

During the past thirty years the major lending agencies have appraised the viability of projects through cost-benefit analysis, and particularly by the calculation of the economic internal rate of return (IRR). Some agencies, such as the Overseas Development Administration, prefer the indicator of Net Present Value,[1] but this has a similar effect on project planning when the selected discount rate is high. The most important effects include the way discounting reduces the importance of operational and maintenance costs in comparison with initial capital expenditures, so that long-term durability has a relatively low valuation, and the way that considerations of national benefit and national shadow prices can obscure the actual prices and concerns of the people living in the project area.[2] The current methodology was elaborated for industrial projects in developing countries by Little and Mirrlees in the late 1960s,[3] the leading text for agricultural projects being that of Price Gittinger, originally published for the World Bank in 1972.[4] The Bank's guidelines on agricultural projects and irrigation projects were first published in the 1970s and were in constant demand. The irrigation one was revised in 1983 and the agricultural investment one in 1985.[5] The latter is a considerable improvement on earlier

versions, and does suggest that it might be desirable to comment on government ability to meet operational and maintenance costs. The Bank now recognises that the IRR should not be the only criterion for project selection, but it remains the first hurdle that a project has to cross if it is to be deemed fundable.[6]

Part of the problem with the IRR is that it has a simplistic attraction for busy decision-makers in governments and investment agencies. It is a single figure that appears to sum up all aspects of the project. In practice, projects have come to be designed in order to show that they can secure the required rate of return. A major problem with this is that it assumes that good management is available; it does not necessarily provide the conditions and incentives for good management. Because the necessary conditions for good management are often lacking, the IRR has often proved a bad prophet. This can be observed in the case of irrigation projects, where Table 10.1 shows the large variations in IRR calculation at appraisal, project completion and some years later, during an impact assessment.

However, it should be emphasised that the record of irrigation projects is not necessarily worse than that of other types of rural project; it is simply that there has been more work, more concern and more analysis in the case of irrigation than for other types of projects. Similar in-depth work on projects in forestry, animal husbandry, plantations, etc. might reveal a similar picture.

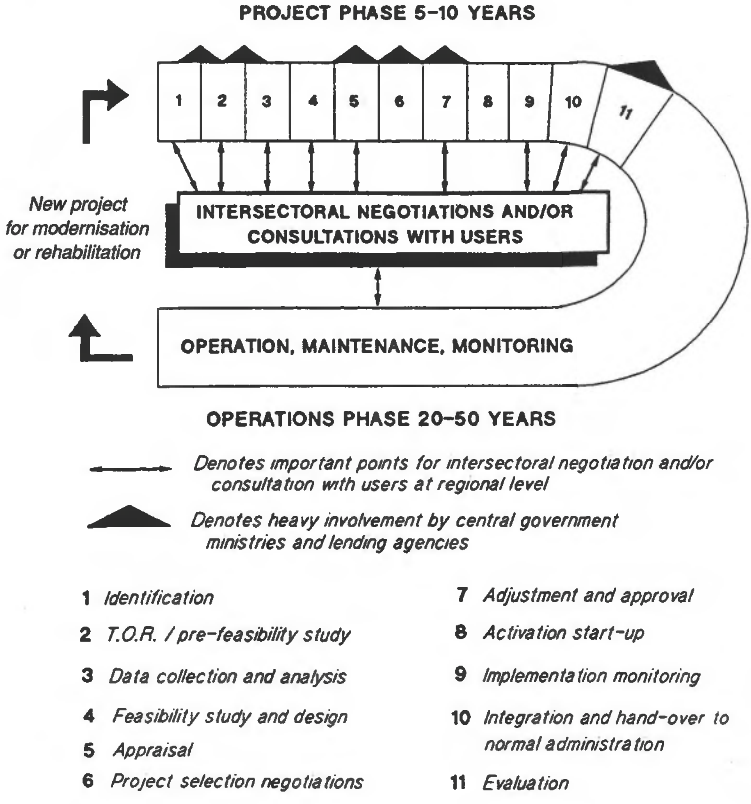
Table 10.1: Internal Rate of Return on irrigation projects as calculated at three points in time

Scheme	*Appraisal*	*Completion*	*Impact evaluation*[a]
Doukkala I	11.0	21.0	11.7
Panuco, Mexico	20.0	15.8	7.5
Sinloa, Mexico	12.0[b]	11.0	9.0
Third, Mexico	11.0	21.0	17.0
Upper Pampanga, Philippines	13.0	14.0	8.9
Aurora Penaranda, Philippines	17.0	8.6	2.6
Lam Pao I, Thailand	22.0	22.0	12.6
Lake Alaotra, Madagascar	11.0	22.0	negative
Agricultural Devt. Gambia	30.0	22.0	negative

a. Normally 5 to 10 years later.
b. A re-estimate midway through implementation, due to cost escalation.

Source: World Bank reports.

Figure 10.1: The project cycle phase in relation to project life.



The small concern of project planners with the long term is shown in the standard diagram of the project cycle. This ends at project completion — that is, the final loan disbursement, and the evaluation of implementation. It entirely omits the period when the project really justifies itself, in the twenty to fifty years after 'completion' (see Fig 10.1).

If we shift the emphasis of project design by requiring, first, that the project should show that the incentives and resources for good management during operation are present, and, only if it meets this criterion, making the second requirement that it should show an overall economic benefit to the country concerned, we focus our attention on the managers of the rural environment. (This,

incidentally, is the recommended practice for the most used handbook for European irrigation project assessment, by Bergmann and Boussard.)[7]

Who are the managers of the natural resources of land and water in the rural sector? There are three groups: farmers; modern sector managers of rural services; and traditional authorities. We look at these in turn.

The largest, both in terms of the area utilised and the number of managers, are the farmers, livestock keepers, collectors of forest products, who have ownership or use rights over land and water. Normally, their activities run in a cycle whereby they deplete the inherent fertility of the land by taking off a crop, then restore that fertility by returning nutrients in the form of fertiliser, manuring, or fallowing. In the large majority of cases they are interested in maintaining the long-term fertility of the land, or in protecting a watering point for their livestock, because they wish it to remain capable of supporting their children. However, they also wish to use the least costly method of maintaining the resource in good order. In the past, in countries with an abundant land resource, that may have involved shifting cultivation.[8] This practice does not permanently reduce fertility (though it reduces species diversity), *provided* that a sufficient interval elapses between the cultivation cycles to allow the natural vegetation to regenerate. Unfortunately, under conditions of population growth, the fallowing cycle gets reduced, and degradation will occur unless other means of restoring fertility can be adopted. Our technical knowledge of how to maintain fertility under annual cropping in the tropical forest zones is, quite simply, still inadequate;[9] we do, however, know more about the conditions necessary for the intensive management of tree crops in these zones, and there are cases where plantations have gone through several cycles of replanting.[10]

Because of our lack of knowledge on the management of fragile environments, growing populations have also to be maintained by far more intensive farming methods in what we can call the high potential areas, by means of more irrigation, greater use of fertiliser, improved crop varieties, higher grade livestock on smaller but better managed and protected land, planting and protecting trees, etc. This type of higher input-higher output farming is sustainable and profitable *provided* the resources are there for the farmers to restore nutrients and to invest in protective measures, which may range from the building of terraces to fencing, from livestock

housing to the digging of wells. A recent study by the World Bank has identified profit as an essential condition for the success of dryland environmental management schemes.[11]

The first condition for agricultural project planning that does not cause long-term damage to the environment is, therefore, a realistic assessment of the profitability of the recommended type of farming, ensuring that the farmers will have both the resources and the incentives to invest in fertility maintenance. The incentives include both a return on their private investments and a reward for the extra work and risks involved. This means giving financial analysis at the farm level far greater importance and depth than it has had in some project analysis in the past. It implies having a thorough knowledge of the existing range of rural activities, which the farmers will be comparing with those possible under the project. This is a tougher condition than the internal rate of return criterion. But, as Bergmann and Boussard have said, it is 'wasted effort to continue to study and execute a project if it cannot be used very profitably by the farmers'.[12] Experience has shown that if private profit and utility are not there farmers simply ignore the project infrastructure, which decays unutilised or under-utilised. This applies from irrigation structures to forest nurseries.

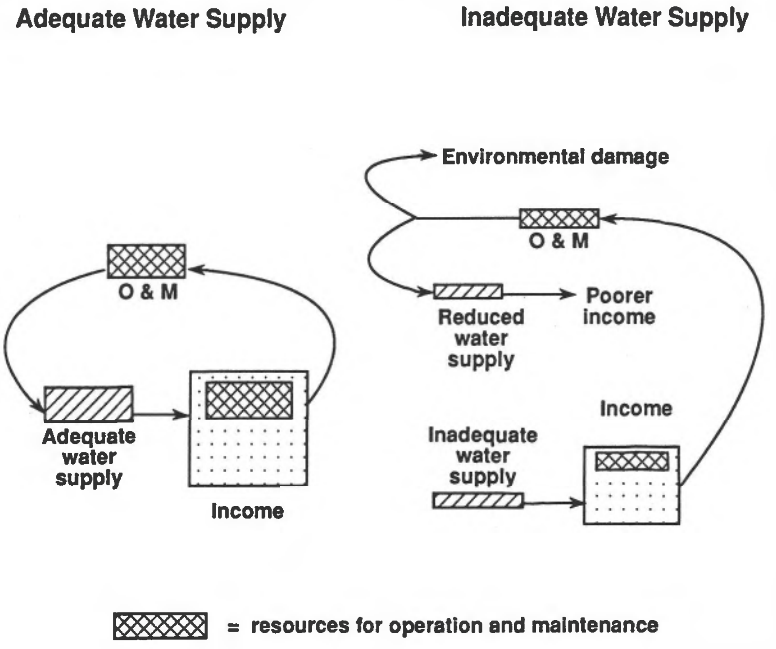
Moving to a higher input-higher output type of agriculture implies more buying and selling of inputs and output, and requires a range of rural infrastructure such as roads and electrification. This brings us to the second group of people concerned with rural resource management. These are the managers of rural services, often but not always civil servants. The second condition for sustainable projects is that the authority which is responsible for infrastructure, land or services for the benefit of many people must have adequate management capacity and revenues to operate and, above all, to protect and maintain the resource. This has often been the least observed condition for sustainability. Much of the infrastructure concerned is provided by government and the operational and maintenance costs are paid for out of general revenues disbursed by the Treasury. Even when farmers make direct payments, for example for irrigation services, the revenue is generally paid into the Treasury, and the operational department meets costs out of its government-allocated budget. In times of financial stringency, the equipment and materials items in the budgets are cut to a much greater extent than staff costs. In consequence, we have staff who are paid, but who are unable to

maintain roads, clean drains, desilt canals, repair fencing, etc. for lack of materials. Lack of maintenance of essential facilities then becomes a direct cause of environmental degradation — for example, gullying and soil erosion when roadside drains are not maintained; waterlogging and salinisation (when irrigation drains are not maintained or canals are left to leak); the health problems associated with stagnant water, etc.

It is obviously difficult to cure such problems by economic analysis, since what is required is an often unpopular political decision that the user must pay, and that the project authority must keep its staffing costs down and its efficiency up. Very often, it is only if the project authority maintains its facilities in good condition, that the user can afford to pay the costs of maintenance. This is most obvious in the case of irrigation, where only a reliable supply of water will enable the farmer to make the profits that permit him to pay the costs of operating and maintaining the system; if maintenance declines, water supply declines, revenues decline and so does the ability to pay for maintenance, leading into an economically and environmentally vicious circle[13] (see Fig. 10.2). It has been found in Asia that the best maintained and operated irrigation projects are those where the farmers' irrigation service fees go directly to the agency that provides the irrigation service; the least well operated schemes are those which are dependent on a central treasury.[14] Nevertheless, although the problem is essentially political, project planners do have a responsibility to take note of the lessons of experience, and to recommend virtuous self-financing circles where possible. Self-funding is not always possible; it has obvious difficulties in the case of roads, although in some areas local authorities charge a cess on lorries.

The feasibility of self-funding agencies has obviously got to be tested. To quote Bergmann and Boussard again 'If the irrigation project is carried out by organisations which are legally and financially independent .... profitability should be calculated separately for these organisations'.[15] There are notorious cases where it has been assumed that a farmers' co-operative can run a service, such as providing a pumped water supply, without any realistic investigation into whether there are the management capabilities to do so, or of the real prices and risks attached to their getting regular and timely supplies of diesel and fertiliser from distant stockists — over roads which are all too likely to be ruinous to lorries. One reason why the Gezira project in the Sudan operated

Figure 10.2: Relationship between water supply, income, and amount available for Operation and Maintenance (O&M)



well for its first thirty or forty years was that the government and the managing company got a percentage of the cotton profit. If the government failed to maintain the canals, or the company to get the seed out in time, they got a percentage of nothing — a powerful incentive for efficiency. Putting all the costs on cotton when other crops became important was economically distorting; the current system where no-one knows what the real costs are, and revenues are only remotely connected with services delivered, is proving economically disastrous.

Too often, economists dismiss such matters as farm budgets and project authority's cash flows as being beneath them — something for mere accountants to worry about. Farm budgets are indeed drawn up; the IRR could not be calculated without them. They appear in Volume 6, or some such place, in a large feasibility study. Because they are not regarded as central and fundamental, great constructions of economic analysis, shadow pricing, sensitivity

analysis, risk analysis, and now environmental impact analysis, are constructed on the shaky foundation of yield assumptions that simply will not be attained if the incentives and resources for good management are not in place.

Good management is connected to security of rights and authority. What has been said about farmers protecting land for the sake of their children obviously does not apply when they hold the land on lease. In some cases, the owner imposes conditions on management in the terms of the lease; this is normal, for example in the United Kingdom. It does not apply everywhere; it is not a condition in, for example, the leases of mechanised farmers in the Sudan, who have been described as following a mechanised shifting cultivation regime.

It is well known that the worst problems of degradation may occur on land that is not individually owned. Normally, degradation is less of a problem when a specific body of people have rights to use a specific area of land, since the corporate body normally also has rights of regulation. However, the corporate body can decay, or be effectively undermined, in changing circumstances. In some cases, a traditional authority once had recognised rights to regulate use of an area of communal land: perhaps a village based-authority, perhaps the elders of pastoral tribes. These are the third group of people who have responsibilities for rural natural-resource management. In some countries the traditional rights of specific communities and groups have been superseded by national laws declaring such land state property. However, if the state has not the means nor the will to enforce regulation, and if the power and authority of the traditional managers have been undermined, the result is that no-one carries out the necessary protection and regulation. All too often projects have assumed that because the state had declared its ownership, therefore a 'modern' system could be substituted, only to find that the new state authority has neither legitimacy in the eyes of local people, nor the means of enforcement. Once the powers of traditional authorities have been undermined, it may not be possible to restore them, though there have been examples of success.

The management of natural resources inevitably involves political issues, administrative capability, management incentives. One that I have not mentioned, but which has obvious importance in view of the importance of profit, is the regulation of prices and taxes

which affect the farmers' income.[16] We should remind ourselves that our science started out as *political economy*.

Nevertheless, we must not ignore such fundamentals as the economics of the firm — or farm. The management of the rural environment in such a way that it can cope with rapid population growth and rising expectations of welfare is a challenging task in which we have to work with the grain of rural people's aspirations. We certainly do not know all the answers — but we are more likely to find them in a return to realistic microeconomic analysis of the farm and the appropriate organisations, considered in the context of local resources and aspirations, rather than in the development of ever more sophisticated tools of economic analysis.

Research Needs

When we look at research needs, there appear to be glaring gaps, particularly on management issues. There has been little work on the budgetary and personnel policies of government departments. Some government services have no idea of the true costs of services, because personnel costs go under one general head in a Ministry budget, while operational and maintenance costs for a particular department are listed under another head. The department head may not know the staff costs of his service — yet the monitoring of operational costs in relation to staff costs is essential to prevent the common phenomenon of government staff without the equipment to work.

We also know comparatively little about how farmers and livestock keepers obtain the information that leads them to change their technology; we suspect this often derives from indigenous experiments and perhaps from the activities of voluntary organisations[17] and this ought to affect the way we plan extension and research services. We know comparatively little about how farmers and livestock keepers obtain the capital for farm improvements; perhaps the rural post-office which enables them to keep in touch with urban relatives and to transmit and receive money is more important than the government-sponsored co-operative. Too often any impact analysis which is done is confined to one activity, such as the extension services, without concern as to whether government money might have been better spent in an alternative way.

Since the project planning and financing requirements of lending agencies seem to have been little geared to sustainability, we need to take a hard look at the outcome of projects, and to see how this outcome was related to planning methods. It is good to note that the World Bank is now doing more impact evaluations on groups of related projects, and making these public;[18] this will help build the data base that we need from which to learn. The Overseas Development Administration makes most of its evaluations public, but could be encouraged to do more works of synthesis.

Comparison of the effectiveness of different types of activity in raising incomes and knowledge of resource management demands a type of research which crosses sectoral boundaries. ODI is now undertaking a study of this nature in conjunction with the University of Nairobi, by measuring how much the environment in Machakos District has changed since the 1940s under conditions of very rapid population growth, and then looking at the technologies and the institutional mechanisms which had the greatest impact in checking degradation and providing for the income needs of the population. It is hoped that the methodology generated can then be applied to similar studies elsewhere.

ODI's Agricultural Administration Unit has for the last fifteen years been focusing attention on management issues, particularly those at the juncture between farmers and government services. It has endeavoured to spread the knowledge of good practices through its research and through dissemination of its own work and that of other people via four networks covering irrigation, agricultural research and extension, pastoral development and social forestry. The networks contain both researchers and practitioners; it is the exchange of experience between the two that can lead to realistic improvements in rural planning.

Notes

1. Overseas Development Administration, *Appraisal of Projects in Developing Countries*. London: HMSO, 1988.
2. Mary Tiffen, 'Dethroning the Internal Rate of Return: the Evidence from Irrigation Projects', *Development Policy Review* 5(4), 1987, goes into more detail on the effects of the IRR and high discount rates. For more detail on the importance of designing with the local economy in mind see Mary Tiffen, 'The Identification of Crucial Socio-Economic and Institutional Parameters for the Design of Irrigation schemes' in Hydraulics Research, *Irrigation Design for Management: Asian Regional Symposium*. Wallingford, 1987.

3. The standard text is I.M.D. Little and J.A. Mirrlees, *Project Appraisal and Planning for Developing Countries*. London: Heinemann, 1974.
4. J. Price Gittinger, *Economic Analysis of Agricultural Projects*. Baltimore: Johns Hopkins University Press for the World Bank, 1972.
5. FAO, *Guidelines for the Preparation of Irrigation and Drainage Projects: revised version*. Rome: FAO/IBRD Co-operative Programme, 1983 and FAO, *Guidelines for the Preparation of Agricultural Investment Projects: revised version*. Rome: Investment Centre, FAO, 1985.
6. J. Olivares, 'The assessment of water resources projects involving economic, social and environmental costs and benefits: the World Bank's view', *Natural Resources Forum*, New York: United Nations, 1986.
7. H. Bergmann and J.M. Boussard, *Guide to the Economic Evaluation of Irrigation Projects (Revised Version)*. Paris: OECD, 1976.
8. For a discussion of the economic, social and institutional aspects of shifting cultivation, see *Institutional Aspects of Shifting Cultivation in Africa*, FAO, 1984 (main author Mary Tiffen).
9. H. Ruthenberg, *Farming Systems in the Tropics*. Third edition. Oxford: Clarendon Press, 1980. His judgement was substantially confirmed at an FAO/University of Ibadan seminar on shifting cultivation in 1982; to my knowledge there has been no major progress since, though there have been some advances for root crops and agro-forestry.
10. References to some of these methods will be found in Chapter 6 of M. Tiffen and M. Mortimore, *Theory and Practice in Plantation Agriculture: an Economic Review*. London: Overseas Development Institute, 1990.
11. J.E. Seve et al., *World Bank Drylands Management Study*. Washington, DC: World Bank, Economic Development Institute, 1989.
12. Bergmann and Boussard, *Guide*, op. cit. p.33.
13. Recently illustrated in a study of a scheme in Nyanyadzi: M. Tiffen, *Socio Economic Parameters in Designing Small Irrigation schemes for Small Scale Farmers: Nyanyadzi Case Study. Report IV: Summary and Conclusions*. Wallingford: Overseas Development Institute and Hydraulics Research, 1990.
14. L.E. Small et al., *Financing Irrigation Services: A Literature Review and Selected Case Studies from Asia*. Colombo: International Irrigation Management Institute, 1989.
15. Bergmann and Boussard, *Guide*, op. cit. p.73.
16. It is therefore very much connected with structural adjustment policies.
17. Paul Richards has been one of the leading researchers in the field of indigenous knowledge. For discussions and citations on the role of farmers in research see J. Farrington and A. Martin, *Farmer Participation in Agricultural Research*, AAU Occasional Paper No.9. London: ODI, 1988, and subsequent papers in ODI's Research and Extension Network. ODI is currently carrying out research programmes into the role of NGOs in agricultural technology development, and on the impact of NGO activities on rural production and incomes.
18. For example, Operations Evaluation Department, *World Bank Experience with Irrigation Development*, Report No.7876. Washington, DC: World Bank 1989, which relates to Mexican and Moroccan projects, and which will shortly be available in 'blue' covers, ie without restriction.

11: Project Planning and Sustainable Wetland Management

R. Kerry Turner

A large number of water resource projects — dams, irrigation schemes; drainage schemes and their related activities — initiated during the 1970s and early 1980s in developing countries have proved to be uneconomic. They were more expensive than originally envisaged in terms of capital construction costs and also yielded low returns when operational. They have also generated extensive costs in environmental damage. Large areas of wetland ecosystems have been and are being lost either as a direct result of conversion to more intensive agriculture, aquaculture or industrial use, or through more gradual qualitative changes caused by hydrological perturbation, pollution and unsustainable levels of grazing and fishing activities.[1]

These are very significant losses, as wetlands in aggregate provide all of the following functions/services: flood storage, flood protection, wildlife habitats, nutrient cycling/storage and related pollution control, landscape and amenity services, recreational services, non-use value benefits, agricultural and other commercial outputs, shoreline protection and storm buffer zones and extended food web control.[2]

Factors in the Wetland Loss Process

Disproportionately narrow methods of project appraisal have played a part in the process of wetland loss. Conventional cost-benefit analysis has often failed to include the full long-run

social (private plus external) costs of the projects under review. The total economic value of the natural wetland systems has not been adequately captured by the conventional appraisal process. The lack of an inventory of basic land evaluation data was and is a major constraint. But the over-utilisation of wetlands has been caused by a wider set of more fundamental factors — the presence of economic development, information failure, market failure and intervention failure — which underlie and condition the project appraisal process.

Thus planners have failed to appreciate the full economic value of conserved and/or sustainably managed wetlands. This problem of information failure has contributed to market failure as wetlands have suffered from both quality degradation induced by pollution and from over-exploitation because of their characteristic open-access nature. Intervention failure, inefficient and inconsistent intersectoral policy, has compounded the resource misallocation.

In parts of Africa, for example, water resource policy, involving dams and flow regulation, has contributed to wetland loss. Farmers utilising wetlands via flood recession agriculture have been badly affected. The result has been to force them onto more marginal land and, in turn, pastoralists on to smaller areas of grazing lands. Over-grazing and soil erosion risks are thereby increased. The Hadejia-Nguru wetlands covering an area of 30,000 ha of seasonably damp or flooded land in north-east Nigeria, and fed by the rivers Hadejia and Jama'are, are a good case in point.[3]

The Hadejia-Nguru floodplain is a multi-functional resource which has for centuries been a source of economic output value, based on the exploitation of natural capital assets through flood agriculture, small-scale irrigation, fishing, grazing and hunting. The floodplain supports a large population while still producing a surplus for trade. The economic significance of the area is increasing with time, particularly as drought affects the north of Nigeria. The floodplain is also of high value for nature conservation.

The rivers servicing the area lose flow as a result of evaporation, transpiration and the infiltration of river water into the Chad formation aquifer to recharge groundwater. But since the early 1970s there has been a general shortage of rainfall throughout the Sahelian zone and there seems to have been a reduction in the size of the river floods, a decline in their duration, a reduction in the area inundated and a general shortage of water. This flow reduction could have potentially serious negative implications both for the

traditional wetland activities and the supporting ecology. The floodplain also provides important dry season pastures which are used partly by nomadic people. Conflicts are, however, now developing over access to flooded areas as dry season agriculture intensifies.

The severity of the drought risks has been increased by decisions on water resource planning taken in the 1970s. Dams, large-scale irrigation and water-basin transfer schemes devised by river basin development authorities and government departments were based on data for the relatively wet period up to 1973.

The planning was also afflicted by a lack of co-ordination and communication between the various agencies, resulting in high capital cost but projects yielding low net benefit (intervention failure). Because of capital budget constraints the majority of the schemes were only partially completed or have yet to be constructed. This, it would seem, is just as well because full implementation of these schemes would not meet the internal water target needs, would desiccate the Chad aquifer along with the economic and ecological systems that depend upon it, and would reduce the traditional output value of the floodplain. Some 15,000 to 30,000 ha of traditional cropping, only minimally subsidised even when a recent pump installing programme is taken into account, would be threatened.

Nevertheless, the increasingly drought-prone area does still require a water resource plan. Long-term dams at Katin Zaki and Challawa Gorge would allow an operating regime (natural regulated reservoir releases) sufficient to service some large-scale and small-scale pump irrigation, but not at the expense of the floodplain wetlands system. There would be some adverse effects of this regulated regime because of a reduction in groundwater levels.

Devising a sustainable strategy for the area is clearly a complex task. Economic activities in the floodplain are closely integrated. Different households in the same village may use different economic strategies (farming, grazing and fishing) at different times as their resource endowment and external conditions change. As already noted, access to and rights over grazing and other resources have generated some conflict. This is typical of open-access multi-use resource systems. The economy of the floodplain is dynamic and is reacting to a combination of natural hazards, the implications of

water resource planning, changes in access and land tenure, and the influence of increasing urban trade.

Floodplain economic activities are, of course, fundamentally interrelated with the ecosystems of the area. Ecological conservation is a vital element in any sustainable development strategy and in the case of the Hadejia-Nguru floodplain zoning is required. Some combination of nature reserves, buffer zones and sustainable utilisation of the rest of the floodplain is needed, but will not be easy to ensure.

Principles for Sustainable Development

The Bruntland Report's definition of sustainable development as 'development that meets the needs of the present without compromising the ability of future generations to meet their own needs' is the Pareto criterion for establishing an increase in the overall welfare of society. In practical cost-benefit analysis this criterion is modified (to reduce its restrictiveness) in order to incorporate the idea of potential compensation. Thus there is an increase in potential welfare, if those who gain from a project are able hypothetically to compensate those who lose. But the idea of potential welfare, while being consistent with the criterion of economic efficiency, is not consistent with that of equity. An equity-orientated approach requires that compensation by gainers to losers must be actual.

Hence sustainable development requires that both equity and efficiency objectives are served through actual compensation (intra-generational and inter-generational) by means of the transfer of a non-declining stock of capital assets ('critical' natural capital,[4] 'other' natural capital and man-made capital). If future generations are not to be worse-off, then they require the same potential economic opportunities to achieve welfare as the current generation. The portfolio of capital assets (including, for example, the functions and services of ecosystems) must therefore be managed in such a way as to ensure these potential opportunities. The management process will not be costless and therefore such capital assets require correct valuation. It is also vitally important to make sure that these values (total economic value = use + existence + option values) are properly reflected in, and integrated via project appraisal methods and techniques into, economic policy.

As the Hadejia-Nguru wetlands example indicates, the sustainable usage of wetlands cannot be neglected in the context of the developing economy, although the conservation (i.e. the management of the rate of change in the ecosystem) of higher 'natural function and structure value' remains a national and international priority objective.

The highest-value wetlands represent 'critical' natural capital assets and should be retained in a natural/semi-natural condition and shielded from transformations that would degrade their quality or destroy them. In the developing economy context such conservation could have a high opportunity cost. If the Hadejia-Nguru wetlands are to be conserved, then key areas must be designated as strictly managed natural reserves. But compensatory and sustainable development options must be encouraged in buffer zones and elsewhere on the floodplain. *Fadama* rehabilitation with pumped irrigation may be an example of sustainable use, although care is needed to take into account possible conflicts between pastoralist, cultivationist and fishing interests.

In the case of low-value wetlands it may prove to be socially efficient to adopt a conversion option. The possibilities of wetland reconstruction and/or restoration may exist and in that case the concept of the shadow project, or environmentally compensating project, has much to recommend it.[5] The idea is that within the project 'portfolio' there should be at least one project that 'compensates' for the environmental degradation in wetlands generated by the other projects in the portfolio, to ensure the overall sustainability of natural systems. Wetland creation can be a protracted and costly exercise and in some cases is not possible at all. But wetland restoration is a more practicable possibility. To take just one example, the rehabilitation of Lake Fetzara in Algeria illustrates the case quite well.[6]

In the nineteenth century, the lake was an extremely important freshwater wildfowl asset. But it was completely drained in 1937 and lost most of its ornithological value. Since floods in the early 1980s, a sluice on its outflow canal has been closed in the winter to retain floodwater. This sustainable utilisation practice allows springtime irrigated agriculture downstream and supplies summer grazing around the lake, as well as flood protection in winter. From the conservation perspective the lake is now an important site for wintering waterfowl. If some water were retained all year round the site might again be suitable for breeding waterfowl and a

commercial fishery. Because of the open-system nature of wetlands an extensive approach to management is necessary. What are required, but will be difficult to achieve, are long-term, integrated river basin management strategies co-ordinated with national water resource and wetland policies. Failure will risk the loss of a sustainable wetlands stock.

Project Appraisal Procedures

To return to the original concern of this chapter — the 'inadequacy' of conventional project evaluation methods and techniques — four courses of action have received some support during the recent 'sustainability' debates:

(a) continue to use conventional cost-benefit analysis as a measure of economic efficiency. Equity considerations and a wide range of environmental impacts would not be incorporated into the monetised analysis. Environmental Impact Assessment (EIA) would be seen as an entirely separate procedure, producing quantified but non-monetary data to be channelled to decision-makers separately;

(b) adopt a modified 'extended' cost-benefit analysis as a measure of economic efficiency, but also encompassing equity considerations (including inter-generational fairness). The analysis would attempt to incorporate a diversity of environmental impacts and estimate their monetary equivalents. The distributional consequences of the project would be explicitly assessed. Distributional issues and sustainability constraints would be responded to not via discount-rate manipulation but by the use of compensating offsets (shadow projects). Compensation would therefore be actual (not hypothetical); the shadow projects should be fully costed and included in the analysis. EIA would be viewed as a complementary technique, providing the necessary database on impacts for quantification and eventual evaluation;

(c) adopt a radically modified cost-benefit analysis procedure in which pre-emptive environmental standards (for example, nature reserves, conservation zones, etc.) necessary to protect environmental assets would be set prior to any economic analysis. Once the standards had been set (on scientific, political, ethical and cultural grounds) economic cost-effectiveness analysis could be deployed to ensure practicability. EIA would play a leading role in the standard-setting phase;

d) abandon cost-benefit analysis and implement a 'strong sustainability' strategy. Policies aimed at the development of low-intensity economic activities and maximum nature conservation on a national basis would be favoured.[7]

Option (b) is the line of action supported in this chapter. Overall, a balance will have to be struck between wetland conservation, sustainable utilisation and conversion. The most appropriate type of management system (supported by the extended cost-benefit analysis appraisal procedure) for any particular wetland will depend on a flux of factors: biological conservation needs; the wetland functions and services requiring protection, and their value; regional economic opportunities; the subsistence needs of local people; adjacent land-use patterns; and the availability of environmentally sensitive aid flows.[8]

Notes

1. See R.K. Turner, 'Economics and Wetland Management', *Ambio*, 1990.
2. R.K. Turner, 'Wetland Conservation: Economics and Ethics' in D. Collard, D.W. Pearce and D. Ulph (eds), *Economic Growth and Sustainable Environments: Essays in Memory of Richard Lecomber*. London: Macmillan, 1988.
3. W.D. Adams and G.E. Hollis, 'Hydrology and Sustainable Resource Development of a Sahelian Floodplain Wetland', University College, London, 1988.
4. D.W. Pearce and R.K. Turner, *Economics of Natural Resources and the Environment*. Hemel Hempstead: Harvester Wheatsheaf, 1990.
5. D.W. Pearce, E. Barbier, and A. Markandya, *Sustainable Development: Economics and Environment in the Third World*. Aldershot: Edward Elgar, 1990.
6. A.C. Stevenson, J. Skinner, G.E. Hollis and M. Smart, 'The El Kala National Park and Environs: An Ecological Evaluation', *Environmental Conservation*, 15 (4), 1988.
7. R.K. Turner and D.W. Pearce, 'The Ethical Foundations of Sustainable Economic Development' in L. Freese (ed.), *Advance in Human Ecology*, Vol.1, Greenwich, Conn: AI Press, 1990.
8. R.K. Turner, 'Economics and environmentally sensitive aid', *International Journal of Environmental Studies* 35, 1989.

12: Natural Resource Management in the Sahel:Bridging the Gap Between Top-Down and Bottom-Up

Camilla Toulmin

This chapter looks at the variety of tenure systems currently in operation in the Sahelian countries, the contradictions between them, and the general difficulties faced in bridging the gap between local and national interests and capacities in the management of land, water, trees and grazing. It concludes with an assessment of current changes in resource management systems and the conditions for their effectiveness.

Tenure Systems Vested in the State

It is at the national level that formal tenure over a country's natural resources has been held since colonial times. This system stems from colonial legislation and has been subsequently modified following independence. In general, it has involved the nationalisation of land and water resources, while allocating rights of usufruct to traditional users. These rights usually refer to land currently under cultivation; by contrast, rights of farmers and herders to land in fallow and to traditional grazing territory are far less clearly defined, and in practice this has in many cases permitted the alienation of these resources from customary users. Formal ownership of the land by the state allows the authorities to gain access to particular pieces of land when necessary, for example to carry out an irrigation or mining project.

Parallel to state ownership of the land is the state's right and duty to manage and plan how resources should be used. In practice,

national and local administrators have rarely been able to carry out these functions effectively. The very large areas of land involved, their scattered populations, and the weak capacity of local administrations have combined to create a power vacuum on the ground. Local communities have lost the legal power to decide and enforce decisions about rights of access to local resources, yet this loss has not been replaced by a state-provided system at the local level able to ensure firm and fair allocation of rights when brought into dispute.

Tenure Systems Vested in the Community

The second system of tenure which exists in some form throughout much of the Sahel is based on the traditional pattern for managing resources found in much of Africa, whereby access to land is obtained through membership of a given community which has rights of custody over a given area. Generally such land rights are acknowledged to derive from settlement, so that the first families to establish a farming hamlet are the ones to exercise subsequent control over who may gain access to land. Traditional rules of tenure ensure rights of usufruct to land for so long as the household maintains its other obligations to the community by, for example, making the necessary religious sacrifices at the start of the farming season. Rights to resources other than land (such as water from communal village wells) may be contingent on membership of the community, while others (such as hunting) may require special authorisation by the appropriate body (such as the local hunters' association). Ownership is more tightly defined where a family has invested time and effort in raising the productivity of a particular resource; for example, families may claim ownership of certain trees in the village's woodland when they have been pruning these trees regularly, while ownership of a well is also usually attributed to the person or group responsible for having dug it.

These traditional tenure systems stem from pre-colonial times; nevertheless, their operation and acceptance has not always been free of conflict both internally and externally. Higher authorities could be called in to defend rights where these were not adhered to by others. Only within the central heartland of pre-colonial states were rights likely to have been firmly enforced, while on the edges there was much insecurity surrounding which communities had rights to what, leading to raids between opposing sides.

Tenure in Practice

Despite the state's formal right to manage all resources, in practice throughout much of the Sahel local communities continue to exercise some of the functions they held under traditional tenure. Local administrators, recognising the extreme weakness of their own resources, may leave communities to manage and police their own affairs. Communities themselves may do their best to avoid involvement with the local administration, even where there is a serious conflict, since to call in government is likely to lead to very heavy costs, in terms of payments to the appropriate officials and the ultimate fine which may be imposed on both sides to the dispute. However, in certain areas and increasingly throughout the region, all resources are coming under mounting pressure, particularly higher-potential farming and grazing land, trees and pastures in more accessible areas close to urban markets, etc. In these cases, where the stakes may be high and the returns to gaining secure rights of access great, the state is likely to intervene, to avoid conflict and to allocate rights according to certain principles. Officially, these principles usually refer to the ability of the person demanding the resource being able to put the land to good use (*'la mise en valeur'*), giving priority to those able to demonstrate access to labour, capital, and other resources. 'Making good use of land' tends to be interpreted to favour farming, rather than grazing. In this way, throughout dryland Africa, herders have lost access to prime grazing lands in low-lying areas (*fadama, bas-fonds, wadis*) to make room for dry season gardens, rice and wheat cultivation. Principles of allocation also benefit those able to manipulate and make use of contacts within the administration to acquire rights in priority over other potential users.

The main factors responsible for this increased pressure on resources, and the increasing disorder associated with their management and use, are common to most other areas of dryland Africa and include:

- the prolonged period of drought over the past 25 years;
- population growth and the expansion of the cultivated area, aided by the introduction of animal traction and mechanised farming techniques;
- rising levels of conflict and insecurity which have forced people

to concentrate in certain safer areas, where degradation intensifies while insecure areas are under-used;

- the lack of clarity regarding by whom and how decisions about land and water use are taken, due to the breakdown in traditional authority over the allocation of use rights and the government's incapacity to carry out these functions effectively;
- rising demand for certain commodities such as charcoal, fuelwood and fodder, and their increased commercial value.

Adverse Effects of Current Systems on Land Husbandry

The state's right to control and allocate land not currently under cultivation takes from local communities the incentive to manage and set aside land for sylvo-pastoral use and for future farm land. There is an increasing tendency for farmers to develop highly extensive forms of land use, and to demarcate for themselves a large area which they can demonstrate as being under cultivation, however rudimentary. Similarly, herders have felt it necessary to start cultivating land, in however vestigial a fashion, in order to demonstrate to the authorities that they have certain rights to a piece of land, since customary tenure of grazing land has rarely been considered to carry the same weight as that of farmland. These forms of land use are often highly damaging to the vegetation and soils, as land may be cleared of trees and the soil exposed but little viable crop cover developed, increasing risks of soil erosion.

The state also retains the right to appropriate and re-allocate cultivated land in some cases. The importance of this right has received considerable attention in the development literature, and in certain contexts it may prove a powerful disincentive to good land management. For example, on irrigation schemes, farmers usually have very weak rights of tenure which strongly discourage their investment of labour in improving the land. The general insecurity surrounding land tenure has been ascribed a primary role in explaining low levels of investment in land. However, other writers have maintained that in practice farmers have rarely been discouraged from making investments in manuring and in building soil conservation works by this lack of firm title, as they are confident that their rights to their farm land would be supported in the event of any conflict.

Tree tenure presents particular problems. In most countries, a tree can only be cut down on possession of a permit from the relevant authority, even when it 'belongs' to a particular person who either planted it or on whose land it is growing. This permit must be obtained from the forestry officer at the local government headquarters and usually costs a significant sum. Even those who have planted a tree must obtain an official licence to harvest it, in theory. In practice, of course, such legislation is not enforceable, but it is probably sufficiently discouraging to prevent some tree planting from taking place. The existence of this process and the accompanying legislation also provides an endless source of conflict between forest guards and local people, the former being able to impose substantial fines on the latter where there is suspicion of their being involved in woodcutting.

Pastoral land tenure has been the subject of great debate over many decades, with competing models for managing these extensive and highly variable resources. Solutions proposed in the past have ranged from privatisation through the development of ranches to attempts to allocate rights to a certain group of herders. Currently, tenure systems betray a mixture of open access regimes, particularly around public bore-holes, and more demarcated regimes where certain herders have been able to maintain some rights to control access to water and hence to surrounding pasture lands. In areas of particular value, such as the inner Niger Delta in Mali, remnants of the traditional pre-colonial system for controlling access to floodplain pastures have been used to establish a new model. However, here, as in other areas of high value, it is clear that establishment of contacts within the administration of this tenure system may confer unfair advantages in helping to guarantee prior access by certain herds to these high quality grazing lands.

The pastoral sector throughout the Sahel has been badly hit by successive periods of drought, the continued rapid spread of farmers into former grazing areas, impoverishment of herding families by the loss of their livestock capital and poor terms of trade, and the progressive involvement within the livestock sector of outside investors, leading to the loss of control over herds and pastures. Herders have not been able to defend their customary rights to grazing land against the incursions of farmers; in cases of conflict over land, judgement is almost always made in favour of cultivators. The formal ownership and management of water and pasture by the state have led to even greater problems of controlling

access and use of these resources than in farming areas, because of the vast areas involved and the practical impossibility of the government 'policing' access to water and grazing.

Cynics view the current situation regarding land rights and their lack of clarity as a conscious strategy by national and local decision-makers. Governments use the current anarchy in land management and use to justify continued central control, on the grounds that local populations are evidently incapable of managing their own resources. Local administrators help to create further chaos by arbitrary decisions and thus ensure that contesting parties will hope to obtain a decision in their favour by providing large bribes. Clear land legislation would damage the interests of these administrators by removing from them the power to allocate as they see fit. As far as pastoral tenure is concerned, any devolution of power over water and grazing to politically marginal pastoral groups is seen as very unlikely, as this would strengthen their autonomy, which is seen as a threat to the power of central government.

Policy Changes: Rhetoric or Real?

Since the early 1980s, governments and donors have talked increasingly of shifting to local communities the rights to manage resources within their territory. Government documents have set out policies leading to the 'responsibilisation' of farming and herding populations and all those involved have peppered their strategy and project documents with commitments to people's participation in the design of projects and in managing their resources. All this seems very encouraging. Work is proceeding on the definition of land tenure codes in several countries which it is hoped will provide the legal basis for communities to plan and manage how they use their land, with the guarantee, in theory, that the state will enforce their rights should they be contested. Several countries have begun pilot schemes for the management of village lands.

However, there are still many questions about this process of shifting responsibility and power to local communities which need to be considered. It must also be recognised that devolution of control to the local level is no guarantee of fair access rules and wise decision-making, and begs a number of questions, which include the following:

(i) At what level is the local community to be defined — the village, or a group of villages, the herding camp, or herders' associations? Must new structures be set up or can control be vested in existing social organisations? Given the heterogeneous nature of all communities, is there a representative body at the local level able to manage and control access to resources fairly?

(ii) If power to manage resources is vested in each village or herders' group, what support will they need from local government to provide, first, the rapid and effective enforcement of their rights when these are brought into question and, second, the technical support and skills required to make the most of these resources? Can local government provide this support? Often it will not be able to.

(iii) The interests of local communities and national government may not always coincide. Examples include land of great economic or strategic interest to the state, or of outstanding natural or scientific value. Whose interests should receive priority and how should this be decided? Management structures need to be evolved which bring together local representatives and national government to agree on management rules in cases of this sort. A particular case where local and national interests are at odds concerns the settlement of migrant farmers moving from one part of the country to another in search of better land. For example, the cotton-growing region of Burkina Faso has seen a huge in-migration of farmers from drier zones further north. As a result, many villages have seen their reserves of fallow and grazing land swallowed up. What rights should indigenous populations have to set the terms on which outsiders can obtain access to their land, water, trees and pasture? And if indigenous populations do not have firm control over rights of access, what incentive do they have for investing in the careful management of these resources?

A pessimistic view of the trend towards 'responsibilisation' of local communities might see various forces at work, such as the following. Governments have been pushed by donors to talk about greater participation by their populations in the development process and in the management of their own resources. The 'new conditionality' and pressure for multi-party democracy now coming from many bilateral funders are further recent trends in this direction. However, governments have become skilled in handling the development discourse and in emphasising the terms and approaches currently in vogue amongst donors. In reality,

governments have made little if any progress in transferring real power away from the centre. The only 'responsibilisation' that will take place, according to this view, is likely to concern cases where the state can divest itself of certain costly obligations, for example by transferring responsibility for maintenance of bore-holes to pastoral associations, and by handing over the role of maintaining irrigation schemes to water user groups. 'Responsibility' for funding maintenance costs is unlikely to be rewarded by the transfer of real decision-making powers where these run counter to current or future interests of the government.

A more generous interpretation of current policy in much of the Sahel sees a growing number of government officials becoming increasingly aware of the need to find solutions to land tenure issues and to develop a closer dialogue with their populations. Transferring rights and responsibilities back to local users may be the beginnings of a solution. However, it is a solution which still requires an important role for local and national government in the guaranteeing and enforcement of rights, in the technical support needed and in the balancing of local versus outsider and national interests. The experience of the next few years should establish whether there is the political will necessary at national level and the resources available from the donor community to enable such changes in resource management by local users to work effectively.

V. URBAN AND INDUSTRIAL PROBLEMS

13: Urban and Industrial Environmental Policy and Management

David Satterthwaite

Introduction[1]

While recent years have seen encouraging signs among various aid agencies of a greater interest in urban problems, what is less encouraging is the current level of understanding about urban change and urban problems (including urban environmental problems) among many researchers and many of the staff of aid agencies.

For some thirteen years, my research programme has monitored the policies of aid agencies towards urban problems and the scale and nature of allocations of development finance to these problems. From this work and from discussions with staff from aid agencies, it appears that few have a clear and well-defined policy on urban problems. Some agencies have a good justification for this; for instance, that their aid programme is heavily concentrated in the poorest (and most rural) nations and this means a low priority for urban problems. Others have good reasons: for instance, that they have found rural problems easier to deal with, perhaps most especially since many of their staff are trained in some form of natural-resource management and rural problems have appeared to be soluble through rational 'good science'. Other agencies justify their lack of involvement by recourse to inaccurate and misleading stereotypes — for instance that 'urban populations already benefit from urban bias' (a point to which this chapter will return) or that 'rural development will help slow the growth of urban areas and

thus diminish urban problems'. Perhaps there is a little of the rural romantic in all of us.

This chapter seeks to outline some deficiencies in our knowledge of environmental problems in urban areas and of urban change. A final section discusses some ways and means of addressing these.

Environmental Problems

Existing documentation about environmental problems in the Third World often gives scant attention to problems in urban areas or to the linkages between what are perceived as rural problems (for instance, deforestation and soil erosion) and urban-based consumption and production. For instance, many of the 'environmental profiles' produced by Western aid agencies on Third World countries give little attention to problems in urban areas, even in nations where half or more of the population live in urban areas.

Most of the documentation available in the West about environment problems in Third World cities also has a somewhat narrow perspective.

(i) **Almost all the documentation about urban environmental problems is about environmental problems in the largest cities.** What little documentation exists on problems outside these cities suggests that they deserve more attention since they include a substantial proportion of the urban population of most nations and their inhabitants suffer from serious environmental problems, mostly linked to inadequate and contaminated water supplies and inadequate provision for safe disposal of excreta. There are also the special problems faced by those living in urban centres with high concentrations of agro-industries or heavy industries which have developed outside the larger cities.

(ii) **Most of the documentation about environmental problems is about 'environmental problems as viewed by the West'.** Measurements for levels of air pollutants such as carbon monoxide, sulphur dioxide, the oxides of nitrogen, airborne lead and particulates are easier to obtain than measurements of drinking water quality.[2] Yet the impact of contaminated drinking water on mortality and morbidity is likely to be much greater than that of air pollution. Figures for per capita fuel consumption are more common than figures for per capita water consumption and yet the quantity of water available to a household and the price which has to be paid

can be as important to their health as water quality.[2] The collection, disposal and management of industrial solid and liquid wastes often receives more attention than the collection, disposal and management of human excreta, when the inadequate provision for managing the latter is known to have a far more serious and widespread impact on human health.

The influence of Western concerns can also be seen in the problems which Western sources choose to highlight. For instance, stress is often laid on the loss of agricultural land to urban development. Although, in certain unusual circumstances, this might be justified (for instance, the case of Egypt with such a tiny proportion of its land area cultivable), in most nations it cannot be ranked as one of the main environmental problems since the proportion of agricultural land lost is so small. In addition, 'urbanised land' on many city peripheries may have a much higher and more valuable production of foodstuffs than high quality agriculture (see, for instance, a recent study on the scale of food production in urban areas of Kenya and its importance to the income and nutritional status of low-income families).[3]

One explanation for this is the separation in the West of what might be termed 'environmental health' problems from 'environmental' problems. In the West, environmental health problems linked to contaminated water supplies, poor sanitation and inadequate drainage and garbage disposal were no longer the key environmental issues when, in the late 1960s and early 1970s, Western governments were pushed into taking action to safeguard the human environment. In the West, the new ministries or agencies for environmental protection did not need to direct their attention to the installation of piped water systems, sewers and storm drains or to a health care system which sought to limit the damage done by the lack of these. It seems that Third World governments drew heavily on the Western models and precedents (no doubt advised by Western consultants), with inadequate attention to what were the most pressing environmental problems in terms of impact on human health.

(iii) **There is still a tendency to view environmental problems in cities as 'general city-wide problems' with little disaggregation in terms of which groups of people suffer most from these problems.** Per capita water consumption figures for a city may suggest a satisfactory level of supply, whereas a comparison of per capita supply figures between rich and poor areas reveals a small

elite very well served and half or more of the population very inadequately served. For instance, in Mexico City, just 9% of domestic consumers account for 75% of all consumption.[4] Once some disaggregation is made in terms of who is worst served or most affected, attention must be given to the reason why. Poorer households' unstable and inadequate incomes and inadequate diets underlie their poor health and low resistance to many diseases. Low incomes underlie their inability to move away from dangerous and polluted residential areas. The World Health Organisation suggests that in many of the poorer and worst served residential areas of cities, a newborn baby is 40-50 times more likely to die before the age of five than a baby born in Europe or North America, and the main cause or a major contributing factor to virtually all the difference can be attributed to the unhealthy or dangerous living environment.[5] Perhaps more telling than this is the fact that a baby born to a middle- or upper-income household in the same Third World city often has 1/20th to 1/40th the risk of dying before the age of five.

(iv) **Environmental problems in urban areas are often considered in isolation from environmental problems in rural areas, though many rural environmental problems can only be understood (and effectively acted upon) when the rural-urban links are understood.** The demand for rural produce or resources from city-based enterprises and households can pre-empt their use by rural households. For instance, in cities where wood and charcoal are still widely used for cooking and heating (mostly by lower-income households), city-based demand often pre-empts supplies formerly used by rural inhabitants. High demand from cities for fuelwood may be a prime cause of deforestation (and the soil erosion which usually accompanies it) and this may be taking place at considerable distances from the city. Electricity demand in cities can also cause problems for rural areas. The environmental impacts of large hydro-electric dams, such as the loss of agricultural land and the resettlement of rural people (to make way for the reservoir) and the introduction or exacerbation of water-borne or water-related diseases, are usually 'rural', even if most of the electricity will be consumed in urban areas. There is also the environmental impact of wastes from city-based consumption and production which affect rural areas, including water pollution (which often damages local fisheries), solid waste disposal (which may

contaminate groundwater used by farmers and rural inhabitants) and air pollution (which may be linked to local acid rain problems).[6]

(v) **A tendency to generalise when the scale, nature and relative importance of different environmental problems, their causes and their impacts differ so much.** This is a point developed in greater detail below in the discussion of our level of knowledge about urban change.

Urban Change

While many aid agencies have been slow to consider their role in addressing urban problems, part of the reason may be the many 'urban proponents' who exaggerate the importance of urban issues over rural issues and mis-direct attention as to the location and nature of 'urban problems'.

The main deficiency in knowledge about urban change parallels that about environmental problems: the lack of detail about change within each particular city and urban system and the lack of specificity in identifying the social, economic and political factors which underlie such change. A good knowledge of urban trends in the Third World can only come from dozens (or even hundreds) of detailed city-level and national-level studies. But even where these exist, they are rarely used by those who write general works about urban trends in the Third World. Below are a few examples.

(i) **International comparisons for city populations or growth rates or levels of urbanisation are not based on comparing like with like.** The differences in the criteria used by governments to define their 'urban population' and the boundaries for cities are sufficient to limit the validity of international comparisons for levels and rates of urbanisation and for city populations and population growth rates.

To consider first the criteria used to define urban populations. Some governments define all human settlements with more than a few hundred inhabitants as 'urban centres'; others consider as urban only those settlements with 5,000 or more inhabitants. Since, in many nations, a substantial proportion of the national population live in settlements with between 500 and 5,000 inhabitants, these would be 'urban' in some nations and rural in others.

For instance, in Peru in recent censuses, 'urban centres' are defined as populated centres with 100 or more occupied dwellings. India, considered a predominantly rural nation, would be a highly

urbanised nation if its government chose to adopt this criterion, since most of India's rural population live in settlements with 100 or more occupied dwellings. If the Indian Government did make this change, this in turn would significantly affect the world's level of urbanisation. Indeed, the governments of India and China could, between them, make the world's population more than half urban today or significantly less urban by changing their urban criteria. Any nation's level of urbanisation can be changed substantially by altering the urban definition; thus, in 1976, Bolivia's population could be considered 32% urban if urban centres were settlements with 20,000-plus inhabitants or 43% urban if urban centres were settlements with 2,000-plus inhabitants.

One of the problems with comparisons between city populations or population growth rates is the differences in the ways in which boundaries are defined. Population figures for some cities include everyone living in a city region of several thousand square kilometres. For other cities, population figures only include those people living within an area of perhaps 30-60 square kilometres in the central core of a city region defined by old city boundaries over which the city population has long overspilled. In the first instance, official figures overstate the population since the boundary encompasses large areas of agricultural land and substantial numbers of rural inhabitants. One example of this is the figure of over 10 million inhabitants commonly cited for the Shanghai urban agglomeration. This figure is actually the population in an area of over 6,000 square kilometres which includes large areas of highly productive agriculture and many villages and agricultural workers.[7]

In the second instance, the population is understated. Take the example of Colombo in Sri Lanka whose population is often quoted as being around 600,000, with a comment that this is relatively small for the largest city in a nation with more than 16 million inhabitants. But these 600,000 inhabitants live in an area of 37 square kilometres. If Colombo's population was measured according to a city-region of some 1,800 square kilometres, it would be some 4 million inhabitants. If it was measured according to an urban core of 235 square kilometres, it would have a population in excess of 1.3 million inhabitants.[8] Colombo's rate of growth in recent decades also varies greatly, depending on which of these definitions is used.

Different statistics exist for the population of virtually all large cities — based on different boundaries — but most statistics are reported with no comment as to which boundary has been used.

For example, for Metropolitan Manila, in the Philippines, in 1978, there were at least eight different definitions in use by different government agencies, all of which gave different figures for the Metro Manila population.[9] For Dhaka, Bangladesh, population statistics may refer to the historic city (5.6 square kilometres), the metropolitan area (414 square kilometres), the Statistical Metropolitan Area (1,121 square kilometres), Dhaka Sadar subdivision (1,601 square kilometres) or the District (7,459 square kilometres). A study of Metropolitan Dhaka in 1981 chose yet another boundary which differed considerably from all these.[10]

(ii) **The lack of data.** The most serious deficiency for any commentary on contemporary urban change is the fact that the latest population data available for most nations derive from censuses held in the late 1970s or the first two years of the 1980s. This prevents any general picture of how urban change has been affected by the recession that hit most Third World nations during the 1980s or by the increasingly serious nature of the debt crisis.[11] Virtually all urban statistics for 1985 or 1990 in statistical compendia are based on projections from earlier census data. It is by no means clear that such projections will prove accurate, as will be discussed below. There are even more serious problems for particular nations; for instance, figures for Nigeria's urban population are based on projections from the 1963 census, since (at least until very recently) that was the last reliable census. Without accurate figures for Nigeria, no accurate figures can be given for urban trends in sub-Saharan Africa because Nigeria has around a quarter of the region's population.

(iii) **The myth of most or all urban centres having rapid population growth rates.** Urban researchers or writers who generalise about urban change in the Third World tend to focus on a relatively small sample of 'rapidly growing cities' and to presume that growth rates in this sample are representative of what is happening in all urban centres. We have lost count of the number of documents which still describe current rates of urban growth as 'unprecedented' or cities' populations as 'exploding'. It is hardly valid to derive cities' current population figures from extrapolations of populations and population growth rates in the 1950s and 1960s and then to claim that urban growth rates are still very rapid. Analyses of census data suggest that many of the Third World's major cities experienced their most rapid rates of population growth during the 1950s and 1960s while most large Latin American cities

experienced their most rapid population growth rates in the late nineteenth or early twentieth centuries. Certain more detailed city or national studies are also showing how many large cities are growing more slowly in recent decades.[12] In Latin America, where IIED's Human Settlements Programme is currently undertaking an analysis of long-term urban trends, and drawing from over 250 different censuses in doing so, it is possible to produce a table of thousands of urban centres which, in the last inter-censual period for which data are available, had strong net out migration, while hundreds experienced declines in population. If a nation like Colombia with some 28 million inhabitants in its last census has over 600 urban centres with enormous diversity in their inter-censual population growth rates, and (perhaps more surprisingly) a weak correlation between urban centres which grew most rapidly in the last and the previous inter-censual period, it cautions against generalisations about urban change in just one nation, let alone generalisations for the 'Third World'.[13]

(iv) **The assumption that rapid urbanisation will continue up to the year 2025 and beyond.** Most documents about urbanisation in the Third World claim that 'half the world's population will be urban by the year 2000', while some even suggest that 'half the Third World's population will be urban by the year 2000'. We have never discovered the basis for the latter prediction. For the former, the basis was projections which assumed that rapid urban growth rates (and increases in urbanisation levels) evident during the 1950s and 1960s would continue throughout the period 1970-2000 or even 1970-2025. But analyses of the factors which underpinned rapid urbanisation in most Third World nations during the 1950s and 1960s suggest that these are no longer present, or are acting with much less force.[14] Data from many censuses taken in the years 1978-85 have also shown that many cities and metropolitan areas grew substantially more slowly in the latest inter-censual period than that projected in earlier years. Estimates and projections by the United Nations Population Division as to when the world will become 'half urban' have been pushed well beyond the year 2000 in their more recent documents.

Some historical examples suggest the need for caution in making long-range projections based on extrapolating past trends into the future. Extrapolating trends in urban population growth in China from 1949 to 1960 to give a guide as to what would happen in the next 40 years would make China's population 100% urban before

the year 2000 and could hardly provide a useful indicator of future trends after 1960, since the proportion of China's population in urban areas declined between 1961 and 1976.[15] Extrapolating population growth in Sao Paulo from its growth from 48,000 inhabitants in 1886 to 484,000 in 1916 would have given it a population of some 48 million in 1976,[16] more than three times its actual population by that date. Projections made for Calcutta during the 1970s suggested a population of 40-50 million inhabitants by the year 2000, and yet recent estimates suggest a figure of less than 15 million.[17]

These may seem extreme examples to use in questioning the value of future projections, but United Nations projections published in 1980 for cities such as Dar es Salaam (Tanzania) or Nairobi (Kenya) seem just as unreal. Even someone with a relatively unsophisticated knowledge of Tanzania's economy and potential for urban development would find it hard to imagine sufficient economic change to sustain a city of 4.6 million people in Dar es Salaam by the year 2000.[18] The obvious questions are — on what will they live and how will they be fed? People will not move to Dar es Salaam if there is no chance of an income or of food. For comparable reasons, suggestions that Nairobi will grow from under one million inhabitants to 18.9 million inhabitants between 1980 and 2025, as projected by the United Nations in 1982, must be treated with a measure of disbelief. Population projections far into the future assuming constant rapid urban growth are even made for cities such as Beirut or Maputo where economic or political circumstances dictate a very uncertain urban future.

(v) **The over-concentration on the mega-city.** Much of the general literature about urbanisation in the Third World concentrates on the problems of large cities, and it is common to find claims that a high proportion of the Third world's urban population live in 'mega-cities'. Yet drawing on the most recent census data available, we estimate that less than 2.5% of the Third World's population actually live in cities or metropolitan centres with 10 million-plus inhabitants. There are also good grounds for questioning whether many existing 'mega-cities' will continue to grow rapidly or (as noted above) whether many new mega-cities will emerge. Many British geographers in the 1930s were obsessed with the fact that London was going to grow to an unmanageable size and yet the population within the Greater London Area peaked around 1940 and has been in decline ever since. Most urban specialists in Europe

and North America were also caught unawares in the 1970s when evidence began to grow of fundamental changes in urban trends — which are usually termed 'counter-urbanisation'.

Three points are worth stressing: first, that many of the predictions for the growth of mega-cities are unlikely to be realised; second, that a high proportion of the urban population in most Third World nations live outside large cities; and third, that a concentration on urban growth rates misses more significant changes and re-arrangements of production within urban systems and core regions.

Table 13.1 gives examples of the proportions of national populations and national urban populations living in small and intermediate urban centres. It shows how a lot of urban citizens do not live in large cities — even if the trend in most nations has been towards such increased concentration, at least until recent years.

Perhaps the most basic failing in most studies of urban change is the failure to establish a detailed understanding of the social, economic and political factors which underlie it. Such an understanding gives a stronger basis for predicting urban change in the future. Ironically, as such knowledge improves, it will probably discourage long-range predictions as urban change is understood to be a result of many factors. It will be shaped by changes in the location, type and scale of productive activities, by changes in GDP and by changes in the distribution of income. Few would consider it appropriate to predict how these will change over the next forty years in any nation and yet, without this, predictions of urban change are hardly grounded in substance.

Some of the most interesting papers on urban issues in recent years are those which explore the relationships between urban change and social, economic and political change. These reveal more complex, nation/or region-specific patterns, although the consolidation of core regions around major metropolitan centres with declining populations in city centres has become common in many of the Third World's most industrialised nations. The key urban issue is not so much the growing mega-city but changes in urban systems and the complex interactions between the different centres of population concentration within the systems. More detailed city-specific or nation-specific studies have also helped researchers recognise new urban forms which are particular to the social, economic and political structure within which they occur.

Table 13.1: Proportion of national and urban population in small and intermediate urban centres (selected nations)

Country	*% of national population in small and inter-mediate urban centres*	*large urban centres*	*% of urban population in small and inter-mediate urban centres*	*large urban centres*
Kenya (1979)	7.5	7.7	49.5	50.5
Sudan (1973)	12.3	5.3	69.0	30.1
Tanzania (1978)	8.7	4.6	65.9	34.0
India (1981)	16.8	5.8	75.5	24.5
Pakistan (1981)	17.4	10.4	61.5	38.5
Colombia (1985)	40.5	30.7	56.9	43.1
Cuba (1981)	46.3	19.8	70.0	30.0
Ecuador (1982)	23.7	25.6	47.9	52.0

Source: Condensed from 'Outside the Large Cities', Chap. 9 of Hardoy and Satterthwaite, *Squatter Citizen.*

Note: Cross-country comparisons are invalid since the choice as to which urban centres are 'large' is made within the urban context for each country.

One example is the 'ruralisation of African Cities', as outlined by Richard Stren.[19]

> ..as African cities continue to grow under conditions of economic stagnation or even absolute deterioration, they take on more of the qualities of their rural hinterlands. Some of the evidence for this.....includes the increasing importance of urban agriculture, the weakening of effective land use controls and the more diverse utilization of urban space, the spread of 'spontaneous' settlements and of petty commodity production, the deterioration of formerly high standards of urban infrastructure and services and the maintenance (perhaps even the strengthening) of rural economic links and regional cultural identities on the part of the urban migrants. As the institutions of urban management respond — albeit haltingly and incrementally — to the inevitability of these profound changes, the special qualities of the African city become institutionalised and its distance from the colonial past becomes more pronounced. In the years ahead, a primary task for African researchers will be to study both the changes themselves, and the adaptation of formal institutions to the new reality.

Other researchers have documented what might be termed the 'urbanisation of rural areas' as a result of very different economic and social changes.[20]

(iv) **Urban bias, large city bias or rich-inhabitant-powerful-enterprise-in-large-city bias?** One of the reasons given for little attention to urban problems is the concept that urban centres and their inhabitants already benefit from urban bias. Much of the literature about development in the last fifteen years assumes that there is an 'urban bias' in the policies and expenditures of governments and aid agencies. This was the view suggested by Michael Lipton's *Why Poor People Stay Poor: Urban Bias in World Development* first published in 1976[21] and this has been accepted as 'conventional wisdom' by most people.[22] With the discovery in the early 1970s that economic growth was not necessarily lessening poverty — and in some instances, seemed to contribute to more poverty — explanations were sought and 'urban bias' seemed to be one valid explanation. If there is urban bias in most government policies, it greatly weakens the case for more attention to urban problems since it implies that governments and aid agencies already favour people living in urban centres over those living in rural centres.

It is worth considering the evidence: Do urban dwellers or urban governments receive more national government resources, programmes and subsidised goods and services than rural dwellers? Studies of the urban population living outside the large cities suggest little or no evidence that the inhabitants of most small and intermediate-sized urban centres benefit from any 'bias' in their favour. Indeed, most small and intermediate urban centres seem to have been as starved of public investments and as ignored in public programmes as most rural areas. In most instances, their governments have been progressively weakened. Very few small urban centres have benefited much from public provision of basic services; indeed, their inhabitants' access to safe and sufficient water supplies, schools and health clinics usually seems as inadequate as that of most of the rural population. Many governments do depress the price that farmers receive for their crops — either to provide tax revenues or to keep food prices low in urban areas. But so many people in small and intermediate urban centres depend on the demand for goods and services by farmers and agricultural workers that low crop prices also lower their incomes. Although there is insufficient information to ascertain precisely the extent to which

the populations of small and intermediate urban centres have or have not benefited from government expenditures and policies, at least there is sufficient evidence to cast doubt on the idea that their populations benefit from 'urban bias'.

Perhaps the concept of 'urban bias' should be amended to become 'large city bias' or 'capital city bias'. Certainly, many government policies directly or indirectly subsidise consumers or businesses in capital cities or other large cities. Most of the evidence presented by those who write about 'urban bias' is drawn from a comparison of rural areas with capital cities or large cities. But the key question is — does all, most or some of the population in large cities benefit from this bias? The (limited) statistics that exist on health problems among lower-income groups in large cities imply that they are not healthier than rural populations; indeed, in some instances they have substantially higher rates of infant mortality or infection from serious disease. Perhaps in some nations, the poorest households in large cities have worse health problems than the poorest households in rural areas.

Large cities do appear to have benefited from many more public services — for instance the concentration there of investments in hospitals, water supplies, sewers and drains. But what proportion of the population in each city actually benefits from these investments? In many large cities, a considerable proportion of all households receive no benefits. Large hospitals, doctors and other medical specialists may be concentrated in large cities but this does not mean that they provide medical care to poorer households. Poor households paying water vendors 10-20 times the price paid by middle-income groups for a litre of water are unlikely to be benefiting from 'bias'. City-dwellers may have access to subsidised food. But for those living in illegal settlements, it may be impossible to obtain the ration-card to obtain the cheap food because obtaining such a card requires residence at an official, legal address. In many nations, heavily subsidised public housing or serviced site schemes have been built in large cities but a small section of middle- or upper-income households are usually the main beneficiaries. Subsidised credit is often provided for house construction or purchase but, again, poorer groups rarely meet the criteria which govern who is eligible. Many industries and businesses in large cities are indirectly heavily subsidised in that the government does not enforce regulations to ensure that they protect their workers from unsafe conditions and over-long working hours and does not

enforce pollution controls. But, again, poorer households receive no benefit from this and many bear a heavy health cost from such a 'bias'. Subsidies on health care and education may favour 'urban citizens' over 'rural citizens' but does this bias favour all urban citizens?

Thus, the bias in most governments' public policies, investments and services may largely be only in favour of the better-off inhabitants and more powerful industrial, commercial and financial concerns. Even if some poorer urban households do benefit from some subsidies — for instance, cheap food — the benefit may be nullified as the businesses that employ them reduce wage levels because food is cheaper.

If, within a nation, the better-off inhabitants and the more powerful industrial, commercial and financial concerns are concentrated in or close to large cities, this will appear to be 'large city bias', unless consideration is given to who benefits. It may also be that in certain urban centres — (especially the largest) — in certain nations, workers' organisations and associations of community leaders from illegal settlements have successfully organised and received some concessions from government. As such, they are beneficiaries of some 'bias'. But we suspect that this is unusual and that the concessions made to these groups are rarely sufficient to compensate for biases against them in other areas of public policy.

If there is no 'urban bias' or 'large city bias' but 'bias' only favouring the more important businesses and upper- and some middle-income households in larger cities — and too few studies exist to determine whether this is the case — the case against government investments in urban areas is greatly weakened. But the case for more investments rests on meeting the needs of poorer groups in urban areas and in building government capacity to do so. In fact, much of what the authors writing about 'urban bias' recommend, i.e. the need for rural policy to concentrate on more equitable land-owning structures and more attention to the needs of small farmers, would also help promote a more decentralised pattern of urban development; prosperous intensive agriculture where land ownership patterns are relatively equitable can prove a very powerful stimulus to urban development and economic diversification within small urban centres.[23]

Some Ideas for a Research Agenda

Three of the most essential elements in promoting action by governments on environmental problems in their cities are:

(i) an understanding of the scale and nature of environmental problems within each city and its surrounds, and some indications of their ranking in terms of impact on human health and damage or depletion of the natural resource base;

(ii) a more disaggregated view of who suffers and who benefits from current government policies and expenditures (or lack of them); and

(iii) constant pressure on government and on the major polluters to act. Of course, a fourth is ensuring that local government has the capacity to act.

On the issue of who suffers most from current environmental problems, research must go beyond 'rural-urban' comparisons. Figures on infant mortality in 'urban areas' may be lower than those for rural areas, so the assumption is made that the urban population is better-off than the rural population. But there are likely to be far more significant differences in infant mortality rates between richer and poorer urban districts within the same city or between richer and poorer rural districts. There are likely to be even more significant differences between richer and poorer income groups. There is such diversity between different rural areas and between different urban centres that aggregate statistics 'for all urban centres' or for 'all rural areas' are very misleading. To identify the people most in need of government services and support, one must look in far more detail; for instance, by district within rural areas and by neighbourhood within urban centres, since some rural districts will have few poor people while some urban neighbourhoods have a high proportion of poor people, even if the urban centre of which they are part is rich and well served. Then within these districts and neighbourhoods, the identification of those most in need must consider income and gender, since, within districts and neighbourhoods, it is the poorer households and within households it is usually the women and children whose needs government programmes most often fail to meet.

On the issue of who benefits most from current government policies, one critical area for research is separating out who benefits and who loses out from government services and subsidies and from lax laws (or their enforcement) in regard to pollution. It may

be that the major industries and commercial and financial businesses get all the advantages (the water they need, telephones, electricity, solid waste collection, sites with drains) for which they are charged below the real cost of their provision. Their operating costs are kept down by no controls on their pollution of the air and of local water bodies and no checks on their disposal of solid and liquid wastes. Their labour costs may be kept low by little or no government provision for, or enforcement of, health and safety and minimum wage laws. Meanwhile, their taxes are kept low because government spends very little on ensuring adequate housing and living conditions for the city's population.

Outside agencies can bring knowledge, expertise, capital and advice but they cannot solve problems without effective local institutions. Each Third World city has its own unique problems; it is only our lack of knowledge about Third World cities which has produced so many generalisations about them. Third World cities are too diverse and their environmental problems too rooted in local social, economic, cultural and political circumstances for outsiders to be able to provide the diagnosis and the basis for action, even if outsiders can provide valuable help in the tools and methodology for making the diagnosis.

A research agenda to address Third World cities' environmental problems should concentrate on support for local research institutions and pressure groups (for instance, consumer groups and NGOs). In many instances, this will mean helping to develop their capacity to document the scale and nature of environmental problems. Perhaps one of the more important research areas is the methodology for relatively quick but comprehensive surveys of environmental problems and the identification of indicators and the means for their measurement which equips local groups with greater capacity to measure and monitor.

Such a research agenda is unusual in that not only is it seeking to provide the knowledge on which policy-makers can act but also to strengthen the institutions most likely to put pressure on government and on polluters to act. The pioneering work of such Third World NGOs as the Centre for Science and Environment in India, and the Consumers Association of Penang and Sahabat Alam in Malaysia also gives an indication of the sort of institution which can be effective.

Notes

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12. For instance, see Nigel Harris, 'Some Trends in the Evolution of Big Cities', *Habitat International* 8 (1), 1984.
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14. See Chap. 8 of Hardoy and Satterthwaite, *Squatter Citizen*, op. cit. for more details.
15. R.J.R. Kirkby, *Urbanization in China: Town and Country in a Developing Economy, 1949-2000 AD*. London: Croom Helm, 1985.
16. Derived from census statistics presented in a fact sheet on Sao Paulo

City, 1985, prepared by the Municipal Planning Bureau, City Hall.

17. Statistics drawn from United Nations, *Calcutta* in the series of monographs on 'Population Growth and Policies in Mega-Cities', Population Policy Paper No.1, ST/ESA/SER.R/61, New York, 1986.
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20. See for instance Gavin W. Jones, 'Structural Change and Prospects for Urbanization: South-East and East Asia with special reference to Indonesia', paper prepared for the Conference on Urban Growth and Economic Development in the Pacific Region, Tapei, quoted in Dean Forbes and Nigel Thrift, 'International Impacts on the urbanization process in the Asian region: a review' in Roland J. Fuchs, Gavin W. Jones and Ernesto M. Pernia (eds), *Urbanization and Urban Policies in Pacific Asia*. Boulder, CO and London: Westview Special Studies on East Asia, 1987; and the suggestions for new classifications in T.G. McGee, 'Urbanisasi or Kotadesasi — the emergence of new regions of economic interaction in Asia', Working Paper, Environment and Policy Institute, East-West Center, Hawaii, April 1987.
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VI. SOCIAL DIMENSIONS: POPULATION, GENDER AND THE ENVIRONMENT

14: Gender and Environment: Ideas for Action and Research

Joan Davidson

Background

The relationship that most poor women have with the natural environment is both distinctive and largely neglected in development thinking and practice. This was already recognised by 1985 and the end-of-decade Women's Conference in Nairobi; it has been explored by a growing number of agencies since then. Recently, the emphasis has begun to shift towards a more realistic and practically useful perception of just what the relationship is all about.

In Nairobi, the facts emerged: women in the South are major environmental managers. For them, sustainable natural systems are fundamental for the survival of their families and their livelihoods. In all their many roles, as carers and producers, as providers of food, fuel, water, shelter and health, and in enterprise development, women are concerned to use natural resources wisely. They are knowledgeable and adaptable resource managers, effective in restoring, sustaining and creating livable, productive environments. They have also proved themselves to be successful campaigners against environmental destruction and pollution. All these roles are reflected in economic benefits for countries and localities (though women do not often benefit financially, for these activities lie outside the market).

The dominant approach at the conference in Nairobi (and during subsequent ecological catastrophes in the Sahel and elsewhere) was

to see women as *victims* of environmental devastation. Clearly, this is a major facet of their relationship with the environment and they continue to suffer at the sharp end of long-term, large-scale and ill-conceived development programmes which have brought deforestation, drought and desertification.

The repercussions of the Nairobi Conference and expediency in development action have widened the interpretation of women's role in the environment and some of this has filtered down into practice. More aid projects are now directed at improving women's position. More development schemes now involve women as active participants. Some projects have an environmental component and here too women are increasingly acknowledged to be valuable ingredients of project success. Indeed, the current wisdom is to see women not just as victims but as major *local assets* to be harnessed in the interests of better environmental management. This has been the case where women working as 'animateurs' have reversed the fortunes of some social forestry schemes in Karnataka, India, and, for example, in integrated health and reforestation projects in urban areas of Pakistan.

The danger is that this will add yet again to women's increasingly harsh work burdens. Not only must they continue to subsist in rapidly deteriorating environments and cope with the 'double day' of labouring on cash crops, but take on extra environmental tasks — for little or no reward. The newly-coined sustainable development philosophy of 'Primary Environmental Care' could similarly damage women's interests, although it also presents an opportunity for women to gain more from their environmental management roles.

A New Perspective

A major conclusion of recent thinking (developed, for example, in the OECD DAC Women-in-Development Group) is that not only must women's crucial role in protecting and restoring the environment be more widely recognised, but they must be enabled to *benefit* directly from that role.

A few case studies which have explored the women/environment relationship in some detail (in San José, Costa Rica, Kenyan Green Belt schemes, and village pilot projects in Ghana) all show that it is possible for women to capitalise on their environmental activities. By deploying their own traditional solutions and acquiring new

skills, they can generate incomes and improve their confidence, independence and status — all steps towards further empowerment. In these projects, women are growing and selling trees (specially selected for their drought and pest resistance and fuel properties), producing vegetables and medicinal plants, reclaiming wasteland, actively conserving soils and water resources, designing and building successful settlements, setting up new enterprises, exchanging environmental skills with each other and organising themselves in more effective groups.

Enabling women to become better environmental managers in all these ways is fundamental for any durable improvements in their own position as well as for the wider goals of sustainable development. There are other benefits in the longer term: increasing women's incomes and status is a proven route to improving maternal and child health and reducing family size.

Attitudes Must Change

There is still much to do to persuade governments, and aid and other development agencies that what happens to the environment is central, not marginal, to most women's lives in the South; that they are directly affected by environmental damage; that they have the right to participate in decisions which affect their living conditions and livelihoods and important contributions to make. But for development agencies versed in 'Western' solutions, assigning value to traditional practices requires a substantial shift of attitude. Only two National Conservation Strategies — in Zambia and Pakistan — address the issues of women and environment in any detail; country aid programmes and policy dialogues between donor and recipient rarely do so.

Both the environment and women (traditionally marginal issues in development) are receiving more attention. The need now is to emphasise the close links between them — at policy and project levels — to reinforce action for sustainable development and development for women.

A number of agencies are beginning to work on these issues — for example, OECD's Development Assistance Committee (DAC), working through its Expert Groups on Women-in-Development and on Environment, the International Union for the Conservation of Nature (IUCN), the Commonwealth Secretariat, and the Environment Liaison Centre International (ELCI).

In the run-up to the 1992 UN Conference on Environment and Development, all these will need to use their influence internationally to argue that local action has to be supported by strategic policies (not least on structural adjustment) which recognise women's environmental interests and enable them to continue to play an effective part in managing natural resources. This will mean strengthening their capabilities as managers and removing obstacles — by increasing their access to (and control over) land and other natural resources, credit, appropriate technologies, education, technical and organisational training and family planning.

More Practical Action

Field projects can be important indicators of new policy directions and invaluable for training. But there are too few projects which link environmental management and women's development, testing out opportunities for income generation and new enterprises. There is too little detailed reporting on good practice. More and better projects are needed, together with case studies which describe successes and failures. A start could be made with the analysis and exchange of relevant experience in the donor agencies. Much useful information about managing natural resources more sustainably already exists at the local level, but this information is not being effectively transferred.

Women themselves want *integrated* projects — those which link environmental, social and economic components, and involve both men and women. But this will need more effective co-ordination of different development sectors, and a willingness to devolve decisions to the community level — and accommodate social conflict. Case studies from Ghana show how important it will be for men in government, at all levels, to accept that women *can* play an active part in decisions.

Careful analysis is needed at the project planning stage — to identify the environmental tasks that women (and men) perform and the practical solutions they have devised to deal with problems. Local knowledge and experience must then guide the way projects are implemented and evaluated. Women can and should participate in devising indicators of performance, and these will be social and cultural as well as financial. Aid agency evaluations can thus be complemented by local perceptions of success. It has to be

recognised that conventional project times may need to be extended to allow problems and successes to emerge, and actions to respond.

Local projects can also be used as vehicles for training women to exchange traditional environmental skills, to adapt them where necessary and to learn and use new (but appropriate) technologies. Work has started on these themes in the Commonwealth Secretariat and in IUCN: more is needed.

Changes in Aid Agencies

To support this practical action, aid agencies will need to explore ways of addressing the women and environment relationship — at policy, programme and project levels — in their discussions with recipient countries and in their organisation and training. They could introduce (as some already have) a regular dialogue between environmental and Women in Development advisers, and adapt their formal and informal project screening procedures to highlight the interactions. Donors will then be better able to modify or reject projects that damage the environment or women's interests — and often both.

Primary Environmental Care (PEC)

PEC is emerging as a potentially useful and unifying concept for the organisation of sustainable development at the local level — a way of meeting basic needs while maintaining environmental quality. The idea is currently being discussed within OECD/DAC, in IUCN's work on the second World Conservation Strategy, and in a number of NGOs.

Drawing upon some of the theory and practice of Primary Health Care, the architects of PEC see certain common elements — a 'bottom-up', community-based, participatory approach to decision-making, sectoral integration, local enablers, and longer time scales for investment.

Present definitions assign no special role to women. Yet, in many areas, they are already the most important *unpaid* agents of Primary Environmental Care — sustaining the resource base for development. An extension of PEC could be a way of safeguarding and transmitting women's environmental skills and experience. Women have as vital a role to play in environmental management as they do in local health care, but there are lessons to be learnt from

that experience. PEC, like PHC, should not be 'local action on the cheap': it will require budgetary efficiency and flexibility but also substantial overall funding to provide the back-up technologies, training and other supports needed.

Further Work

To support the strategic and local action needed, the following research themes are suggested as among the priorities:

- probing major bilateral donors, the World Bank and UN agencies, on the practical expression of women and environment relationships in their work;
- devising guidelines to help agencies recognise and give operational content to links between women and environment at policy and project levels, looking, for example, at the environmental costs and benefits to women;
- working with women and their groups to define performance indicators of sustainable development which could be used in monitoring and evaluating aid projects and programmes;
- further study of women's traditional conservation knowledge and methods (in a variety of environments and cultures), to establish:
  — how this knowledge can be safeguarded
  — the most effective means of transmitting good practice
  — the incentives needed for women to adopt conservation measures
  — the potential for associated income generation and other direct benefits for women and their groups and the supports (credit, skills training, market information) needed;
- guidance on natural resource management training — both for agency staff and project participants and beneficiaries;
- exploration of the theory and practice of 'Primary Environmental Care', drawing upon the experience of Primary Health Care programmes;
- gender analysis of the local use and management of natural resources — including, for example, time budgets and income generated by different household members to show the full extent of women's environmental management tasks;

- production of inspirational case studies and other training and awareness-raising materials which emphasise the women and environment links;
- analysis of the specific effects of structural adjustment policies on women's use and management of natural resources at the local level, and exploration of the ways in which structural adjustment can be adapted to safeguard women's environmental interests.

Conclusions

A major problem is apathy — and the generation of words rather than action. With development work already so complex, there is little incentive for environment and development specialists to see how new links might work in practice; the danger is that they will retreat further behind narrow professional and sectoral boundaries. But this is not how the environment works at the local level. Women have long experience of integrating resource management tasks; their supporters — North and South — must recognise and build on this. By learning from local action and extending good practice, development agencies will be better placed not only to reduce the damage being done to women but to enhance their role in sustaining the environment.

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VII. BIO-DIVERSITY

15: Bio-diversity: The Economics of Conservation and Management[1]

Jeffrey A. McNeely

Introduction

The world is being impoverished by the loss and degradation of its most fundamental capital stock — its genes, species, habitats, and ecosystems. The pace at which this phenomenon has been occurring in recent decades is unmatched since the dinosaurs died out 65 million years ago. Some scientists predict that if present trends continue, some 25% of the world's species will be lost in the next 25 to 50 years.

This loss of the living richness of the planet has profound implications for development. Biological resources are renewable: forests, fisheries, wildlife, and crops reproduce themselves and can even increase when managed appropriately. Natural habitats — those which maintain their productivity without significant management inputs from people — have long provided local people with the means for survival, supplying food (meat, nuts, fruits, vegetables), fodder, firewood, construction materials, medicinal plants, wild genes for domestic plants and animals, and so forth. In more recent years, forests and fisheries have been major contributors to export-oriented economic development. Furthermore, the highly diverse natural ecosystems which support this wealth of species also provide important ecological services, including maintaining hydrological cycles, regulating climate, contributing to the processes of soil formation and maturation, storing and cycling essential nutrients, absorbing and breaking

down pollutants, and providing sites for inspiration, tourism, recreation, and research.

But instead of conserving the rich resources of forest, wetland, and sea, current processes of development are depleting many biological resources at such a rate that they are rendered essentially non-renewable, leading to forms of development that are not sustainable. The roots of this problem are found in the distribution of costs and benefits of both over-exploitation and conservation.

The Distribution of Costs and Benefits: The Major Problem

The distribution of costs and benefits is a topic whose complexities would require many volumes to unravel.[2] I shall address just a few issues that affect biological diversity, and which will help justify the research priorities proposed.

Who benefits from over-exploitation?

A considerable body of information is now available on how living natural resources are being over-exploited (that is, harvested at rates far in excess of what can be sustained, leading to reduced productivity). Note that over-exploitation is quite different from conversion; if forest is converted into agricultural uses which can be sustained, productivity for humans can often be greatly increased (which of course is one of the objectives of development). So some conversion is probably inevitable, even beneficial.

But the available evidence suggests that current rates and patterns of conversion of natural habitats are in fact not sustainable, and that many species are being lost as a result. For example, the most recent estimates suggest that more than 142,200 square kilometres of tropical forests were lost in 1989, a rate of about 27 ha per minute;[3] only a small portion of this land is converted to permanent agriculture, with most being degraded to low-productivity pasture, scrub, or secondary forest. Since tropical forests hold well over half the world's biological diversity, and many of the species are confined to relatively small areas, the number of species being lost is certain to be very high indeed; some experts suggest that at least several hundred species are being lost every year (mostly invertebrates). Where these species are lost as a result of over-exploitation — that is, non-sustainable use — the public has great cause for concern.

Many forces are blamed for this over-exploitation, but it is useful to ask who has benefited from it. The short answer is that the lion's share of the benefits have flowed into relatively few pockets, and that most of the profits are earned by the wealthier sectors of the population. In the case of tropical forests, most governments have nationalised their forests and let harvesting rights to timber concessionaires while collecting only a small portion of the economic rents available.[4] In Brazil, World Bank studies have shown that much of the deforestation has been stimulated by government subsidies of a small handful of relatively wealthy ranchers who have cleared the forest for cattle pastures.[5] Numerous similar examples are now available in the economic development literature.

In general, wild nature (which contains most non-domestic biological diversity) has been treated as a public good, benefiting everybody now and in the future, without individuals being charged for these benefits (or even realising that they are benefitting). When the natural system being harvested appears to be limitless, or has a very low price placed upon it — which is often the situation of tropical forests — then the system is easily subject to over-exploitation. Such over-exploitation is often in the interest of the individual seeking to maximise profits.[6]

Who pays the costs of over-exploitation?

Some conservationists would answer this question by saying 'everybody', to the extent that everybody benefits from biological diversity and therefore suffers when it is reduced. This is not a totally satisfactory answer. Nature certainly has some built-in redundancy, and some species could disappear (indeed are disappearing) without anybody missing them. But, little data are available on which species are particularly important in the functioning of ecosystems; we cannot therefore determine the real extent to which the general public is suffering from the loss of biological diversity.

A much more specific answer is often available, however. In the case of tropical forests, the people who pay are very often the people who live closest to the forest, and who had long earned sustainable benefits from harvesting the goods and services from the natural productivity of the system. In many parts of South-East Asia, for example, farmers are up in arms over forestry policies which enable outside concessionaires to deplete the forests which had long been

the source of their irrigation water, construction materials, medicinal plants, and game animals.

It is also informative to consider who does *not* pay the costs. Very often, the individuals who are earning excessive rents from resource exploitation do so because they are able to externalise the environmental costs. For when logging activities affect downstream agricultural systems, for example, by reducing the quality or supply of irrigation water or reducing the storage capacity of a reservoir through increased siltation rates, the affected farmers pay. When harvesting timber disrupts functioning ecosystems, for example by killing coral reefs by run-off sedimentation, the benefits derived from those systems are inevitably reduced as well.[7] The timber concessionaire typically externalises such environmental costs, if indeed he is even conscious of them.

Who Earns the Benefits from Conserving Biological Diversity?

Two broad kinds of benefits are derived from conservation. Direct benefits are obvious from sustainable harvests of biological resources, contributions to ecological functions, tourism, and other measurable goods and services, including the maintenance of ecological functions. It is less easy to define or measure the benefits from existence, option, and bequest values, though many economists are attempting to do so.

It is clear that conserving biological diversity — that is, using biological resources in a sustainable manner which does not reduce the overall diversity of the ecosystem involved — can bring very considerable benefits to those who directly harvest the biological resources. Such conservation — what many of us would call effective management for sustainable yields — has been a common approach of rural people since time immemorial; and indeed, a precondition for the survival of societies throughout history has been the capacity to manage their resources for a sustainable yield. But in recent times — beginning in the colonial period but greatly accelerating after 1950 — the traditional systems for managing a sustainable yield have been replaced by government resource management agencies which have tended to fragment responsibility along sectoral lines and have made insufficient investments to be very successful.

When protected areas — an invention of the Industrial Age — are managed for tourism or game production, insufficient benefits have gone to the local people. In the Luangwa Valley in Zambia, for example, both national parks and hunting areas have been managed primarily for the benefit of outsiders (tourists and safari hunters), with the earnings going to the central government and the private sector in Lusaka. Not surprisingly, the local residents, denied access to resources previously under their control, have become increasingly impoverished and resentful.[8] While there are a few bright spots, the general finding is that relatively few direct benefits have flowed to the people who live closest to the over 3,000 protected areas that have been established in tropical countries over the past 50 years. They may, however, have earned benefits from the conservation of ecological functions such as watershed protection; some of India's well-protected tiger reserves, for example, are now providing year-round water instead of seasonal flows.

Many of the benefits earned from existence value are being earned by 'free riders', who obtain them without having to pay the costs involved. Conserving the tiger in India is of much greater importance to comfortable urban dwellers than to the local people who lose cattle or family to tigers; school children in Northern countries may care far more about orangutans and Javan rhinos than do their peers in Java. Farmers (and consumers) in Europe benefit when Peru conserves wild relatives of potatoes, or when Mexico conserves wild relatives of maize. The wealthy nations of the North therefore earn a considerable consumer surplus when tropical countries conserve a natural area containing a high degree of biological diversity. But the tropical countries also earn option and bequest values, which presumably contribute to their conservation decisions.

Who pays the opportunity costs?

At both the international and local levels, the opportunity costs of conserving biological diversity are paid disproportionately by the people who live closest to the greatest diversity. In one of conservation's greatest ironies, the nations with the richest endowment of biological diversity tend to be the poorest developing countries, and within those countries, the individuals who live

amidst the greatest biological wealth tend to be the poorest of the poor.

In another of conservation's ironies, when a central government establishes a national park because of its outstanding value to the nation and to humanity, it simultaneously denies access to any marketable value of the area to the local people who once benefited from the goods and services that area formerly provided, and which the national park was established to protect.

So the opportunity costs of modern conservation programmes which restrict access to resources are falling disproportionately upon the very nations and communities that development assistance agencies are most interested in assisting. If conservation programmes are to be socially accepted, then new and more appropriate means of apportioning opportunity costs, or providing compensation for them, need to be sought. Economic incentives can provide one mechanism for doing so.[9]

Some Productive Areas for Research

If the maldistribution of costs and benefits of over-exploitation and conservation is a major problem facing biological diversity, then solutions should be sought through the better distribution of these costs and benefits. Economic research can play an important role, at several levels: developing improved macroeconomic policies (the subject of other chapters in this volume); developing policies to integrate conservation and economics at the national or local level; and developing ways to integrate economic thinking into programmes for managing biological resources. Research could seek to investigate how much inequity is inevitable and how much could be corrected through improved policies, and to determine the extent to which inequity in costs and benefits leads to the degradation of biological diversity.

What are the economic tools which can be used to ensure that the benefits of conserving biological diversity are delivered? I shall suggest five possibilities, though many more are certainly worth exploring.

(i) *Identifying the linkages between biological diversity and macroeconomic policies*

Many macroeconomic policies have significant impact on the costs and benefits of conserving (and exploiting) biological resources.

Economic research is required to show how diversity is affected by interest rates, the design of national income accounts, terms of trade between agriculture and industry, tax policy, trade policy, land tenure, and so forth. In addition to the general policy research, specific analysis in specific countries would be very useful in specifying new approaches to the problems.

(ii) *Using prices to guide decision-making*

Some have said that if current trends continue, we shall progressively lose everything of value in the countryside that does not have a price, and we are reminded of Oscar Wilde's definition of a cynic as someone who knows the price of everything but the value of nothing. Even so, much greater attention needs to be devoted to finding ways of assigning prices to biological diversity, including both market and non-market values. But, at the same time, it is most unlikely that we shall ever be able to assign comprehensive values to all the subtleties of biological diversity. The aesthetic and intangible dimensions are important to all of us, and we do no service to economics or the arts if we seek to write off anything which cannot be evaluated economically or indulge in complex mental gymnastics to put a value on the intangible; trying to assess inter-generational costs and benefits is particularly difficult, and becomes more so the farther into the future one seeks to project.

Nevertheless, being able to place a financial value on at least some of the attributes of biological diversity will help encourage appropriate investment in its conservation, and assist in the design of packages of appropriate economic incentives.

Incorporating the costs of over-exploitation and the benefits of conservation into the measurement of utility will require improved methods of assigning values to different aspects of biological diversity. Some economists will contend that once resources appear to be limited, they will tend to acquire prices which reflect their scarcity. This should not be accepted as an argument that market forces alone will ultimately yield the 'true value' of biological diversity, or of species, because extinction is irreversible and one species cannot be substituted for another. We cannot wait for biological diversity to generate its own market as diversity declines, if we hope to arrest degradation before the threshold of irreversibility is crossed.

In the case of tropical forests, it may well be that alternatives to timber exploitation may be more attractive if the economic potential of other uses is made better known.[10] Research might then focus on new types and combinations of the sustainable use of tropical forests, and the more comprehensive application of comprehensive ecological cost accounting. This could be expected to lead to ways of distributing costs and benefits that would conserve biological diversity more effectively.

(iii) *Delivering greater benefits to local communities*

The moral justification for a system of protected areas or any other programme to conserve biological diversity is strengthened when it generates a flow of benefits to people. The more people benefit directly from the proper conservation and use of wild resources, the greater the incentive for them to protect the resource and the lower the cost to government of doing so. If a government decides that it is important for an area to be conserved, and this involves opportunity costs to local communities, then it would seem only appropriate that these local communities be compensated through a series of economic incentives.[11] In fact, one could argue that the cost-benefit ratio of conservation must ultimately be positive for the local people if the resources are to survive. What mechanisms are available to encourage such a positive balance?

At the policy level, research is required to demonstrate to governments that such an allocation of benefits makes economic sense; or, rather, help define the conditions under which such allocation of benefits makes sense.[12] How can the structure of economic incentives be designed in specific cases to ensure that the benefits of conserving biological diversity can be delivered? How can economic arguments be marshalled to support a fundamental change from government responsibility for biological diversity to a more appropriate balance of responsibility between government and local people?

(iv) *Using economics to help decide on how to invest in conserving biological diversity*

Since resources for conserving biological diversity are always limited, it seems sensible to seek to use the most cost-effective means available. Experience has shown that conserving species which have been reduced to very low populations is often phenomenally expensive; the California Condor, for example, has already cost

well over $25 million and most biologists doubt that it will ever be successfully returned to the wild. The expense of conserving such gravely threatened species is often far in excess of what would be required to conserve a less endangered species. It may well be, then, that funding for the preservation of endangered species is disproportionately large relative to other strategies for conserving biological diversity; but it appears that many conservation agencies pursue a rather cost-inefficient strategy favouring high-risk species (though cost efficiency is not the only consideration involved with the more charismatic species).

It may be that focusing the available resources into relatively few units will be better than spreading the effort more evenly. In the Luangwa Valley, it has been shown that an annual investment in protection of about $400 per sq km is required to maintain stable populations of elephants and rhinos; but the funding available will cover only a small part of the Valley at this rate of protection. Individuals who are given the responsibility for managing areas which contain biological diversity of worldwide interest need to be able to use economic tools to help them make decisions on how they allocate their scarce resources. What economic tools will be most helpful to them, and how should these tools be designed so that they can be used by resource managers?

(v) *Utilising international willingness to pay*

Judging from the contributions made to voluntary conservation organisations such as the World Wildlife Fund, the public in industrialised countries are willing to make substantial payments for the existence value of biological diversity in the tropics. How can developing countries capture more of this willingness to pay? How can the consumer surplus be reduced? And perhaps more important, how can we convert this willingness to pay into increased amounts of biological diversity?

One possibility is to establish a system of 'conservation concessions' which would work something like timber concessions, but which would instead be designed to conserve areas of outstanding natural value. Research could focus on some very specific examples of how this might work, involving such factors as appropriate concession fees, agreed management plans, the role of government oversight agencies, and so forth.

Conclusion

In general, those establishing the economic policies governing the use of biological resources have three broad options: to manage for a sustainable yield and therefore maintain the future option of depleting a resource (when prices may be higher); to draw down supplies slowly, in an effort to spread earnings over many years; or to deplete existing stocks quickly, taking a quick profit which can then be reinvested elsewhere. Most conservationists would suggest that the first option is far preferable, but many governments in developing countries are exercising the third option in the case of forests, fisheries, and wildlife.

Determining the full costs and benefits of each option will have a major influence on determining which is most profitable; careful economic analysis could well demonstrate that rapid depletion is only profitable if the environmental costs are externalised. Improved economic policies also need to consider the flow of benefits, and it would be useful to provide economic tools which will enable conservation benefits to be delivered to those who live closest to the greatest biological diversity, and therefore will determine how much of that diversity will survive.

Notes

1. This chapter has benefited greatly from the thoughtful comments provided by Martin Holdgate and Kenton Miller.
2. See, for example, John A. Dixon and S. Wattanavitukul, *A Summary of Work on Benefit-Cost Analysis of Natural Systems and Environmental Quality Aspects of Development*. Environment Policy Institute, East-West Center, Honolulu, 1982.
3. N. Myers, *Deforestation Rates in Tropical Forests and Their Climatic Implications*. London: Friends of the Earth, 1989.
4. R. Repetto and M. Gillis (eds), *Public Policies and the Misuse of Forest Resources*. New York: Cambridge University Press, 1988.
5. Hans P. Binswanger, 'Fiscal and Legal Incentives with Environmental Effects on the Brazilian Amazon'. Washington, DC: *World Bank Report* ARU 69, 1987.
6. Colin W. Clark, *Mathematical Bioeconomics: The Optimal Management of Renewable Resources*. Chichester and New York: John Wiley and Sons, 1976.
7. G. Hodgson and John A. Dixon, 'Logging versus fisheries in the Philippines', *The Ecologist* 19 (4), 1989.
8. N. Leader-Williams, 'Black rhinos and African elephants: Lessons for conservation funding', *Oryx* 24 (1), 1990; S.A. Marx, *The Imperial Lion: Human Dimensions of Wildlife Management in Central Africa*. Boulder

CO: Westview, 1984.

9. J.A. McNeely, *Economics and Biological Diversity: Developing and Using Economic Incentives to Conserve Biological Resources*. Gland, Switzerland: IUCN, 1988.
10. See, for example, Charles M. Peter, Alwyn H. Gentry and Robert O. Mendelsohn, 'Valuation of an Amazonian rainforest', *Nature* 339, 1989, pp.655-6.
11. McNeely, *Economics and Biological Diversity*, op. cit.
12. See J.A. McNeely and R. Dobias, 'Economic incentives for conserving biological diversity in Thailand', *Ambio*, 1990.

16: Adding Up the Costs and Benefits of Conserving Bio-diversity

Scott Barrett

In Chapter 15, Dr McNeely reminds us that the question of *who* bears the costs and *who* benefits from both the depletion and conservation of bio-diversity is just as important as the question of whether the *total* net benefits are positive. This issue commands surprisingly little attention among economists.

When making a social decision — like whether a hydroelectric project should be built or whether a pricing policy should be changed — we need not only to calculate the costs and benefits of the decision, but also to add these costs and benefits up. This raises the question of whether all people affected by the action should be given the same weight, or whether some should be given greater weight. In social cost-benefit analysis, greater weight is sometimes attached to poorer people, the reason being that the project was proposed in the first place to raise the income of poor people. One way of realising McNeely's concerns about the use of cost-benefit analysis for protected areas might be to attach greater weight to the people living nearest the affected areas. A more vexed question concerns the effects of the decision on the unborn. What weight do we attach to these people?

When economists carry out a social cost-benefit analysis they are invoking ethical views about how individuals are to be weighted within a generation and how different generations are to be counted. Partly because of this problem, it is not clear that we should want to carry out a cost-benefit analysis for every decision. We shall always want to *know* the costs and benefits of a decision, but we

may choose to ignore the calculus if we believe, for example, that future generations have a *right* to a certain level of bio-diversity or even if species themselves have a right to exist. However, resorting to decision-making on the basis of rights is not always very helpful. For example, suppose it is believed that future generations have a right to a certain level of bio-diversity, but that current generations also have a right to a minimum disposable income. Then a problem may arise in that these rights may conflict. It is partly for this reason that cost-benefit analysis is helpful to decision-making when there are unpleasant trade-offs to be faced. The point is that underlying any advice given by an economist on the question of bio-diversity there will be some ethical implications, although these too often are hidden (and are sometimes not even understood by the economist). It amazes me that some people object to the use of economics in matters such as biological conservation because they see the use of economics alone as being unethical. But one cannot use economics in this context without also using ethics. The two are not separate.

A problem arises, however, in that the ethical views of the economist are not always the ethical views of the decision-maker. Let me give an example from the developed world that illustrates this nicely.

The test case for the US Endangered Species Act was the Snail Darter v. the Tellico Dam. The Endangered Species Act prevented any development that would threaten the existence of an endangered species. But a hydroelectric project in Tennessee — the Telico dam — had been given federal funding before it was discovered that a rare species of fish — the snail darter — lived in the river where the dam was to be built and nowhere else. There followed a big fight in which expert economic advice was delivered. It was shown that the project itself was uneconomic even if one ignored the threatened fish. Yet the project was finally given the go ahead.

Why was this decision taken, when the economic analysis showed convincingly that the project was not viable? The reason is that special interests prevailed. Those who had a stake in the project being built argued that a little fish — as Senator Howard Baker from Tennessee, the primary supporter of the dam, said, 'quite a nice little fish as fish go' — should not prevent a previous commitment (to the constructors) from being met, or the goals of economic progress and energy security from being advanced.

The ending to this story is happier than it might have been, for the snail darter was later found to inhabit other waters and was eventually taken off the endangered species list, leading an observer to comment that 'the entire controversy may have revolved around a dam that was not worth building in the first place and a fish that did not really need to be saved'.[1] But the experience makes one wonder whether the economic model is very useful in such cases. The economic analysis of the snail darter was not criticised, but it ignored the political claims and distributional implications of the development. A more activist approach by the economists might have suggested an alternative project that would have satisfied the fish *and* the special interests. It may also have been the case that the economists could have been more effective advocates of economic analysis and not simply left the matter to the decision-makers.

The lesson is that in carrying out an economic analysis it is not enough sometimes to take into account all interests and to say that the project should still go ahead because the losers could theoretically be compensated by the winners. The social decision might have to involve actual compensation; otherwise the decision that is in the best interests of all may not be taken.

Likewise, from an international perspective we know that the greatest beneficiaries from biological conservation are often those that live outside the jurisdictions where decisions about the fate of species are made. It will not do for the economist to say that the benefits of conservation exceed the cost if those who must bear the cost are not compensated. For, according to international law, Brazil and the other tropical countries can do what they like with their rain forests. If the world's biological diversity is to be conserved, the international community must co-operate to offer the countries in which these resources reside the required compensation. As in the national case, unless compensation is paid the best decisions will not be made.

It is this issue which is perhaps the most important.

Notes

1. This comment was made by Robert Davis in his fascinating analysis of this important case; see R.K. Davis, 'Lessons in Politics and Economics from the Snail Darter', in V.K. Smith (ed.), *Environmental Resources and Applied Welfare Economics: Essays in Honor of John V. Krutilla*. Washington, DC: Resources for the Future, 1988.

VIII. ENERGY QUESTIONS

17: Economics of Energy and the Environment: A Discussion of Issues

Dennis Anderson

Introduction

Looking at the emerging patterns in world energy consumption, it is clear that a major geographical shift is taking place towards the markets of the developing countries. In 1970 their total consumption of commercial energy — oil, gas, coal, nuclear and hydro — accounted for *16* million barrels of oil equivalent energy per day (16 mbdoe), or 15% of a world total of 104 mbdoe. Despite the oil price shocks in the 1970s, and the debt crises in Africa and Latin America, consumption rose significantly in all developing regions in the following two decades, and is currently triple its level twenty years ago, around 45 mbdoe, accounting for 25% of world consumption and 44% of the growth in the period (Table 17.1).

These trends are well known, and were correctly anticipated by the industry more than a decade ago. It is also not difficult to defend

Table 17.1: Commercial energy consumption by economic grouping

	mbdoe		*% distribution*	
	1970	*1990 (e)*	*1970*	*1990 (e)*
OECD economies	66	85	73	50
Developing economies	16	45	15	26
USSR and Eastern Europe	22	40	21	24
Total	104	170	100	100

Source: *Energy in Profile*, Shell Briefing Service No.3, 1989 and BP, *Statistical Review of World Energy*. (1990 estimates are trended up from 1985-9 data).

a scenario in which (i) world energy consumption doubles over present levels in a generation or so, (ii) the demands of the developing countries greatly outstrip those of the OECD economies, and also of Eastern Europe and the USSR, and (iii) there is every prospect of continued growth for some decades thereafter, since the per capita consumption of commercial energy in developing countries would still be only 25% of that of the industrial countries today (it is less than 10% today). The demands in Eastern Europe and the USSR are also likely to be another, though more moderate, source of growth.

No analysis of the emerging environmental issues related to the production and use of energy can proceed therefore without reference to the perspectives of the developing countries. For issues other than the greenhouse effect — such as acid deposits, the removal of particulates and other pollutants from boiler and vehicle exhausts, and the treatment of effluents — there is much that can be learned from the experiences of the industrial countries, and a wide range of technologies to draw upon. The instruments of policy, such as environmental taxation, regulation and direct investment, are also available. Major reductions of emissions and effluents can be achieved, with significant cost savings, without going to best-practice techniques, and for some fuels, such as gas, there may even be environmental improvements with cost reductions. Policies related to these more or less 'standard' emissions and effluents problems of the industry are discussed later in this chapter.

Turning to the greenhouse effect, however, the issues are less tractable. How are the uncertainties in the situation best dealt with? As David Pearce and many others have remarked, it may be a decade before we can be certain whether global warming is really occurring, or whether it is merely a climatic cycle caused by non-greenhouse gases.[1] The costs of policies related to it could be immense. So should the developing countries 'wait and see', and rely on leadership from the OECD economies? Or should they, too, put precautionary policies in place? For example, should they consider introducing carbon taxes or emission permits, taxes to encourage energy conservation, and so forth? Or would the 'deadweight' losses be too high? In the long term, can the developing countries 'afford' to participate in policies to address the greenhouse effect, and, if not, what sort of assistance might be sought from the industrial countries?

The following discussion of environmental issues in the energy industry has two purposes. One is to provide a brief review of policy options and approaches. The other is to identify areas for research.

The Emerging Geographical Patterns of Energy Demand

The record of economic forecasting in the energy industry, as in many other areas, has not been a good one, and has led to costly errors. In the 1950s, projections of exponential demand growth and limited fossil resources — the latter greatly underestimated — were used to justify major nuclear power research and investment programmes. In the 1970s and 1980s, the capacity of the industry to discover new oil and gas resources, pessimism on costs and, again, demand optimism, led to predictions of oil prices rising indefinitely to $50-70 per barrel or more, perhaps a $100 per barrel in the early years of the next century (in today's prices). Nevertheless, investment planning requires some view of the future, not least where environmental matters are concerned. The lead times for energy investments are typically 5 to 10 years, 15 to 20 years for R & D, and most investment decisions being taken today will not be operational till around 2000, with the lifetimes of the investment extending to the period 2020-30.

Assumptions

There is much that can be learned from Shell's approach of considering scenarios,[2] in which the underlying assumptions are clearly stated and considered relevant for planning purposes. So what might be appropriate assumptions when we are examining issues in energy and the environment? I would suggest the following:

(a) an eventual peaking or saturation of OECD markets, helped by a 'recovery' of real energy prices and — especially important — gains in energy efficiency;[3]

(b) continued economic growth in Asia, and an eventual recovery in Africa and Latin America. Associated with this:

(c) fairly rapid demand growth for commercial energy in the developing countries, of around 4%; (it was 5.3% in the period 1970-90). For reasons discussed below it is likely to remain strong, barring economic calamities, for some decades, *even assuming major*

improvements in energy efficiency brought about by a recovery of prices and other factors;[4]

(d) moderate growth of the energy markets in Eastern Europe and the USSR, helped by economic recovery, but also dampened by significant improvements in energy efficiency.

These seem to be a consistent and operationally interesting set of assumptions. One could, for instance be pessimistic about the growth prospects in developing countries or recovery in Eastern Europe. But this would not be a good basis for policy analysis. The main challenge ahead is to find a structure of policies that is consistent with — and will help — the aims of economic recovery and growth in the developing countries and elsewhere. These policies include meeting the demands for commercial energy in an economically efficient way, and of course addressing the emerging environmental concerns.

Explanatory factors

What are the main factors that explain energy demand? Although there are a number of studies for particular markets and fuels, mainly in the OECD, a good functional form is still lacking which embraces OECD and developing country markets. In the OECD countries, there is still a tendency in empirical work to assume constant income elasticities and to neglect the possibility that these markets may be 'maturing' or saturating, and may even decline with improvements in the efficiency of energy conversion processes, insulation and so forth. The developing countries, on the other hand, are still on the early to 'mid' ranges of the logistic (or 'S') curves for energy-using appliances, equipment and vehicles; per capita consumption is still low, and there are strong upward pressures on demand.

Six major influences on the demand for commercial energy can be identified:

(i) Efficiency — the scope for demand reductions through improvements in energy efficiency.[5]

(ii) Per capita income growth, *combined with*:

(iii) The positions of various regions on the 'S' curve.

(iv) Population growth.

(v) Price.

(vi) Substitution for fuelwood.[6]

Table 17.2: Factors influencing the demand for commercial energy

	Economic Group/Region			
	OECD	*Developing*	*E. Europe & USSR*	*Comment*
(i) Energy efficiency	strong	strong	v. strong	-1% p.a.?
(ii) Per capita income growth	2%	2-6%	2%	Combined effects:
(iii) Position on 'S' curve	mature phase	high growth phase	upper ranges	· weak in OECD · v. strong in ldc
(iv) Population growth	0.2%	2%	1%	
(v) Price	strong	strong	strong	Currently, prices are weak. May recover in long term
(vi) Substitution for fuelwood	0	1%?	0	

Table 17.2 presents a rough summary of how these influences might work out in different regions.

In a fairly 'energy-efficient' scenario therefore, and assuming a gradual increase in real energy price — either through taxation, a rising call on OPEC resources, or both — a long-term growth rate of less than 1% for OECD counties, 4% for the developing countries, and 1 to 2% for Eastern Europe and the USSR, seems a reasonable starting point for analysis.

It might be argued that improvements in energy efficiency may lead to more dramatic reductions in demand than suggested in this paper.[7] While more significant reductions in demand may arise from this source in the OECD and Eastern Europe, the possibilities for further improvements over those assumed below for developing countries are limited. The demand scenario presented is a full 2-3 percentage points below the expected growth for them, assuming economic recovery in Africa and Latin America, and 1-2 percentage points below the growth rates of the 1970s and 1980s. To assume

the developing countries could do with significantly less commercial energy than such growth rates imply is to assume the problem away, and to neglect the technological challenges that meeting their energy demands will present.

Demand patterns

The main upward pressures on demand are therefore likely to arise from the growth of per capita income and populations in the developing countries. Table 17.3 presents a scenario of overall demand, on the assumptions described above; Table 17.4 shows that, even allowing for two or even four decades of sustained growth, per capita consumptions in developing regions would still be low relative to the OECD today.

Alternative scenarios are of course plausible, and the analysis would obviously benefit from more disaggregation by region and fuel type, as noted above. However, they would be unlikely to alter the general point made here about the changing geographical balance of the demands for commercial energy — and for fossil fuels in particular, which currently make up nearly 90% of total supplies.

An aside on scenario choice

The energy demands shown in Table 17.3 are in the middle of a broad range of possibilities reviewed by Keepin, Mintzer and Kristofersen,[8] who rightly counsel against working with only one scenario. I have three reasons for *beginning* with the one above, in the mid range, before turning to other possibilities in the following section. *First*, taking higher energy demand figures would merely

Table 17.3: Energy demand scenarios by economic group (mbdoe)

	Actual			*Scenarios*	
	1970	*1980*	*1990 (e)*	*c 2010*	*c 2030*
OECD	76	75	85	100	90
Ldcs	16	28	45	100	200
E. Europe & USSR	22	30	40	50	60
	104	140	170	250	350

Source: *Energy in Profile*, Shell Briefing Service No.3, 1989 and BP, *Statistical Review of World Energy*.

Table 17.4: Per capita consumption of commercial energy*

	boe/capita/year			*ratio, relative to US (%)*		
	1990	*2010*	*2030*	*1990*	*2010*	*2030*
USA	58	53	45	100	100	100
W. Europe	26	27	26	45	50	60
Ldcs	4	7	10	7	13	23
E. Europe & USSR	36	40	45	62	75	100

*Based on Table 17.3 and supporting calculations.

reinforce the conclusions reached without materially altering them. *Second*, the plan below is to begin with *expected* demands, under the conditions described, and then to consider the sorts of policies that would reduce emissions to lower levels if global warming is indeed occurring. The authors of the lower range of scenarios quoted by Keepin et al. all incorporate a number of policy proposals intended to address the greenhouse effect, the most notable being those to raise the efficiency of energy conservation processes and uses.[9] Such proposals are very important. However, the intention below is to discuss policy, and its implications for energy demand and supply, separately. As discussed later, even the 'high efficiency' scenarios may in fact be pessimistic about the innovative potential of the industry, under the right tax and regulatory incentives, and it is possible that there may very well 'exist' a low net emission scenario with high energy consumption in the long term.

A *third* reason for working with the above scenario is different. Although some studies, most notably those of Edmunds and Reilly, cited by Keepin et al., work with regional demand estimates, the overall focus has been on global demands and emissions. When we turn to policy issues, however, the expectations of the developing countries need to be distinguished from those of the industrial countries, Eastern Europe and the USSR if we are to begin addressing problems posed for international and domestic policies — on equity, aid, the role of foreign direct investment and finance, and what makes for an efficient and operational approach in local circumstances. There is a good case for concentrating on the differing energy demands and expectations of each of these country groupings before turning to the issue of emissions reduction.

Implications

The rapid emergence of developing country markets would normally be considered wholly beneficial both for the energy industry, and for the developing countries. For the countries themselves it implies a major shift out of fuelwood to commercial energy and a rapid accumulation of energy-using assets and appliances normally associated with economic growth, and considered among its fruits. The linkages with the local economy — the industrial and service sectors, in particular — are likely to be strong, and a force for industrialisation. For the industry internationally, at a time when its markets are maturing new ones are beginning to emerge of far greater size and importance. It also has a huge capital base and is highly creditworthy; offers good returns to local and foreign equity; the more enlightened of the multinationals are already allocating appreciable resources to the development of local technological and managerial skills, and to opening markets; and the linkages with the supplier industries worldwide are extensive — in the manufacture of boilers, turbogenerators, electrical and distribution equipment, of exploration and production equipment for oil and gas; in refinery construction, shipping, transport and distribution, and so forth. Furthermore, there has been an impressive range of technical developments in the treatment of residuals and effluents, noted further below.

Yet concerns about the greenhouse effect are now calling the expansion into doubt — or at least its dependence on fossil fuels. The above analysis is consistent with the now familiar projections of a 30-50% rise in carbon dioxide concentrations in a generation or so and further accumulations thereafter.[10] It also shows that (a) the costs of attempts to reduce the rate of accumulations may very well be felt most by the developing countries, and (b) no attempt to reduce them can be successful without the full participation of the developing countries in the policies. What do economic principles have to tell us on these issues?

Emissions Problems and Policies

It is useful to begin with more familiar emissions problems, such as those of acid deposition or of lead in fuels. Similar policy instruments apply in principle to all emissions, whether carbon

dioxide or otherwise, and the main question is how best to apply them in the present situation. The two instruments that we need to consider are environmental taxes and regulations, with pollution permits being a variant of the regulatory alternative. Consider the tax option first.

Emissions in general

An initial aim of environmental taxes is to raise the prices of polluting products or practices in such a way as to reflect the external costs to other parties in the price. The immediate effect is a *quantitative* reduction in the polluting activity via the effects of price on demand and supply. However, such effects are a small part of the story, the least important and the least interesting. If a tax were to add, say, 25% to marginal production costs, pollution damage might fall by 10-15% in cases where demand and supply were fairly elastic — a rather small effect for such a large price increase, and one which would soon be eliminated in the case of energy by added demands arising from income growth. It would rarely be sufficient to allay environmental concerns.

A much more important effect (which applies equally to taxes and regulation) is to encourage substitution towards less polluting fuels — such as gas, and low sulphur coals and oil in the case of sulphur taxes — or to induce changes in production technologies to reduce pollution. Two recent publications of the OECD, *Energy and the Environment: Policy Overview* (1990) and *Emission Control Technologies in Electric Power* (1988) have provided an admirable overview of the rich range of options here, which are classified into four groups:

- add-on technologies, such as scrubbers and catalytic converters;
- 'clean technologies', involving redesigns and reconfigurations of the combustion process: lean burn engines, fluidised bed combustion in boilers (reduces SO_2 and NO_x) and lower temperature combustion (reduces NO_x);
- fuel substitution;
- greater energy efficiency in consumption.

Some of the options and their characteristics are summarised in Table 17.5. The main point is that technological innovations may bring about dramatic reductions in emissions once the rents are

created for their introduction by environmental policies. Looking at the cost data presented it is clear that, in the case of electric power, major reductions of the order of 90-95% may be achieved over the long term (as the new approaches are brought on stream) even with quite moderate environmental tax incentives.

Another point is diminishing returns. The incremental costs of reducing emissions escalate very rapidly at low emission levels. The following data illustrate this point by reference to the costs of removing sulphur from gasoils. Many other examples could be cited to make the point.

Gasoil specification (% sulphur, by weight)	*0.43%*	*0.4-0.2%*	*0.2-0.15%*	*<0.15%*
Incremental cost of reducing sulphur content to below 0.43% ($ 1983)	—	1900	7000	9000

Source: *Air Pollution: an oil industry perspective*, Shell Briefing Service No.1, 1987.

Suppose the extra marginal costs of using low pollution options are denoted by MUC and the marginal costs of the polluting options are MC. Then if prices (including the environmental taxes) are greater than MC + MUC, low polluting options will gradually be introduced; taxes will decline to low levels — because low polluting options are virtually tax-exempted — prices to MC + MUC, and the environmental concerns would be fully internalised in the pricing system. The extra value added by the low polluting options will be roughly MUC × total demand, an important source of employment and earnings opportunities and of returns to capital invested.

The process is summarised in Figure 17.1, where three effects are noted:

- *Quantitative reductions*, accompanied by rapid growth of tax revenues and a moderate reduction of environmental damage.
- *Innovation and substitution*, as the new technologies, substitutes or practices are introduced; in this phase, tax revenues (and prices) begin to decline.
- Environmental concerns are fully *internalised*, the switch to low polluting options is virtually completed, tax revenues are negligible, and prices reflect the marginal costs of the environmentally inoffensive product or practice.

Table 17.5: Potential for emissions reduction: examples from electric power generation

A: Fuel substitution

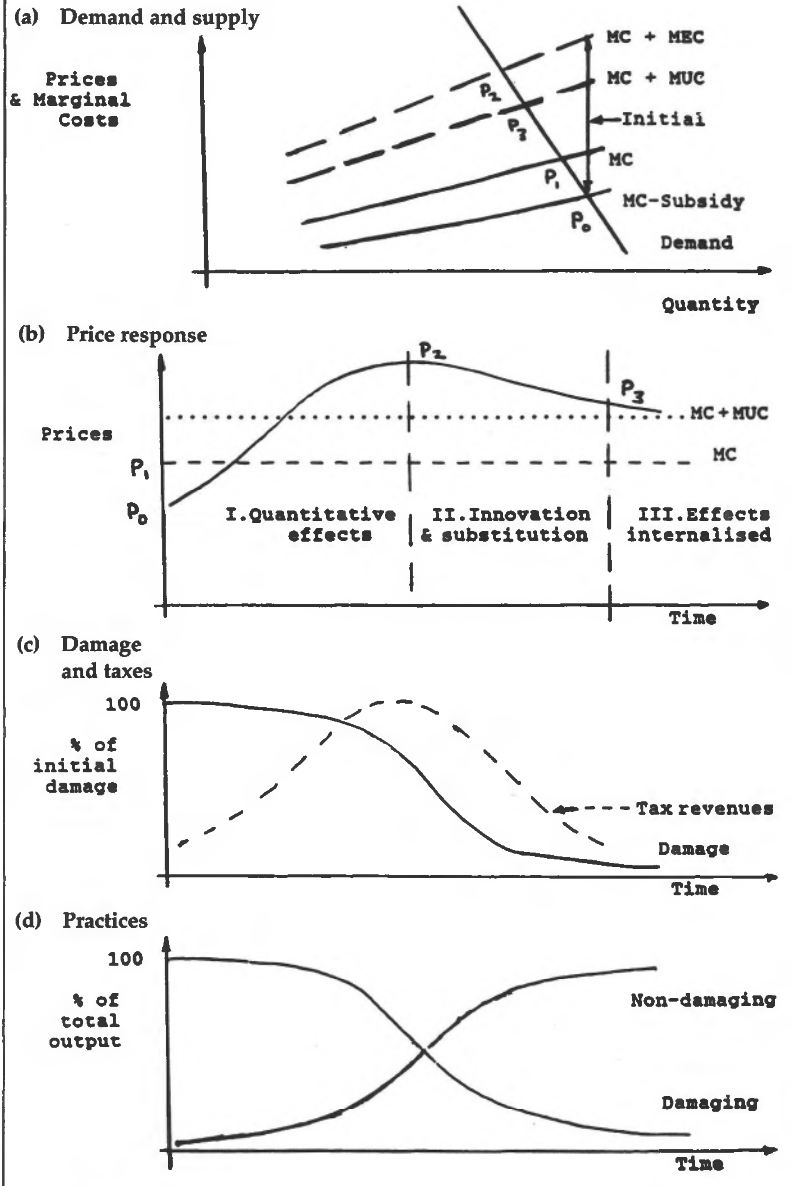
Fuel	*Sulphur content* %	*SO_2 Emissions* *mg/ MJ*	*NO_x emissions* *mg/ MJ*
Coal	1	720	245
Coal — low sulphur	3	2200	
Fuel oil — heavy	3	1400	155
Fuel oil — low sulphur	1	480	
Gas oil	0.3	140	
Natural gas	0.002	0.73	115

B: Technology options (selected examples)

Technology	*% reduction*		*Status*	*Costs, as % generation costs*
	SO_2	*NO_x*		
Pre-combustion:				
— Coal cleaning	10-30		Commercial	
— Adv. coal cleaning	90		R & D	
Combustion control				
— Low NO_x		30-50	Commercial	
— Adv. low NO_x		Up to 70	R & D	1%
— Catalytic		80	Testing	
— Sorbent injection	60-75		Demonstration	
— Fluidised bed	70-95		Operational; R & D	
Post-combustion				
FGD	90	Up to 80	Several options: commercial & R & D	10-15% for coal & oil
Selective catalytic reduction		80-90		10% for coal, 2-5% for oil and gas
SRC				

Source: OECD/International Energy Agency, *Emission Controls in Electricity Generation and Industry*. Paris: OECD, 1988.

Figure 17.1: Responses to environmental policies



Note: MEC = environmental tax

The same effects can be achieved in principle by pollution permits or regulations. The tax approach generally has the advantage in terms of cost-effectiveness.[11] It is also a more operational approach since it can be grafted on to existing systems of indirect taxation. However, emissions permits and regulations may be preferred in some cases; they can be shown to achieve the same end-result over the long term, albeit at a higher cost.[12]

Greenhouse effect

There is now much discussion about introducing carbon taxes in industrial countries. Notwithstanding all the uncertainties about global warming, the case for introducing some form of precautionary carbon taxation seems a strong one. It would have some quantitative effects on demand and would rekindle commercial R & D activities in renewable sources of energy, which were widely shelved following the oil price collapse in 1986. The revenues could also be used to finance R & D and provide tax relief on energy conservation measures (much as the United States provided such relief in the 1970s, following the oil price shocks). Carbon taxes may also have advantages in developing countries, where they could become part of the existing structures of indirect taxation. Since energy demands are fairly inelastic the deadweight losses may be relatively small — taxes on energy have long been thought to be a particularly efficient form of taxation — while the revenues would help to alleviate fiscal problems in many countries.

The alternatives of carbon permits and regulations may be unworkable at the present time, since little is known about the limits or targets to which they should be related. In addition, the transactions costs in trading and in coping with default may be insurmountable at the international level. An advantage of the tax approach — to developing and industrial countries alike — is that it provides a perpetual incentive for innovation; it generates revenues that could be put to good purpose (not least to public and private R & D) and does not require precise agreements on or knowledge of the targets.

Another merit of the tax approach, thinking of the international dimensions of global warming policies, is that it is something that each country could initiate without being tied at the present time to some arbitrary CO_2 emission level or target. The most important aim in the present circumstances should be to initiate those policies

which most analysts agree are desirable, notwithstanding the prevailing uncertainties. To recapitulate, they include:[13]

- the generation of resources and finance for R & D on global warming and related issues;
- the rekindling of commercial and public interest in renewables, beginning with R & D;
- the provision of incentives for energy conservation (for which there are many possibilities);
- the allocation of more resources for afforestation programmes on farmlands (for example, agro-forestry) and for the protection and maintenance of forest reserves.

Such policies will require significant public and private financial resources. The tax approach helps in this respect by generating public financial resources directly and creating rents for private enterprise. This applies equally to the developing and the industrial countries, though the latter may well consider the use of concessional aid to assist the developing countries in implementing the required tax reforms. What would be attractive about them, as widely noted, is that the policies would be desirable *even if* the greenhouse effect turns out to be less of a problem than many people now think it is.

Affordability of Policies

Much effort is being expended on estimating the costs of climatic change arising from greenhouse gas accumulations. However, given the uncertainties involved, there is a good case for estimating the costs of avoiding such change, or alternatively of estimating what the costs would be of keeping accumulations to below various levels. For instance, what would be the costs of gradually raising carbon taxes sufficiently to bring about major innovations (perhaps in renewables and conservation)? How would they differ between developing and industrial countries?

Let us begin with the costs in terms of long-run economic growth. Current world output, in round figures, is $20 trillion, of which about 20% or $4 trillion goes to gross investment and the rest to public and private consumption. Assuming 3% growth, real output would rise to around $27 trillion in 10 years time. Supposing then

a carbon tax is gradually introduced, rising to $20/boe. (This is an illustrative calculation, I am not proposing such a tax at this stage.) This would divert $20 from consumption and investment for each boe of energy consumed. Taking fossil fuel consumption to be 200 mbdoe/day at that time (see Table 17.3), it would divert $20 × 200 × 365/$10^6$ = $1.5 trillion from consumption and investment — say 0.8 × 1.5 = $1.2 trillion from consumption and $0.3 trillion from investment — assuming the tax is so structured that the marginal propensities to save and invest are unaffected. Gross investment without the tax would be $27 × 0.2 = $5.4 trillion. The capital-output ratio and the growth rate would decline by (1-5.1/5.4) = 6%, quite a small effect.

Table 17.6 summarises the above calculation, which is repeated separately for the major country groupings assuming they follow policies (tax, regulation or otherwise) to raise the prices of fossil fuels by similar amounts.

These calculations are deliberately intended to raise more questions than they answer. They suggest that even quite momentous changes in energy taxes could be absorbed without severely hampering growth prospects in the long term. Given the huge rents involved, they would certainly have a major impact on innovation and investment. However, they remain illustrative. Aside from reminding us that we need to think more deeply about

Table 17.6: Long-term impact on economic growth of a postulated future $20/bbl carbon tax by year 2000

	World	*OECD*	*Ldcs*	*Centrally planned economies*
		$ trillion		
(1) Output	27.0	20.0	5.4	1.6
(2) Resources diverted by the tax:	1.5	0.7	0.5	0.3
(3) Consumption	20.4	15.7	3.7	1.0
(4) Investment (gross)	5.1	3.6	1.2	0.3
		% per year		
(5) Economic growth:				
(a) without tax	3.0	2.5	6.0	2.5
(b) with tax	2.8	2.4	5.3	2.3
(c) difference	-0.2	-0.1	-0.7	-0.2

Notes: Propensities to invest are taken to be 18% in OECD, 23% in cpes and 20% for the world, 25% for ldcs. All figures are rounded. Item (3) is thus (1)-(2) times the propensity to consume and (4) is (1)-(2) times the propensity to invest.

appropriate carbon taxes and their implications for resource allocation and growth, the following points seem to deserve further research:

(i) *Phasing.* Whatever tax (or its regulatory alternative) is decided upon, it would be wrong, in principle and in practice, to introduce changes abruptly. Nor, given the uncertainties involved, would there be a case for huge taxes at the present time. Rather, there is a good case (noted earlier) for precautionary taxes to finance R & D, rekindle commercial interests in renewables and other non-greenhouse gas alternatives, stimulate conservation, and in developing countries, to finance such activities as the protection and maintenance of forest reserves and social forestry programmes.

(ii) *Gas.* One danger of a carbon tax is that it could easily create a 'bonanza' in gas with little R & D and investments going to other ways of reducing greenhouse gas accumulations in the long term. The development of non-greenhouse gas alternatives, increased conservation and so forth may need to be targeted in other ways — for example, through subsidies, tax relief or direct investment, perhaps supported by the carbon tax revenues. In other words, carbon taxes and their effects should not be analysed in isolation from the other instruments of policy applied to other elements in the programme such as renewable sources of energy and conservation.

(iii) *Differences between countries.* There is no reason in theory why countries should have exactly the same policies, or even the same tax rates if the economist's case for the tax approach is well received. Thus one strategy might be for some OECD countries to show some leadership by introducing carbon taxes first, perhaps combining this with the incentives just noted to encourage private R & D in renewables and conservation. (The companies supplying gas would find a significant increase in cash flows, and thus would be well placed financially to reactivate their R & D programmes on these matters if (see (ii)) they were so induced or required.) In this way they would bear the initial costs and risks of innovation and, as the research develops, the policies (and their fruits) could spread to other countries.

(iv) *Developing countries.* However, before dismissing the restraints on fossil energy use by means of taxation (or its alternatives) as entailing too much sacrifice, the developing countries might well consider the following gains from the approach:

- Energy taxation, whether via carbon taxes or otherwise, has long been thought to be a good form of taxation in the circumstances of developing countries. These are grounds for taking the following as working hypotheses: that (a) the deadweight losses would be lower than those of the alternatives, so that there might be efficiency gains from carbon taxation, and (b) the taxes would be progressive.

- The revenues could help alleviate fiscal problems in some countries and could be recycled in others, for example to finance afforestation programmes.

- There may also be long-term social cost advantages to the use of renewables in developing countries, particularly in solar energy.[14] Some of the more promising schemes are already to be found in the developing regions; mean annual solar insolation in developing countries is about 40-50% higher than in OECD countries, while the land areas available for solar projects are much greater. There may thus be a good case for creating rents in renewables early so as to attract foreign direct and domestic investments in this area.

(v) *Effects on growth in the short and long term.* The above calculations also relate to the long-term effects on growth. The effects of carbon taxes (or their alternatives) would be to shift resources gradually into higher-cost forms of energy supply. Economic growth would be higher if the cheaper (fossil) forms of energy could be used indefinitely; the calculations reflect this elementary point.

Even if carbon taxes (or their alternatives) were introduced, however, fossil-based energy would continue to be used for some time. It would take several decades, in fact, for the taxes (or their alternatives) to alter the pattern of energy supply dramatically. Hence in the medium term, the main effects of the taxes would be redistributive: income would be transferred to governments and, via 'rents', to the suppliers of the lower greenhouse gas-emitting energy sources — not least gas or solar energy and other renewables. The deflationary impact of such taxes would be fully offset by the expenditures they make possible (except in the developing countries with high inflation, where they could be used as a deflationary device). Indeed, as noted under (iv), there may be some efficiency gains.

The short- and long-term allocative effects of carbon taxes on output and growth clearly need more analysis and research. The above calculations are intended as a starting point for discussion. But it does seem that the overall effects of carbon taxation need not be damaging in the short term, and might even be beneficial; they are certainly absorbable in the long term, and would have profound effects on the industry's development.

(vi) *Cost dynamics.* Marginal costs are rarely constant quantities. For new technologies and practices they show rapid declines with scale and with technical progress. This has been a feature throughout the energy industry since its inception: in all aspects of electricity production, generation, transmission and distribution; in oil and gas production, refining, shipping and distribution; and in coal. There is no *prima facie* reason why renewable sources of energy or other non-greenhouse gas alternatives and methods of conservation should not likewise benefit from scale economies and technical progress. For instance Starr and Paltz reported progress that[15]

> A decade ago, silicon solar cells encapsulated into modules cost over ECU 100 per peak watt of delivered power. As production technologies have improved and manufacturing volume has increased, the module price has been steadily falling and in mid-1982 was about ECU 8 to 11 per peak watt for large orders..... The objective of worldwide research and development effort is to achieve production techniques and volumes that will enable modules to be sold for less than ECU 1.00/Wp and complete systems [including storage and d.c./a.c. conversion] for ECU 3.00/Wp.

This is still very much in line with current expectations; costs are now around $4-5 per peak watt, and are declining and becoming competitive with some hydro schemes and diesels outside urban areas. The cost dynamics of manufacture and use are an important subject for research and policy analysis.

(vii) *International agreements.* Too much analysis of the global problem, in my judgement, suffers from the 'top-down' syndrome. The assumption that since the greenhouse effect is a global problem it must be addressed by global policies can be misleading. Co-operation among countries will, of course, be fundamental for a policy's success. However, in order to achieve it, it will first be necessary to understand the energy demand requirements of each country, and the economic, institutional and other constraints it is

facing. Furthermore, whatever policies are finally agreed upon, they will work only if they influence the activities of individual people in the course of their economic and domestic affairs. In other words, the policies will have to work, eventually, through local systems of taxation, regulation and public administration. A necessary starting point for analysis must therefore be to decide what sorts of policies are best likely to work in a local context, and what their effects might be, bearing in mind the constraints just mentioned.

(viii) *International distributional issues.* The above analysis suggests that the costs of restraints on the use of fossil fuels, either via taxation or otherwise, would be the highest for developing countries. Although they may ultimately have as much to gain from the policies (again, on the assumption that the global warming problem is serious), there is a role for concessional aid (a) to absorb some of the costs and risks of adjustment, and (b) as 'good will', perhaps to encourage them eventually to participate in the policies. These issues clearly require more analysis. But if the remarks made under (iii) to (vii) are valid, the focus for aid would need to be not on 'global' policies in and of themselves, but on winning agreement on appropriate systems of *local* taxation and regulation to address the emerging global problems. As discussed, this would not be without commercial interest to the OECD economies, the developing countries, or the major energy industries and their suppliers.

(ix) *Private and public investment.* Indeed, other than in nuclear energy, the bulk of energy-related R & D and investment is undertaken by private corporations, who would also have a long-term commercial interest in the renewables industry if carbon taxes (or their regulatory alternatives) were introduced. Hence the scope of energy policy should not simply be confined to purely energy-related matters, but needs, in addition, to help create conditions for private foreign direct and domestic investments to take place profitably. Foreign direct investment would also facilitate the long-sought goals of technology transfer. These conclusions also follow from the recent study by DeAnne Julius on the 'globalisation' of business.[16]

(x) *Uses of funds.* The revenues from carbon taxes would be large. Analyses of how they would best be applied to meet the goals of allocative efficiency (including allocative efficiency in the production and use of energy resources) and distribution must be

a necessary aspect of carbon tax analysis, as it is of any other form of taxation.

(xi) *Energy efficiency*. There is much dispute among analysts as to how much can be achieved by improving the efficiency with which energy is produced and used, and what the costs would be. In the context of demands from developing countries, a formal analysis of the three components of economic efficiency is lacking: namely, of technical efficiency (how fast the technology shift-term or 'frontier' can be expected to move), managerial efficiency (whether a given resource is being managed as well as it could be), and price efficiency (how close prices are to social opportunity costs, including external costs and the costs of raising public financial resources).

Conclusions and Suggestions for Further Research

The emerging demands for commercial — primarily fossil — energy in the developing countries are very strong, and will probably be far greater than those of the OECD countries within 15 to 20 years or so, and four times those of Eastern Europe and the USSR combined. Energy demand growth rates in the developing countries were 6% per year in the 1970s, curiously about the same in Asia, Africa and Latin America, despite the oil price shocks; they were 6% again in Asia in the 1980s, though they had declined to 2% in Africa and Latin America owing to the crises of internal balance and debt. Per capita consumption is less than one-tenth of that of the OECD countries today, and would still be less than one-quarter in four decades time assuming 4% annual growth (2 percentage points below the expected rate, assuming an eventual economic recovery in Latin America and Africa). The countries are still low on their 'S' curves for practically all forms of energy-using durables, equipment and vehicle fleets; and the growth of populations and per capita incomes, and the substitution from fuelwood to commercial energy, are all likely to exert strong effects, even making generous allowances for the very important potential of efficiency improvements in the production, conversion, management and uses of energy.

Hence a major geographic shift in the demands for commercial energy is taking place and, with it, the backward linkages into the engineering industries providing the supporting infrastructure — in exploration and production, refining, conversion (synfuels, electricity generation), distribution and marketing facilities. The

demands of Eastern Europe and the USSR are also potentially important; however, like those of the OECD, demand growth could eventually be tempered by improvements in efficiency and price increases.

It is ironic therefore that at a time when industrial country markets are maturing, and the long-awaited growth of the developing country markets is about to exert a major influence on world demand, the expansion is being called into question by environmental concerns. These concerns fall into two categories:

- Those about which we are fairly well informed, where the technologies or substitutes to deal with them have been developed and can be introduced at a relatively low cost. They include the emissions of sulphur dioxide and nitrogen oxides (acid deposition), particulates, and carbon monoxide; the use of lead in fuels; and the treatment of effluents and wastes.
- Those about which we are poorly informed, where the technologies to deal with them are not developed and, at present, appear to be very costly — perhaps several times the current costs of fossil fuels. These concerns are, of course, those of the greenhouse effect.

For the industrial market economies, the policy options available to deal with the first have been well defined,[17] and turn on finding an appropriate mix of environmental taxation and regulations, that is, of applying the polluter pays principle. For Eastern Europe the issues are more complex, partly because of the severity of the problems, and partly, as Helm and Pearce note,[18] because the systems of market-based incentives and regulations as they are understood in the OECD economies are not available. Nevertheless, the sorts of investment required, their effects on emissions and effluents, and their costs can be fairly well-defined for the analysis of investment policy options.

Still on the first category of problems, there is clearly much research to be done in the developing countries. The instruments of policy are available, particularly environmental taxes, if it is decided to apply them and, again, the costs of options to reduce effluents and emissions can be estimated reliably. The main issues requiring research are (a) the actual rates of discharge of emissions and effluents into the environment, and (b) the external costs, mostly to the countries themselves, of the discharges. Local analyses of (a)

and (b) in the countries concerned would clearly be desirable if good policies are to be defined; in other words, what is lacking is the information, not the tools.

Turning to the greenhouse effect, the research agenda is much larger. Earlier in this chapter an attempt was made to sketch out some areas for further research and to comment on approaches; the main points will not be repeated here.

On the policy front, the best option, as many have noted, would be to introduce some sort of carbon tax, in the first place to finance R & D, and to rekindle public and private interests in renewables, conservation and other options. This is an area where the OECD countries might exert some leadership. There is no theoretical reason why the developing countries should be expected to follow suit at the present time — other than that it might be in their own commercial and economic interests to do so. If global warming turns out to be a false alarm, the costs of the policy, as many have also noted, will not be great. There is already an economic use for renewable sources of energy in many areas (especially in the developing countries) and a good case for conservation, while the tax surpluses and the rents to private enterprise may very well entail few deadweight losses in the medium term.

If, on the other hand, global warming is not a false alarm, then clearly the carbon taxes (or their alternatives) would have to be tightened and accompanied by other measures, first to stimulate innovation and, second, to achieve co-operation among the major industrial and developing countries.

Improvements in the efficiency with which energy is produced and used may lead to significant savings, as many have noted, and policies which might achieve such improvements must be an important element in the overall policy framework. *But 'energy efficiency', as it has come to be called, will not solve the problem, and it is dangerous to assume that it would.* In any scenario of growth and development, the demands for commercial energy from the developing countries are likely to become very large; and any attempt to curtail growth in demand, without making non-greenhouse gas alternatives available, would impose intolerable costs on developing societies.[19] Hence policies must also emphasise substitution and innovation.

The nature of the substitutions and innovations, their costs, and their overall effects on the patterns of energy supply can only

vaguely be seen at the present time; it is also in the nature of R & D and technical progress that it is a source, sometimes of failure and disappointment, but also of unlimited surprises. Two points can, however, be made with confidence. One is that innovation is more likely to take place if 'good' incentives are provided. The other is that the innovative capacity of the industry should not be underestimated.

Notes

1. *Oxford Review of Economic Policy* 6 (1), Spring 1990.
2. See Joop de Vries, *Images of the Nineties*, Shell Selected Papers. London: Shell Centre, 1988.
3. See Ged Davis, *Global Warming: the role of energy efficient technologies*. London: Shell Selected Papers, 1989 on this.
4. Numerous people have drawn attention to the potential for improvements in energy efficiency in developing countries. See, for example, World Bank, *Energy Efficiency Strategy for Developing Countries: The Role of ESMAP*, a background paper of the World Bank's Energy Department. Washington, DC: November 1989.
5. Again, see ibid. and Davis, *Global Warming*, op. cit.
6. For a recent analysis, see Peter Pearson, *Energy Transitions in Less-Developed Countries: Analytical Frameworks for Practical Understanding*. Cambridge Energy Research Group, EDP Discussion Paper, July 1988.
7. A point made to me by Stewart Boyle. The term efficiency is generally used to include price effects, as well as improvements arising from technological change and methods of managing energy resources. In Table 17.2, price effects are shown separately.
8. 'Emissions of CO_2 into the Atmosphere', Chapter 2 of Bert Bolin, Bo R. Doos, Jill Jager and Richard A. Warrick (eds), *Scope 29: The Greenhouse Effect, Climatic Change and Ecosystems*. Chichester and New York: John Wiley and Sons, 1986.
9. For example, those of Amery Lovins, cited by Keepin et al.
10. Current emissions from combustion are about 5.5 bn tonnes per year, while the amount now stored in the atmosphere is 725 bn tonnes. Fluxes are about 160 bn tonnes each way between the atmosphere and the earth's surface. See Bolin et al., *Scope 29*, op. cit.
11. This is the familiar case for environmental taxes. See W.J. Baumol and W.E. Oates, *Theory of Environmental Policy* (2nd edn). Cambridge: Cambridge University Press, 1988, who originally developed the argument in 1971. Also W. Beckermann, *In Defense of Economic Growth*. London: Jonathan Cape, 1984.
12. *Oxford Review of Economic Policy*, 6 (1), Spring 1990. See also R.W. Hahn, 'Economic Prescriptions for Environmental Problems: How the Patient Followed the Doctor's Orders', *Journal of Economic Perspectives* 1989 for a review of US experience.
13. See the Commonwealth Secretariat's 1989 Report on *Climate Change* for

one of many good overviews of options.

14. See, for example, E. Terrado, M. Mendir and K. Fitzgerald, *Impact of Lower Energy Prices on Renewable Energy Technologies*. Energy Series Paper No.5, Energy Department, World Bank, Washington, DC: 1988.
15. M.W. Starr and W. Paltz, *Photovoltaic Power for Europe*. Dordrecht: D. Reidel Publishing Company, 1983, p.9.
16. DeAnne Julius, *Global Companies and Public Policy: the Growing Challenge of Foreign Direct Investment*. London: Pinter Publishers for the Royal Institute of International Affairs, 1990.
17. Once again, the OECD has put out numerous informative publications on the technological options, policies and costs.
18. *Oxford Review of Economic Policy* 6 (1), Spring, 1990.
19. With an income elasticity of demand equal to 1.0 (a conservative assumption) and a price elasticity of -1.0 (also a conservative assumption), the real price of commercial energy would have to grow at a real rate equal to the income growth rate to keep demand constant (i.e. 6% per year for developing countries or, say, 2 percentage points less than this (4%) allowing for significant improvements in technical and managerial efficiency).

18: Commentary on Energy Issues
Gordon Goodman

Ever since the oil price crises of the 1970s, energy and environment specialists worldwide have been arguing over the complex issues involved in this problem area. Although urged to come up with answers, no solutions put forward ever found favour to the extent of being fully implemented. In any case, in 1986 the urgency began to subside again with falling oil prices.

From 1973 to 1986, the problem was perceived as how in practice to replace the currently expensive oil by such alternative energy sources as coal, nuclear, or direct solar power (photovoltaics, solar thermal) as well as by indirect solar (wind, waves, falling water, biomass, ocean temperature gradients). Geothermal and tidal energy potentials were also closely examined, as well as various forms of energy saving. One of the most promising among the latter was the efficient use of energy to deliver the same amounts of heat, light, shaft-power and other 'energy services' but with less fuel input.

Although we never really cracked the problem, we did at least learn that:

(i) Generally speaking, the problem was not so much the unavailability of suitable energy technology but rather the way that current political and institutional arrangements tended to hinder the economic and legislative mechanisms needed to promote change to a 'lower-oil' energy mix. In short, the market mechanism was not wholly adequate for the job.

(ii) In trying to formulate any new policy on energy mix, in an important sense, and whether we liked it or not, we inevitably formulated a new environmental policy.

All this is not to suggest that no progress was made and nothing was achieved throughout the 1973-86 period. During this time, many market economies improved their energy efficiency by 15-30% although their GDP growth continued, unaffected by the virtually zero increase in energy supplies. For instance, the US economy grew by about 40%, with energy use pegged almost constant. In fact, thousands of private and public sector decisions, in a number of industrialised countries, took altogether an average of about US$250bn worth of fuels a year out of the energy economy over the period. In some countries, increased efficiency also meant economic advantage. For example, by 1986, Japan was using 4% of its GNP to pay for fuels compared with 10% in the United States — a US$200bn difference, which has been calculated as conferring a 5% cost advantage on Japanese products in the US market.

Another very important gain was the fact that a lot of Research and Development effort and thousands of demonstration projects combined to give the world a much sharper and far more realistic picture of the extent to which energy alternatives could really deliver, and under what socio-economic and institutional circumstances they were usable.

There were many other successful battles, but nobody really won the energy war. Now it has broken out again, this time for environmental rather than economic reasons, as we learn what carbon dioxide emissions into the atmosphere are doing to the radiation balance of the planet. Climatic change induced by greenhouse gases appears to be inevitable, with CO_2 emissions contributing at least half the problem, though the time, rate and scale of onset and impact are all uncertain.

This time round, the struggle is made much harder by the fact that we can no longer rely on coal — the favourite replacement for oil during the 1973-86 period — as a fuel option. Even in 1980, just prior to the emergence of global warming as an issue, the problem of serious damage to lakes, forests and soils, and the corrosion of the built environment, from acidification by oxides of sulphur and nitrogen as well as by oxidants formed during fossil fuel combustion was causing great concern. The regional scale of this damage across Europe and North America, and its emergence as a threat in the newly industrialising countries, was enough to cause many

environmental analysts to question the future rapid growth of oil and coal use.

Adequate energy supply is interactively connected to a whole set of issues closely related to environmental quality and rapid development. These central questions are: poverty; indebtedness; food scarcity; woodland and soil loss; water shortages; population growth and urbanisation; landlessness; human migration; nuclear proliferation; and pollutant damage to health and the biosphere. All except the last two have been firmly on the agenda of developing countries for some time and have been written about a great deal in energy terms. The last two are increasingly becoming the concern of industrialised countries both old and new. All these issues prejudice social equity and basic human rights, aggravate the North-South divide, and damage society, the economy and the environment, with important consequences for peace and security worldwide.

As Professor Anderson states: 'It is ironic therefore that at a time when industrial country markets are maturing, and the long-awaited growth of the developing country markets is about to exert a major influence on world demand, the expansion is being called into question by environmental concerns'. In other words, will environmental problems such as acidification and global warming slow down the development expected in the future by inhibiting the release of the primary energy supplies needed to fuel it? If not, how can we ensure that energy is available for development without running into serious environmental damage on a global scale?

In Anderson's 'planning' scenario, world energy use is allowed to grow more or less normally (on a 'business-as-usual' basis) and to double by the year 2030. This assumes that energy consumption in developing countries will grow by about 3.5% a year, so that by 2030 they will be consuming about twice as much primary energy as the Western industrialised countries. It means the converse of the present situation, in other words that a quadrupling of developing country consumption is anticipated in this 'plan'.

There is of course absolutely no doubt that the developing countries need the heat, cold, motive power and other 'services' provided by this extra energy to power their GDP growth. But everyone hopes that they will be able to quadruple their energy services without quadrupling their primary energy consumption, particularly if the current fuel mix is continued.

Anderson's paper hints that the 'greenhouse' effect may be a blessing in disguise if we can use the device of a carbon tax, or something similar, to stimulate the more efficient use of energy and the switching away from coal, oil and ultimately gas, to more environmentally benign energy sources. So the big question then is: Do we really have to double world primary energy use and suffer all the attendant environmental problems in order to achieve the doubled world energy services 'planned' for the year 2030?

Taking first the environmental problems of sulphur and nitrogen oxides, Anderson's paper clearly demonstrates that light can be seen at the end of the tunnel. The technological, fiscal, economic, institutional and legal mechanisms for their successful management are by now well proven and available to us. And we also know that one unit of control costs saves at least three units of damage costs to fisheries, trees, soils, corrosion, etc. in the industrialised countries. The big question here is how we stimulate political will, especially in the newly industrialising countries. What is needed is clear information connecting acidification to damage in developing and newly industrialising countries.

Such knowledge would certainly help motivate the political will needed to act. Unfortunately, however, we know practically nothing about the potential vulnerability of tropical soils, vegetation or aquatic systems — fisheries etc. — to acid and oxidant harm, although we could already collect a lot of the acid-dose/environmental-response data from ecosystems around those cities in developing countries which already suffer air pollution. An even more critical issue is whether some developing countries have the effective meteorological services needed to get the wind-rose and trajectory data needed to predict where emitted pollution is likely to be deposited. These gaps in knowledge raise important R & D issues. Professor Anderson is right about acidification when he says, 'what is lacking is the information, not the tools'.

His paper mentions switching away from wood fuels in developing countries, and since we now know that, in terms of human health, wood-smoke is as harmful as coal-smoke, the use of kerosene, or better still bottled gas, is a cleaner and healthier option than biomass burned domestically.

Energy derived from coal in developing countries is at present a little more than that from oil and, despite its poor environmental showing compared with oil and especially natural gas, coal will inevitably be used where it occurs, notably in China, India, and to

a lesser extent in parts of Africa and South America. Are there ways in which we can use it really efficiently?

This brings us on to the 'greenhouse' question, where energy saving, fuel efficiency and fuel switching are crucial. The technology available for CO_2 absorption and secure disposal is extremely expensive to run. We therefore have to rely on reducing emissions. Otherwise, we must face up to the costs of adapting to a warming world of changing regional climates and rising sea-levels. A certain amount of adaptation is already inevitable from the global warming to which we are already committed, but it will be prudent not to allow this to increase.

We can look back and thank OPEC for forcing the world to do some important experiments with energy switching and saving in the 1970s and early 1980s. Energy efficiency efforts since then have tended to slip, especially in the United States, under the euphoria of cheap oil, but nevertheless we learned a lot. Today we have available aircraft that use a third less fuel, cars that use anything from one half to four-fifths less fuel, and housing, especially in Sweden, using only one-third of the heating or cooling of their US equivalents. We have modern electrical appliances (fridges, heat pumps) using one-third to one half less electricity, and fluorescent light bulbs using only one-quarter of the power for the same level of illumination. The cost of saving electricity this way may often be 3-4 times less than the cost of building the extra generating capacity. Often, simply good energy housekeeping can save a third of fuel use; one enthusiast for energy saving has calculated that the total energy lost from ill-fitting US windows is about the same as that flowing down an Alaskan pipeline.

Looking more carefully at the energy saving and efficiency potential in developing countries, it is safe to conclude that the same energy services could be delivered by using one-third to a half less primary energy, with huge economic savings. The real problem is how to raise the investment capital in these countries to purchase the energy-efficient end-use equipment needed to start this energy revolution and whether it can be achieved, as Professor Anderson stresses, in the face of currently inexpensive oil.[1]

I believe the strategy proposed by Professor Anderson of interventions in consumption (via carbon taxes) rather than at the emissions stage is a far more manageable and flexible instrument, not only for controlling CO_2, but also for oxides of nitrogen and sulphur. It can give consistent signals to the energy markets in

favour of fuel switching and investment in new and renewable energy sources as well as in saving/efficiency measures. The paper makes a very good case for carbon taxes and if these are initiated by some of the industrialised countries, with an allowance being made for a support fund for technology transfer to developing countries similar to what was proposed at the Toronto Conference of June 1988, then I believe real progress can be made with the 'greenhouse' issue.

Getting the necessary political backing will certainly take some doing and this is why it is really important, as Anderson points out, to start if necessary with only a few industrialised countries, without waiting for a global consensus. In any case, the leaders in this initiative will have nothing to lose even if the 'greenhouse' effect does not materialise. The measures supported all make very good sense in terms of sound environmental management, as well as representing solid economic opportunities by creating markets for new technological products and end-use appliances. Professor Anderson's paper gives us much room for hope, but it does not take much imagination to see the magnitude of the task that lies before us, of translating these global and regional guidelines into effective energy policies to fit each individual nation's needs.

Note

1. Since March 1990, when this commentary was written, we have witnessed another oil price rise following the Iraqi occupation of Kuwait. So we have seen in 17 years uncertainty over oil, driven by economics, environment and politics. It will by no means be the last.

IX. METHODOLOGICAL ISSUES

19: Economic Valuation of Environmental Resources[1]

John A. Dixon

The Present Situation

Economic analysis of environmental and natural resource management problems has been a 'growth industry' of the 1980s. This trend promises to continue in the 1990s in both the developed and developing countries, and by national governments as well as bilateral and multilateral aid agencies and development banks. Economists are increasingly being asked to show how their theories and techniques can be used to address real, immediate problems, both at the project and at the policy level.

The record to date is mixed. In part this is a natural result of the inherent limitations of economics from a theoretical basis and the diversity of problems it is being called upon to address. As a science, economics is an empirical, quantitative discipline that is ill suited to address certain subjective or qualitative topics. The 'value' of human life is a well-known example of just one of these problem areas. Others abound in the environmental/natural resource management field: species preservation, genetic diversity, traditional social-cultural systems, and aesthetic concerns among others. Some of these are currently receiving widespread public attention.

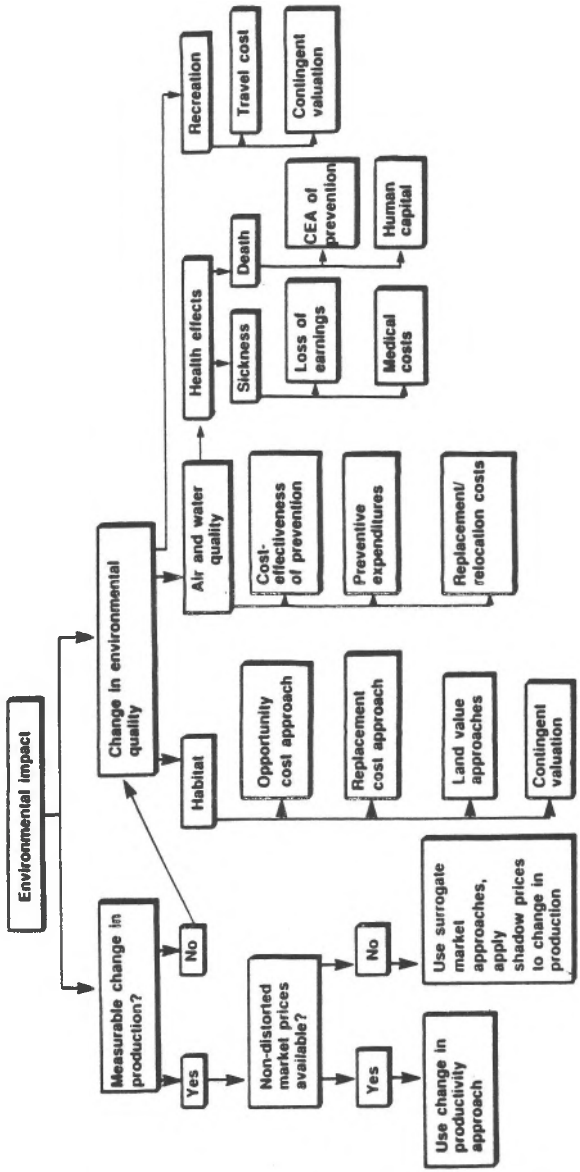
Other topics that were once thought too subjective to evaluate are now routinely analysed within an economic framework. For example, the value of recreational resources is now commonly evaluated using the travel-cost approach, developed by Knetsch and

others.[2] The use of survey-based contingent valuation method (CVM) techniques to obtain information on willingness-to-pay (WTP) or willingness-to-accept-compensation (WTAC) for various resources is increasingly accepted as a useful technique (even though the divergence between the two approaches has been a topic of some concern). Recent books by Cummings et al. and Mitchell and Carson examine CVM approaches in detail.[3]

Still other environmental concerns result in changes in physical production or health which, if data are available, can be measured and valued. Some of these are the 'easy ones' from an economic perspective — direct impacts on the production of goods and services that can be valued using market prices. These environmental benefits and costs can then be added to the other direct project benefits and costs to undertake what has been called an 'extended' cost-benefit analysis resulting in a broader evaluation of alternatives. To reach this step, however, the potential environmental impacts have to be identified and measured (assessed), evaluated in monetary or qualitative terms, and incorporated into an evaluatory process (frequently some form of cost-benefit analysis). Details on valuation techniques are found in numerous references.[4]

Matching economic technique with environmental effect is not an exact science. The actual technique used in any case will depend on a number of variables, including time, data available, financial resources and the skill of the analyst. Figure 19.1 presents one approach: a simple evaluation flow chart that starts with an identified environmental impact. Though by no means complete, this flow chart provides useful guidance on where to begin. A variant on this is seen in Table 19.1 from a recently completed manuscript on dams and the environment prepared for the World Bank.[5] It lists various potential environmental effects of dams, their economic impact, whether they are likely to be benefits or costs, and representative valuation techniques. Whereas Figure 19.1 presents generic impacts, Table 19.1 lists more specific environmental effects. Neither approach, however, tells which effects are the most important or of greatest concern. The integration of environmental and economic assessment is, therefore, necessary to ensure that the right questions are asked and the most appropriate alternatives are considered.

Figure 19.1: A simple valuation flow chart



Source: J.A. Dixon and J.P. Bojo, 'Economic Analysis and the Environment', a Report to the African Development Bank, Abidjan, 1988.

Table 19.1: Selected environmental effects of major storage dam projects and their economic impacts

Environmental Effect	*Economic Impact*	*Benefit (B) Cost (C)*	*Representative Valuation Technique*
Environment on Dams			
1. Soil erosion — upstream, sedimentation in reservoir	Reduced reservoir capacity; change in capacity; change in water quality; decrease in power	B,C	Change in production, preventive expenditures, replacement costs
Dams on the Environment			
1. Chemical water quality — changes in reservoir and downstream	Increased/reduced treatment cost, reduced fish catch, loss of production	B,C	Preventive expenditures, changes in production
2. Reduction in silt load, downstream	Loss of fertiliser, reduced siltation of canals, better water control	B,C	Replacement costs, preventive expenditures avoided
3. Water temperature changes (drop)	Reduction of crop yields (esp. rice)	C	Changes in production
4. Health — water-related diseases (human and animals)	Sickness, hospital care, death; decreased meat and milk production	B,C	Loss of earnings, health care costs
5. Fishery — impacts on fish irrigation, spawning	Both loss and increase in fish production	B,C	Changes in production, preventive expenditures
6. Recreation — in the reservoir or river	Value of recreation opportunities gained or lost, tourism	B,C	Travel cost approach, property value approach
7. Wildlife and bio-diversity	Creation or loss of species, habitat and genetic resources	B,C	Opportunity cost approach, tourism values lost, replacement costs

8. Involuntary resettlement	Cost of new infrastructure, social costs	B,C	Replacement cost approach, 'social costs', relocation costs
9. Discharge variations, excessive diurnal variation	Disturbs flora and fauna, human use, drownings, recession in agriculture	B,C	Relocation costs, changes in production
10. Flood attenuation	Reduces after flood cultivation; reduces flood damage	B,C	Changes in production, flood damages avoided

Source: Dixon, Talbot and LeMoigne, 'Dams and the Environment'.

Limits of Current Practices

We face a situation where most major environmental problems are known and many appropriate economic analytic techniques have been developed, especially for project analysis. The techniques of project analysis, including cost-benefit analysis (CBA) and cost-effectiveness analysis are also well developed.[6] And yet, the record of actual application is disappointing; this is true both for broader resource management issues and individual projects.

A fundamental division appears to exist between applications of these approaches in developed and developing countries, in part because of differential access to financial resources and in part owing to public and private awareness of environmental problems.

In *developed countries*, a major question is the appropriate *level* of environmental protection to adopt. Developed countries are relatively rich in data, trained manpower and financial resources. The differences between financial analysis and social-welfare (or economic) analysis are well known. Institutional arrangements and regulatory means exist to enforce decisions, once made. There are still tensions, however. At the project level, enhanced environmental measures will usually mean increased financial costs in order to ensure larger social benefits. The decision-making process must contend with powerful forces on both sides. Well organised and financed project proponents must frequently contend with equally well organised (and sometimes powerful) 'environmentalist' groups, whether private NGOs or government regulatory agencies.

The net result of this tension has tended to be positive: projects today are more environmentally sound and development is more sustainable. Notable success in improving air and water quality, hazardous waste disposal, and land management has been achieved. These actions have usually required increased 'up-front' expenditures to ensure larger long-term benefits. Two 1989 reports are of note. *Environmental Policy Benefits: Monetary Valuation*, prepared by Pearce and Markandya for the OECD, surveys the question of valuation of environmental effects in a concise manner. A more popular publication that discusses these issues in the context of sustainable development is *Blueprint for a Green Economy*, by Pearce, Markandya and Barbier.[7] Although the *Blueprint* was written with the United Kingdom in mind, the approach and lessons have much broader applicability.

In *developing countries*, however, home to a very large and rapidly growing share of the world's population, a different set of problems exist. In answer to the demands that environmental and resource concerns be accommodated while meeting economic development objectives, a number of responses are commonly encountered. These include the following:

We already are doing it. Many countries have elaborate environmental legislation on the statute books, but enforcement is usually weak. In other cases, major projects are funded by bilateral or multilateral donors who also impose their own requirements. In this instance, implementation of protection measures and post-completion maintenance are major problems.

We can't afford it. One frequently hears the complaint that environmental protection measures are a 'luxury' that developed countries can afford but that place an unacceptable burden on developing countries. In some cases, there is an element of truth in this assertion. More often, however, this view reflects a myopic approach to development in which the increased *financial* costs of environmental measures are given much more weight than the even larger *social economic* costs that result when no action is taken. In addition, the increase in worldwide awareness that this is an international problem may result in increased international resource flows.

We can't measure it. There is uncertainty about some links between cause and effect, particularly where major natural ecosystems are involved. In many cases, however, the lessons learned from previously implemented projects or development programmes are

very instructive in anticipating likely effects. Once the physical links are established, the economic connections can begin to be estimated. At the same time, as mentioned earlier, there are certain impacts or effects that are not appropriate for quantification and translation into monetary terms.

We don't know what we can do. This is a real question, but one that can be addressed. The growing worldwide interest in environmental assessment and applied economic analysis is one result of this question. The approach outlined in Figure 19.1 and the listing in Table 19.1 are but two examples of how to begin. More case studies are needed of the actual application of economic principles to real development problems in developing countries. Some examples, both *ex-ante* and *ex-post*, are given in two recent publications.[8] More work is needed in this area.

An Assessment of Recent Experience

Notwithstanding the growing number of cases where economic and environmental analyses have been successfully linked, it appears that there are definite limitations on what can be done, particularly in developing countries. This is due to several factors: (i) limitations on data or knowledge, (ii) the existence of non-quantifiable impacts, (iii) the major cumulative impacts of individual actions, and (iv) major financial and/or political costs involved with some potential actions.

First, considerable uncertainty still exists about the links between cause and effect associated with some ecosystems. For example, the exact effect of upper watershed deforestation on changed streamflow patterns downstream, particularly in larger watersheds, is not as clear as was previously thought. No doubt there is some impact but the full extent of flooding induced by land-use changes is not certain.[9] Similarly, mangroves are important ecosystems that provide goods and services both within the mangrove and beyond. One important link is between the mangrove forest and the nearby fishery. It is known that a link exists via breeding habitat and nutrient flows but the exact magnitude is uncertain. The conversion of part of a mangrove forest to an alternative use may not affect the nearby fishery, while total conversion will. A grey area exists in between, however, and scientists do not yet know what portion of the original mangrove must be maintained to ensure preservation

of the associated fishery. Without this information, the economist cannot assess the fishery costs of mangrove conversion.

Second, non-quantifiable (in monetary terms) impacts have already been mentioned. These range from changes in traditional lifestyles to loss of historical or religious sites to loss of as yet unused genetic material. While potentially very important, these impacts may not be amenable to conventional tools of economic analysis. They should, therefore, be retained in a qualitative manner in the analysis of alternatives. These concerns are very important in Latin America with its large areas of tropical rain forests and Amerindian populations.

Third, a much more fundamental problem is the fact that in most developing countries the major environmental problems are not the result of large, individual projects but rather of actions by thousands or millions of individual decision-makers — farmers, fishermen, small workshops or other actors. Because of the difficulty in controlling or regulating these groups, it becomes necessary to use macro policies to affect micro units. Recognition of this fact is attracting increasing attention; the resulting focus on natural resources management via macro-level policies is reflected in recent writing by Repetto and Warford among others.[10]

The diffuse nature of these micro units means that traditional environmental management tools — regulations, technology specifications, fiscal measures — are much less effective than in the case of major development projects. Macro measures have the advantage of working through the economy and potentially affecting all resource users who are part of the economic system. Their weakness is the slow and uncertain nature of the response to new policies. For example, it has proved much easier to control vehicle emissions by regulation of the small number of major car manufacturers than to control industrial pollution, particularly from a large number of small-scale plants.

Government policies designed to promote growth may prove counterproductive in some cases. Two recent studies on the interaction of Brazilian government policies designed to promote economic development and deforestation in the Amazon highlight some of these issues.[11] Binswanger, for example, analysed the impact of tax policies and land allocation procedures on deforestation. Tax credits to promote ranching have also promoted deforestation with short-term private benefits and major long-term social costs.

Finally, major financial and/or political costs inherent in some actions may remove them from a realistic 'feasible set'. Economists, after all, do not make the final decisions. They can provide useful information to decision-makers who must weigh it with many other factors, including political considerations. In other cases, certain environmental quality goals (such as for air or water) may be too expensive for an economy to afford, even using the most cost-effective technology.

Given these reasons for limited application of economic analysis to many natural resource or environmental management questions, should we be hopeful or pessimistic about the future? On balance, it appears that much has been gained and, in hindsight, we might be surprised at how far things have improved, especially at the project level. The care and attention routinely given to environmental concerns today is a reflection of this evolutionary change.

In terms of economic analysis, two major thrusts are evident:

First, *cost-effectiveness analysis* is increasingly used to determine technological responses to predetermined emission standards for individual projects.

Second, the most useful approaches for valuing environmental effects, especially of projects, have frequently been the *simplest*. Change in productive approaches, preventive expenditure techniques, opportunity cost approaches, travel cost techniques, and human health techniques have all proved helpful. The more experimental techniques, or those that require extensive data sets like the property-value approach, have had much more limited applications to date.

In developing countries the most useful approaches have been those that require the fewest assumptions and the least amount of data. Approaches that rely on physical goods and market prices (for example, change in productivity, opportunity cost, relocation costs) have proved particularly useful. It has proved much harder to 'sell' the results of more hypothetical or abstract techniques (for example, the various survey-based contingent valuation approaches).

To some extent, these trends in both developed and developing countries reinforce the 'we are already doing it' perspective. The biggest hurdle in improving economic analysis of environmental management decisions has been gaining acceptance of the fact that environmental concerns are legitimate and that many can be

handled at the project level by certain basic approaches. Improved environmental management is not dependent on the development of sophisticated, 'magic-bullet' techniques.

The fact that major environmental problems still exist is less a comment on the state of development of analytical techniques than a reflection of the hard trade-offs as individuals pursue their own self-interests. To meet this problem one has to address the broader policy level. Precisely because of distortions in prices and other signals, uninternalised 'externalities', and short time horizons, market failures occur that often lead to environmental problems. Policy failures are also a common cause of environmental degradation. The solution to these problems, therefore, requires more than merely doing a better job of assessing environmental impacts and valuing the associated benefits and costs, it also requires realistic political decisions that change policies and the 'rules of the game'. In short, it requires political will. Improved economic analysis can aid in this process, but cannot cause it to happen by itself.

Future Research Needs

The 1990s hold the promise of becoming an environmental decade. The awareness of national and international environmental problems exists, the political will to do something about these problems is building, and the financial resources to make changes may increasingly become available. In terms of future research needs, therefore, economists will be increasingly called upon for practical, implementable advice. Fortunately, economics is now a vast and very specialised discipline and there is no shortage of manpower to address these issues.

With respect to economic valuation of environmental resources there appear to be two major, and very different, research needs.

First, at the global or international level, additional research is needed in analysing the economic dimensions of proposed policies to handle international problems such as acid rain, global warming, tropical rain forest loss, and preservation of bio-diversity. Take preservation of bio-diversity as an example. If a country, or an international group, wanted to spend one, five or ten billion dollars on this, how would one begin? What are the likely benefits of alternative actions? Is it better to use a cost-effectiveness or a safe minimum standard approach? Can a traditional cost-benefit

analysis of a policy be undertaken? We still know very little when big numbers and international effects are involved. The need, therefore, is for both theoretical approaches and initial policy analysis. Major difficulties include problem identification and specification, uncertainty, valuation and handling long-term impacts.

Secondly, at the project or individual level, the major research need is not for more theory or techniques, but for application of existing methodology and approaches to concrete problems in both developed and developing countries. Which approaches work and which do not? Are there important differences due to region, income level, the type of resource being studied. What approach is most cost-effective?

This suggestion may not be popular with many academic economists. The development of new theory and the refining of existing ones is, of course, important. The question remains, however, of relative importance and allocation of total research effort. The need for improved resources management in the developing world is so pressing that some reallocation of research effort towards applications would appear warranted. This can take place at the farm or household level, at the level of projects, both large and small, or at a national or sectoral level. In this regard the emerging work on natural resource accounting holds much promise.

Notes

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4. See D.W. Pearce, *The Valuation of Social Cost*. London: Allen and Unwin, 1978; J.A. Sinden and A.C. Worrell, *Unpriced Values: Decisions Without Market Prices*. Chichester and New York: John Wiley and Sons, 1979; M.M. Hufschmidt, D.E. James, A.D. Meister, B.T. Bower and J.A. Dixon, *Environment, Natural Systems and Development: An Economic Valuation Guide*. Baltimore: Johns Hopkins University Press, 1983; J.A. Dixon, R.A. Carpenter, L.A. Fallon, P.B. Sherman and S. Manopimoke,

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7. D. Pearce, A. Markandya and E. Barbier, *Blueprint for a Green Economy*. London: Earthscan Publications, 1989.
8. J.A. Dixon and M.M. Hufschmidt (eds), *Economic Valuation Techniques for the Environment: A Casestudy Workbook*. Baltimore: Johns Hopkins University Press, 1986; J.A. Dixon, 'Experience and lessons from environmental applications of economic analytical methods', paper presented at the workshop on Integrating Environmental and Economic Assessment, organised by the Canadian Environmental Assessment Research Council in Vancouver, BC, 17-18 November 1988.
9. L.S. Hamilton with P.N. King, *Tropical Forested Watersheds: Hydrologic and Soils Response to Major Uses or Conversions*. Boulder, CO: Westview, 1983.
10. See selected papers in G. Schramon and J. Warford (eds), *Environmental Management and Economic Development*. Washington, DC: World Bank, 1989.
11. D.J. Mahar, *Government Policies and Deforestation in Brazil's Amazon Region*. Washington, DC: World Bank, 1989; H. Binswanger, *Brazilian Policies that Encourage Deforestation in the Amazon*. Environment Department Working Paper No.16, World Bank, Washington, DC: 1989.

20: Economic Valuation: a Comment on Dixon

J.T. Winpenny

Dixon notes the disappointing uptake of economic valuation techniques, especially in developing countries. He also points out that the techniques used tend to be those that are the simplest and most intelligible to decision-makers (for example, those based on changes in productivity, preventive expenditure, human health, travel cost and replacement cost). In contrast, the more experimental ones (for example, hedonic methods and contingent valuation) have had much more limited applications. This view tallies with my own observation of valuation case studies in developing countries.[1] I would make the following generalisations:

(i) There has been a mismatch between the effort that has gone into the methodological literature of environmental economics (hedonic methods, contingent valuation, travel cost, the cost-of-risk approach to valuing human life, amongst others) and the methods used in practice in developing countries, which are based largely on productivity effects, preventive expenditure, replacement cost and cost-effectiveness methods.

(ii) The bulk of the studies could have been (and indeed often were) done by mainstream economists, especially agricultural economists, without resort to the specific tools of environmental economics. Most studies rely on estimates of the productivity of land with and without certain assumed changes. In turn, most of the effects going into the studies happen on-site, and are 'internalised' in the decisions of those responsible. Most conservation programmes are justified by reference to the direct

products of the scheme (wood, fruit, fodder, etc.) or their effect on on-site soil productivity and crop yield.

(iii) Environmental economists rely on data about physical effects, based on cause-and-effect relations (dose-response, damage functions, etc.) In general, these have not been well established, outside certain well studied areas in agriculture and fisheries. Even then, most data are highly site-specific.

Let me briefly elaborate.

Some of the 'hardest' data are from studies of soil erosion, in the context of watershed conservation, relying on variations of the Soil Loss Equation, and resorting principally to on-site gains and losses in fertility. Some of them make limited recourse to off-site or downstream effects, most commonly the sedimentation of reservoirs which affects the output of power and irrigation schemes. Even these depend on sediment-delivery rates which are crude and uncertain.

There are some data on the effects of sedimentation (and reef and wetland destruction) on fisheries, based on site-specific research. There is also material on the ecological externalities of trees, shelterbelts and agro-forestry on surrounding farmland, but this mostly depends on site-specific field work and trials, and sometimes even on using relationships validated in other countries deemed to be comparable.

Preventive expenditure and replacement cost are useful methods based on observed behaviour, but both depend on a view that these actions are worth doing, in the sense that their cost is justified by the damage they prevent or restore. This begs a large question.

The human capital approach depends on medical and epidemiological data which are uncertain over important areas. For instance, the effect of air pollution on human health, although strongly suggestive, cannot give us data good enough to estimate externalities at the project level. The effect of working in stagnant water on the incidence of bilharzia has been demonstrated (though in 'ideal' research conditions). Likewise the effect of faecal contamination on intestinal disorders has been demonstrated quantitatively in the United States and no doubt has some validity in tropical conditions too.

There are few applications of contingent valuation, travel-cost or hedonic methods in developing countries.

Research Needs

Environmental economists need to decide whether valuation studies are an 'infant industry' that deserves encouragement in developing countries, backed by a major programme for their further applications, as Dixon argues, or whether the present pattern of studies is a true reflection of what is possible and plausible, in which case some new direction is called for.

In defence of 'more of the same', there are important gaps and weaknesses that could sensibly be filled:

- The link between air pollution and, variously, health and productivity; materials corrosion in tropical conditions; and agricultural crop yields.
- Local people's perception, ranking and valuation of different kinds of environmental problems — especially in the urban context — and the implications for using contingent valuation. For instance, is noise a serious environmental issue in the cities of the Third World, or is it swamped by more pressing concerns?
- What are governments' own 'revealed preferences' for environmental benefits as uncovered by the consistency of different kinds of decision?
- Do the property and labour markets of developing countries lend themselves to hedonic methods, or are they too 'imperfect'?
- Can contingent valuation be made more plausible, by examining what light the operations of real markets throw on hypothetical values (for example, actual preservation bids for rare natural resources, bio-diversity, rare species; tourism earnings attributable to particular wild species; the value of 'vicarious consumption' of wildlife through books, films, etc.; what money local campaigns actually raise to clean a beach, preserve a park, or clean up a neighbourhood)?

The alternative viewpoint is that experience so far is a fair reflection of the extent to which valuation can be pressed in the context of developing countries. On this view, the travel-cost technique is unsuitable for the different circumstances of environmental quality in developing countries, and imperfections in their property and labour markets, rule out the serious use of hedonic methods. Contingent valuation is also inappropriate

because of differences in the perceptions and value systems of the people concerned (as opposed to those who developed the concepts). Furthermore, it could be argued that the state of science will never be enough to enable us to pin our faith, let alone our values, on cause-and-effect relationships. There are also those who think that trying to put a value on bio-diversity is a travesty of nature.

In this case, we would be entitled to conclude that traditional cost-benefit analysis is a weak and misleading aid to decision-making, since it cannot incorporate much of the environmental effect of projects. There is the additional methodological problem, which we shall not explore here, of justifying projects with long pay-off periods using discount rates. For whatever reason, there is considerable scepticism about cost-benefit analysis amongst professionals from other disciplines who work with economists in project appraisal (and amongst many economists themselves). This explains the current interest in alternative decision criteria, especially those incorporating the treatment of uncertainty and risk.

This would be too negative a note on which to end. Extending valuation to include environmental effects will make cost-benefit analysis more useful in selecting development projects, provided it is based on reliable physical data and the technique used is robust, plausible and intelligible to the decision-maker. This is not to argue that the search for alternatives or refinements to cost-benefit analysis is unimportant; the opposite is true. But some of the concepts recently brought into currency by environmental economists need much more thought and testing if they are to be of real operational value.

Note

1. J.T. Winpenny, *Values for the Environment: a Guide to Economic Appraisal*. London: HMSO, Spring, 1991.

21: Natural Resource Accounting: An Overview

Salah El Serafy

The Setting

The purpose of this chapter is to convey my personal views on the 'state of the art' of natural resource accounting. Given the fact that the state of the art has not yet settled, these views, like those of anyone else who might survey the field at present, cannot be comprehensive, and at any rate should be treated with caution. My brief, however, is, in fact, a little wider than resource accounting, for I also want to outline recent achievements in research/*policy making*; whether a consensus is developing, indicating gaps in our knowledge of *policy problems* and suggestions for future research, with estimates of the likely time for their realisation. Let me say at the outset that I shall limit myself, by and large, to accounting at the expense of *policy*. Not that I think policy is less important; on the contrary, it is the accounting which has a limited function, and I begin by stressing the distinction between the two.

Accounting and Policy

Accounting is a backward-looking function, which has little to do with prescribing future behaviour, though quite obviously future behaviour should heed what the accountants are saying about the past. A primary function of accounting, ever since the profession began, has been to indicate a level of income or profits for individuals and businesses. If such an income were to be consumed

by its earners, the individual or the enterprise could continue in business only by re-employing the original capital. Keeping capital intact is, therefore, a basic concern of the accountant, who must purge all capital elements (such as stocks used up, and depreciation of machinery, buildings and equipment) from the receipts of the enterprise, in order to arrive at a true measurement of net, i.e. consumable, income, which is only part of the receipts realised by the enterprise. Proper income measurement thus serves the useful purpose of indicating to the income earner a ceiling on his consumption. Preserving capital intact is a prudent act, because erosion of capital reduces the capacity of the individual, the enterprise or the nation to generate future income. In practice, however, imprudent individuals and nations do occasionally consume part of their capital, either as a result of faulty accounting, or more generally, because they ignore the message imparted by the accountants.

It should be emphasised at the outset that such a concept of capital intactness claims no precision. It is only approximate since, with changes in technology and fluctuations in prices, the accountant is rarely able to reach an objective assessment of capital. In practice, rules of thumb have been developed (sometimes related to tax authorities' regulations and deductible allowances) on how to treat such things as inventories and depreciation. When in doubt accountants would lean to the side of caution, underestimating income rather than overestimating it, for one of their primary concerns is to protect the integrity of capital. The balance sheet, from which the net worth of the enterprise can be calculated, is likewise estimated with caution, often underestimating net worth rather than overestimating it. It is with this conventionally cautious attitude of the accounting profession in mind that one views with abhorrence the kind of national accounting that exaggerates income by including in it capital elements which reflect depletion of natural resources and degradation of the environment.

The confusion over the function of the accountant and his definition of income has been a source of controversy in the area of resource accounting. For economists are used to looking forward, interested more in the optimisation of resource management than in the *ex-post* calculations of the accountant, which belong more with economic history. Thus they seem unable to resist attacking the rules of thumb developed by the accountant, for instance on depreciation, pointing out the limiting assumptions involved, and

often confusing efforts at national resource accounting with *ex ante* exercises of optimisation. Over the past few years this has caused much argument, but these debates have luckily subsided, and I count this as veritable progress.

Whatever the accountants say, the behaviour of people and nations can ignore their calculations. Although I believe that we should get the accounts right, at least as a basis for measuring economic performance accurately, and also as a foundation for valid macroeconomic policy prescriptions, I think it is through policy, by devising environmentally benign incentives, and taxing environmentally harmful practices, that environmental concerns would be more effectively addressed.

The State of the Art

Great progress has certainly been made over the past few years in indicating what the state of the art is, and in particular a heightened awareness of the importance of the subject has developed. This has increased the potential of contributions coming from sources that had previously been at best passive, but more generally even hostile to the need for adjusting national income measurements to reflect resource and environmental degradation. In my attempt at expounding the current state of the art, four areas need to be covered: conceptual; data collection and deployment; revision of the United Nations System of National Accounts (SNA), and case studies. Let me take these up in turn.

Conceptual controversies

Progress would have been much easier if the concepts of adjusting national income calculations were clear and universally accepted. We all know how difficult it is to ascertain what quantities of natural resources we have and what functions they are performing, or are capable of performing, before we can attempt to put money values on them and their services. The complexity of factors affecting, say, the contribution of a rain forest to soil stability, and providing a human biological habitat to species known and yet to be known, let alone to carbon dioxide reduction and the global climate, makes it very difficult to translate this into economic valuations to be brought into national account calculations. But this is only part of the problem. The main problem, in my view, has been the multiplicity

of purpose, leading to divergence of views, on the part of people who have advocated the adjustment of national account reckoning. They include the ecologists who look at the problem as a diminishing stock of environmental assets which they would want to measure in order to direct attention to the loss we are experiencing. They also include the 'welfarists', who believe that national income calculations should indicate some level of happiness to be derived from income, and who view environmental degradation as a loss of welfare which national income measurements do not capture. In addition, there are economists, like myself, who eschew ecological issues and abstract from the welfare implications of income measurements, but who wish to see income adjusted simply because mixing capital with income is bad economics, yields misleading measurements of economic performance, and, inevitably, leads to faulty macroeconomic policy analysis and advice. To me the inclusion of environmental erosion in the national accounts simply brings into the annual exercise of income measurement the longer-term perspective of sustainability of current economic performance. For income, we must remember, is not income at all unless it is sustainable.

This diversity of objectives has led to much loss of time and concentration, and it still affects the current debate in that it has produced a variety of approaches to changing the accounting. At one extreme there are the 'holists' who want to take stock of every natural resource and then put a money value on it in an effort to heighten awareness of the environment's worth and draw attention to environmental stress. They hanker after value estimates of environmental stocks, to be derived from present market prices if they exist, or otherwise to be based on willingness to pay to maintain specified preservation goals or standards of environmental purity. Alternatively, they may relate such values to estimates of future utilities, or costs of repairing or warding off environmental damage. Behind all this is the hope that if we were to capture the deterioration of this stock from year to year, we could adjust our apparent income by such deterioration. But there are also those who, while approaching the subject from the stock-of-resources side, would be content merely with quantitative measurements of tons of biomass lost, hectarage of deforestation, changes in air and water quality indices, tons of carbon released into the atmosphere, population density, and the like, with the objective of not supplanting, but merely supplementing, existing measurements of

income in the way the Quality-of-Life advocates produce their indices. In this way they seek to show that the economic measurements produced by conventional national accounting are at best partial, and certainly fail to indicate a 'sustainable' level of 'happiness'.

But there are also many national accountants who remain jealous of past income series. Even if past national income calculations are shown to be wrong, they still wish to maintain their continuity, valuing continuity as a worthy objective. Such statisticians have been reluctant to give up old habits, and it is they who would rather confine any adjustment to 'Satellite Accounts' (see below), so that the core accounts remain unchanged. That we have to accept Satellite Accounts at this stage does not mean that this should be the ultimate objective of changing income calculations to reflect environmental degradation, but half a loaf is better than none, and it may be useful, considering the current state of the art, to have this medium — the satellite accounts — to experiment with adjustments until much of the present controversies has been settled. Such conservatism also expresses itself in reluctance to adjust the gross product when the analytical argument for adjusting it is overpowering. That is why we find widespread preference for adjusting only the net product (through environmental 'depreciation') leaving the gross product unadjusted (on this see note 6, below).

If I were to sum up the areas of remaining controversy, the resolution of which would carry our efforts forward, I would list the following: (a) over-emphasis on stock accounting or balance sheets, annual changes in which would be carried into the flow accounts; (b) viewing environmental degradation simply as (capital) depreciation; (c) aversion to imputations when no market parameters exist, and (d) (somewhat related to (c)) reluctance to adjust the accounts at all on the grounds that the environment involves largely non-market activities similar to the exclusion of housewifely services from income.

Reinforcing reluctance to change is the fact that the technological basis of many environmental concerns is still uncertain: how the ozone hole has been created and measured, if it exists at all; what makes a watershed, and what are its true functions; what is the effect of soil erosion (as measured, say, by tonnage of topsoil lost) on land productivity, and is such an effect linear; what is the true value of a forest, not just as a source of timber and fuelwood, but

as an amenity, a habitat for indigenous peoples and a haven for untold species of flora and fauna? If we add externalities, not only to individual and corporate perspectives, but also transnationally and even globally, and if we bring in common property issues, we are left with great areas of uncertainty and indeterminacy. This explains the reluctance of many economists to be seen as advocating national income adjustments despite the popularity of the environment as a political concern. It is generally believed that such areas of indeterminacy need concerted research, essentially by scientists, before economists can properly address the problem.

But we would be deceiving ourselves if we thought that economists should await further scientific progress before they can get their teeth into the problem. For instance, despite some serious gaps in our knowledge, scientists seem to know a great deal about the biology of renewable resources, such as fish and forests. And yet, bearing in mind that the accountant's task is really limited, and that his calculations need not be all that exact, accounting rules of thumb can be derived in the interim, and applied to income calculation while scientific inquiry advances our knowledge. For this purpose the appendix to this chapter gives a brief description of the kind of knowledge available about fisheries, and concludes with a rule of thumb, indicating how fish extraction from unconfined habitats can easily be treated in the accounts. The work on forestry by economists at the World Resources Institute in Washington also shows accounting short-cuts which are readily applicable and should be used until these are gradually refined.[1]

Environmental data bases

In data collection and deployment, real progress has been made and continues to be made. The availability and reliability of such data are, of course, the beginning of all environmental accounting. These data would not only feed the new satellite accounts but would encourage analysts to reassess incomes, and provide better bases for economic policy analysis and prescriptions. Several countries have led the way in this respect, particularly France, Canada and Norway.

In the UNEP/IBRD volume[2] Jacques Theys, writing about France, mentions that in 1966 Bertrand de Jouvenel proposed that 'the national accounts include environmental services, the cost of pollution, and resource extraction', and advocated the production

of supplementary components to existing accounting structures. So, in 1978, according to the same source, France decided to design an accounting system to assess the quantity and quality of the 'natural patrimony' and trace the causes and effects of its change. Certain progress has been made towards what remains, for the French, an elusive goal of estimating 'simultaneously the ecological, social and economic value of the natural patrimony'. Advances have been made in limited areas (water, forestry, soil and wildlife), but, for France, as might have been expected, the goal of setting money values on the natural patrimony and its changes from year to year has remained unrealised. In a similar vein, but without the ambitious goal of the French, Statistics Canada has collected and published a vast quantity of data on the Canadian natural patrimony. The intention has been to diagnose the current and foreseeable state of the environment, but without attempting to put money values on the resources. Canada, in my view, is a case where much valuable information has been collected and published, but where the supply of data has until now far exceeded its utilisation.

Real progress has also been achieved with the recognition by the United Nations system of the importance of environmental data. Urged by the Statistical Commission of the United Nations, the UN Statistical Office has, in recent years, lent its authority and resources to the development of a framework of Environmental Statistics. A *Manual of Environmental Statistics* is being completed, and a first report on *Concepts and Methods of Environmental Statistics: Human Settlement Statistics*, has already been published.[3] A second Report, entitled *Statistics of the Natural Environment*, has been prepared in draft, and reflects in its ambitious coverage the work of Anthony Friend (previously of Statistics Canada). Both volumes aim at presenting methodologies for the whole field of environmental statistics, with an annex on statistical variables and their classification.

Revising the SNA

The most tangible progress, however, relates to the revision of the UN System of National Accounts, known as the SNA. This system embodies international recommendations for the computation of national accounts, and was last revised in 1968. Most countries calculate their national income in the light of these recommendations. The 1968 version of the SNA has been under

review for many years, and the dominant wisdom has been that the system needed only marginal revisions, and that such revisions definitely excluded adjustments for environmental degradation. I like to think that it is at least partly as a result of the series of workshops held by the UN Environment Programme jointly with the World Bank, between 1983 and 1988,[4] that the reluctance to change the old system, which had been in force for over twenty years, gave way to a limited acceptance of the need to revise it to deal with environmental concerns. Over the past five years the UN Statistical Commission has entrusted the SNA revision to an Inter-Secretariat group (made up of the UN Statistical Office, OECD, EUROSTAT, the IMF and the World Bank) which has managed the revision process with the help of internationally recruited experts.

The revised SNA is not expected to be adopted by the UN Statistical Commission before 1993, and no great changes are foreseen. This is because the mandate given by the Commission to the Inter-Secretariat group specifically excluded an overhauling of the system, calling only for 'clarification, elaboration and simplification'. The work done on environmental accounting in the context of the joint UNEP/World Bank workshops, and independently by other individuals and institutions, including the World Resources Institute and scholars in various parts of the world, and also the mounting political pressure by environmentalists, heightened the inadequacy of the present SNA to address the serious problem of natural resource depletion and environmental degradation, which remains unrecorded under the SNA in the vast majority of cases.[5] It was not until January 1989, however, that an SNA Expert Meeting agreed to the notion that the new SNA should contain a set of Environmental Satellite Accounts, linked to, but not to be an integral part of, the core accounts. This represents a tangible, though modest, advance.[6] A revised SNA manual is now being produced, and, when completed, will cover a set of Environmental Satellite Accounts and recommend work conducive to the establishment of these accounts. Towards this end, the World Bank is currently supporting a research effort for 'Improved Accounting of Natural Resources and the Environment for More Sustainable Resource Management'. This covers re-estimating national income for two countries in order to reflect environmental changes. (Initially Mexico and Malaysia were specified, but Malaysia may give way to another country.) An analytical framework is being developed under this initiative (with

financial support from the Noyes and Ford Foundations in the USA) in co-operation with the UN Statistical Office, leading to the production of a handbook containing recommendations for preparing adjusted income from natural resources. A preliminary draft of this handbook should be ready by June 1990, when a conference is expected to be held at the World Bank to discuss it.

Case studies

There has been a notable reluctance to undertake case studies of adjusting the national accounts, despite the progress indicated in environmental awareness and knowledge. This is referred to below, but here I wish to stress that in my view it is high time that such case studies should be undertaken in order to test competing methods and refine our approaches. There would appear to be sufficient basis already for making partial adjustments in income without delay.

Achievements and Lacunae: A Summing-up

In the foregoing I have found it difficult to strike a balance between reporting on substantive progress made, and merely indicating areas of advance and points still to be settled. Let me correct this imbalance somewhat.

In general, we have come a long way, but the goal is still far distant. The subject has been debated for a long time, and although there has been much initial confusion about the functions and objectives of accounting, many things have become clearer. This is not to say that there are not still many controversial areas, even in respect of fundamental issues. The awareness of the misleading measurements produced by the SNA has certainly heightened, and the subject appears now to be very attractive to a wide circle of analysts and policy-makers. By policy is meant here the whole gamut of economic and fiscal policies, not just natural resource management policy. For the estimation of income is central to macroeconomic management in general. The acceptance by the national income statisticians of the need to adjust the SNA is a positive development, though satellite accounts are only a first step. The collection and publication of data bases, as described above, represent yet another advance, as they now enjoy the support of powerful international bodies. What we are going to witness now

is a growing volume of published data on the environment. Meanwhile, debates such as the ones carried out in the framework of this book are multiplying, not only within academic establishments, but in national, regional, and international fora. Early in 1990 the Environmental Protection Agency of the US Government organised a conference in Washington DC on sustainable development at which national income accounting received special attention. In May 1991 a conference on Environmental Accounting is planned in Austria by the International Association for Research in Income and Wealth. These are just two examples of an obviously growing activity.

Lack of application

All this indicates a modicum of success. Impediments to advance are not a lack of interest in the subject or even a want of ideas about measurements. What is really lacking is the actual application of ideas to the problem. It had been hoped that the handbook on the satellite accounts would be written simultaneously with cases of application so that it would benefit from the practical experience of estimation. But case studies have lagged behind other efforts. That is why I value the work done by the World Resources Institute in Washington DC on forestry as well as on Indonesia. While I may have misgivings about some aspects of this work, I commend its courage and pioneering spirit. This is what is most needed now: to re-estimate income, and show how the new calculations give different results from conventional national accounting.[7]

I have heard it said that what the World Resources Institute did for adjusting the accounts of Indonesia involves only back-of-an-envelope kind of calculations. This may well be true, but accounting conventions can all be worked out on the backs of envelopes, and this is not a fault. Estimation should proceed, however imperfectly, as it is only when we have a record of actual calculations that the conceptual controversies fall into place. In the Appendix I mention that we know a great deal about fish reproduction, but in the end the best we can do about accounting for fish is a rule of thumb to the effect that we consider extraction totally as reduction of the stock. This is also what the WRI study of Indonesia did with forestry. Rules of thumb can similarly be devised for other aspects of environmental degradation such as soil erosion, declining water tables, increased land salination, etc.

As for pollution, if we can identify actual expenditure on pollution in a country context, we should take such expenditure out of income estimates, as it should be a charge against income, not a factor in income creation. But there are those who wish to estimate proper levels of pollution abatements, based on desirable quality standards of air and water purity, and who would adjust income by the estimated cost of attaining such standards whether or not the expenditure concerned has been made. Such an approach, though unobjectionable, is too ambitious in practice. What we need to do is to carry out an identification of actual anti-pollution expenditure, and net this out of income estimates, since it is in the nature of keeping environmental capital intact. We shall find that even in the most environmentally-sensitive countries, such expenditures are small relative to GDP, and I have no quarrel with netting them out to arrive at net income at least as a first step.

What we should push for now is to adjust income reckoning without delay, confining the adjustment to what we now know about those aspects of environmental degradation which can be ascertained with confidence, in the expectation that the adjustment being introduced is partial and is likely to be expanded over time. I am reminded in this context of Pigou, writing on economic welfare. He thought that human welfare is such a vast and complex concept that it cannot, with advantage, be studied in its totality by the economist. He saw the subject of welfare as extending all the way from an economic end to the ultimate end of total human happiness, and believed that the best economic approach to the subject was to focus on those aspects of human welfare that can be brought under the 'measuring rod' of money. He also believed that such a coverage would increase as our knowledge developed and as we were able to put money values on a wider set of aspects of welfare.[8] This is exactly how I feel about what we should do. We should not wait until the whole spectrum of environmental issues has been covered. We should bring in what we know, adjust income partially and gradually, and not wait until all the questions are answered. Pollution matters, though important, are probably less significant for the accounts of the countries suffering most from pollution, than resource depletion is for the economies of the less developed countries. That is why the focus on natural resource problems in the developing countries should claim our urgent attention.

Finally, a word on policy. If the national accounts are improved the better to reflect environmental degradation, macroeconomic

policies will be better based. I would suggest that the subject of identifying policies to combat harmful emissions from vehicles using gasoline is separate from that which sorts out the cost of installing and maintaining catalytic converters that would reduce the emissions. Policies to raise the price of fuel and of pesticides, or setting a stumpage fee on felling trees, are not related directly to accounting. However, as indicated earlier, the probing questions raised by accountants regarding exploitation rates relative to the available stock of resources, will inevitably sensitise policy-makers to the need to manage resources efficiently.

Such policy areas have received attention from analysts, and will certainly gain from further work. But I have yet to see a good discussion, say, of the ideal rate at which North Sea oil should be liquidated. The accounting for petroleum along the lines I have already suggested should help,[9] but policies bearing on the environment should be designed independently to bring about the behaviour we want to see. The environmental policy agenda is endless, and there are very tricky issues involving transnational externalities. I would not venture to guess when tangible results will be forthcoming in these areas to guide our efforts. Work on sustainability has been very useful in this respect, and this should eventually translate into environmentally benign policies.[10]

Compared with these policy matters, progress in environmental accounting has been much greater because income adjustment, if viewed as a partial and gradual process, is much more tractable and involves less politics. If sufficient resources can be directed to developing alternative estimates of national income in a variety of situations, while avoiding putting a value on the total stock of resources, and focusing instead on the identification of changes from year to year in the stock of resources, the ultimate goal will be realised all the sooner. How much more fruitful (and easier to understand) would the present controversies become, if we could hang our concepts on real figures!

Appendix

Consider the Fishes: How Can We Adjust Income to Reflect Exploitation?

Fish are a 'renewable' resource which regenerates itself at more or less known rates, depending on the species concerned and on habitat considerations. In theory, therefore, we can tell how much to extract from a given population in a confined milieu, without jeopardising its

continuation. A parabola is usually drawn to depict the relationship between fish stock size and its growth. The top of the curve indicates the *maximum sustainable yield* (i.e. the largest catch that can be perpetually sustained). Larger catches would be possible over the shorter term, but these will not be sustainable because they will reduce population size and may lead to extinction. If a constant cost of fishing effort is expended, and on the assumption that the fish caught per unit of effort is proportional to stock size, the largest net benefit is obtained at the point where the tangent of the parabola is equal to the (constant) slope of the total cost line which emanates from the origin. This occurs at a size lower than that which gives the maximum sustainable yield, and indicates a static equilibrium level of 'efficient' catch, since the difference between the cost and benefit of fishing is at a maximum. The maximum sustainable yield is efficient only if the fishing effort were costless, and with cost, the efficient catch is below that level. With lower costs the static equilibrium catch rises beyond the maximum sustainable yield, indicating that it may be profitable for some time to fish at these rates, but over the longer term the result of this overfishing is lower catches in the future. Balancing future net benefits against current benefits involves discounting which yields a 'user cost' indicating capital consumption. The stronger the time preference (i.e. the higher the discount rate) the lower the user cost, and the higher the 'efficient' level of the catch. With lower discount rates (which value future interest in the resource) the dynamic equilibrium point of sustained yield would indicate a smaller catch. In practice, extinction may not occur, however, as the cost of effort is likely to rise with fewer fish, thus the dynamic efficient-catch rate is, in most instances, smaller than the maximum sustainable yield.

The accountant, if he were to possess these functions as well as the costs and prices of the catch, would aim at estimating the 'user cost' of fish stock depletion, counting this as depreciation or capital consumption. It is unlikely, however, that he would ever be in possession of all the facts. More pragmatically he would be comparing the actual catch with the natural net growth of the stock, and he might ignore capital consumption altogether if the former fell short of the latter. He would be inclined to charge against the gross product, as depreciation, any excess of catch over net growth. For confined fish populations in aquacultural enterprises, one would expect the accountant to do this. But the problem is much less tractable in the great majority of cases involving fishing in the wild: in open areas of water where the problem of the commons presents itself. To the biologists fish belong to a K-type reproduction category, where large numbers of offspring are produced in the hope that a small fraction will survive. This natural 'strategy for survival' worked well in the past before the waters got seriously polluted and the stock depleted. In the present conditions of environmental stress, many fish species are endangered. Of

the vast quantities of larvae produced, a lot perish by predators, sudden changes in temperature, incidence of acid rain, and the like. Survival beyond these hazards increases further survival as the size of individual fishes grows (and the quality of their offspring apparently also improves with age) though they become more attractive to human predation.

With migration and transnational externalities, there is no certainty that the catches are confined to levels indicated by rational concern for sustainability, and the presumption is therefore often justified that the offtake is greater than the sustainable yield. To be on the safe side, therefore, the national accountant should be inclined to count all the offtake from the wild as depreciation of the capital stock. Note here that I refer to capital consumption or depreciation, implying that I find no fault with the calculation of the gross product in the case of a renewable resource such as fish. The same argument applies also to forests.

Notes

1. See Robert Repetto et al., *Wasting Assets: Natural Resources in the National Income Accounts*. Washington, DC: World Resources Institute, June 1989, and Repetto, *The Forest for the Trees*. Washington, DC: World Resources Institute, May 1988.
2. Yusuf J. Ahmad, Salah el Serafy and Ernst Lutz (eds), *Environmental Accounting for Sustainable Development*. New York: UNEP/World Bank, 1989.
3. New York: United Nations, 1988.
4. I was rapporteur for one of these workshops and chairman of another two. A record of these meetings, participants and papers discussed is given in an Appendix (pp.93-5) of Ahmad et al. *Environmental Accounting*, op. cit. The impetus for this effort was provided by Robert Goodland at the World Bank and Yusuf Ahmad at UNEP.
5. Such degradation tends to be accounted for where resources are exploited in the private sector and are therefore tradeable (for example, petroleum, fisheries, and forests grown by pulp and paper interests) and where legal standards of emissions are set to combat pollution. Where such resources are exploited in the public sector, as is the tendency in developing countries, they are totally ignored by the SNA.
6. The 'wearing down' of resistance to change on the part of national income statisticians can perhaps be dated to the Paris Experts Meeting in November 1988 (organised jointly by UNEP and the World Bank). This brought together, probably for the first time, participants from academia, national statistical offices, the UN Statistical Office, OECD, the European Communities and Environmental Ministries. See Ahmad et al., *Environmental Accounting*, op. cit., p.95 for a list of participants and their affiliations.
7. My misgivings relate to the estimation of income from non-renewable resources. If these are wasting assets as the WRI correctly states, then their sale is tantamount to their liquidation, (i.e. conversion into money). Proceeds from asset sales are not value added, created by

original factors of production. To keep these proceeds in GDP, as is suggested, is, in my view, wrong, and to take the depletion out as depreciation in order to arrive at NDP, negates the contribution such a revenue makes to net income. If we reflect new discoveries or re-estimation of reserves in the flow accounts, as the WRI study has done, the result becomes of very little value. In 1981 I published a paper in the *Journal of Energy and Development* showing how much of such proceeds can be reckoned to income, by converting such temporary receipts into a permanent income stream. This method has been incorporated in my chapter in Ahmad et al., *Environmental Accounting*, op. cit. One advantage of this method is that it draws attention to the implications of current extraction for the life expectancy of the reserves and forces policy-makers to compare the market rate of resource appreciation with the yields on alternative investments.

8. A.C. Pigou, *The Economics of Welfare*, (2nd edn). London: Macmillan, 1924, pp.10-11.
9. El Serafy, Chap. 3, in Ahmad et al., *Environmental Accounting*, op. cit.
10. Work on economic sustainability is currently being conducted at the World Bank by Herman Daly. One product of this effort is John Pezzey's paper, 'Economic Analysis of Sustainable Growth and Sustainable Development', World Bank Environment Department Working Paper No.15, Washington, DC: March 1989.

X. CONCLUSION

22: Some Items for an Economic Research Agenda

J.T. Winpenny

The widespread concern about the state of the environment that is reflected in the preceding chapters has injected many new issues into development research. It has also added urgency to research on age-old themes, and launches conventional development thinking on to a new trajectory. This concluding chapter pulls out some of the salient themes emerging from this book and attempts to compile an agenda to guide future development research in this increasingly important area.

Common Themes

A number of suggestions are made about the general approach to research, or what might be called its 'philosophy'. While many of them would seem obvious common sense, they are worth stating nonetheless.

(a) Research should be re-oriented to reflect the needs of the likely users. By implication, much current research emanates from the interests of researchers themselves. It is pertinent to ask, 'Who will use the findings?' The users' own agenda should shape research programmes rather more than at present. There is a great deal of research being conducted in developing countries which needs acknowledgement and support.

(b) Research should focus on the motivation behind people's behaviour towards the environment, the incentives that are in play,

and how policies can affect them. Socio-economic and social anthropological studies are vital.

(c) Management, legal and institutional systems are vital to understanding people's use of their environment. Property rights in their widest sense are fundamental. The state has often overridden local concerns and weakened local incentives to conserve and manage habitats. There are many local instances of apparently successful participatory or communal management schemes which deserve further study to see if they can be replicated.

(d) More information is required on how and why decisions are made at political and official levels that affect the environment. Environmental arguments should be cast in terms that will influence key decision-makers such as Presidents and Finance Ministers. Can we offer criteria for allocating public funds amongst competing 'environmental' uses? In what circumstances is it safe to assume that governments are more altruistic and beneficent than their subjects?

(e) There is great interest in identifying 'success stories' in environmental management, examining whether they have any common features, and whether they are transferable and replicable.

(f) Existing research data — extensive in some cases — should be used more effectively. The most elementary barrier is the poor state of inter-disciplinary understanding. This needs urgent study. What are the best agencies for disseminating received wisdom?

(g) There is currently a gap between micro- and macro-level research work, which hampers a co-ordinated attack on environmental problems. The weakness is well brought out in the neglect of environmental factors in the design of economic reform and structural adjustment programmes.

(h) Researchers from developed and developing countries tend to approach the environment from opposite ends: the former instinctly look for conservation solutions, whereas the latter are looking for ways of reconciling growth and exploitation with sustainable resource use. There is an urgent need for greater empathy with the predicament of developing countries. This is vital if there is to be successful international 'deal-making'.

(i) The most basic information on physical environmental processes is often lacking for social scientists. This points to the need for better scientific and ecological data on such processes as the links between air pollution and health, the determinants of

corrosion of materials in tropical conditions, influences on farm crop yields, etc.

More specific suggestions are recapped below under headings following the broad divisions of this book.

International Policies to Respond to Global Environmental Threats

The potential for international conflict arising from transboundary pollution, spills of hazardous substances, 'ecological refugees', etc.

Study of the scope for negotiating international conventions on global warming, bio-diversity, etc. and models of mediation (e.g. the Montreal Protocol).

Sector-by-sector assessment of the need for, and scope of, technological adaptation (e.g. 'no-waste' and 'low waste' processes, recycling techniques, etc.), and the modalities and funding of technology transfer.

Study of the costs likely to fall on developing countries and how they can be defrayed. Implications for international financial flows — volume, sources, mechanisms, terms and conditions.

Influence of Macroeconomic Policies on the Environment

Impact of Structural Adjustment Programmes on the environment. How can SAPs be designed to mitigate these effects or encourage environmental management? How extensive are trade-offs? What is the potential for fine-tuning?

Study of National fiscal implications of 'green' policies. How can national tax systems be redesigned?

Impact of SAPs on the maintenance of infrastructure and the support of relevant public programmes for environmental management.

Appropriate policy reforms for countries depleting their natural resources.

The indirect effects of reform programmes on, for instance, savings, interest rates, and the boundary between the public and private sectors.

Natural Resource Degradation

(i) *Tropical forests*

More, and improved, studies on the valuation of rain forest products and services, including the value of non-timber products.

Research on the socio-economic causes of deforestation.

Consideration of international mechanisms to protect forests (trade restrictions, debt-for-nature, preservation bids, compensation, etc.).

Possibilities of marketing the products of the rain forest.

The scope for transferring models of participatory management from dry forests to rain forests.

(ii) *Wetlands*

More case studies of the functional assessment and valuation of wetlands in tropical conditions.

Analysis of the effect of policy distortions on wetland destruction, and suggestions for appropriate reforms.

More socio-economic studies of the use of wetlands by local people, and their role in degradation.

Research on how sustainable use can be combined with conservation.

(iii) *Drylands*

Analysis of the effects of government policies and price-fixing in causing degradation.

Studies of the costs of dryland degradation.

Socio-economic studies of tenure, management and integrated resource use systems, and how they affect the motivation of dryland peoples.

(iv) *Irrigation*

How irrigation finance affects sustainability (budgeting, personnel, cost recovery, charging methods, and their effect on water use).

The adaptation of cost-benefit analysis for the environmental appraisal of dams and irrigation schemes.

Reforming systems of advice and finance to mitigate environmental costs in irrigation systems.

Socio-economic studies of irrigation systems (tenure, water access rights, cropping patterns, income distribution).

(v) *Tropical dry forests*

Socio-economic studies of the value of tropical dry forests to local populations.

Relevance of dry forest management systems to humid forest conditions.

(vi) *Land degradation and soil erosion*

Case studies of the economic cost of soil erosion.

Research into policy-related causes of erosion.

Socio-economic studies of farmers' role in degradation and the scope for conservation. The resolution of disincentives, and group conflicts.

Case studies of successful interventions to prevent further degradation, and their common features. Design of low-cost solutions, and agencies for disseminating news about successful solutions. The potential roles of NGOs and consumer groups.

The respective roles of poverty, population growth and general policies as factors causing land degradation.

Urban and Industrial Problems

More research into the perspective on urban environmental problems held by poor urban communities. How do they rank the various problems? What is the real impact of urban environmental conditions on the living conditions and health of the poor?

Analysis of policy instruments and project interventions likely to be most efficacious in improving the environmental conditions of developing country cities. Evaluation of major urban improvement programmes.

Study of the actual impact of current policies on the majority of urban dwellers.

Analysis of the pattern of urban energy consumption and its implications for energy policy and pricing.

Studies of the impact of the urban built environment on the natural environment.

The development of short-cut methods for urban environmental assessments, including quality of life indicators, for the use of local NGOs.

The implications of tourism growth for cities.

Social Dimensions: Population, Gender and the Environment

Research into population issues, especially motivation for family planning, and women's access to education, employment and income opportunities.

Investigations of traditional conservation knowledge and methods, how they can be transmitted to others, and turned into income for women.

Women's views on performance indicators for sustainable development.

The development of guidelines for the conduct of training, exchange of experience, and the production of 'inspirational' case work relevant to women.

Further work on the concept of Primary Environmental Care.

Gender analysis of natural resource use.

Studies on the impact of Structural Adjustment Programmes on women.

Analysis of successful cases of community management of common resources.

Research into the effects of tenure, institutions and customs on women's incentives to be environmental managers.

Bio-diversity: the Economics of Preservation and Management

Study of the relationship between trade in wildlife and the incentives to hunt sustainably.

Research into the cost-effectiveness of various ways of spending to preserve bio-diversity, and the development of decision guidelines for conservation managers.

Analysis of what, and how much, bio-diversity needs to be

preserved, including the question of critical minimum levels of certain types.

Establishment of the links between macroeconomic policies and bio-diversity.

Investigation into the scope, and techniques, for economic valuation of bio-diversity.

Identification of ways in which local communities can benefit from preserving bio-diversity.

Identification of the gainers and losers from conservation, and the design of compensation devices.

Study of the design of schemes to tap international willingness to pay for conservation, and how to elicit preservation bids.

Study of the process whereby conversion/exploitation should yield to conservation, and the critical points in this process.

Energy Questions

Measurement and valuation of the discharge of polluting emissions by developing countries.

Study of the feasibility of devices to discourage emissions (e.g. carbon taxes, leasable permits) in the context of developing countries, and the detailed design of such devices.

Analysis of the national energy demands of developing countries and the scope for using non-depleting substances and renewable sources of energy.

Study of the modalities involved in the transfer of suitable technology to developing countries, the availability of low-cost technology and the role of the market in achieving this transfer.

Assessment of the costs and benefits entailed in reaching different emissions targets.

Economic Valuation

Further case studies of the application of economic valuation techniques to developing countries.

Consideration of supplementing or superseding cost-benefit analysis with other decision techniques.

Experiments with appraisal using actual, rather than theoretical, compensation from gainers to losers.

Examination of the revealed and expressed preferences of governments as a guide to relative social values.

National resource accounting

Clarification and interpretation of the underlying economic concepts of income, capital, investment, and consumption in the context of national environmental accounting.

More partial exercises in the adjustment of conventional accounts.

Research on the relevance and value of satellite accounts.

Conclusion

The above list adds up to a long and varied research agenda, with a number of recurring themes, e.g. incentives, institutions, policies, valuation. It would be presumptuous, and would call for superhuman detachment, to set priorities between one subject area and another. Policy-makers have their own legitimate views on research priorities, and a strong sense of urgency in generating relevant research findings. Academic researchers have a more detached (some would say, cloistered) view of relative priorities, and may feel, with some justification, that hurried research may be unsatisfactory ('If you want it bad, you get it bad!').

In developing countries, the viewpoints of 'users' and 'researchers' may well be more coincident than in countries further removed from the problems under investigation. However, it can be valuable to have access to comparative experience, requiring an international perspective. A useful research programme will be the result of forces exerted by parties with a number of different standpoints. It is to be hoped that this book will play some part in their exchanges.

The recent explosion of concern for environmental issues and demand for prompt action has caught many members of the development community unprepared. This book brings together for the first time the exponents of environmental disciplines and researchers and policy-makers in mainstream development studies. The result is a searching review of the state of the art in key areas of development, concluding with a innovative agenda for future research.

The twenty-two chapters span international issues, macroeconomic policies, natural resources, and urban, industrial, social, gender, biodiversity, energy and methodological questions. Each issue is discussed by a leading exponent in that area.

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£9.95 ISBN 0 85003 141 9

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