Investing in Environmental Wealth for Poverty Reduction

Prepared on behalf of the Poverty-Environment Partnership by

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International Institute for Environment and Development

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Other Poverty-Environment Partnership publications

1. Linking Poverty Reduction and Environmental Management: Policy Challenges and Opportunities (2002)
2. Poverty and Climate Change: Reducing the Vulnerability of the Poor through Adaptation (2003)
3. Environmental Fiscal Reform for Poverty Reduction (2005)

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Foreward

An historic opportunity—the eradication of poverty—is within reach of the 2005 World Summit. However, a critical barrier persists: progress on eliminating poverty will only be possible with expanded, more effectively targeted investments in environmental management as a means of achieving the Millennium Development Goals (MDGs).

Speeding progress towards the MDGs will require stepping up attention to and investment in the environment. Investing in sound and equitable environmental management makes good economic sense, and a major scaling-up of worldwide investment in the environment is essential for creating the opportunities that people need to lift themselves out of poverty. Increased investment alone is not enough, however. To be effective, investment must be accompanied by the empowerment of communities, local governments and the private sector to lead local development efforts. Of particular importance is the need for governance and policy reforms that extend to poor people secure property and user rights over the environmental assets that provide their livelihoods, and that ensure a greater voice in decisions affecting how these assets are managed.

To inform deliberations at the Summit, the Poverty-Environment Partnership (PEP)—a network of more than 30 international development and environment agencies—launched the *'Environment for the MDGs'* initiative to galvanize support for the significant scaling up of worldwide investment in environmental management to help win the fight against poverty and achieve the MDGs. The PEP commissioned two background reports—one on the economic case for investing in the environment to reduce poverty and the other on tools and methodologies for assessing environment's contribution to poverty reduction and pro-poor growth. The Partnership has also prepared a brief synthesis paper summarizing the key messages of the two longer, more technical reports.

The following report on *Investing in Environmental Wealth for Poverty Reduction* makes an important contribution to the debate about poverty-environment relationships by documenting and evaluating the economic evidence surrounding investment in environmental assets as a strategy for fighting poverty. Prepared by leading environmental economist David Pearce, Professor Emeritus at University College London, the report surveys the current state of knowledge on several key environmental dimensions of poverty, including the direct and indirect dependence of the poor on natural resources, the vulnerability of the poor to environmental risk, the total cost of environmental interventions and investments needed to reach the MDGs, the economic benefits and rates of return to environmental investments, and major reforms needed to create a policy and governance context that will be conducive to cost-effective investments. Noting that current knowledge is sufficient to warrant immediate policy action, Professor Pearce nonetheless identifies a few key areas where significant information gaps remain and further research is needed.

The 2005 World Summit provides a critical opportunity to mobilize a much wider 'coalition' of interested governments, inter-governmental organizations, research institutes, businesses and civil society organizations to take this agenda forward, as an essential component of global action to end poverty and secure the benefits of healthy ecosystems for all the Earth's inhabitants, now and in generations to come.

About the Poverty-Environment Partnership

The Poverty-Environment Partnership (PEP) is a network of bilateral aid agencies, multilateral development banks, UN agencies and international NGOs that aims to address key poverty-environment issues within the framework of international efforts to achieve the Millennium Development Goals. Analytical work and knowledge-sharing activities undertaken by the PEP since 2001 points to three broad, fundamental lessons that underpin efforts to link poverty reduction and environmental management:

The environmental quality of growth matters to people living in poverty;

Environmental management cannot be treated separately from other development concerns;

People living in poverty must be seen as part of the solution rather than part of the problem.

PEP Member Organizations: *Bilateral Agencies*: Belgium, Canada, Denmark, Finland, France, Germany, Ireland, Japan, Netherlands, Norway, Sweden, Switzerland, United Kingdom, United States. *Multilateral/UN Agencies*: African Development Bank, Asian Development Bank, European Commission, UN Food and Agriculture Organization, Inter-American Development Bank, International Fund for Agricultural Development, International Monetary Fund, Organization for Economic Cooperation and Development, UN Department for Economic and Social Affairs, UN Development Programme, UN Environment Programme, The World Bank, World Health Organization. *International NGOs*: International Institute for Environment and Development, IUCN-The World Conservation Union, World Resources Institute, WWF International.

More information on the PEP can be found at www.povertyenvironment.net/pep.

Preface

The common perception of many is that the environment is still the "Cinderella" of development policy. Although environmental issues receive increasing public and media attention, it seems that many development decision-makers are still not persuaded that investing in the environment can make as much of a contribution to poverty reduction as more conventional measures, such as infrastructure and education. One MDG – MDG7 - explicitly addresses the environment, but members of the PEP take the view that preventing further environmental degradation, and improving environmental quality, is central to nearly all the MDGs.

There are many ways of understanding what has come to be known as the "poverty-environment nexus." This report adopts the perspective of environmental and development economics. It will not necessarily appeal to all members of the development community nor is it intended to do so. It is aimed at those decision-makers and opinion-formers who look for a compelling economic case for investing in the environment to secure poverty reduction consistent with the MDGs. Some will already be persuaded of that case. Others might accept it in general terms but seek hard evidence that it makes sense. Yet others may be unpersuaded but have an open mind when confronted with the evidence.

Making the economic case does not diminish other arguments – for many there is a simple moral compulsion about poverty reduction (or environmental conservation) which does not need economic justification. But economics can help, as we try to show in this report. Copious use is made of footnotes to the literature. This is deliberate. The goal is to offer judgments and conclusions based on evidence, and those who wish to pursue the supporting literature will be able to follow up on the extensive references upon which this report relies.

Finally, tackling poverty in practical ways that have a reasonable chance of success is immensely complex. This report focuses on *one* dimension of this complex issue – addressing the management of environmental assets to improve the lot of the poor. Drawing boundaries around this dimension has proved difficult, simply because there are so many interdependencies in poverty policy. Singling out environmental policy and investments as a major means of helping the poor will not work unless many other conditions are satisfied – notably governance and institutional change within developing economies, and changes in the way the rich world currently treats the poor world. One report cannot do everything, and if it tried it would quickly descend to the bland and the general. The focus on the economics of the environment and investment in environmental assets, therefore, needs to be borne in mind while reading this report.

David W. Pearce

Acknowledgements

The Steering Committee for the PEP *'Environment for the MDGs'* initiative includes UNDP (Peter Hazlewood and Charles McNeill), UNEP (Esther Reilink and David Smith), DFID (Helen O'Connor), IIED (Steve Bass and Tom Bigg), IUCN (Joshua Bishop and Andrew Deutz), SEI (Johan Rockström), WRI (Dan Tunstall) and WWF (Dawn Montanye and David Reed). The supporting paper on the economic case for investing in the environment to reduce poverty and support pro-poor growth was led by IUCN. David Pearce, Professor Emeritus at University College London, is the principal author of the paper.

The Steering Committee is grateful to many PEP members and others for contributing valuable insights and information. Special thanks go to Karen Holmes, who edited the Executive Summary, and to Kimberly Soffar, who guided publication design and production.

Note from the author

This report has not been easy to write. It tries to tell a coherent story, rooted in economic theory and evidence. If it succeeds, then it is due to the substantial efforts of individuals within the Poverty and Environment Partnership who have commented extensively on earlier drafts and supplied many relevant studies and documents. If it fails, then it will be due to my own limitations in handling the enormous amount of information and comment I have received. Among the many who have helped, I am especially grateful to Joshua Bishop, Jeffrey McNeely, Hans Friedrich, William Jackson and Simon Rietbergen of IUCN in Gland, Switzerland; Steve Bass, Maryanne Grieg-Gran and Gordon McGranahan of IIED, London; Paul Steele (Sri Lanka); Lucy Emerton of IUCN, Sri Lanka; Edmund Barrow of IUCN (Nairobi); Helen O'Connor and John Burton of DfID, London; Rati Mehrotra of IUCN; Marit Kragt of the Environment and Water Directorate, Netherlands Ministry of Foreign Affairs; Jon Strand of the International Monetary Fund; Jan Bojö of the World Bank; Monique Barbut of UNEP, Paris; Dawn Montanye of WWF US; and Mustapha Chouikha, Melita Rogelj, Pedro Novaes and Hammad Naqi Khan, all Fellows of the LEAD Programme, based at Imperial College London.

If I have left anyone out, my apologies in advance.

Executive Summary

The following report, *Investing in Environmental Wealth for Poverty Reduction*, examines investments in and policies for improving environmental quality and natural resources management, and documents the critical role played by these investments and policies in creating opportunities for people to lift themselves out of poverty. Its intended audience is decision-makers who require hard economic evidence to evaluate the proposition that investment in sound, equitable environmental management is an effective—indeed, an essential—strategy for reducing poverty.

The economic case for investing in the environment to reduce poverty is grounded in analysis of what has come to be known as the *poverty-environment nexus*. Such analyses can be, and are, made without reference to economics; however, the rapid expansion of the subject of environmental economics in recent years provides an opportunity to examine poverty-environment issues in a context that is likely to yield the kind of insights and arguments that many consider to be particularly persuasive.

Environmental sustainability and the MDGs

Achieving the MDGs will require expanding per capita endowments of capital assets, especially the environmental assets used by the poor to earn their livelihoods and increase their well-being.

This report begins from the premise that environmental sustainability is central to achieving all the Millennium Development Goals (MDGs) and that the conditions required to meet the MDGs involve expanding per capita endowments of capital assets or wealth. To eradicate poverty, the focus must be on the assets owned or used by the poor to earn their livelihoods and increase their well-being. Achieving MDG 7 on environmental sustainability, including its cross-cutting impacts on all the other MDGs, will require that policymakers target the productivity of environmental resources, especially those that promote agricultural productivity, such as soil and water resources.

The need for policy attention to the environmental assets of the poor has been driven home by the Millennium Ecosystem Assessment (MA), a comprehensive, multiyear study of the status of the world's ecosystems and their links to human development. The multinational team of scientists conducting the MA concluded that the ability of ecosystems to meet current and projected human demand for environmental services is seriously limited. They stressed that conversion of natural ecosystems, such as conversion of natural forests to cropland, often increases human well-being, but at a cost—namely, foregoing some or even most the environmental services provided by natural systems.

Recent analysis shows that environmental improvement can be consistent with economic development, debunking the so-called environmental Kuznets curve.

In light of MA's sobering findings, the question of the mutual compatibility of environmental improvement and economic growth takes on added urgency. Some have argued, incorrectly, that environmental quality must decline, or should be traded off, in the short run in order to achieve long-term economic gains. This argument, known as the 'environmental Kuznets curve' (EKC) hypothesis, is both invalid and potentially dangerous for the world's poor, as it can bias development effort against investments in environmental management and more sustainable forms of development.

Available evidence indicates that the EKC hypothesis fails to describe experience with many forms of environmental change. Clear instances include biodiversity loss and global climate change, which entail irreversible losses that no amount of income growth can restore. Even where the EKC broadly fits experience, it is highly sensitive to policy measures that enable a 'tunneling through' by which societies can bypass an early period of accelerating environmental decline and move directly onto a development trajectory that traces a path of environmental improvement. In short, environmental degradation is neither the inevitable price of, nor a desirable path for, economic development (Box 2.3).

Poverty, wealth and the environment

Poverty reduction strategies must achieve a two-fold goal: expanding the asset base of the poor and increasing the efficiency with which those assets are converted into well-being for the poor.

Successful, sustainable poverty reduction requires expanding the asset base of the poor and raising the productivity of those assets for generating income and well-being for the poor. The focus on an asset-based rather than an income-based approach to fighting poverty is important because the nature of assets held by the poor determines the strategies they can use to improve their well-being. Moreover, economic evidence suggests that inequalities in asset holdings worsen the prospects for economic growth and hence for poverty reduction based on stimulating overall growth of the economy.

Using an asset-based approach to poverty reduction leads to policy implications that may differ from those associated with a conventional income-based approach. For instance, shifting policy focus from income to assets makes it clear that investing in improvements to soil productivity on marginal lands is a potentially effective strategy for poverty reduction, because such investments could, in effect, help ameliorate inequalities in the value of land owned by the rich versus the poor.

Poor households rely heavily on environmental assets as a source of wealth from which to generate income and improve their livelihoods.

The health and well-being of all humans depends on clean water, clean air, fertile soils and other services provided by natural systems. However, environmental assets and the services they provide are especially important for people living in poverty. A majority of poor people in rural areas draw much of their livelihoods from forests, pastures, fisheries or farming. Nearly 1.1 billion people worldwide depend on forests for their livelihoods, and forest-related income provides a significant share of total household income in many global regions. Other ecosystems provide similarly important benefits; for example, coral reefs are a source of substantial income for poor households from fishing.

Environmental capital is a critical component of the asset base of most developing economies.

Environmental assets also make up a far larger share of national wealth in developing countries than in high-income countries. Using innovative 'wealth accounting' techniques for measuring the asset base of nations, a World Bank study estimates that environmental wealth accounts for 26 percent of the total wealth of low-income countries, versus 13 percent of wealth in middle-income countries and only 2 percent of wealth in OECD countries (Table 3.2). Wealth accounting also provides insights into the nature of income growth experienced by countries, and whether this growth is based on sustainable increases in per capita wealth. In many instances, observed income growth represents illusory improvements produced by 'mining' of assets (including environmental assets) to convert national wealth into current consumption or income (Table 3.1).

Addressing the low quality and vulnerability of the environmental assets of the poor is an important objective for anti-poverty policies.

Even more so than other kinds of assets, the environmental assets that make up a disproportionately large share of the wealth of the poor are prone to rapid depreciation, unless cared for and regenerated. With few assets, low-quality assets and lack of access to technology to make their assets more productive, poor households and communities may have incomes that are too low to generate re-investable surpluses for maintaining, much less expanding, their asset base. Insecure property and resource rights and other disincentives to wise management and use of resources also contribute to degradation of environmental assets.

Strategies to reduce poverty must address another important dimension of the poverty-environment nexus: the greater vulnerability of the poor to environmental hazards, including natural hazards, such as storms, floods and droughts, as well as man-made threats, such as air and water pollution. This vulnerability has been revealed by recent evidence from poverty mapping studies, which confirms that the poor tend to reside in areas with stressed and/or low-quality environmental resources, such as land of naturally low soil fertility, polluted air, contaminated water and water shortages. For instance, the poor often live on marginal lands, such as steeply sloped areas, where they are at higher risk of landslides and resulting loss of life during storms and floods.

Poor people also suffer greater loss of life and health from pollution and other environment-related causes. Developed by the World Health Organization, an indicator that adjusts life expectancies for the burden of disease shows that, on average, 20 percent of the total loss of life expectancy in developing countries is attributable to environmental causes, versus only 4 percent in rich countries (Table 3.6). Losses of human capital due to environmental causes have been estimated for various cities in the developing world; extending these estimates across all developing economies suggests that total damages could be on the order of US$200 billion per year. Treating these costs as a stream of damages over a 30-year time horizon indicates a net present value of some US$550 per person in the developing world.

Within poor households, women tend to bear greater losses than men from natural resource scarcity and low-quality environmental resources.

The typical division of labor within poor households means that women suffer more when resource scarcity necessitates walking longer distances to collect water and fuelwood. Women and children also are exposed to greater health damage from the effects of indoor air pollution caused by burning of biomass fuels (wood, dung and charcoal) for cooking and heating.

The poverty-environment nexus

Poverty, population change and environmental assets interact in complex ways that have come to be known as the poverty-environment nexus.

It is difficult to generalize about poverty-environment interactions, as experience varies from location to location. Nevertheless, analyzing the various linkages between poverty, population and the environment is important for creating better understanding of *why* the poor are poor.

Addressing the 'short-termism' and high discount rates of the poor is crucial for encouraging optimal levels of investment in environmental assets, such as soil conservation and tree planting.

One key area for policy action is addressing the 'short-termism' and high discount rates of the poor. Because the poor are more concerned with day-to-day survival than with longer-run well-being, they are likely to give a low weight to the future when making decisions, including decisions about managing their environmental assets. While people in rich countries typically have discount rates of less than 10 percent, evidence from the developing world suggests discount rates of 30-150 percent, and higher (Table 4.1).

Improving access to credit, capital and insurance markets would do much to lower effective discount rates, creating important benefits for the poor through impacts on investment in environmental assets. For example, one likely benefit of increasing the access of the poor to insurance is, perhaps surprisingly, decreased pressure on fragile soils and marginal grazing lands. This effect comes about because, in the absence of access to insurance, the poor hold larger herds of livestock than they would if they could secure alternative forms of insurance.

Recent research suggests the appropriate scope for policy interventions to help ensure that local institutions of communal resource management are able to adjust to conditions of resource scarcity quickly enough to avoid ecosystem collapse.

Resource scarcity and/or degradation requires that local institutions (that is, social and legal norms of behavior) shaping natural resource use in poor rural societies adapt to cope with these changes. Often this adaptation will take the form of changes in resource rights and local environmental governance. The capacity for adjustment is not automatic and institutional change may not occur quickly enough to avoid collapse of the resource or ecosystem in question. Some societies have proved able to successfully negotiate a dynamic process of change in traditional institutions and resource regimes, while others have not.

One key implication of research on this phenomenon concerns the appropriate scope of policy interventions. Direct government involvement in actual reforms to local institutions for managing communally held resources is likely to be counterproductive; however, there is often a role for policy action to defend working systems of communal resource management, especially with respect to preventing outsiders from usurping resources and rights during periods of institutional transition.

The investment response

Estimating a global budget for investments in environmental assets needed to reach poverty reduction targets is subject to considerable uncertainty; however, the best available evidence suggests that US$60-90 billion per year will be needed to address poverty-environment goals over the next 10-15 years, and at least US$80 billion more per year will be needed to tackle global climate change over the next half century.

Developing countries will likely need external assistance to meet poverty reduction goals. Such assistance must focus on interventions that produce sustained additions to the environmental wealth of poor rather than temporary measures to increase incomes.

To meet MDG 7 and related MDGs, needed investments encompass expenditures for water and sanitation (i.e., halving the population without access to safe water and sanitation), for access to sustainable energy (additional 500 million people to have access to electricity as well as replacing traditional biomass fuels for cooking and heating), and to address land degradation (anti-desertification investments), protected areas (expansion of the global network of protected areas from 13.2 million to 20.6 million sq km), and slums (improving the lives of 100 million slum dwellers).

Note that investment in new protected areas needs to be environmentally effective, and not just in 'paper parks' that lack adequate resources and capacity and are plagued by corruption. Most important, existing and new protected areas must properly compensate those whose access to resources and livelihoods has been or will be disrupted, with such compensation to be based on foregone wealth rather than foregone income.

Estimates of investment needs for addressing global climate change depend strongly on assumptions made about timing and emissions control path.

Numerous studies have examined the potential costs of controlling global climate change, with estimates varying substantially according to assumptions made about the potential for win-win opportunities (such as energy efficiency), timing, targets and impacts on global energy prices. Estimated costs for complying with the Kyoto protocol range from US$50-250 billion per year from 2001 to 2015, depending on the availability of and rules for emissions trading.

Beyond that, reaching the longer-term target of stabilizing atmospheric concentrations of greenhouse gases at 550 parts per million is expected to cost from US$80 billion to US$1.1 trillion per year. The projected cost varies depending on the timeframe of emissions reductions (that is, over 20 years versus 50 years) and the path of emissions reductions.

The scale of needed investment signals an important role for expanded global development aid *and* for mobilization of other sources of finance.

The budgets outlined above are for environment-poverty goals only, yet they correspond broadly with the total official aid budget proposed at the G8 Summit in Edinburgh in June 2005. This suggests that the scale of global aid budgets needed to be increased even further and that other sources of finance must be investigated.

Rates of return to environmental investments

The investment needs of the poor are diverse, and decision-makers must weigh the need for pro-poor investments in environmental assets against investment needs in other sectors, including education, health and infrastructure. Some have argued that scarce development finance should not be allocated towards environmental investments because, worthy though such investments may be, they secure a lower rate of return than investments in other forms of capital.

Until fairly recently, it has been difficult, for technical reasons, for economists to measure rates of return on environmental investments and so test the assumptions that underlie this argument. However, modern economic research on the complex interrelationships between poverty and the environment has now shown that the returns to environmental investments are multifaceted, and environmental economists have taken huge strides in demonstrating the benefits of such investments in money terms.

Investments in increasing *access to water supply and sanitation* yield very high rates of return, with benefit-to-cost ratios in the range of 4:1 to 14:1, making them extremely attractive from a social investment standpoint.

Improved water supplies and sanitation create time savings (that is, time not spent traveling long distances to fetch water) that translate into higher economic output and productivity as well as greater school attendance. Cost savings from reduced incidence of waterborne diseases also are a significant source of benefits. Because of economies of scale, achieving comprehensive water and sanitation targets often generates higher returns than less ambitious targets. For instance, one study found a benefit-cost ratio of 14:1 for providing the entire population with access to safe water and sanitation, *plus* chlorine treatment and safe water storage, while the

benefit-cost ratio for reaching the MDG7 target (that is, halving the population without access to safe water and sanitation) was 7.5:1 (Table 5.1).

Rates of return to investments in *soil conservation measures* can be very high, with substantial variation according to geographic context and the specific conservation technology used.

An economic survey of soil conservation in Central America and the Caribbean found mixed results (Table 6.3), with high rates of return (60 to 85 percent) for various conservation measures (such as terraces, rock walls and diversion ditches) on diverse crops (corn, sorghum, coco yam) in diverse settings (Costa Rica, Haiti, Honduras, etc.). Evidence from other global regions is not as well-documented, but partial surveys suggest a similar picture. Moreover, such studies often understate the benefits of soil conservation because they take into account only the impacts on crop productivity and do not incorporate other significant benefits of slowing land degradation, including improved food security, increased school attendance (due to decreased demand for child labor), enhanced creditworthiness and access to finance for farmers (based on better land quality), protection of vulnerable habitats for maintaining biodiversity, and reduced contribution to global warming.

Increasing *access to sustainable energy services* is likely to yield high returns on investment.

Although the MDGs contain no explicit target for energy supply or energy 'quality' for the poor, it is difficult to imagine major progress in eradicating poverty without significantly expanding the quantity and quality of energy services consumed by the poor. The International Energy Agency estimates that investments of about $17 billion per year over 12 years will be needed to provide an additional 500 million people with access to electricity by 2015, consistent with MDG 1 of halving extreme poverty by 2015. Further investment on the order of $11 billion per year is needed to replace the traditional biomass fuels (wood, dung, charcoal) used by the poor for cooking and heating with cleaner, modern fuels, such as kerosene. Surprisingly, economic studies have not estimated in money terms the benefits of these investments. However, benefits of $40-56 per person per year would be sufficient to just offset costs. Since this figure represents less than 10 percent of average rural expenditure for energy and only 2-3 percent of average urban expenditures, investments in access to sustainable energy are likely to have significantly positive benefit-cost ratios.

Moreover, replacing the traditional biomass fuels used by the poor would yield multiple benefits in terms of time savings (for women and children who currently spend hours per day collecting fuel), improved human health (due to better indoor air quality), reduced environmental damage from fuelwood cutting, and improved soil quality (from returning animal dung to farmers' fields rather than burning it).

Investments in *protecting and restoring natural ecosystems* can produce substantial net benefits, especially for the poor.

Investments in conservation can help protect intact ecosystems from conversion to less diverse uses, such as agriculture. When carefully designed and managed, conservation pays and the poor gain, too.

The economic values of forests have been extensively studied, including the benefits of sustainable timber management. Of critical importance are payments for carbon storage and sequestration, since the evidence suggests that these dominate other forest ecosystem values. However, agroforestry, a conservation option that incorporates trees and enhanced wildlife habitat into cropland, produces high returns on investment, with benefit-cost ratios ranging from 1.7 to 6.1 (Table 6.8).

Economic studies of wetlands and mangroves consistently show that conservation is economically attractive, with benefit-cost ratios in the range of 1.2 to 7.4 (Table 6.11). Notably, the conversion of mangroves to shrimp aquaculture appears to be economically very unattractive.

Investments in better management of over-exploited fisheries can produce significant economic and ecological benefits due to reduced catch effort, although the costs in terms of unemployment can be high. An example of successful investment in improved fisheries management comes from Madagascar, where a system of long-term tradeable licences was introduced in 2000. Preliminary evaluation of the scheme suggests a very acceptable benefit-cost ratio of 1.5.

Investments in wildlife conservation can also help the poor when the benefits of conservation, largely in the form of tourism revenues, are shared equitably with local communities. Experience in southern Africa has shown that wildlife conservation can be more profitable than alternative land uses, such as cattle ranching (Table 6.12).

The policy context for successful investment in environmental assets for poverty reduction

Without the right conditions, investments frequently fail. By and large, the institutions and policies that need to be in place in order to make pro-poor investment in environmental assets 'work' are well known.

Social capital is essential for successful management of communally held resources, but the role of policy in efforts to create social capital is subject to debate.

Cohesive and cooperative communities clearly are pre-requisites for communal resource management regimes capable of protecting local environments and raising living standards. However, social capital tends to break down under conditions of environmental degradation, as resource scarcity can strain community cohesiveness as well as the rules governing access and use of communal resources.

Such impacts raise questions concerning the potential role of policy in creating the social capital needed for effective management of communally-held environmental assets. The evidence suggests that the most appropriate role for policy is likely to be in removing factors that inhibit social capital formation, such as weak resource and property rights. Direct policy interventions designed to increase social capital are likely to be counterproductive.

The quality of governance influences the effectiveness of pro-poor investments and pro-poor policy.

Investments in environmental assets are unlikely to be successful in reducing poverty without clearer definition and enforcement of resource rights of the poor. Studies indicate that better governance is strongly associated with higher income growth, and a better policy environment enables opportunities for asset formation. Strong resource rights, such as secure land titling, can help provide collateral for investments in soil and water conservation.

Access to credit is crucial for investments in environmental assets to reduce poverty.

Without access to credit at affordable interest rates, the poor cannot smooth their consumption across good and bad times, making poverty worse. Lack of credit also prevents the poor from being able to make the short-term sacrifices needed to realize long-term benefits.

A key concern for policy is ensuring that not only is credit accessible and affordable, but also that incentives are in place to make sure that credit is directed to pro-poor asset formation rather than current consumption. Strengthening the market for informal credit is usually more effective than trying to expand formal credit markets. Informal credit markets have several key advantages, especially the closer relationships between lenders and borrowers, who generally are known to each other.

The poor need improved access to insurance to cope with vulnerabilities to environmental hazards, such as droughts.

Because the poor rarely have access to formal insurance markets, their predominant strategies are self-insurance (through liquidation of assets, such as cattle) and mutual insurance (in which households agree collectively to make up shortfalls in any one household's income). With few tangible assets, the poor have limited ability to self-insure, and mutual insurance schemes are easily overwhelmed by events, such as natural disasters, that strike entire communities. Growing evidence indicates that the environmental assets of the poor act as a source of 'natural insurance'. For example, a study of farming households in the Brazilian Amazon demonstrates that households resort to gathering more non-timber forest products (such as nuts and fruits) as agricultural incomes fall.

The removal of environmentally damaging subsidies is a top policy priority for stimulating pro-poor investments in environmental assets.

Regardless of the initial motivation for subsidies, in the end the poor usually are not the main beneficiaries of developing-country subsidies, which tend to be 'captured' by richer groups. However, a higher priority is reform of subsidies in the rich countries. OECD government spending on subsidies in the agriculture, energy and water sectors damage developing economies and outstrips the development assistance provided by these governments by a factor of 10.

Market-based environmental policies for pro-poor asset formation may be a longer-term goal for many developing countries, due to institutional capacity constraints.

A limited number of such instruments are already in use in developing countries, including local fishery quota schemes (Madagascar), trading in water rights (Chile, Mexico), and air pollution quotas (Chile). The distributional impacts of market-based environmental policies such as environmental taxes and charges may prove to be somewhat of an obstacle, since taxes are likely to impose a larger burden on the poor, proportionate to income, than on relatively rich groups. In some cases, the solution may lie in looking at dispensations for poorer groups, as has been done with water and energy tariffs in many countries.

Payments for environmental services (PES) may have significant potential for pro-poor benefits.

Although the primary purpose for PES is environmental improvement, there appears to be considerable scope to design and implement PES so as to integrate poverty reduction benefits with the environmental goals of such schemes. The key requirement is for all parties, buyers and sellers alike, to be better off with the PES than without it.

Evidence of the pro-poor nature of PES schemes to date is limited. However, the poor may face special obstacles to participation, including lower bargaining power than other, non-poor contracting parties. Also, unless the poor have clearly established legal rights to their resources, they may not be able to participate in PES or only able to participate with the government acting as intermediary.

Some surveys have found that PES can constitute a significant fraction of income in poor households. For instance, a study in Nicaragua found that small farmers participating in cooperatives supplying organic and 'fair trade' coffee were better off than their counterparts competing in unstable world markets for conventionally grown and traded coffee. However, in some cases, such as one Costa Rican program, pro-poor impacts were limited, as most recipients of PES were relatively wealthy landowners.

Information gaps and research needs

Although the current state of knowledge about poverty-environment relationships is more than sufficient to justify policy action, information gaps remain, suggesting an agenda for additional research on specific topics.

This report shows that a great deal is known about poverty-environment interactions and the ways in which investments and policies designed to improve environmental and resource management can help reduce poverty. Remaining information and research gaps include:

Spatially disaggregated information on poverty and ecosystem conditions. Poverty mapping techniques can be used to gain additional insights on the geospatial overlay of poverty, ecosystem conditions, and the use of environmental resources relied on by the poor for their livelihoods. In addition, the large variety of resource rights needs to be mapped in relationship to poverty.

Additional research on wealth accounting. Further insights are needed on a wider range of resources and ecosystem services, as well as household-level wealth accounts. We need to know more about direct and indirect use of environmental assets by poor households; that is, the kind of information emerging about the use of forest resources by poor households needs to be replicated for other ecosystems and assets.

Further research on rates of return to environmental investments. Such research needs to address both benefits *and* costs of environmental interventions, rather than just the benefits.

Far greater attention to the effects of global climate change on the world's poor and on ways to help them adapt to climate change. Such an effort should include support for diffusion of seed and water technologies adapted to the various agroecological impacts of global climate change in different global regions, as well as interventions to protect vulnerable populations from rising sea levels.

Quantitative analysis of the environmental impacts of subsidies, especially the impacts of subsidies in sectors other than energy, including water, fisheries and land conversion.

Distributional impacts of environmental policies and investments within a nation.

Links between different types of capital. The various forms of capital assets are interdependent; for example, environmental investments and policies affect human capital through improvements in health and additional time and resources for schooling. Further research needed on how these interactive effects show up in aggregate economic output and productivity.

A Note on Reading This Document

The links between poverty and the environment are broad and complex. There are many valid ways to assess these links; this report offers one perspective. In short, it is important to appreciate the limitations of this report:

- It does not attempt to explain all the causes of poverty nor does it provide a comprehensive menu of actions to address poverty.

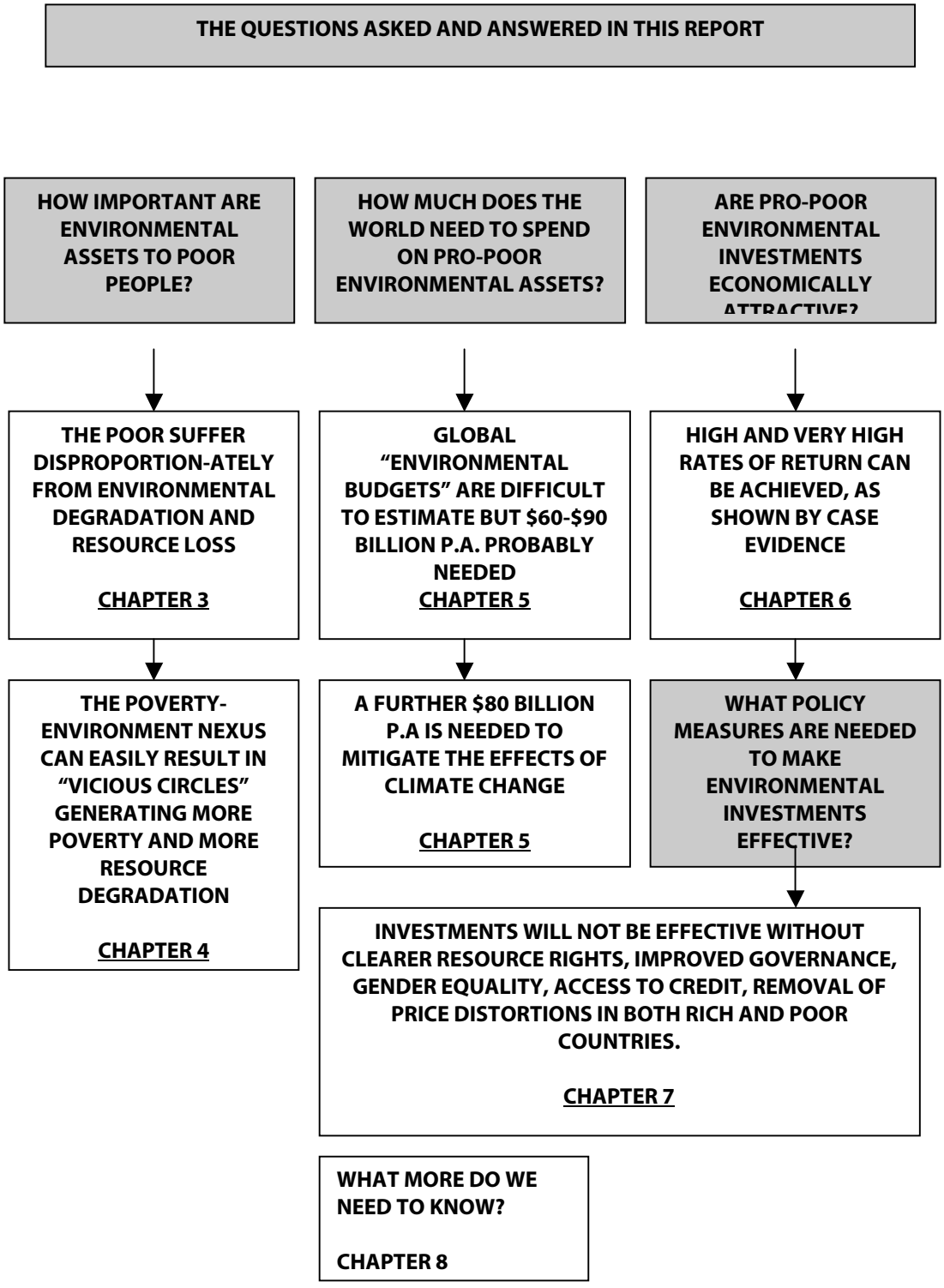
- It is concerned with just one aspect of poverty, but one that the members of the PEP believe to be vital – the state of the environment in poor countries, the way this interacts with poverty, and the economic case for investing in environmental quality and natural resources as a means to reduce poverty.

- It touches only briefly on the wider issue of North-South relations, which may sustain and cause poverty – the structure of world trade, globalization, exploitation by the powerful, etc. These are important issues. For some they may be the most important issues. But they are beyond the scope of this report.

- The arguments presented are economic in nature, partly because that is how many influential people see the issues, and partly because economic logic and evidence can help to clarify what needs to be done to reduce poverty.

- *Above all, many still see the environment as a "luxury good," something the poor can address when they are richer, but not now. This report is dedicated to correcting that view: Investing in the environments on which the poor depend often makes immediate economic sense.*

A Guide to the Report



1 Introduction

1.1 Purpose and focus

This report sets out to prove that policy measures aimed at improving the natural environment and investments in environmental assets can, and do, play a critical role in improving the well-being of the world's poor. It does so by showing that:

- poor people are poor because their assets are few, and often of low quality;
- a significant fraction of those assets comprise natural and environmental resources that provide valuable ecosystem services;
- environmental assets are highly vulnerable to overuse and external appropriation;
- it is extremely easy for local, national and global events and policies to trigger mechanisms that damage environmental assets, forcing the poor into "vicious cycles" of poverty and further environmental loss;
- although rich people can often protect themselves against many of the effects of environmental degradation, the poorest usually cannot;
- when carefully managed, the "social rate of return" from investments in environmental assets can be very high and of special benefit to the poor; and
- such investments need a favorable policy context to make them effective and sustainable.

The implication is that environmental improvement is not just a national need in poor countries, it is also a special need for the poorest within those countries. In short, environmental improvement is a requirement for sustainable economic development in its broadest sense, and an essential condition for poverty reduction. The report seeks to show that efforts to reduce poverty through economic growth can be thwarted unless those efforts also target improvements in the quality of the natural environment and the stock of natural resources.

Although these messages are understood by many in the development community, for others the case has yet to be made.[1] Thus:

> "…[sustainable natural resource management] is at time dismissed as an extra cost with low returns, or a desirable goal but with a low priority compared to other rural poverty alleviation needs such as health, education, infrastructure, water and sanitation, etc."[2]

In part, and despite several excellent recent efforts to convey the message,[3] the lack of recognition of the role of the environment in development reflects a wider failure of the environmental community to provide the substantive evidence for their claims. Several major contributions to the environment-development debate note

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[1] Thus, one of the world's leading environmental and development economists, Sir Partha Dasgupta of Cambridge University, in his *Human Well-Being and the Natural Environment*, remarks that he has long drawn attention to the neglect by development economists of environmental economics and that environmental economics has made "no contact with poverty in poor countries." "The two fields of specialisations had passed each other by and had weakened in consequence" (Dasgupta, 2001, p.viii).

[2] Gutman (2003), p11.

[3] For example, DfID and others (2002), and Duraiappah (2004.).

that environmental issues have not so far been fully integrated into strategies and policies for achieving the Millennium Development Goals.[4] The perception remains that the environment is something to be addressed at a later stage of economic development. Indeed, in some cases, addressing environmental concerns now is still seen as a restraint on economic development.[5] This view reflects an outmoded understanding of the environment-development nexus, and one that is not confined to the developing world. Even in rich countries, environmental improvement is often seen as the enemy of competitiveness and productivity. Clearly, if such a perception exists, there must be reasons for it. This report suggests that the perceived conflict between environmental management and pro-poor growth persists in part because, to date, the evidence showing that it is wrong has not been assembled in a robust and convincing way.

1.2 The audience for this report

This report is aimed at those decision-makers and opinion-formers who look for a hard economic case for policy change and investment to secure poverty reduction. The economic case for managing the environment to reduce poverty is one of several approaches to addressing what has become known as the "poverty-environment nexus." It is not an exclusive approach: Similar arguments can be made without resorting to the language of economics. But economics makes an important contribution, as the rapid expansion of the discipline of environmental economics has shown. That expansion underlines the fact that many find economic arguments to be persuasive – and not only in environmental contexts. Finally, this report addresses only the environment-poverty nexus. A comprehensive strategy for poverty reduction would involve many policies and measures beyond those discussed here.

The audience for this report is thus the decision-maker and opinion-former in need of economic evidence to make a case they may already be persuaded of, and others who may be skeptical that there is a case at all for focusing on environmental improvement to reduce poverty. In both cases, the individuals in question are likely to seek an economic justification for policies and investments. This report tries to provide that justification. It is as well to be clear, however, that not all the building blocks are in place – there are enormous data deficiencies that need to be addressed. Nonetheless, the report argues that enough is known already to establish a strong case for poverty reduction via environmental improvement.

1.3 A note on terminology

Assets, wealth and capital

Throughout the report, three terms are used interchangeably: *assets*, *wealth* and *capital* are all the same thing. However, since "capital" has overtones of focusing only on financial assets or man-made machines, infrastructure, etc. (and raises ideological hackles in some quarters), this report favors the terms "assets" or "wealth." The basic idea common to all three terms is the notion of a broad array of assets, any one of which has the potential to yield a flow of goods or services through time, and which can depreciate or appreciate (increase) physically or in value. Although man-made capital is one form of asset, so are human health and education, since each of these ensures the flow of labor and other services. In the same way, what is widely known as social capital also yields services (benefits) through time if, it is maintained, e.g., the relationships within the community and the institutions that form to maintain those relationships. Finally, environmental assets yield flows of services. At a global level, the earth's atmosphere regulates surface temperatures, but this asset can be depreciated through excessive emissions of greenhouse gases. The ozone layer similarly regulates ultraviolet radiation, which would otherwise damage human health and other biota. At the local level, clean air contributes to human health, while the depreciation of clean air (air pollution) harms it. At the household level, clean air

[4] For example, UNDP (2005).

[5] Sixty of the 100 countries surveyed in UNDP (2005) regarded environmental concerns as a constraint on development.

serves the same function, while indoor air pollution depreciates the asset and harms human health. Local forests provide many kinds of timber and non-timber products, and so on.[6]

The environment and natural resources

The asset approach also helps to explain what the report means by "environment" and "natural resources." Uses of these terms vary, but they can also be thought of as synonymous. Clean water is an environmental asset, as is soil, clean air, the ozone layer, and the global atmosphere. A forest, mangrove, wetland, coral reef, a waste disposal site, and wildlife are also environmental assets, as are coal, oil, natural gas, biomass fuels etc. The last few are perhaps more commonly thought of as "natural resources," but if the characteristic of a natural resource is that it functions as an asset and is natural in origin, then these natural resources are not conceptually different to the environmental assets listed earlier. Hence, environment and natural resources will also be used interchangeably in the report.

Finally, the asset approach underlines the variety and extent of environmental assets. The "environment" is not just about exotic birds and fine landscapes: They are indeed part of the wide panoply of environmental assets but only a small part.

1.4 Structure of the report

The report has the following structure:

Chapter 2	Briefly reviews the Millennium Development Goals and the role of environmental improvement in achieving them. A reflection on the environmental Kuznets curve hypothesis, which may have misled many into thinking the environment is a luxury, something that can be afforded only after poverty has been eliminated. An appraisal of the view that it is assets (wealth) that matter for poverty reduction.
Chapter 3	Investigates in more detail the asset-based approach to poverty reduction, showing how it links to the economics of sustainable development, the "sustainable livelihoods" literature and Amartya Sen's "entitlements" approach. Improving the asset base of the poor is seen to be vitally important, but asset inequality may also slow income growth generally.
Chapter 4	Explores the complex interlinkages in the poverty-environment nexus, showing how easily "vicious circles" can result from events such as natural disasters, climate change, misguided policy and external factors. Once environmental assets are degraded, incentives may arise that exacerbate poverty, leading to more environmental degradation. Institutional change may not be fast enough to halt the process of degradation.
Chapter 5	A brief look at some broad-brush estimates of investment needs to meet the Millennium Development Goals, which explicitly or implicitly address the environment-poverty nexus.

[6] For detailed descriptions and evaluations of these flows of services see UN Millennium Ecosystem Assessment (2005a, 2005b).

Chapter 6	Reviews the empirical evidence to show that investments in the environment can yield "high" economic rates of return.
Chapter 7	Outlines the policy context. Investments will not succeed unless the conditions for sound and sustainable investments are present. The "correct" policy context will vary, but some generalizations can be made. The broader issues required for *any* measures to work are only hinted at, since the chapter focuses on what is needed for environmental investments to work.
Chapter 8	Although the economic case for investing in the environment for poverty reduction is much stronger than is usually supposed, there are significant gaps in information and research. This chapter outlines some of the issues that still need to be addressed.

References can be found in the accompanying bibliography, which also includes material not necessarily cited in this report.

2 The Millennium Development Goals, Sustainable Development, and The Environment

2.1 The Millennium Development Goals

United Nations member states signed the Millennium Declaration in 2002 and, in so doing, committed themselves to its eight goals and 18 targets aimed at cutting extreme global poverty by 50 percent by 2015 relative to 1990. The Millennium Development Goals (MDGs) include Goal 7 (MDG7) which in turn embraces three environmental sustainability targets:

- Integrate the principles of sustainable development into country policies and programs, and reverse the loss of environmental resources;
- Halve, by 2015, the proportion of people without sustainable access to safe drinking water and basic sanitation;
- Achieve by 2020 a significant improvement to the lives of at least 100 million slum dwellers.

2.2 Wealth and sustainable development

These MDG7 targets, particularly the first – the "mainstreaming" requirement, encompass wide-ranging action. If sustainable development is construed as sustained rising per capita well-being, then the focus of interest should be on the key conditions for achieving that goal. The emphasis on per capita well-being is a reminder that it is not enough to increase aggregate levels of well-being. If population growth is faster than the expansion of aggregate well-being, average well-being will decline. Box 2.1 shows that the absolute numbers of people in poverty can still increase despite major efforts to reduce poverty.

This report adopts the view that the conditions required for increased average well-being involve raising the per capita endowments of capital assets, or wealth.[7] Wealth in this context refers to the sum total of all assets, and an asset is defined as anything that generates a flow of well-being through time. Thus, a plough is an asset. It generates a flow of services over its lifetime before it has to be replaced because it wears out over time – it depreciates. Knowledge is an asset because it can be used again and again. It too may depreciate as the holders of that knowledge die, but it can also be handed down to new generations and in that sense is perpetual.

It may not be so obvious that the environment is a capital asset. Yet it fulfils the same criteria as others: Environments and natural resources yield flows of services that contribute to well-being. Soil fertility is an environmental asset – in combination with other inputs, it generates crop and livestock output. Clean air and potable water are assets that sustain human health. A forest produces timber, many non-timber products, watershed protection and carbon sequestration. Wetlands and coral reefs sustain fisheries (and, hence, food supplies), provide storm protection, recreation and other benefits. The stratospheric ozone layer protects human health and other biota by limiting ultraviolet radiation.

Finally, the set of relationships among individuals in society and the associated institutions provide the "glue" that holds society together. This is "social capital" and the breakdown of those dependencies, for example through crime, family breakup and family loss, destroys social capital. Population migration may also affect social capital, perhaps depleting it if out-migration mainly consists of the young, perhaps reinforcing it if newcomers bring new skills and more cultural diversity. Even political and other freedoms can be thought of as assets, since those freedoms are themselves conditions for the fulfilment of individual capacities.

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[7] This is very much the economist's way of interpreting sustainable development, but it offers considerable insights, not least because it lends itself to measurement. Chapter 3 looks in more detail at the basis for this view. See also Pearce and Barbier (2000) and Atkinson et al. (1997).

Box 2.1 Population growth and poverty reduction

The Millennium Development Goal on poverty reduction is expressed in terms of halving the proportion of people in extreme poverty by 2015. Since population in poor countries is growing, meeting proportional goals can still mean that the absolute number of people in poverty may not decline and could even increase. The World Bank estimates that:

- Between 1981 and 2001, the proportion of world population living on less than US$1 per day fell from just over 40 percent to 21 percent.
- In the same period the proportion living on less than $2 per day fell from 67 percent to 53 percent.
- In absolute numbers, the corresponding figures are 1.48 billion down to 1.09 billion ($1 per day), and 2.5 billion rising to 2.7 billion ($2 per day). Thus, using the $2 per day figure, absolute numbers in poverty actually increased over the 20-year period.
- On both measures, sub-Saharan Africa shows marked increases in poverty; in each case close to doubling the numbers by 2001.
- The reduction in poverty, using either measure, is largely accounted for by improvements in China.

The numbers above highlight the need to focus on per capita measures of well-being, thus allowing for population growth. Even then, the data on poverty are the subject of an extensive debate with different sources producing different results, sometimes with significant variations.[8]

2.3 Population and technology

The sum of these assets, or forms of capital, constitutes overall economic wealth. For development to be sustainable, this overall wealth must rise on a fairly consistent basis over time and in per capita terms. The per capita requirement again underlines the need to consider the links to population change: The evidence strongly suggests that population growth beyond a certain level threatens sustainable development.[9] Yet poverty may itself reinforce the pressures to expand family size, an example of a vicious circle in development.

[8] The data in Box 2.1 come from Chen and Ravallion (2004).

[9] Some research suggests that this threshold population growth rate (inclusive of all sources of population growth – natural plus migration) is surprisingly low, at about 1.2 percent per annum. Above this rate, there is a risk that wealth per capita may fall as assets are diffused across a greater population (see Hamilton (2000)).

Technological change has the effect of raising the "productivity" of assets, enabling more well-being to be generated from a unit of wealth. The technology in question may be anything from machines to bicycles, from changes in crop rotation to the use of fertilizers and tractors, from faster growing trees to water filtration. In each case, more welfare-enhancing services are obtained from the same level of the relevant asset. Technology transfer is, therefore, an important additional component of strategies to reduce poverty.

Since the focus of this discussion is on poverty, the assets that matter most are those that are owned by or accessible to the poor. Ownership may not be essential. It is the use of assets, and how the benefits derived from that use are distributed, that matters. The poor make use of many environmental assets that are not owned by anyone ("open access" resources) or which are owned by the state but with limited enforcement of restrictions on access ("de facto" open access resources). These assets are vulnerable. If too many people make use of them, there is a strong risk of depletion. Like all individuals, the poor also make use of assets owned or managed at the communal level. These assets may be more secure, so long as communal management systems do not break down or are not overruled by external powers. Other assets, such as infrastructure and transport, also affect poverty and these may be owned by the state or local government. Here the poor may find that they have unequal access to available infrastructure (schools, hospitals, even roads and public buildings), although the picture is often complicated (see Section 3.8).

The aim of poverty reduction now becomes (a) increasing the asset base of the poor to give them the capability to increase their own well-being, and (b) raising the productivity of the assets they already have through technological change.

2.4 Environmental sustainability and the MDGs

Although MDG7 is the only MDG that explicitly addresses environmental issues, it is important to understand that the targets associated with MDG7 have a cross-cutting influence on the other MDGs. Without this understanding, MDG7 might be wrongly construed as a "stand alone" objective and secondary to the other goals. For example, reducing rural poverty requires increasing agricultural productivity, something that cannot be done if soil fertility is low and water is scarce. Child mortality is strongly linked to unclean water, and mortality generally to both indoor and outdoor air pollution. The health of the poor and, hence, their productivity cannot be ensured if water quality is poor or if women are forced to travel long distances to fetch meager water and fuelwood supplies. There is often a strong gender bias in the use of natural resources, with women in developing countries bearing the brunt of fuelwood and water collection and a disproportionate impact from indoor air pollution. Similarly, providing schooling for children cannot be achieved if they are in poor health or must spend long hours collecting fuel and water. The linkages between MDG7 and the other MDGs are not comprehensive – the case can be made for other goals being a condition of achieving environmental goals, while the environment has little or nothing to do with reducing HIV/AIDs. But it is clear that the environment is central to the MDGs in general.[10]

[10] The linkages among the goals are explored in World Bank (2002), DfID et al. (2002) and UNDP (2002). They are emphasized again in the report of the UN Millennium Project's Environmental Sustainability Task Force – UN Millennium Project (2005b).

Subsequent to the formulation of the MDGs, the United Nations commissioned the Millennium Project with 10 Task Forces to elaborate the implications of the MDGs.[11] The Task Force on Environmental Sustainability reported in 2005[12] and concurs that:

> "Environmental sustainability is essential to achieving all the other Millennium Development Goals" (p.1).

Box 2.2 summarizes the links between environmental management and the Millennium Development Goals.

2.5 The Millennium Ecosystem Assessment

Although there have been many reports on the state of the world's natural environments, the Millennium Ecosystem Assessment (MA) is unique in being so comprehensive and in linking the state of the world's ecosystems to human development.[13] The MA documents the changes that have occurred in global ecosystems, noting that many of those changes are due to human appropriation of ecosystem products and services, often on an unsustainable basis. Many wild plant and animal populations have declined in number, although at the same time there has been a reduction in the genetic diversity of domesticated crops and livestock. Overall, the MA argues that ability of natural ecosystems to meet current and, more importantly, projected future human demand is seriously limited. In line with the arguments presented in this report, the MA acknowledges that conventional measures of income and output (e.g., gross domestic product) can increase, even while underlying natural wealth is declining. The MA thus reinforces the emphasis placed on wealth accounting in this report. Ecosystem change self-evidently increases the potential for human well-being, e.g., forest land converted to agriculture supplies food resources. But the MA stresses the costs of this conversion process in terms of the forgone ecosystem benefits, with the additional observation that many ecosystem conversions fail to provide the hoped-for benefits. The immediate drivers of ecosystem change are often of less interest than the underlying forces (i.e., "indirect" drivers), which include population growth, income growth, exploitation by richer sectors of society, and distorted and missing markets.[14]

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[11] The Task Forces have produced 14 reports; four focus on HIV/AIDs, malaria, TB and access to essential medicines. In addition, there is an overview report – UN Millennium Project (2005a).

[12] UN Millennium Project (2005b).

[13] UN Millennium Ecosystem Assessment (2005a, 2005b). The MA comprises a number of reports – see www.millenniumassessment.org/en/products.aspx. for a complete list and details of availability.

[14] A distorted market may be one in which prices are heavily influenced by subsidies. A missing market is where ecosystem products and services have no associated market, i.e., they appear to be "free."

Box 2.2 Environment and the Millennium Development Goals[15]

Environmental Management Measure	Dimension of Poverty	The MDGs
Sound and equitable management of biodiversity and ecosystems		1 – eradicate extreme poverty and hunger
—		
		2 – achieve universal primary education
Ensure access to safe water and sanitation	Enhance livelihood security	
—	—	3 – promote gender equality
Improve air quality and exposure to toxic chemicals	Reduce risks to health	4 – reduce child mortality
—	—	5 – improve maternal health
Mitigate natural disasters and resource-based conflict	Reduce vulnerability	6 – combat major diseases
—		
		7 – ensure environmental sustainability
Reduce and mitigate climate variability and change		

[15] Adapted from DfID et al. (2002).

The MA constructs several scenarios to indicate likely future changes in the world's ecosystems. As long as the global community takes "proactive" measures, there is scope for ecosystem improvement. Otherwise, the future could be worse than the present. Future change is to some extent predictable, but there are changes that might occur in a sudden and fairly unexpected way. Human intervention tends to increase the latter risks. Scientific information on the interactions between ecosystems and human well-being remains weak. Among the many gaps in knowledge are (a) limited understanding of the economic value of ecosystems, and (b) the cultural benefits of ecosystems. Among many proactive measures suggested to prevent further loss of ecosystems are the expansion of protected areas and strengthening of international environmental agreements. There is no "plan of action," in the MA since this was not the aim of the study.

Given the compelling and disturbing story told by the MA and other similar studies, the question arises as to why so little is being done to reverse the loss of ecosystem products and services. One reason is the prevailing view that the environment is a luxury, something which can be addressed when nations are richer but not before. To some extent, this long-standing misperception has been reinforced by recent literature on the relationship between environment and economic development. This issue is discussed in more detail in Section 2.7 Other explanations for the neglect of the environment are documented in a useful commentary on the MA[16]:

- One long-standing explanation is that the environment is "pervasive": All economic decisions affect the environment, and many environmental changes affect the economy. As a result, it is difficult to "mainstream" the environment compared to, say, education or infrastructure or even health. There has accordingly been "insufficient coordination and leadership at the national level."[17] Where there have been local successes in improving the environment and well-being, all too often the lessons are not replicated at a national scale. Environmental issues are rarely integrated in national development policies.[18]

- There has been an overemphasis on "process" targets – for example, setting up decision-making procedures – at the expense of "output" targets, such as quantitative reductions in pollutant emissions or total area under protection.

- Directories or compendia of what works are lacking. It may be that what works in one location will not work elsewhere, but there is an urgent need to learn from practical case studies as far as possible.

- The balance between "policy" concerns and "investment" needs has swung too far in favor of the former. This report addresses this issue directly by showing that increasing wealth is a precondition for poverty reduction, and that increasing wealth requires increased investment, along, of course, with the corresponding policy context.

- Many environmental strategies exist only on paper and lack a budget to facilitate their implementation. There is a need to face up to the financial implications of improving the environment and reducing poverty – this report explicitly addresses this issue.

[16] Schmidt-Traub (2005).

[17] Schmidt-Traub (2005).

[18] Bojö et al. (2004).

2.6 Is environmental improvement consistent with sustained economic development?

Despite all the efforts to show that environmental improvement is a precondition for poverty reduction, there remain concerns that the centrality of the environment to the MDGs has not been fully appreciated in all quarters. Perversely, it may be that some recent and fairly popularized work in environmental economics has contributed to this perception. The environmental Kuznets curve (or EKC) is an empirical construct which suggests that the environment degrades in the early stages of economic development and then improves later, once some income threshold has been passed.[19] The literature on the EKC is very large and the construct is easily summarized in the form of an upside-down saucer-shaped curve (see Box 2.3). The simplicity of the basic idea has contributed to its popularity. The temptation has been for some commentators to take the construct and use it to argue, incorrectly, that not only has poverty alleviation got nothing to do with the environment, but that the environment actually has to get worse, or should get worse, for the poor to improve their lot.[20] Even if some in the development community do not refer explicitly to the EKC, they may articulate the same argument by stating that the environment is a luxury, something the developing world cannot afford until it is richer.

Such a view is not only invalid in intellectual terms, it can bias development efforts against the environment, harming the prospects for more sustainable forms of development.

- First, a growing literature is challenging the generality of the EKC as an empirical construct. It appears not to describe experience with many forms of environmental change.[21] Some have even questioned its validity for the original pollutants that were studied – notably conventional air pollutants such as sulphur oxides and particulates.[22]

- Second, the rural poor tend to occupy environmentally marginal land which, if degraded, can quickly become "desertified," i.e., with close to zero soil productivity. One "good news" story that appears to belie this view and which fits the EKC notion, is that relating to the Machakos District in Kenya.[23] This area suffered severe degradation in the inter-war years but now sustains a larger population than it did then and at higher levels of per capita income. The transformation is attributed to technological change brought about by the fact that population growth forced the communities to face up to resource exhaustion. The Machakos story is encouraging in many ways, although just what combination of internal and external forces brought the change about is debated. More importantly, the Machakos case does not appear to be capable of generalization. Some societies respond well to resource scarcity, others sink into a worse poverty spiral.[24]

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[19] The EKC has nothing to do with Simon Kuznets, Nobel Prize winner in economics, but takes its inspiration from Kuznets's observation that income inequality tends to worsen in the early stages of economic development and then improves later. The EKC mimics the same worsening-improving sequence as development occurs. How far Kuznets's original postulate is true is open to question (see Deininger and Olinto (2000)).

[20] For example, Beckerman (1992) argued that "the way to attain a decent environment in most countries is to become rich."

[21] For the example of air pollution see Dasgupta et al. (2004). On deforestation see Koop and Tole (1999).

[22] See Harbaugh et al. (2002).

[23] The Machakos case is documented in considerable detail in Tiffen et al. (1994).

[24] The complex interaction of environmental change, population growth and institutional adaptation is described in López (1998).

- Third, if environmental losses are irreversible, no amount of income growth will restore those losses. A clear instance is global climate change. All the economic-climate models show that the developing world will suffer more than the rich world in terms of damage as a proportion of income (see Chapter 4). Yet global warming is to all intents and purposes non-reversible. This is acknowledged in the international long-run climate targets. No one is arguing for the conservation of the "current" climate, as measured by concentrations of greenhouse gases in the atmosphere (currently around 370 parts per million). Long-run goals center on a warmer world with concentrations at 550 parts per million.[25] The corresponding temperature increase is effectively irreversible in policy terms. Yet even this long-run goal will impose disproportionate harm on the poor of the world.

The EKC also masks the incidence of poverty, since the measures used to indicate real incomes are averages. Economies may grow and average incomes rise, but the poor may not share proportionately in those rising incomes. Indeed, the original construct of a Kuznets curve linked real incomes to inequality rather than to the environment. The hypothesis was that the initial stages of economic growth would be accompanied by a worsening of inequality, which only later would decline. A related issue concerns human health. Rising incomes are normally associated with better health, but if the environment worsens as incomes rise, there will be an offsetting effect on human health. In some cases, the detrimental effects of environmental degradation on health can outweigh the beneficial effects of rising incomes.[26]

Finally, the evidence suggests that, even where the EKC broadly fits experience, it is highly sensitive to policy measures that enable a "tunneling through," as shown in Box 2.3.[27] This means that policy measures can be adopted which flatten the curve, avoiding the early environmental degradation and moving rapidly to the declining section where the environment improves. Tackling corruption is one way to flatten the curve.[28] It hardly makes sense deliberately to inflict environmental damage on the poor just because this was the way the rich nations developed hundreds of years ago. There is no need to repeat that unhappy experience. In short, the EKC is neither inevitable, nor does it describe a desirable path of development.

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[25] This long-run goal has been adopted by the European Union.

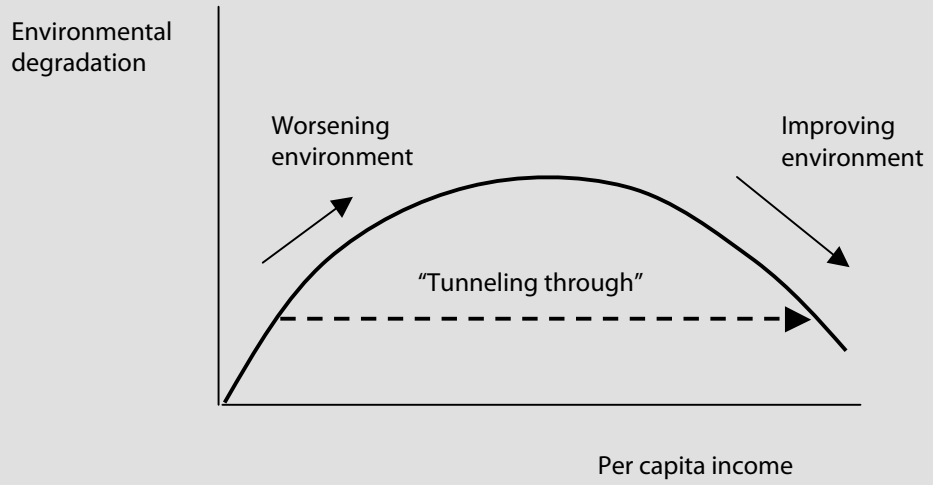
[26] See for example Gangadharan and Valenzuela (2001).

[27] For example, see Panayotou (1997).

[28] See López and Mitra (2000).

Box 2.3 Does the environment have to get worse for the poor to become rich?

The Environmental Kuznets Curve (EKC) shows how measures of environmental degradation vary with per capita incomes. The shape generally supposed to result is shown below as an upside-down saucer.



One implication, drawn by many casual observers, is to argue that we do not need to worry about the environment in poor countries. Once the poor have become better off, it is suggested, they will pay more attention to their environment and seek to improve it, correcting past degradation in the process. Indeed, such a process looks remarkably similar to the way that industrialized countries proceeded in the past – only in the latter stages of the Industrial Revolution were laws passed to protect water quality and reduce air pollution. But this interpretation of the EKC is both invalid and dangerous for the world's poor:

- There is a debate as to whether the EKC is valid for more than a few forms of environmental degradation.
- The rural poor tend to occupy environmentally marginal land. Degradation is often irreversible, although there are occasionally some "good news" stories, such as the case of Machakos District in Kenya.
- At the global level, the poor suffer more than the rich from climate change. Yet global warming is to all intents and purposes irreversible – we can only aim for stabilized, but higher, temperatures.
- If the environment worsens as incomes rise, so human health may actually decline if the detrimental effects of environmental degradation outweigh the beneficial effects on health of rising incomes.
- The evidence suggests that, even where the EKC does broadly fit experience, it is highly sensitive to policy measures that enable a "tunneling through," as shown in the diagram above. In short, the EKC is neither inevitable nor does it describe a desirable path of development.

3 Poverty, Wealth and The Environment

3.1 Wealth, institutions and incentives

Chapter 2 sketched the elements of a theory of sustainable development in which future well-being depends on the accumulation of capital assets but where the nature of those assets extended across a broad domain of physical, social, environmental and human capital. The role of technological change in making assets more productive was emphasized. These assets and technologies define the potential capability of individuals and communities to generate well-being. Of course, for this potential to be realized, many other factors must be present: notably, the "right" institutions and the "right" incentives. For example, if communities have no secure rights to their land or other natural resources, they may quickly lose their livelihoods because they cannot prevent others from using or usurping them. Property rights matter. Situations where no exclusive rights exist – so-called "open access" – are not conducive to wealth creation. Communal and/or individual ownership is essential wherever resources are scarce relative to demand. Similarly, if prices in the local economy fail to reflect the scarcity of the resources being used, there will be incentives to overuse those resources, risking resource exhaustion. The presence of subsidies may distort price signals as well, as will laws that give title to land only if it is cleared of forest or a wetland drained, and so on.

Accounting for wealth is , therefore, only part of the analysis of environment and poverty links. The full story is more complex and must recognize, at the very least, the presence or absence of property and resource rights, and the structure of incentives. These factors define the "context" for wealth enhancement.[29]

Box 3.1 shows the links between this asset-based approach and other prominent approaches to sustainability and poverty reduction. Poverty reduction needs initially to focus on encouraging more wealth creation (or more wealth redistribution) for the benefit of the poorest sections of a community. Moreover, there is evidence to suggest that wealth (asset) inequality inhibits economic growth generally, whereas the evidence that "income inequality" inhibits growth is limited.[30] If so, not only is wealth augmentation for the poor essential for poverty reduction, it will also affect positively the general economic prospects of the nation (see Section 3.5).

[29] Siegel (2005).

[30] For the empirical evidence for these propositions see Deininger and Olinto (2000).

Box 3.1 Approaches to sustainable development and poverty reduction

What this report calls the "asset-based approach" unites several strands of thought in the development, environmental economics and poverty reduction literature.

The ***economic theory of sustainable development*** treats wealth increases as the basic requirement for sustained rises in per capita well-being through time. In this literature, wealth is construed broadly as man-made, human, social and environmental (natural) capital. The main body of this literature regards these forms of wealth as substitutable over the range of likely policy measures. As assets decline, however, their scarcity increases, and the rate at which they can be substituted by other assets will itself decline. In the limit, no-one would survive in the total absence of environmental, human, social or man-made assets, so it makes no sense to say that the rate of substitution between them is the same for all time. Additions to wealth are known as "genuine savings" which is simply the total savings in the economy minus the depreciation of all assets. Some refer to this as "genuine investment." The terms are interchangeable. If genuine saving is negative, depreciation exceeds savings (investment), so that the capital base of the economy must be declining; the asset base is being "mined." Since no one can live off capital forever, negative genuine savings is symptomatic of non-sustainability. The introduction of population growth to the analysis permits its reformulation in wealth per capita. The basic condition for sustainability is that the rate of growth of genuine savings (as a fraction of all capital) must exceed the rate of population growth. Although the theory was developed in a mathematical fashion, the basic intuition is fairly easy to grasp: The aforementioned rule derived above amounts to saying that the rate of net asset formation must rise in per capita terms. Importantly, the approach lends itself to quantification, i.e., it is possible to classify economies according to their degree of sustainability. This is the task of ***wealth accounting***, with the major exercise on this being conducted at the World Bank.

Recently, development economists have also focused on ***asset-based growth***. This has strong similarities with the economics of sustainable development and focuses on asset growth as a precondition for long-run rising per capita incomes. The assets targeted in this literature have so far tended to exclude environmental capital, but there is no reason why the approach cannot be extended to include environmental assets. The literature tends to emphasize the role played by a major part of human capital – education. For any household, an indicator of ownership and access to assets is multiplied by a rate of use of the asset and then by the "price" of the asset. Income increases can then be achieved by (a) expanding the asset base, (b) increasing the rate of utilization of assets and (c) raising the unit value of the assets. For example, developing a labor market for school dropouts increases the value of education and the likely rate of use. As with wealth accounting, asset-based growth is capable of quantification.

The role of assets also figures prominently in the emerging literature on ***pro-poor growth***. Pro-poor economic growth requires that growth in the economy benefits the poor by reducing their absolute poverty level. Perhaps surprisingly, given past development aid efforts to raise average incomes in developing countries, absolute poverty does not necessarily fall as economic growth takes place. Initial levels of inequality appear to have a lot to do with this result: The greater the initial inequality, the less likely are the poor to share in the benefits of economic growth. Low initial shares of wealth translate into low shares of future wealth. The policy implication is that measures to address inequality are important for growth to benefit the poor. How does initial inequality bring this state of affairs about? The suggestion is that limited access to assets - especially education, health and infrastructure - inhibits the poor from participating in the growth process. Changes in inequality also matter, and various factors may be at work, not least the way in which the growth process affects different sectors, e.g., agriculture. Inequality also shows up in differences in access to credit, making it difficult for the poor to invest in human and physical capital (and this report would add environmental capital too). High inequality also suppresses the incentives for entrepreneurship and wealth accumulation, for example, by removing relationships of trust among different groups (social capital).

Nobel Prize winner Amartya Sen developed his ***entitlements approach*** to poverty reduction some 25 years ago. Sen's initial observation was that famines appeared to occur even when food supply was plentiful. Sen noted that the poor starved not because there was no food, but because they had no command over food. This was a failure of "entitlements," or what things (food, resources, etc.) the poor can acquire and make their own. As with the asset-based approach, what matters is the initial endowment of entitlements and the possibilities of expanding entitlements through production and trade. The ability to work defines the entitlements of most of the poor, but it is easy to see that Sen's approach can be extended to entitlements to natural resources. The term "entitlement" is a reminder that resources may be available but not under the command of the poor. Wildlife might be plentiful as a potential food resource, for example, but if the poor are denied access, then they have no entitlement. Lack of access might be due to any number of reasons, including legal restrictions, an inability to travel long distances if the resource is located far away, an inability to compete with more powerful individuals and groups, and so on. In short, Sen's approach can be expanded to include "environmental entitlements."

The ***sustainable livelihoods*** approach emphasizes consultation with the poor to secure articulation of their wants and needs and an understanding of their own strategies for securing a livelihood. It is , therefore, highly people-oriented and pays considerable attention to within-household relationships, especially the role played by gender issues. It emphasizes sustainability across all the dimensions noted in this report – economic, environmental, social, human and institutional. Recent work has focused on integrating sustainable livelihood approaches with human rights and power ("political capital"). If freedoms, rights and power are viewed as assets, then the sustainable livelihood approach can also be thought of as an asset-based approach, which is how many of its proponents see it. The term "livelihood assets" tends to be used. The sustainable livelihoods literature debates the relative importance of the various assets, and importance tends to be determined more by case study experience than by the use of quantified techniques. Particular debates have centered on the role of markets, on rights and governance, on the distribution of power, and on links to the private sector.

There is substantial overlap between the various approaches to poverty reduction outlined above. The asset-based and entitlements approaches historically tended not to emphasize environmental factors, but are easily extended to take account of them. The sustainable livelihoods approach has always allowed for environmental assets, while environmental concerns were very much the driving force for the economics of sustainable development approach. The assets-based and sustainable development approaches have gone furthest in terms of quantification. The sustainable livelihoods approach tends to be more qualitative, and the links to sustainability per se have perhaps still to be developed.

Outlines of the various approaches can be found in:

Economics of sustainable development: Atkinson et al. (1997), Pearce and Barbier (2000).

The asset-based development approach: Attanasio and Szekeley (2001a, 2001b).

Pro-poor growth: Ravallion (2004)

The entitlements approach: Sen (1981, 1987, 1999).

Sustainable livelihoods: Carney (2002).

The poor are poor because they have limited assets, inferior access to those assets that do exist, and limited access to technology. These factors preclude them from accumulating surpluses for investment in asset growth, trapping them in a vicious circle of low assets, low income, no re-investable surpluses low assets. An important extension of this focus on assets is the way in which the poor seek to supplement their asset base by using "free" assets. For example, in rural areas, forest products, and more generally the goods and services arising from ecosystems, are important assets. In urban areas, asset poverty shows up in the formation of slum dwellings that make use of waste land neglected by the market. The poor may also exploit others' waste as a "free" resource, e.g., collecting materials from waste disposal sites. Although these processes expand the asset base of the poor, the absence of well-defined property rights creates risks of overuse, overcrowding, degradation and risk of exploitation by others more powerful than the poor. Where ecosystems are in their early stages of widespread use, they generate "rents" (profitable opportunities) that attract outsiders such as loggers, large land owners and others who can easily displace the poor and exploit the ecosystems (see Box 3.2). As ecosystems degrade, so the supplemental asset base declines, and the poor once again find themselves in a vicious circle of asset poverty. In urban areas, the poor may easily be dispossessed as cities expand and marginal land rises in value to developers.

Box 3.2 Resource rents and the poor

Economic rent is the difference between the price of an ecosystem's products and the (marginal) cost of extraction. "Rent seekers" are those who try to appropriate, or "capture," as large a share of the rent as possible for themselves. Rent seeking is generally unproductive in that it does not generate additional wealth but simply redistributes existing assets. For example, the allocation of a forest area for logging creates potential economic rents wherever there is a significant difference between extraction costs and the market price of timber. Rent seekers such as those who vie for logging concessions often have more political power than the poor and are wealthier, although the poor themselves may be attracted by available rents. In general, however, the poor tend to lose out to other rent-seekers and are displaced from traditional uses of resources. In other cases, the poor may gain, for example, if a logging company opens up areas that were previously inaccessible. Once the logging company has taken what it wants (usually the highest value tree species), the forest may become an open access resource for the poor.

Natural resource discoveries – e.g., oil and gas deposits – also stimulate rent-seeking and arguments about rent capture. One reason that some countries make apparently poor use of natural resources is that massive efforts go into fighting over the division of the rents, rather than reinvesting the proceeds in future development. In many cases, resources rents accrue to the few and are consumed or taken offshore. A few countries – for example, Botswana – have adopted successful strategies for managing their natural resource endowments, using some of the proceeds to enhance current consumption, while reinvesting the balance in education, health and infrastructure.

Subsidies offer another example of rent-seeking. Although some subsidies may be designed with the aim of helping the poor, experience suggests that the poor usually lose out in the race to capture the rents that subsidies represent, with richer groups in society enjoying most of the benefits. Many subsidies are quite explicitly aimed at richer and more powerful groups, e.g., as rewards for political support.

Rent capture is about the distribution of power in society. Poverty reduction strategies must take account of this. Efforts to address the distribution of resource rents present some of the greatest challenges to poverty reduction. Governments must be persuaded to tackle corruption. The limited power of the poor has to be augmented – their voices must not only be heard, but their concerns acted upon. The power of rent-seekers has to be curbed. Democracy has to be encouraged. This often amounts to wholesale political reform in nations that corrupt in part, still enjoy sovereign rights over natural resources.[31]

[31] For an extensive discussion, see Rose-Ackerman (1999).

Wealth can be generated within the household or community and can also be conferred from outside, e.g., through official aid, charity or other transfers. In this way, asset formation becomes the "driver" of poverty reduction since assets determine the strategies that the poor can use to improve their well-being. Again, it is critical to understand the range of assets involved – for a rural agricultural household assets include housing, land holdings and soil fertility, water availability and quality, livestock and seeds, access to credit, personal woodlots, access to communally owned or open access forest, access to fisheries, indoor air quality, education, skills, personal health, capacity to express views and opinions freely, local infrastructure, agricultural machinery, access to technology and markets (location), and social and institutional linkages, including gender relationships. For the urban poor, the assets may be narrower in range, with more goods and services being secured through markets but with environmental variables still of importance, e.g., outdoor air pollution from traffic and industry may become more important than indoor air pollution. (Box 3.3 provides a classification of assets.)

Box 3.3 The nature of household wealth

	Household level	**Community level**	**National level +**
Physical assets	Housing Tools Animals Machines	Schools Hospitals Infrastructure	Major infrastructure
Financial assets	Cash	Access to credit/insurance	Access to credit/insurance
Human assets	Labor Education Skills Health	Pooled labor	Labor markets
Environmental assets	Land Soil fertility Woodlots	Common land Fisheries Forests Water Sanitation Air quality Watersheds	Rivers, seas, lakes Large watersheds Minerals Fuels Global climate
Social assets	Family Trust	Community trust Security Governance Participation Cultural assets Rights Justice systems Markets	Inter-community links Trust Political freedoms Rights Justice systems Markets

The challenges are (a) to determine whether any of these assets is key to development, for example if actions on one or a few assets will trigger expansions in other assets, (b) to determine what changes in "context" (e.g., policies, prices, property rights) will be most effective in encouraging wealth creation, and (c) how to ensure that asset bases are sustained.

3.2 The role of children

The role of children as assets is stressed by some analysts.[32] Children often contribute labor while their parents are able to work, and provide informal social security when parents need care in older age. This suggests a positive role for larger family size until such times as labor markets develop more fully, and official social security systems are introduced. Others have suggested that population growth stimulates technological change, rather in the way that industrializing countries in the 18th century secured a stimulus to take off into economic growth as their populations expanded.[33] However, large family size can be detrimental to the health and nutritional status of the household, while rapid population growth generally dissipates available asset stocks, making sustainable development less, not more, likely. Family sizes that are optimal for the household need not be optimal when seen from the standpoint of society as a whole. Children as assets thus embody a duality – both a costly and beneficial role when seen from the household and the social viewpoint. Other complex factors are also involved in family size. Reproduction may not be freely chosen where the woman has inferior status within the household and where information and outside help is limited. The superior status of male children in some cultures can also produce family sizes larger than would be the case where gender equality is recognized.

3.3 Asset depreciation

All assets are subject to depreciation – they wear out with use or are superseded by superior assets. Human capital depreciates within every individual simply because people grow old and die. But the stock of skills and knowledge may be renewed by being passed on to later generations. Hence, human capital is a potentially renewable resource. Where knowledge is not passed on, as with many forms of indigenous knowledge, it can easily be lost. Care has to be taken to conserve this aspect of human capital while allowing it also to appreciate through education and other forms of investment. In the same way, many other assets are renewable and can appreciate so long as their rates of use do not exceed their rates of regeneration. Newly bred livestock replace old livestock, new trees replace felled or dying trees, rainfall replenishes water resources, and so on. But if the incentive structures are such that use rates exceed regeneration, then the innately renewable resources quickly become exhaustible, and exhausted, resources.

The brute fact that assets tend to depreciate, unless cared for and regenerated, further explains the vicious asset cycles that are faced by the poor. If they begin with a low asset base, and if the resulting incomes do not permit surpluses to be generated, then not only will they be unable to invest in the appreciation of assets, they will face the prospect of not even being able to maintain the assets they do have. Once this "model" of poverty is extended to the environment, it is easy to see that, unless the right context exists, environmental assets will also depreciate, worsening poverty.

3.4 Measuring wealth

The measurement of the asset base of nations, and more so of the poor, is in its infancy. Continuing work at the World Bank is building up a picture of national wealth.[34] Table 3.1 shows some of the early results. Broadly speaking, absolute levels of wealth and absolute levels of income are closely linked. But the links between wealth and "growth of incomes" are not so straightforward. Income growth might be expected to be conditional on wealth increases. Using assets more efficiently will raise incomes and raise the value of wealth.[35]

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[32] For example, Dasgupta (1992), Mäler (1997).

[33] This view owes much to Esther Boserup, e.g., Boserup (1980).

[34] See especially Kunte et al. (1998), Hamilton and Clemens (1999) and Hamilton (2000).

[35] This is because the value of an asset is formally equivalent to the (discounted) value of all the future income flows that emanate from the asset.

But incomes might grow without wealth expanding. This comes about through the "mining" of assets – running assets down – and converting the proceeds into income or current consumption.

Table 3.1 shows a selection of countries – the shaded entries – where income growth is positive but wealth per capita is declining. Subject to the uncertainties in the underlying data, these figures suggest that certain countries are pursuing unsustainable economic growth, a process essentially like living off the proceeds of "selling the family silver." The available evidence suggests that just as many nations are achieving their income growth through this unsustainable approach to development, as are achieving it through wealth increases.[36] Unsustainable growth is thus short-term growth and essentially illusory. The reason it can occur is that the underlying wealth on which the growth is based is being neglected. Too much attention is being paid to income, regardless of the reasons why it is increasing. This is why "wealth accounting" – making the effort to measure wealth and changes in wealth – is so important.

Table 3.1 Some estimates of the wealth of nations

	Income per capita 1997 (US$)	% population below $1 day (1990-2002)	Wealth per capita 1997 (US$)	Change in wealth per capita (US$)	Income growth rate (%)
Mozambique	166	38	2,100	- 12	+ 4.9
S Leone	173	57	2,800	- 74	- 4.4
Niger	189	61	2,700	- 76	+ 1.5
Nepal	221	38	2,900	- 57	+ 5.1
Madagascar	251	49	3,600	- 83	+ 0.9
Vietnam	324	18	4,000	- 27	+ 8.6
India	396	35	4,800	- 27	+ 6.0
Azerbaijan	579	16	8,600	- 234	- 15.1
China	735	17	6,800	+212	+11.6
Sri Lanka	814	7	11,200	- 1	+ 5.3
Morocco	1,227	2	16,400	- 74	+ 1.9
Guatemala	1,690	16	27,100	- 572	+ 4.1
El Salvador	1,900	31	31,100	- 433	+ 5.6
Costa Rica	2,748	2	32,700	+347	+ 3.8
Brazil	5,012	8	70,500	- 36	+ 3.4

Sources: All data from Hamilton (2000) other than poverty incidence from UNDP (2004).

[36] See Hamilton (2000), Figure 5, p.17.

The message for poverty alleviation strategies is essentially the same. Those strategies must achieve a twofold goal:

- Expanding the assets of the poor
- Increasing the efficiency with which the poor's assets are converted into flows of well-being.

The only sustainable poverty alleviation strategy is to make wealth grow and, at the same time, generate rising incomes from that wealth creation. The focus on wealth permits this analysis of sustainability, whereas looking at incomes alone can easily disguise the fact that incomes are being generated from the depreciation of assets.

3.5 Asset inequality and income growth

Table 3.1 suggests that even the poorest countries may appear to grow in conventional income per capita terms. But growth unaccompanied by net asset creation is unlikely to be sustainable since it is based on the mining of assets. A second issue concerns the distribution of assets within a nation. Economists have long been interested in inequalities of *income* and the way they affect economic growth. Various interactions have been investigated. The literature suggests that income growth has little effect on income inequality. It is ambiguous with respect to the effects of income inequality on economic growth, some of the studies finding positive effects (more inequality produces more growth), some finding no effect, and some finding negative effects.[37] The literature also suggests that general economic growth produces much more poverty reduction in economies where there is low income inequality than in economies where there is high inequality of income.[38]

When the focus is switched from income to assets (wealth), a clearer relationship appears to emerge. *Inequalities in asset holdings appear to worsen the prospects for economic growth and, hence, for poverty reduction policies based on stimulating the overall growth of the economy.* The result is a kind of "poverty trap" – the poor have few assets, the higher the incidence of poverty, the worse is wealth distribution, and the lower are the chances of economic growth alleviating that poverty. Three results emerge:

- The greater the degree of inequalities in land holdings the lower economic growth tends to be.
- The greater the level of human capital, the greater is economic growth.
- Investment in human capital, e.g., via education, has less effect in economies where assets are unequally distributed.[39]

It also appears to be the case that redistribution of wealth has positive effects on economic growth.

If all these associations are correct, then poverty reduction is most efficiently achieved by increasing economic growth. Increasing growth is best served by reducing asset inequality, and it follows that asset inequality is best served by investing in the asset base of the poor, creating a virtuous circle of growth and poverty reduction.

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[37] For a review of this literature, see Lopez (2004).

[38] For example, see Ravallion (2004) on the "growth elasticity of poverty." Ravallion argues that a percentage growth in income level is associated with significant reductions in poverty when there is low inequality and only very moderate reductions when there is significant income inequality. Kraay (2004) suggests most poverty reduction is accounted for by economic growth.

[39] These results can be found in Deininger and Olinto (2000) building on earlier work by Birdsall and Londoño (1998).

The asset-based approach suggests policy implications for poverty reduction that may differ from the conventional income-based approach:

- Wholesale wealth redistribution *may* be one way of reducing the growth-inhibiting nature of wealth inequality – e.g., land reform. The record of such policies is mixed, however, and in some cases has proved disastrous, especially for the poor.

- Although the previous analysis treats land as being of equal quality, investing in soil fertility and productivity in marginal land areas could have similar effects in reducing the inequality of land ownership.

- Public investments, e.g., in infrastructure, need to be further targeted at the poor.

- Existing policy measures should not worsen the bias of asset ownership.

- Policies to ensure access to credit markets and forms of insurance against local or other disasters need to be strengthened (see Chapter 7).

Other policies, e.g., broadening and deepening educational attainment, which are central to conventional approaches, are confirmed by the asset-based approach.

The central message is that policies aimed at increasing the assets of the poorest sections of the community will reduce asset inequality and simultaneously improve income growth prospects, thus further assisting poverty alleviation. Like national wealth, household wealth must be increasing through time for there to be a sustainable future for the poor. Further, the efficiency of interventions in improving human capital formation will also be increased, making a further contribution to poverty reduction.

So far, the focus has been mainly on assets generally. Our attention now turns to the question of whether environmental assets can be regarded as of equal "worth" to human and physical capital in the quest for pro-poor growth.

3.6 The nature of wealth

The previous sections suggest that policies that increase the asset base of the poor have a good chance of encouraging income growth both on average (at the national level) and among the poor. But this does not establish whether environmental asset formation is any more or less important than other forms of wealth creation.

Table 3.2 illustrates the composition of wealth for world regions. Rather than the separate categorization of man-made, natural, social and human capital, Table 3.2 treats social and human capital, along with any non-estimated components of other forms of capital, as a residual.[40] Earlier estimates from the same methodology suggest that this residual is almost certainly dominated by human capital.[41]

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[40] This can be done because total wealth, without any form of decomposition, can be estimated separately as the discounted value of future consumption. The separate estimates of produced and natural capital are then summed and deducted from total wealth to get the residual.

[41] Kunte et al. (1998). Hamilton et al. (2005) show that important factors explaining the residual are school years, the "rule of law" and remittances.

Table 3.2 Some estimates of the composition of per capita wealth 2000 (2000$)

Income group (excluding oil states)	Man-made, or "produced" wealth	Environmental or "natural" wealth	Residual or "intangible" wealth	Overall wealth per capita	Environ-mental wealth as % of total wealth
Low income	1,174	1,925	4,433	7,532	26
Middle income	5,347	3,496	18,773	27,616	13
High income OECD	76,193	9,531	353,339	439,063	2
World	16,850	4,011	74,998	95,860	4

Source: Hamilton et al. (2005). For earlier estimates, see Kunte et al. (1998). Human capital is subsumed in the residual wealth category.

Table 3.2 shows clearly that environmental assets are far more important, relative to total wealth, in low-income countries, amounting to some 26 percent of wealth, compared to just 2 percent in OECD countries. Table 3.3 shows the decomposition of natural wealth. Crop and pasture land dominate the results for low-income countries at around 70 percent of natural wealth. The data are incomplete. For example, they do not cover wildlife resources, the value of biodiversity (other than indirectly through the value of protected areas) and the amenity value of the environment. Nor do they explicitly account for clean air and water other than indirectly via their effects on human capital and, hence, on output as measured by gross domestic product (GDP). Although the *proportion* of natural to total wealth declines as incomes grow, the *absolute value* of natural capital rises as incomes grow. As the data problems of accounting for natural capital are overcome, the value of natural capital is likely to increase even further. As incomes grow, there is a greater demand for environmental quality, but the evidence suggests that the percentage growth of this demand is less than the percentage growth of incomes.[42]

Table 3.3 The composition of natural wealth 2000 ($2000 per capita)

Income group (excluding oil states)	Subsoil assets	Timber and non-timber forest resources	Protected areas	Crop and pasture land	Renewable resources as % total natural wealth
Low income	325	157	111	1,332	83
Middle income	1,089	289	129	1,990	69
High income OECD	3,825	930	1,215	3,560	60
World	1,302	356	322	536	68

Source: adapted from Hamilton et al. (2005).

[42] The relevant economic concept is the "income elasticity of the willingness to pay for the environment." This is defined as the percentage change in willingness to pay for the environment given a percentage change in income. The available evidence suggests that this magnitude may be around 0.4 to 0.6, i.e. a 10 percent rise in incomes would bring about a 4 percent to 6 percent increase in "demand" for the environment. See Pearce (2006).

There are two possible interpretations of the figures.

- The first would focus on the fact that natural assets appear to be relatively *unimportant* in high-income countries, suggesting, as some have argued, that getting out of poverty and into sustained high incomes involves the sacrifice of natural capital and reinvestment of the proceeds in other forms of capital. There is an element of truth in this view, but it is not a robust argument. Section 2.5 reviewed the dangers in this environmental Kuznets curve approach to economic development. In any event, the value of per capita natural wealth rises as income increases, so that the declining fraction of total wealth simply means that other forms of wealth have increased at a faster rate. Moreover, many high-income countries exhibit high concern for the natural environment, suggesting that the process of substituting human and man-made assets for environmental assets may have gone too far.

- The second is the view taken by the authors of the estimates in Table 3.2 and 3.3. They argue that:

  "The large share of natural resources in total wealth and the composition of these resources make a strong argument for the role of environmental resources in reducing poverty, fighting hunger and child mortality."[43]

There are additional reasons for taking this second view.

- The current comparative reliance of poor countries on natural wealth means that, whatever the composition of wealth in the longer run, addressing poverty *now* requires the careful management of environmental wealth. Moreover, regardless of how nations as a whole treat their natural assets, the focus on poverty reduction requires careful environmental management because the poor depend disproportionately on those assets. (See Sections 3.7 and 3.8).

- This report shows later that the "rate of return" for environmental wealth can be very high, suggesting that the development process may not be best served by a wholesale emphasis on asset formation that is biased to other forms of capital (see Chapter 6).

Wealth accounting is very much a new subject. The preliminary estimates suggest that environmental capital is more important, relative to total wealth, in low-income countries than man-made capital, although almost certainly less important than human capital. Decomposition of environmental capital suggests that land resources, are very important. The fact that environmental capital constitutes only a small fraction of overall wealth in rich countries might be taken to indicate that the best way to increase incomes is to liquidate environmental capital and convert it to other forms of capital. This view was addressed in Chapter 2, where it was shown that it is very misleading and provides the wrong signals for the development process. The absolute level of natural wealth rises as income rises. Above all, the dependency of the poor on natural resources defines the current state of affairs. Provided that investments in natural assets can secure high rates of return, there is every reason to conserve and expand natural assets. Chapter 6 addresses the issue of the rate of return.

This analysis prompts a further investigation of the role that natural assets play in the household wealth of the poor.

[43] Hamilton et al. (2005), p.5

3.7 The importance of environmental wealth to the poor

Wealth accounting has not yet reached the stage where the nature of household wealth can be described in detail in different types of wealth. Nonetheless, a good deal of information exists. The previous sections argued that the environment is part of the asset base of the poor. Measuring household incomes without taking account of this fact will underestimate the wealth of the household. Although this may appear as a "good news" story – the poor are, in many cases, better off than we think – environmental wealth is vulnerable to rapid depreciation, often more so than other assets. Hence, if the story is to be truly good news, this part of the asset base has itself to be maintained and expanded if the poor are to become less poor.

Since uniform wealth accounts at the household level do not exist, some insight into the importance of environmental wealth to the poor can be gleaned from the perspective of income. Income is essentially the rate of return on wealth. A simple example suffices. Individuals with more knowledge and more skills than others are said to have more human capital or human wealth. They also tend to receive higher wages. The difference in their wages compared to someone who is less educated and less skilled, is the "return" to education.

As noted above, the available evidence suggests that environmental *wealth* grows in absolute terms as *incomes* grow, but declines as a *share of total wealth*. In income terms, some evidence supports a similar relationship: what is now termed "*environmental income*" decreases as a fraction of income as *incomes* grow.[44] But some studies find more complex relationships and suggest that environmental income matters both for the very poor and the relatively rich, the latter having greater capacity to extract resources, e.g., using hired labor and perhaps also having larger demand, e.g., for cattle fodder.[45]

Incomes can be thought of as comprising: Market income + Non-market income + Asset sales[46]

Non-market income refers to the incomes received in kind from ecosystem services. In the case of a forest, that non-market income will accrue as fuelwood, poles, and other non-timber products. Less obviously, if the forest protects the watershed against erosion and flooding, and if the household relies on the functioning watershed, then another form of income is being received as well: the protective functions of the forest ecosystem. Asset sales refer to the role that might be played by transferable assets, such as livestock, both in normal situations and in situations of crisis (distress sales). Non-market income may also serve this strategy of coping with risks and crises, e.g., certain forest products, such as edible plants, may not be generally exploited in other than crisis situations or when market and subsistence incomes are lower than normal. Assets in general provide a means of coping with risks to which the poor are especially vulnerable: climatic change, political events, pest invasions, crime, and illness.[47]

The role played by environmental capital in the incomes of the poor is illustrated here with evidence from four ecosystems: agro-ecosystems, forests, coral reefs, and mangroves.

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[44] The relevant literature is, however, fairly modest in size. For a recent review, see Beck and Nesmith (2001). The links between forest environmental income and income are thoroughly reviewed in Vedeld et al. (2004).

[45] For example, Narain et al (2005), Cavendish (2000) and Fisher (2004).

[46] Net incomes would be incomes minus the costs of generating the income – food, shelter, tools, etc. The role of children as assets is then clear since they act as unpaid labor.

[47] The role of assets as insurance against risk is stressed in Dercon (2005).

Agro-ecosystems

The high dependence of developing countries on agriculture is well known. It accounts for some 24 percent of GNP in low-income countries, 9 percent in middle-income countries and only 2 percent in high-income countries.[48] In Africa, some 90 percent of agricultural output comes from small-scale producers. Some 600 million poor people keep livestock, an important source of wealth. Tens of millions of poor people fish coastal and inland fisheries. And around 1 billion of the world's poor rely on forests for income or income supplements.[49]

Within the farm and fisheries sectors, three groups of the poor are likely to be heavily dependent on the assets embodied in agro-ecosystems: small-scale farmers, transhumant pastoralists and artisanal fishermen.[50] The empirical evidence for this dependence is mixed, however. These groups are likely to have less opportunity for non-farm, non-fishery incomes, i.e., the less poor have a more diversified portfolio of income sources.[51] This relationship appears to hold for Africa, but elsewhere the relationships are either ambiguous (Asia) or negative (Latin America – non-farm income gets larger for poorer households). But the general picture is that the poor frequently face barriers to entry to the non-farm sector, barriers that themselves largely arise because of the low asset base of the poor – i.e., the absence of resource rights and access to credit and insurance. If so, it might be expected that the poor have a strong incentive to invest in capital assets since they have few or even no alternatives for coping with the risks of climate variability and other shocks to agricultural production. But this incentive is then strongly constrained by limited assets – lack of cash, lack of access to credit, poor resource rights, lack of insurance, etc.

Forests

Several studies have measured the role that forest ecosystem services play in generating income. According to the Millennium Project, nearly 1.1. billion people depend on forests for their livelihoods.[52] Another major study concludes that:

> "The omission of forest environmental income in national statistics and in poverty assessments leads to an underestimation of rural incomes, and a lack of appreciation of the value of the environment. In areas where environmental income is important, this omission may also lead to flawed policies and interventions."[53]

The latter study concludes that the average annual forest environmental income across the 54 cases they studied was $678 per household, equivalent to 22 percent of total household income. The remaining fractions are 37 percent from agriculture and 38 percent from off-farm activities. Of course, this does not mean that the income of the poor is everywhere supplemented by 22 percent: (a) the estimates are an average of very location-specific studies and (b) some of the income is already included in conventional measures of household income. Nonetheless, the data show the importance of forests as sources of income.

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[48] World Bank (2004).

[49] World Resources Institute (2005).

[50] Ekbom and Bojö (1999)

[51] Reardon et al. (2000)

[52] UN Millennium Project (2005).

[53] Vedeld et al. (2004).

Table 3.4 shows some of the more detailed results. Fuelwood and wild foods dominate the income flows, making up some 70 percent of all forest environmental income. The importance of forest income to total income shows some variation, being lowest for East Africa (16 percent) and highest for Latin America (35 percent). The analysis contains no information on whether the uses studied were sustainable: For example, there can be no presumption that the collection of non-timber products is managed on a sustainable scale. It is well known that high natural resource dependence in a context of *de facto* open-access can lead to rapid overexploitation of resources. In the Congo Basin, for example, bush-meat makes a major contribution to household protein intake, but the rate of harvest is threatening wildlife stocks.[54] Box 3.4 provides a case study of non-timber forest income showing how the benefits are divided among primary producers, intermediaries and retailers. A number of studies document the way in which sales of forest assets help to finance farm inputs and investments.[55]

Comparable meta-studies for most other ecosystems, which contain information on income group dependency, appear not to exist.[56] Resorting to reviews and individual case studies is therefore unavoidable.

Table 3.4 Sources of forest environmental income

Source	Value ($) per household per year	% of total forest environmental income
Wild foods	286	38
Fuelwood	216	32
Fodder	123	6
Timber	28	2
Grass/thatch	83	5
Medicine	47	4
Gold panning	6	Neg
Other	129	13
TOTAL	678	100

Source: Vedeld et al. (2004), Table 4.2. Figures rounded.

[54] Fa et al. (2003).

[55] E.g., Barrett et al. (2001), Fisher (2004), Takasaki et al. (2004).

[56] A "meta-study" is a study of studies, i.e., a statistical analysis of many studies that attempts to explain common results and variations in those results. There are at least three meta-studies of wetlands: Brander et al. (Forthcoming), Brouwer et al. (2003) and Woodward and Wui (2001). The latter two do not contain any information on the income distribution of the beneficiaries of wetland services, and both deal with wetlands in OECD countries only.

Box 3.4 Non-timber forest incomes in Senegal

A detailed study of non-timber forest products in Senegal showed that, at a minimum, unrecorded sales of these products would add around $6 million to Senegal's national income, the sum being about 14 percent of the recorded value added in the forest sector in 2000. The value of forest products exceeds this because fuelwood, charcoal and building materials are also produced, but their value is already recorded in the national income accounts. Although many studies have estimated the produce derived from forests, few detail who the beneficiaries are. In this study, careful analysis showed that 52 percent of value added accrued to rural households ("producers"), about 38 percent to intermediaries (12 percent to ambulant traders and 26 percent to wholesalers) and 10 percent to retailers. Non-timber products thus matter substantially for rural incomes, a finding in keeping with the meta-study discussed in the main text. How far the harvesting of the various products (ranging from honey and tamarind through to palm oil) is sustainable is open to question. There is evidence of some local controls, and there is a strong preference for local community management, but there are also conflicts over some of the resources. Effectively, the existing resource-rights regime hovers between open access and common property, potentially placing the resources at risk of overuse.

Source: Bishop and Garzon (2003)

Coral reefs

Reviews of the economic values of coral reefs show that poor households secure substantial parts of their income, up to 100 percent, from fishing.[57] In many cases, however, they do so through the use of unsustainable harvesting methods such as poison and blast fishing. Coral mining can also generate relatively higher incomes than fishing but is again destructive to the reef. What is a benefit to individuals (the "private benefit") is then a loss of alternative income and other benefit flows to society as a whole. In Indonesia it is estimated that poisoning and blast fishing might generate incomes of $15,000 to $33,000 per square kilometer of reef area but at a cost of $40,000 to $750,000 per square kilometer from forgone activities – sustainable fisheries, tourism and environmental protection. Thus, high resource dependency combined with unsustainable resource management produces a familiar story of short-run resource exploitation. Assets that are potentially infinitely available last only a few decades, as data on reef destruction show. The implications for poverty alleviation policies are formidable: There has to be an understanding of why resource users opt for short-term gains over sustainable alternatives. Without this understanding, policy measures will risk failure. The explanations, to be explored in Chapter 7, center on property rights, obstacles to collective management – especially absent or weak institutions, and factors that engender high discount rates.[58]

[57] Cesar (2000) and IMM (2002).

[58] The discount rate measures individuals' preferences for benefits now rather than benefits later. Chapter 4 shows that the discount rates of the poor are very much higher than those of the rich – far less importance is attached to the future. The effect strongly favors resource "mining," i.e., rapid exploitation of a resource such as the forest or coral reef.

Mangroves and wetlands

Many mangroves are being converted to fish farms or are drained for land reclamation. Yet their ecological services are heavily relied upon by the poor. Direct uses of the mangroves include fisheries, transport, timber and fuelwood. Indirect uses include storm protection, erosion control and water filtration. There are also complex linkages that add to the direct and indirect economic values of the mangroves, for example, their role as a breeding ground and nursery for offshore fisheries.[59] A study of mangrove benefits in Cambodia shows that fuelwood, charcoal, fishing and construction materials added between 20 percent and 58 percent to other incomes, and yet the mangroves are under threat from unsustainable shrimp production, with shrimp farms typically being abandoned after only a few years of operation.[60] A study of a Ramsar wetland site in Cambodia revealed the substantial benefits to local communities from fisheries, water supply, transportation, poles and fuelwood, wild animals and plants, floodplain rice and recreation. These benefits averaged $3,225 per household per year. Significantly, the poorer parts of the communities relied more heavily on fisheries income.[61] The only available meta-study of wetland economic values that includes tropical wetlands suggests that wetland values (a) rise with income, (b) rise with population density, and (c) are high in Africa and Australasia relative to other regions. The highest economic value is associated with water quality.[62]

The analysis reveals that the poor depend on environmental capital to a considerable extent, with in-kind and salable products amounting to upward of an additional 20 percent of incomes. The most detailed analysis of this resource dependency exists for forests, but the case study evidence for coral reefs and mangroves tells a similar story. In all cases, however, the ecosystems that generate this additional income are under threat from unsustainable exploitation by the poor themselves, through exploitation by "rent seekers," from pollution, and because of natural disasters. In some cases, the poor can be excluded from access to environmental assets through measures of environmental protection, e.g., protected areas. The obvious implication is that patterns of resource use have to be changed toward sustainable ones, and, where possible, conservation measures must be associated with the sharing of benefits by the poor.

This story of limited access to assets is not confined to environmental assets, the focus of the current report. (Box 3.5 reveals a similar story for infrastructure.)

[59] Barbier et al. (2002).

[60] Bann (2002).

[61] IUCN (2005).

[62] Brander et al. (Forthcoming).

Box 3.5 The poor and access to infrastructure assets

A detailed study of access to infrastructure assets in 15 countries in Asia, sub-Saharan Africa, Eastern Europe/Central Asia and Latin America/Caribbean found that the rural poor systematically had less access to electricity, in-house water, sewers and telephones than the urban poor.[63] Urban access to electricity in three SSA countries averaged 30 percent to 40 percent for the poor, but rural access was 0 percent to 8 percent. Urban access to electricity in Latin America and the Caribbean was 55 percent in Jamaica but 92 percent in Ecuador. Rural access ranged from 2 percent (Panama) to 63 percent (Ecuador). Urban in-house water supplies ranged from 23 percent to 44 percent in Latin America/Caribbean but only 2 percent to 7 percent for rural dwellers. Although up to 50 percent of households have telephone connections in the East European countries, the rural fraction outside of East Europe ranged from only 0 percent to 10 percent (although Panama had 20 percent).

The analysis confirms the view that the rural poor fare far worse than the urban poor in access to infrastructure. In other respects, some of the proportions appear surprisingly high, e.g., the fraction of urban poor with electricity. The absence of access to formal infrastructure means that the poor either seek other substitutes – notably biomass as fuel and water from vendors – or simply go without. The difference between relatively rich and relatively poor in rural areas makes little difference to the use of biomass fuels. But "rich" and "poor" differ markedly in their use of these fuels in urban areas, the rural poor using far more of these resources.

3.8 Poverty and environmental quality

If the environmental capital upon which the poor depend were plentiful, used sustainably, and were not threatened by other forces, there might be little concern over the environment-poverty link. In that case, efforts could be directed at the non-environmental factors that keep the poor in low incomes. But this is not the situation.

- First, environmental capital has been demonstrated to be an important component of the wealth of the poor. Access to natural resources acts as a complement to wealth, as a means of "smoothing" consumption, and as a means of coping with crises, such as drought.

- Second, the environmental capital available to the poor is often under threat and without ready substitutes. For example, vanishing sources of fuelwood cannot be substituted by kerosene if kerosene is unaffordable.

- Third, what environmental capital the poor have may also be of low quality – for example, poor soils, poor air quality in urban areas, poor indoor air quality in rural areas, poor water quality and disproportionate exposure to risk from natural disasters. This quality dimension may matter as much as the quantities of resources to which the poor have access.

[63] Komives et al. (n.d).

Rigorously researched evidence for this final feature of the "poverty-environment nexus" is not extensive and is only now beginning to emerge. Far more needs to be known. Because the linkages are so complex, it is highly likely that what holds in one location may not hold in another.[64] Nonetheless, some fairly robust evidence can be marshalled regarding the quality of environmental assets available to the poor.

Where the poor live

Table 3.5 summarizes available evidence on the percentage of people living on fragile lands – land generally unsuitable for intensive agriculture but where the links to the land are critical for the sustainability of local communities and for natural resources. Around 1.4 billion people exist on these lands, with the share of total population being nearly 40 percent in sub-Saharan Africa, the Middle East and North Africa.

Table 3.5 People living on fragile lands

Region	Population on fragile land (millions)	Share of total population (%)
Latin America and the Caribbean	68	13
E Europe and C Asia	58	12
M East and N Africa	110	38
Sub-Saharan Africa	258	39
S Asia	330	24
E Asia and Pacific	469	25
OECD	94	11
Other	2	7
Total	1389	25

Source: World Bank (2003). Fragile lands are defined as lands with limited ability to sustain growing populations and include arid lands, significantly sloped land, lands with poor soils, and forest lands. See World Bank (2003, Table 4.1).

Evidence from "poverty mapping" (see Box 3.6) confirms that the poor tend to reside in areas with one or more of features of degraded land, land of naturally low soil fertility, air and water pollution, and limited access to water. A detailed study of three countries suggests that the poor in Cambodia suffer higher exposure to indoor air pollution, poor access to water, and face ecological soil fragility. Deforestation affects the general population, the poor included. In Lao PDR the quality of environmental capital is even worse, extending to indoor and outdoor air pollution, deforestation, poor water quality and poor soils. In Vietnam, the same study suggests that the poor are especially affected by fragile soils and indoor air pollution. In respect to other environmental capital, policy interventions have already done much to reduce the problems.[65] This study suggests that the true

[64] This feature is stressed in Dasgupta et al. (2005).

[65] Dasgupta et al. (2005).

picture may be location specific, not least because many other factors may be at work, worsening or ameliorating poverty.

Box 3.6 Poverty maps

A major effort to construct poverty maps in association with geographical information systems will do much to clarify the nature of the poverty-environment nexus. A poverty map attempts to show the geographical distribution of the poor using income indicators or some other poverty measure (e.g., nutritional status of children). The poverty map can then be overlaid with indicators of various forms of assets, e.g., infrastructure, air quality, water quality, soil fertility, biodiversity, and so on. Statistical techniques can be used to show correlations between asset endowments and poverty. If maps can be constructed for different time periods, then "dynamic" relationships can be tracked to see, for example, how environmental assets change in quantity and quality through time. Hypotheses can be formed about causal connections. Maps have visual appeal, so that information which might otherwise appear in less readable tabular form can be presented in a more intelligible manner. The higher the spatial resolution of the maps, the more targeted that policy responses can be. One lesson emerging from case studies is that policy measures may need to be very location specific, making broad-brush poverty reduction measures less efficient than geographically targeted ones. To date, maps are beginning to show the detailed interactions between poverty and reliance on ecosystem services. Some maps also show ecosystem "disservices," such as the damage done by wild animals such as elephants.[66] Maps can help guide policy-makers to areas where ecosystem capital should be built up in order to expand the asset base of the poor, while at the same time securing a better understanding of the interactions between poverty and the environment.

Box 3.7 shows that the urban and rural poor face similar resource scarcity and pollution threats. But whereas the urban poor are more distanced from natural resource degradation, they face additional threats from overcrowding, fire risks, exposure to waste hazards, disasters and violence. Their security of tenure is often worse too.

[66] See IUCN (2004).

Box 3.7 Urban and rural risks facing the poor

Risk	Rural	Urban
Air pollution		
Indoor	HIGH	MODERATE
Outdoor	LOW	HIGH
Water pollution/sanitation	HIGH	HIGH
Waste		
Municipal	LOW	HIGH
Hazardous	LOW	MODERATE
Overcrowding	LOW	HIGH
Fire risks	LOW	MODERATE
Natural disasters	LOW	HIGH
Violence	LOW	MODERATE
Accidents	LOW	HIGH
Insecurity of tenure	MODERATE	HIGH

Disability Adjusted Life Years

The World Health Organization has developed an indicator that combines life expectancy and the health quality of a year lived: the Disability Adjusted Life Year (DALY).[67] One measure of the burden of morbidity and mortality due to disease and accidents is then the *loss of* DALYs. Another way to think of this is the depreciation of human capital due to reduced health and life expectancy. Table 3.6 summarizes the number of DALYs lost due to various *environmental* causes. Environmental causes are thought to be involved in just under 20 percent of developing country DALYs, compared to about 4 percent in developed countries.[68] Unfortunately, the spatial resolution of the DALY database remains very broad, for example, only some of the larger single countries are listed separately.

[67] The construction of DALYs involves numerically lengthy procedures. See Murray and Lopez (1996).

[68] Lvovsky (2001),

Nonetheless, the significant difference in environmental DALYs in poor relative to rich regions is clear. Poor water quality and lack of sanitation account for nearly 40 percent of all environmentally induced DALYs in developing countries, and around 7 percent of all-cause DALYs, underlining the dominant role that water plays in disease transmission. Second, poor water quality ranks first as an explanation of environmentally induced DALYs in India and sub-Saharan Africa, while urban air pollution is marginally more important in China.

Table 3.6 Breakdown of environmentally induced loss of DALYs (c2000). Million DALYs and percentages of all DALYs.

DALYs: million and (%) of all DALYs	Developed economies	Developing economies	China	India	Sub-Saharan Africa
Water and sanitation	1.0 (1.0)	83.3 (7.0)	7.0 (3.5)	22.5 (9.0)	31.8 (10.0)
Vector diseases (malaria)	0	35.7 (3.0)	0	1.3 (0.5)	28.6 (9.0)
Indoor air pollution	0	47.6 (4.0)	7.0 (3.5)	15.0 (6.0)	17.5 (5.5)
Urban air pollution	1.0 (1.0)	23.8 (2.0)	9.0 (4.5)	5.0 (2.0)	3.2 (1.0)
Agro-industrial waste	2.5 (2.5)	11.9 (1.0)	3.0 (1.5)	2.5 (1.0)	3.2 (1.0)
Total environmental causes: million DALYs*	4.5	202.3	26.1	46.3	84.3

Source: adapted from data in Lvovsky (2001), Fox (2003) and World Bank Web page – www.worldbank.org . Slightly higher losses – 53 million – due to indoor air pollution are reported in von Schirnding et al. (2002).

Note: * totals may differ from sum of components due to rounding.

There are strong links from environmental damage to the loss of human capital. One study estimates health costs for six different developing countries and East European cities and produces an implied value of a DALY of some $11,100.[69] Adopting that value for developing countries alone would produce a global estimate of human capital damage due to environmental causes of over $2 *trillion* per annum. Using a more conventional income per capita value for developing countries, the total loss of DALYs in the developing world would still be some $200 billion per annum. Even the lower limit suggests a formidable cost to developing economies from environmentally induced disease. For example, $200 billion translates into around $40 per person per annum in the developing world. Treating this as a stream of damages over a 30-year time horizon[70] produces a present value of some $550. This can be compared to human capital estimates for India of some $7,000.[71] *Environmentally induced human capital damage would, on these rough calculations, amount to an 8 percent reduction in the total value of human capital.*

Fuels and indoor air pollution

A third feature of the DALY analysis can also be seen. Although there has been a traditional focus on outdoor air pollution as an environmental health problem, exposure to pollutants indoors accounts for about 20 percent of all environmentally induced loss of DALYs in developing countries. The poor tend to rely heavily on energy-inefficient fuels, such as fuelwood, biomass and animal waste.[72] An estimated 2.4 billion people burn biomass for cooking and heating.[73] The resulting indoor air pollution is thought to result in considerable premature deaths and extensive morbidity – at least 1.6 million children and women are thought to die each year from indoor smoke pollution, half of these in China and India alone.[74] Health conditions associated with indoor air pollution include acute lower respiratory infections in children, chronic bronchitis, chronic obstructive pulmonary disease, some forms of cancer, cataracts, TB, low birth weight, perinatal mortality, otitis media, cardiovascular disease and asthma.[75] Table 3.7 shows excess child mortality ascribed to indoor air pollution. Again, the poor have marked mortality compared to the estimated zero deaths in rich countries. The rural poor fare far worse than urban dwellers due to their greater reliance on biomass fuels (see Table 3.8).

[69] Lvovsky (2000).

[70] At a 6 percent discount rate.

[71] Hamilton et al. (2005).

[72] Again, there are geographical variations and in some countries the poor use both biomass fuels and commercial fuels such as kerosene, LPG and electricity. The picture varies according to the availability and use of fuels – e.g., electricity for lighting and appliances, wood for cooking.

[73] Warwick and Doig (2004).

[74] International Energy Agency (2004).

[75] von Schirnding et al. (2000).

Table 3.7 Excess mortality due to indoor air pollution: under-5 mortality and adult female mortality

Region	Excess risk: under-5 mortality		Adult female deaths as % of under-5 deaths
	Urban %	Rural %	%
China	15	35	40
E.Asia/Pacific	15	35	15
Market economies	0	0	0
Former socialist	7.5	17.5	15
India	15	35	15
L.America/Caribbean	7.5	17.5	15
Middle East	7.5	17.5	15
S.Asia	15	35	15
Sub-Saharan Africa	7.5	17.5	15

Source: Hughes (2002)

High dependence on biomass fuels and indoor cooking contributes to the general income inequality of risks. Cross-country comparisons show clearly that infant mortality declines as household incomes grow. Much of the decline is due to better education, higher consumption of food, and a higher "demand" for and provision of basic sanitation and water.[76]

[76] E.g. Wagstaff (1999).

Table 3.8 Reliance by the poor on biomass fuels: percent reliance by the poorest and richest deciles

Country	Urban areas		Rural areas	
	Poorest 10%	Richest 10%	Poorest 10%	Richest 10%
Cote d'Ivoire	92	4	100	94
Ghana	69	20	100	82
Nepal	85	4	100	86
Nicaragua	95	28	99	87
Vietnam	88	27	99	88
Ecuador	13	0	56	22
Panama	10	0	99	11
South Africa	7	0	84	4

Source: Whittington et al. (2001)

Deforestation

On the basis of the environmental capital argument, if deforestation occurs, the poor are likely to suffer most from this resource loss. A comprehensive review of the various quantitative models that seek to explain deforestation concluded that low rural wages tend to be correlated with deforestation but that poverty generally was not clearly correlated with deforestation.[77] As indicated previously, if the links between poverty and resource loss are location specific, aggregate studies of deforestation may well obscure the exact nature of the poverty-environment nexus. A study of Mexico that used detailed *municipio* data found that, along with other factors, poverty was correlated with deforestation.[78] The only available meta-analysis of deforestation assembles some 152 studies of deforestation and indicates that poverty is cited as a causal factor in just over 40 percent of them, but the study does not assess the reverse sequences, i.e., that deforestation causes poverty.[79] Poverty tends in turn to be associated with higher than average population growth and population densities, and many studies find that there are also coexisting policy measures which encourage deforestation. Two thirds of the cases where poverty is important are associated with insecure or non-existent property rights. In short, the poor are agents of deforestation in a sizable minority of studied cases but not in the majority of cases. Care has to be taken in stating even this result: Being an agent of deforestation is quite different from being "responsible" for deforestation. Responsibility implies that an alternative course of action is feasible, and invariably this is not the case for those who practice slash-and-burn agriculture, for example. This explain some of the current emphasis on the policy of "paying for environmental services" (see Section 7.8) whereby those who benefit from

[77] Kaimowitz and Angelsen (1998)

[78] Deininger and Minten (1999).

[79] Geist and Lambin (2001) and Lambin et al. (2001)

forest conservation pay those whose options are limited to deforestation activities to switch into alternative land uses. The payments constitute the factor that enables the resource users to expand the range of options open to them.

Bushmeat

A large number of rural and urban dwellers rely on bushmeat for protein. Detailed information on hunting effort is often difficult to come by, due to the fact that hunting tends to be a mix of legal and illegal activities. Illegal activity occurs when there is a wholesale ban on hunting, when some form of licensing occurs but most hunters operate without a license, or when bush-meat is taken illicitly from protected areas. Sales of bush-meat can be an important source of supplementary income. Willingness to pay for bush-meat is often strong, either because the meat is preferred to that from domesticated animals or because bush-meat prices are lower than domesticated meat – despite often strong local demand. The problem with much hunting, however, is that the resource is effectively an "open access" one, unregulated and, hence, at risk of extinction. The vulnerability of the resource thus places household livelihoods at risk while simultaneously risking dramatic resource loss.

Evidence of the relationship between poverty and bushmeat consumption is limited. A number of studies have found that the importance of bushmeat in household consumption does not decline as income grows, suggesting that factors such as taste and variety may be important.[80] But at least one study, for Bolivia, has found the opposite relationship, with bush-meat consumption declining as incomes grow.[81] The income-consumption relationship is potentially important for policy. If bushmeat is a "normal" good – where consumption grows as income grows – then reducing poverty will have little effect on levels of hunting. If it is an "inferior" good – where consumption declines as income grows – anti-poverty measures could secure a "double dividend," reducing poverty and conserving the resource at the same time. Regulating the trade may save the resource but will tend to have disproportionate effects on poor households. In that case, regulation will have to be accompanied by measures to offset household losses. Efforts so far have tended to concentrate on encouraging the farming of domesticated species, but this has not always been successful.

Energy

Self-evidently, energy is a vital resource if poverty is to be reduced. A study of economic growth in selected developing countries shows that energy contributes significantly to GDP growth at the intermediate stages of development (Brazil, Korea, Mexico, Turkey – where energy's contribution is up to 77 percent of growth) but is still significant at the early stages of developments (up to about 20 percent – China and India).[82] This is as expected, since industrialization calls for significant energy consumption. But low energy assets inhibit growth and development. Countries with low scores on United Nations Development Programme's (UNDP) Human Development Index[83] have low primary energy consumption per capita. Very few countries with less than two tons of oil equivalent per capita per annum achieve a high Human Development Index score. In countries where more than 75 percent of the population receives less than $2 per day income, energy consumption (biomass plus commercial) is around 0.4 tons of oil equivalent (toe) per capita. As the percentage poverty indicator falls to

[80] Wilkie et al. (2004).

[81] Godoy et al. (2005).

[82] International Energy Agency (2004).

[83] The Human Development Index (HDI) averages each country's achievements in life expectancy, education and GDP relative to other countries' performances. A high score (maximum is unity) indicates high human development. A low score indicates low human development (UNDP, 2004).

40 percent to 75 percent, energy consumption rises to about 0.8 toe, and at 5 percent to 40 percent it rises to over 1.5 toe.[84]

As with others forms of assets, the quality of the capital matters as well as the quantity. Electricity and other modern fuels permit flexibility of location, enable transportation to be undertaken more easily, and generally improve household well-being. Life expectancy, schooling and nutrition are all directly correlated with the use of modern fuels. Reliance on biomass fuels using traditional combustion methods perpetuates the poverty trap. Fuels have to be collected and carried, with harmful effects on health, and especially women's health. As resource degradation occurs, collection times increase, exacerbating the heath effects but also displacing time that would otherwise be spent in production or leisure. The burning of dung and crop residues diverts them from being used as mulch and fertilizer, lowering agricultural productivity. Vicious cycles of this kind have been documented in a number of case studies.[85] Human Development Index scores rise very rapidly at low levels of development as electricity consumption increases. More than 1.6 billion people in developing countries have no access to electricity, two-thirds of them in Asia, nearly one-third in Africa. Excluding China, the number without electricity has actually risen since 1990.[86] An index of energy development – reflecting per capita consumption of commercial energy, the share of commercial energy in all energy consumption, and the share of population with access to electricity – is clearly correlated with the Human Development Index, again with the highest response of development to the energy index occurring at the lowest Human Development scores.[87]

The message is that investments in both the quantity and quality of energy for the poor substantially improve the chances of poverty reduction.

Water

As for energy, so with water. Those with access to safe water and sanitation enjoy more rapid increases in income.[88] One report suggests that countries with low incomes (below $750 per annum per capita) and with access to safe water and sanitation grew on average at 3.7 percent per annum, whereas countries with the same per capita income and limited access grew at only 0.1 percent per annum.[89] The same study estimates that policies aimed at reducing water-related diseases could save 330 million DALYs in a single year – 2015. Valuing a DALY at $563, based on the potential average low-income country per capita income in 2015, a single year's benefits would be worth $186 billion.

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[84] International Energy Agency (2004). A very similar picture is found in United Nations (2005b).

[85] E.g., for Ethiopia see Newcombe (1989).

[86] International Energy Agency (2004).

[87] Correlations do not indicate causation, as development occurs more energy consumption is induced, so the directions of causation are both ways from development to energy and energy to development.

[88] World Bank (1994), especially Figure 1.2.

[89] Sachs (2001).

Solid and toxic waste

In many respects solid and toxic waste is the neglected environmental hazard in developing countries. Collection systems in urban areas are often inefficient, while generally being non-existent in rural areas. The resulting health hazards take on several dimensions:[90]

- Since only a fraction of generated waste may be collected, waste is often left in heaps in open pits, by the roadside, in drains and ditches, which act as breeding grounds for mosquitoes and vermin, spreading disease;

- Uncontrolled waste may leach into water supplies, contaminating drinking water;

- Where there are landfill sites, the poor often act as scavengers looking for anything with economic value, but being exposed in the process to the risks associated with sorting through harmful waste. There are costs and benefits here: scavenging is highly labor-intensive and creates employment. The health risks are obvious.

The comparatively rich can avoid these risks, but the poor in general cannot. No estimates appear to exist that relate exposure to waste to human health impacts.

Global warming

The available economic studies of economic damage from climate change are consistent in showing that, relative to their income levels, the poor will lose far more than the rich. Measuring global warming damages in money terms is controversial. Moreover, because of the convention of measuring damages at a fixed point in time – identified as the time when atmospheric concentrations of greenhouse gases are roughly twice those of their pre-industrial level (say, mid-18th century) – a somewhat misleading impression is given that warming beyond that level creates no further damage. But "2 x CO_2" is simply a benchmark. If emissions are not checked, warming would continue beyond that period. Table 3.9 shows the results from some of the main economic models.

Table 3.9 reveals a wide range of impacts, some of them suggesting that the world as a whole might actually gain from warming. However, impacts in developing countries, with the possible exception of China, are negative. Thus, the economic models confirm the wider view that those who will lose most will be in the poorer countries of the world. This is as would be expected: Large populations are involved, many of these people are engaged in climate-vulnerable agriculture, many inhabit vulnerable low-lying deltaic and island areas, and many have limited capability to adapt to changing climate. By and large, the combined economic and science models omit major "catastrophic" events, such as large ice melts, reversed gulf streams and wholesale destruction of the bases for entire communities. Gradually, a literature is emerging that attempts to take some of these impacts into account, but in the meantime the models may seriously understate true damages. Box 3.8 outlines one, somewhat controversial, study that attempts to place global warming risks in the wider context of risks generally. It suggests that global warming control may be a lower order priority compared to other concerns, but there is room for debate.

[90] Pearce and Turner (1994).

Table 3.9 Estimates of global warming damage for a doubling of atmospheric concentrations. Percentage of GNP.

	Pearce et al. 1996	**Mendelsohn et al, 1996**	**Nordhaus and Boyer, 2000**	**Tol, 2002**
Benchmark temperature increase for $2xCO_2$ (_)	2.5°C	1.5°C 2.5°C	2.5°C	1.0°C
Developed Countries	n.a	+0.12 +0.03	- 0.5 to +0.4	
EU-15				+3.7
USA				+3.4
Japan				+1.0
Lesser Developed Countries	n.a	+0.05 - 0.17		
China			-0.2 to - 4.9	+2.1
India			-0.2	-1.7 (S.Asia)
Africa			-3.9	-4.1
World	-1.5 to -2.0	+0.10	-1.5	+2.3

Note: + indicates a benefit, - a cost (damage). The convention in these studies is to show damage relative to the size of *current* GNP, the exception being the study by Mendelsohn, which shows damage as a fraction of GNP at the time of atmospheric CO_2 concentration doubling.

More detailed assessments of impacts are obviously problematic given the spatial resolution of climate models. Numerous studies of region-wide impacts confirm the conclusion that the poor suffer most from climate change. Impacts vary with the level of adaptation. Adopting different assumptions about adaptation, one study finds that the loss of GDP in Africa in 2050 might range from 11 percent (no adaptation at all) down to 2 percent (maximum adaptation) and for Asia from 6 percent down to 0.4 percent.[91]

One study has looked in detail at the impacts of climate change on rural incomes.[92] The study compares the United States and Brazil and finds that climate has an impact on agricultural productivity, which in turn affects rural income. Significantly, the effects are more severe in rural Brazil than in rural United States.

[91] Winters et al. (1998).

[92] Mendelsohn et al. (2004).

Also, there is a clear link to assets through the value of land: Higher incomes are capitalized into higher values of land, and conversely, as climate change reduces productivity and incomes, so land asset values fall. There is then a further link in poorer regions since lower land values further reduce the access to other forms of capital, e.g., access to credit and technology.

The authors conclude:

> "…less productive climates lead to increased poverty. Climate clearly plays a role in determining rural poverty. It is simply more difficult to make a living in rural places that are less productive. This is evident even in the United States which has plenty of access to capital and modern technology."[93]

The same distributional pattern – that the poor will suffer more than the rich – emerges from analyses of natural disasters, many of which can be expected to increase as global warming increases. Although the number of incidents is not very different between rich and poor countries, the rich suffer far less than the poor, as measured by mortality, because of the greater adaptive capacity of the rich.[94]

Box 3.8 The "Copenhagen consensus" and global warming

One widely reported exercise claiming to use cost-benefit analysis to rank global problems is the "Copenhagen consensus."[95] Eight internationally distinguished economists, including three Nobel Prize winners, were asked to rank global issues in their "cost-benefit" ratios, on the basis of detailed expositions of the issues by other experts who in turn were asked to indicate such ratios. The notable result was that, out of 17 issues, those relating to global warming were at the bottom of the list (15,16 and 17). Moreover, the implied benefit-cost ratios for controlling climate change were described as "bad." Controlling HIV/AIDS, addressing malnutrition and hunger, subsidies and trade issues and communicable diseases occupied the first four places. The implication is that the control of global warming is, at the very least, not an issue to be tackled now, if in so doing it displaces resources for higher priority actions.

The exercise is an interesting one, but how valid is it as an indication generally of the priority given to global warming?

- However distinguished the experts, their views are exactly that – those of experts and not of the population at large.
- Cost-benefit analysis does not function with expert values – it requires knowledge of people's preferences.
- Many would argue that global warming will have the very largest impact on the world's poor: addressing malnutrition and hunger is not facilitated by neglecting global warming control.

Although those impacts will be in the future, delaying action does nothing to help the poor since future harm can only be addressed by action now, due to the long time lags in the climatic system.

[93] Mendelsohn et al. (2004).

[94] See, for example, Kahn (2003).

[95] Lomborg (2004).

Finally, some efforts have been made to derive indicators of people at risk from climate change impacts. Table 3.10 shows some possible outcomes in malaria and water shortage, impacts very largely confined to the poorest countries of the world. The alarming numbers relate to water shortages, the suggestion being that an additional 3 billion people would face water problems, or perhaps 40 percent of the world's population at the time. These are "business as usual" estimates, i.e., there is no climate mitigation and no adaptation.

Table 3.10 Numbers at risk from climate-induced malaria and water shortage

Temperature increase	Additional people at risk from malaria and water shortage (millions)			
	2050		2080	
	Malaria	Water	Malaria	Water
+1°C	160-230	1250-2250 2100-3000	-	-
+2°C	200-260	-	225-280	2750-3250
+3°C	-		270-340	3000-3500

Source: Parry et al. (2001).

3.9 Gender, poverty and the environment

Poor households suffer disproportionately from environmental degradation and natural resource scarcity. But within the household, there is also likely to be asymmetric effects between men and women. Women tend to bear greater losses than men. Why?

There is a division of labor within the household. In rural households, women tend to collect water and fuelwood. As resources become more and more scarce, so greater distances are walked by women. Return journeys carrying heavy loads take a heavy toll on women's health. There are also direct impacts on productivity as time is diverted from farming and other activities, including child care.

Women are typically responsible for food preparation and , therefore, tend to suffer the effects of indoor air pollution more than men. Women also have more contact with water than men, so that their exposure to contaminants tends to be greater than men's.

Rural men are more likely to seek off-farm employment, leaving women to manage the household and any land. Women and children , therefore, tend to be the first to bear the burden of land degradation. Women may be less eligible for formal credit than men, and in some societies women are not entitled to own land or other resources. In other countries, where ownership is permitted, the death of the husband may result in the wife being dispossessed in favor of any male heirs.

In high-population growth countries, women spend a disproportionate amount of their lives bearing children. The "time cost of reproduction" refers to the percentage of time an adult woman spends in reproduction. Taking childbearing age to be 15 to 49, means 34 potential childbearing years. If six children each take up 1.25 years for pregnancy, birth and breast-feeding, then 7.5/34 = 22 percent of adult life spent in reproduction, and this excludes failed pregnancies.

Women may also have unequal access to education: When a choice has to be made because of schooling costs, the male child is often preferred. The resulting human capital is thus gender biased. Lower social status may also mean that women's "voices" are heard less because of the barriers to speaking at local meetings, and the lower level of importance that may be attached to female opinion.

If women bear disproportionate burdens from loss and degradation of environmental assets, they have nonetheless shown themselves to be very resilient in many societies, increasingly asserting their rights to be heard and to have their views taken into account. But, just as wealth accounting needs to document assets at the household level, so it will be necessary also to show how that wealth is divided between men and women within the household.

3.10 The "resource curse"

Nations that are poor in income may nonetheless be relatively rich in natural wealth. Examples include those poor nations that have substantial mineral, oil or gas deposits. A curious feature of these countries is that, despite their wealth, their rates of income growth have generally fallen behind those of less resource-rich countries.[96] This has generated the notion of a "resource curse": the idea that having more natural wealth is a disadvantage rather than an advantage. Various explanations for this phenomenon have been advanced, ranging from the effects of this wealth on external exchange rates and the competitiveness of non-resource industries, through to the low human capital intensity of primary resource industries, to the "rent creation" effect whereby resources produce windfalls of wealth, which encourage the wasteful use of such resources. Rules for the prudent management of such resources have usually not been followed, with the consequence that economic performance has suffered, producing the resource curse effect.[97]

In so far as the resource curse arises from the failure to manage natural wealth efficiently, resource-rich, income-poor countries fail to exploit their potential for raising incomes and, hence, to some extent, the incomes of the poor. Efficient management will benefit the poor provided reinvestment is in the form of assets to which they can secure access – especially health, education and infrastructure, but also natural wealth. To get some idea of the scale of the cost of mismanaging natural resources, efforts have been made to construct a "counterfactual," i.e., the outcome if the proceeds of resource extraction had been reinvested according to a prudent rule. The results for selected countries are fairly consistent: Republic of Congo, Gabon, Mauritania and Algeria would have at least twice the level of man-made capital in 2000 had they followed such a rule; Trinidad and Guyana would have had three times the wealth they actually had; and Nigeria and Venezuela would have had four to fives times their actual 2000 wealth.[98]

Although there can be no guarantee that the poorest parts of the economy would benefit proportionately from careful management of tradable resources, the fact remains that the failure to reinvest the proceeds of natural resource exploitation has come at a considerable cost to resource-rich nations.

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[96] Sachs and Warner (2001).

[97] A summary of the alternative explanations linking resource endowments to poor growth performance can be found in Gylfason (1999). The "prudent rule" usually requires that the rents from the natural resources be reinvested in other forms of wealth, maintaining and even increasing the asset base, as is consistent with the requirements for sustainable development. This reinvestment rule is known as the "Hartwick rule."

[98] See Hamilton et al. (2005) and Hamilton and Hartwick (2005).

3.11 The political economy of resource dependency

Many developing economies are heavily reliant on primary production: e.g., oil and gas, minerals, timber, fish and agricultural commodities. As these economies struggle to expand, so natural resources are depleted and/or converted to other uses (e.g., forests to agriculture). This process of deliberate depletion is often biased against the poor, with the main beneficiaries of the process being the rich and relatively rich. One study refers to this phenomenon as "dualism within dualism."[99] The first dualism refers to the dependence of the national economy on primary product exports. The second dualism refers to the dependence of the poor within the economy on primary products produced on marginal land. The main source of increased output will be land that is converted from environmental uses, such as forests and wetlands. The study found that many economies combine both types of dualism. The first shows up as a high dependency on natural resources for exports. The second shows up as a "20-20" rule, i.e., 20 percent or more of the population lives on fragile lands and 20 percent or more of the rural population lives in absolute poverty. As efforts are made to increase exports, so more land is converted, but the benefits are typically "captured" by the wealthier segments of society, which exploit the rents available from conversion. The poor are often left more marginalized than before, with no option but to expand the frontier of conversion into ever more marginal lands. The overall effect is that the benefits from development are largely appropriated by the better-off while little or no reduction in poverty occurs.

Macroeconomic crises often exacerbate the process. Efforts to deal with such crises usually involve currency devaluation, designed to make exports cheaper to overseas buyers, and imports more expensive. But the poor are often ill-placed to respond to this new set of incentives, lacking credit, information and savings to invest. Large-scale producers are generally better able to cope. The process of expanding output may itself be environmentally damaging, for example, if the crops affected are highly erosive, or if timber is harvested unsustainably. More land will be converted, adding to environmental damage and forcing more poor people onto marginal lands. The rise in import prices will make fertilizers and fuel more expensive, with the burden again falling mainly on poorer producers.

Overall, then, there is reason to suppose that not only do resource-rich countries suffer from a resource curse at the macroeconomic level, but that the resource curse, when combined with dualism within the economy, works especially against the poor.

[99] Barbier (2006).

4 Vicious and Virtuous Circles in The Poverty-Environment Nexus

4.1 A conceptual framework

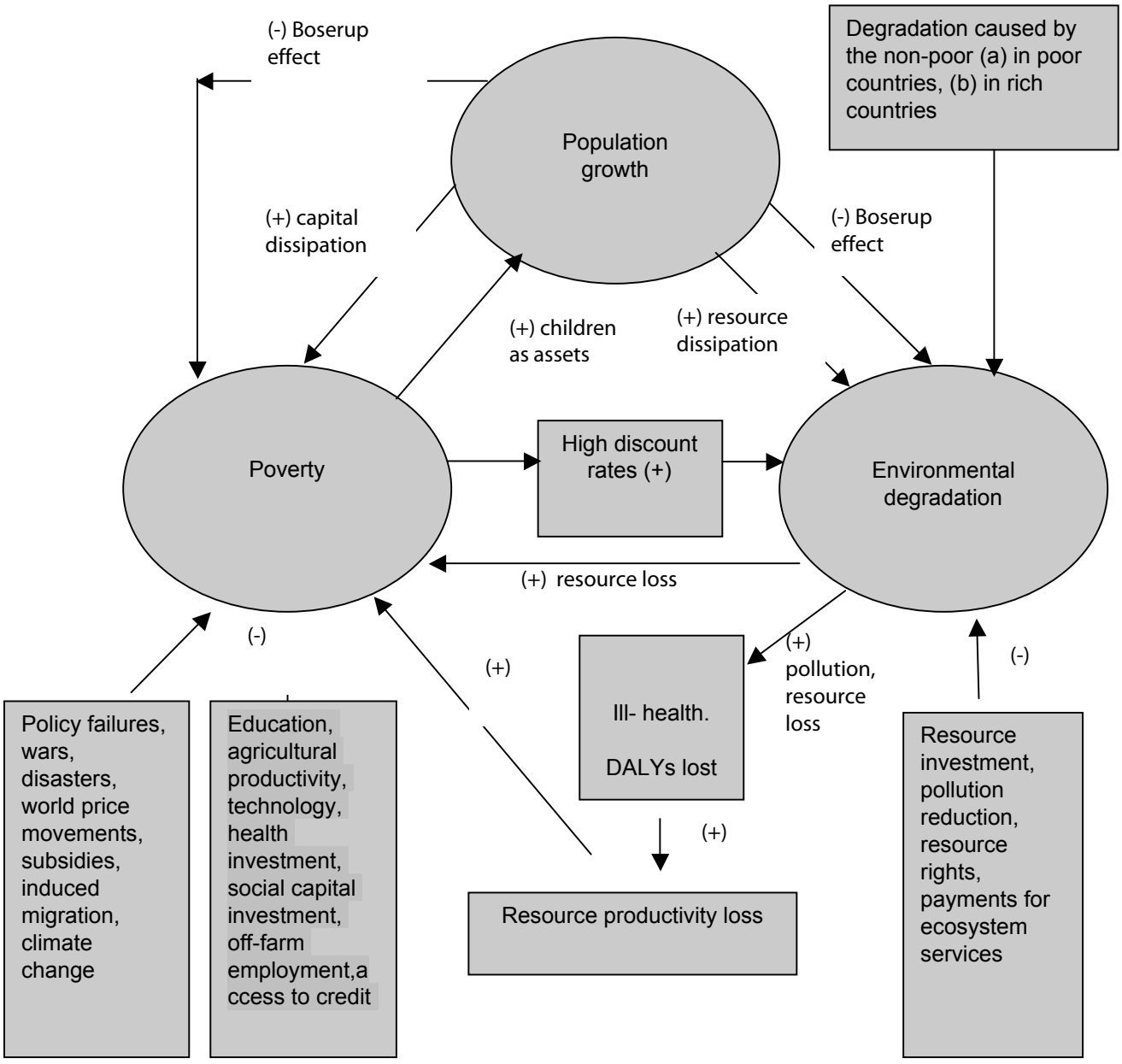
Enough has been said to show that what has come to be known as the "environment-poverty nexus" is complex. This section attempts to paint a schematic picture of the various linkages to better understand *why* the poor are poor. Unless there is a clearer understanding of the reasons for continued poverty, policies to alleviate poverty will tend to be "hit or miss" affairs. At worst, they may be wholly misdirected.

Chapter 3 suggested that poverty exists because of the low asset base of the poor. Escaping poverty , therefore, involves two activities: (a) investing in the asset base of the poor, and (b) encouraging those contextual factors that facilitate investment while removing factors that inhibit investment.

Figure 4.1 provides a schematic picture of the linkages. The arrows show the interactive mechanisms, with "+" denoting a compounding effect and "-" indicating an amelioration effect. Thus, population growth is likely to have a compounding effect (+) on poverty because existing limited assets become dissipated as they are shared among more people. This will be especially true for land, but it will also apply to open access resources such as fisheries. Communal management can be effective in limiting access to such resources, but the focus then shifts to the fate of those who are excluded. Others argue that there may be an ameliorating effect (-) if population growth triggers technological change, as suggested in the work of Esther Boserup. If both effects are present, then the net effect will depend on the scale of each offsetting influence: capital dissipation versus technological stimulus.

Figure 4.1 shows poverty as increasing population growth, partly because children are seen as assets. The argument is that, although children impose family costs in childbearing time and additional resource needs, they also generate income and enhance security. But poverty also worsens the environment if people adopt short-term coping strategies that involve "mining" resources. One way of thinking about the mining of resources is to argue that poverty is associated with high discount rates, an issue more fully explored shortly. Environmental degradation also worsens poverty directly or indirectly via ill-health and reduced labor productivity. Analysis of the poverty-population links in the top left of Figure 4.1 suggests a "vicious circle": Population growth produces poverty (unless offset by the Boserup effect), and poverty induces higher population growth through the "children as assets" effect. The environmental degradation panel to the right of Figure 4.1 shows how the vicious circles can be made worse. Poverty induces resource destruction because the poor have high discount rates, which in turn stimulate "resource mining." Environmental degradation makes poverty worse because the poor rely directly on natural resources, which can be depleted (fuelwood, water, soil, fisheries) or polluted (water, air, oceans). Resource depletion and pollution induce ill-health, which reduces labor productivity and life expectancy, further worsening poverty. Figure 4.1 shows that it is easy to construct a case for supposing that poverty, environmental degradation and population change are interlinked in such a way as to induce a vicious circle.

Figure 4.1 Population, poverty, environment linkages



Note: (+) indicates a positive feedback, i.e., the source of the arrow reinforces the effect at the target of the arrow.

But policy interventions within poor countries can change the situation, first, by acting directly on poverty itself through the creation of human capital (education and health investments), the creation of social capital, access to credit, etc., and, second, by investing in environmental assets and creating markets in the services of those assets. Actions by rich countries can also reduce environmental degradation, e.g., reducing debt obligations that may be linked to exploitation of natural resources to secure foreign exchange for debt repayment.

4.2 Poverty and "short-termism"

If the poor are more concerned with day-to-day survival than with longer-run well-being, then they are more likely to under-invest in resource conservation measures, such as tree-growing and soil conservation. Another way of expressing this is to say that the poor have "high discount rates," i.e., a high weight is applied to the present and a low weight to the future. The "poverty-high discount rate" link is not a *necessary* one: There are many examples of poor communities organizing themselves (or being helped to organize themselves) to facilitate communal resource management. Nonetheless, what evidence there is on discount rates among the poor confirms the view that they will tend to discount the future very heavily.[100] Table 4.1 assembles some of the evidence.[101] Typical discount rates for rich countries tend to be well below 10 percent.

Table 4.1 Discount rates in the developing world

Study	Country	Discount rate %	Comment
Poulos and Whittington. (2000)	Ethiopia Mozambique Uganda Bulgaria Ukraine Indonesia	28 to 49 15 to 46 158 38 to 45 206 45 to 57	Questionnaire on health states 2, 5 and 10 years hence. Median rates, i.e., rate at which 50% of respondents choose a program saving lives now.
Cuesta et al. (1997)	Costa Rica	32 to 83	Questionnaire to farmers
Holden et al. (1998)	Indonesia, Zambia, Ethiopia	28 to 147	

[100] An alternative view is provided by Moseley (2001) who observes that productive assets such as oxen, seeds and plows are carefully conserved during periods of drought in many African countries. He concludes from this that discount rates are, therefore, low. However, the studies in Table 4.1 are based on surveys, whereas Moseley's study is non-quantitative. It is also not clear that conserving seed and machinery are evidence of low discount rates.

[101] Anderson et al. (2004) also find that rural poor in Vietnam have significantly higher discount rates than the urban poor.

In many ways, the high observed discount rates simply restate the poverty of the people surveyed. If so, it would not be justified to make use of such high rates in formulating investment policy in, say, soil conservation. What the data do indicate is that measures to lower these discount rates are likely to be especially beneficial for the poor (and for the environment). The poor invariably lack access to capital and credit markets or, if they do have access, it is at very high interest rates. The poverty of borrowers itself may force lenders to charge high rates, as borrowers' lack of collateral assets makes loans more risky. The only remaining option is to deplete natural resources: The foregone benefit of resource conservation is now less than the interest rate they would otherwise have to pay to borrow money. These strategies arise because of the low asset base of the poor, and the lack of alternatives and safety nets (such as insurance) relative to those available to richer communities.

Improved access to credit, capital and insurance markets would do much to lower effective discount rates as would encouragement of social capital formation to promote collective action to conserve natural resources. A typical example of behavior in response to the lack of insurance is the holding of livestock. Herds tend to be larger in size than otherwise would be the case because of the need to have insurance against drought conditions. But larger herds impose more strain on ecologically fragile grazing lands, so the absence of an insurance market directly contributes to the depletion of pasture land.[102]

4.3 The poverty-environment nexus

The previous sections show how difficult it is to generalize about poverty-environment interactions. Efforts are gradually being made to secure better general understandings of the complexities.

One important attempt to impose some order on the complex linkages in the context of rural poverty is the Lopez model.[103] Lopez focuses on some central concepts: the environmental characteristics of the natural resources used by the poor, especially soil; population change; prevailing institutions; and the rate of change in institutions. He argues that one reason why so many different outcomes emerge from the various interactions is that "dynamics" matter. The primary issue is that, if the resource base begins to degrade (perhaps because of rapid population change), how fast can institutions change in order to cope with the new scarcity? If institutional change lags behind environmental change, chances are that the community concerned will fail to make the transition to cope with resource scarcity. The environment will degrade further and poverty will be worsened. If, on the other hand, institutions are flexible and capable of change, a sequence is possible whereby increasing scarcity is met with technological change and changed institutions. What matters then is "the race between institutional dynamics and environmental dynamics." In turn, success or failure depends on the factors encouraging or inhibiting institutional change.

The first element is the prevailing set of property or resource rights. If resources are open access (OA), whereby there are no owners or rules of access to the resource, then population growth will threaten the resource base as more and more people seek to exploit it. So long as the demands on the resource are below its sustainable yield, OA can persist. Once resource pressure exceeds sustainable yield, two things can happen: Either the system collapses and worse poverty ensues alongside environmental degradation or the community responds by limiting access through some common property (CP) arrangement. CP usually involves rules of access to the resource, implicit or explicit quotas of use, and reward and punishment mechanisms for contributions to the collective effort and transgressions. CP may also have mechanisms for controlling further population growth in the relevant area, e.g., by restricting immigration.

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[102] Mäler (1997).

[103] Lopez (1998).

The strength of these incentive systems determines whether the CP system survives, reverts to OA, or changes to some private property arrangement. CP is more likely to survive if it is free from external interference by central governments or larger-scale commercial activity and if it has access to some form of extension or advice that supports goals of sustainable management of the resource. Vulnerability could be especially high if the CP system does not have registered tenure or resource rights since it may still risk being expropriated by others.

The conditions necessary for CP to change to a private rights regime are also many and varied. A CP system with a large population is less likely to survive because large groups are more difficult to monitor, manage and control than small groups – a feature in common with international agreements, which work best when there are few "players." Moreover, although private property rights might secure the resource against further degradation – because owners have an obvious incentive to manage the resource – private rights may come at the cost of dispossession and relocation of the weaker members of the CP system. Also, if owners' discount rates are high, even a private resource manager will have an incentive to deplete the resource and move on, depending on available alternative opportunities.

For these reasons, designing and implementing a sustainable CP system has many advocates. Since CP systems have evolved over long periods, "blueprints" for turning OA systems into CP systems exist, but are subject to local variation since conditions are rarely identical in any two locations. No CP system can be perpetually static. Lopez's model stresses the need for constant reflection on the existing system as conditions change.

Lopez argues further that one of the dominant factors determining progression or collapse of land-based agro-ecosystems is the fragility of tropical soils. The less resilient the soil ecosystem, the more likely it is that institutional adaptation will fail, simply because the speed of resource degradation is greater than the speed with which institutions can adapt. The following factors appear to be implicated in institutional failure to adapt:

- Environmental fragility, for the reasons noted;

- A lack of awareness by the community that resource scarcity is occurring or, if they are aware, lack of appreciation that exhaustion is human induced;

- Counter-intuitively, strong social bonds within the CP system may inhibit change. The strength of the bonds may result in inflexibility, especially if the bonds are based on strong cultural or religious beliefs formed in an era when resource constraints were not binding;

- The absence of cash savings to finance the transition to the new agricultural regime needed to sustain a larger population – the absence of surplus noted earlier. Existing savings may not be in cash form but in, say, livestock. Holding livestock as assets simply encourages larger herds and, hence, overgrazing. Moreover, the more fragile the ecosystem, the bigger the investment needed to make the transition to a more intensified agricultural system;

- Large populations which, as noted, make CP management more difficult;

- Chance factors such as the presence of entrepreneurs and leaders with the vision to see that institutions must change;

- Inefficiency in the management of CP resources. Although there has been a tendency to eulogize CP as an ideal management system, Lopez notes than many CP systems are inefficiently run. The chances of reversion to OA are then high;

- The degree of integration between the community and the outside world. Lopez's argument here is that such integration makes life more difficult, not less, for CP systems. But the linkages can work both ways. Off-farm work, for example, could result in male household members working away from the rural area, reducing the labor needed for the transition to a new system. Equally, off-farm work results in cash income, which is often repatriated to the benefit of the rural community and may be invested in management changes (e.g., the case of Machakos District in Kenya);

- Lack of access to credit and insurance to finance transitions to new agricultural systems;

- External influences. There are numerous examples here: land grabs by local or national governments (especially the latter, in the name of nationalization) and by commercial enterprises; a refusal by government to register customary land rights; export taxes on crops which, like tree crops, are generally good for the environment; subsidies to land clearance or mechanization; and deliberate relocation and resettlement or urban communities as in Brazil and Indonesia ("transmigration") – the risk being that migrants are not familiar with local ecological conditions and fail to account for them.

Factors that are likely to assist the required transition include:

- More resilient ecosystems, buying time to make the transition;

- Community controls on population change;

- Outside assistance from NGOs or specialized agencies;

- Past experience of resource "shocks";

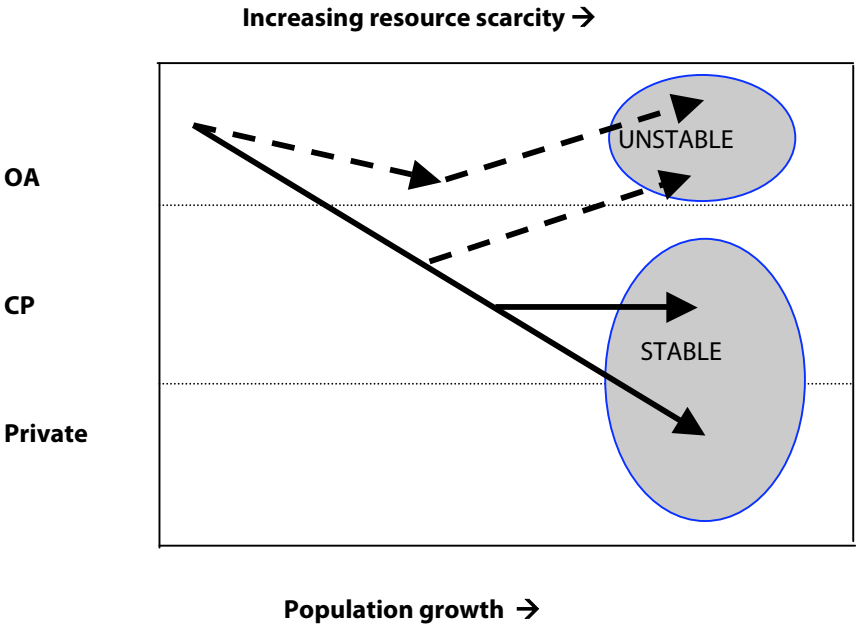
- Strong CP bonds that nonetheless permit an openness to new ideas and challenges;

- Removal of distortionary taxes on labor, encouraging the substitution of labor for resource-intensive capital.

Figure 4.2 tries to bring the essentials together. The "required" transition in the face of increasing resource scarcity and larger populations is from OA to CP or private property, perhaps with a preference for the former if private property is likely to displace the poorest in the community. Some communities may not escape from OA, with dire consequences (upper dashed line). Some will make it to a CP regime that is stable (heavy line), some to CP regimes that collapse (dashed line). Conceivably, private property regimes may also collapse because of internal pressures as opposed to external appropriation, e.g., via state control.

How applicable is the model to other open access contexts, e.g., fisheries? Although the Lopez model was developed for agro-ecosystems, it has a generality. A majority of fishing regimes suffer from the worst features of open access – over-fishing due to the lack of incentive for any one user of the fishery to limit his or her catch. Strong communities will recognize the problem and institute controls on access to the fishery, and controls on catch size. Many simple instruments for control exist: seasonal catch limits, restrictions on total catch by weight or volume, size of boat or number of crew, and so on. There also have to be punishment regimes, or regimes whereby the fishermen can call transgressors to account. Again, it is a race between the development of institutions to sustain the fishery and the forces making sustainability more difficult.

Figure 4.2 The Lopez model



Note that the position of private property relative to common property is not intended to indicate any relative desirability of these forms of property rights. The arrows show private property as an "end point" simply because that is how many rights regimes change, i.e, private property emerges from common property but not usually the other way around.

What does the Lopez analysis tell us by way of policy implications? One essential conclusion is that resource scarcity does not, of itself, guarantee that the "right" institutions will emerge "naturally" to cope with that scarcity. There is, therefore, no justification for a laissez-faire approach to resource degradation. People and institutions will not automatically adjust. Resource rights clearly matter. Whatever happens to all other causal factors, if local communities are denied rights to land and to the resources they need, the prognosis for sustainable institutions is very poor. This suggests that continued pressure for benign land reform is needed. It cannot be assumed that CP systems will work perfectly. They may be inefficient and in need of external assistance to improve management techniques. Although this form of "interference" has justification, most other forms do not. CP regimes will work best when governments keep out of the way or confine their attention to preventing others from usurping CP rights. Above all, incentive systems that encourage resource degradation – such as subsidies to inputs used for extraction of resources, or on resource extraction itself – must be avoided or dismantled. When CP systems work they need to be defended. Involvement of people within the community in decisions about institutional change is important. Local democracy is to be encouraged, but it may also be necessary to signal the need for rapid institutional change to cope with resource scarcity. Privatization should only be encouraged where it is clear that CP systems are not going to work: Care is needed to avoid the poorest members of the community losing out in a "race for property rights." Credit regimes, such as micro-credit, should be encouraged so that savings eventually take the form of cash rather than livestock and so that discount rates can be reduced. Measures to slow population growth need to be encouraged if the CP system does not have population control in place. The establishment of women's groups and female education is important.

Private property may also be an efficient outcome of institutional development. By and large, it is efficient in the sense that the owner of private property has an incentive to maximize the returns from the resource. However, unless regulated, what is maximized is the private returns to the owner, rather than the returns to society as a whole. Regulation, e.g., through taxation of any "externalities," can help to minimize this potential gap between

private and social returns. Similarly, private property could be equitable if there are fiscal instruments designed to tax away some of the private gains and reallocate them to others, e.g., in the form of public goods such as education, health care, etc. Where these reallocation mechanisms do not exist, however, private ownership may well be at the expense of the poor, as a number of case studies demonstrate.[104]

The Lopez model provides an organizing framework for assessing the chances of success or failure of community management of natural resource scarcity. If the poor are to cease being poor they must have a rising per capita stock of wealth. The chances of achieving that are clearly lower the faster population changes. So the capital assets approach bears out Lopez's emphasis on avoiding, where possible, rapid population change. In the same vein, social capital plays a strong role in the Lopez model. Strong community ties are seen be vital to managing CP regimes, although the same strong ties could result in inflexibility and resistance to change. Human capital development contributes to slowing population change (education, especially of women), and environmental capital conservation is clearly central to the Lopez approach.

[104] For example, see the case study of Botswana in Cullis and Watson (2005). Gradual privatization of communal livestock lands has taken place. Cullis and Watson argue that the losers have been both the poor and the wildlife.

5 Reducing Poverty: The Investment Response

5.1 Investing in environmental capital

The previous chapters demonstrate that there is a twofold need for alleviating poverty:

- Investment in assets available to the poor; and
- Policy measures to facilitate efficient, sustainable and pro-poor investment.

This chapter looks at the investment component of the solution and attempts to indicate broad magnitudes of the investment needs for poverty reduction consistent with the Millennium Development Goals. In reality, "costing investment needs are a vastly complicated issue. Nonetheless, there is a demand among the donor community for approximate estimates of cost, and all parties need to have a broad idea of what is involved. Ideally, whatever global sums are needed for reducing poverty will also be found to be economically efficient, in a cost-benefit sense. The latter issue is addressed in Chapter 6.

Investment can be assisted by donors and governments and can be undertaken by poor people themselves. It may be that some policy measures (see Chapter 7) will create the right context for the poor to begin generating the surpluses necessary for replacing their own assets and investing in new ones or to stimulate private investment in activities that benefit poor people. Some countries have already pursued successful pro-poor growth strategies without significant external support. But it is more likely that external assistance will be needed. Where this is the case, it is essential that the interventions generate sustained additions to the wealth of the poor rather than temporary alleviation of income deficiencies. One feature of the asset-based approach to poverty is that it stresses this wealth-sustaining argument by changing the focus from income to wealth, and by recognizing the multi-dimensional nature of wealth.

The remainder of this chapter draws together various estimates of investment needs. The estimates provided are necessarily crude. A proper analysis would take far longer to produce and would require detailed area-by-area assessment of needs. The analysis also focuses solely on environmental investments and does not ask if some of the goals of such investments could not be met by investments in other assets. For example, investing in human capital raises awareness of resource scarcity and is likely to produce better responses to it.

5.2 Investment needs

Water and sanitation

The costs of meeting various water and sanitation targets have been estimated by several agencies. Table 5.1 shows estimates made by the World Health Organization, along with the suggested benefits.[105] The benefits accrue as:

- Time savings from avoided collection of water and visits to sanitation facilities. These benefits comprise some 75 percent of the total benefits from achieving the MDG7 target. Time savings will show up in increased output and productivity, and in higher school attendance;
- Health sector cost savings at just under 10 percent of the total benefits;
- Increased working days and school days from reduced illness make up the remainder of the benefits.

[105] Derived from Hutton and Haller (2004). All "investment needs" estimates need to be treated with caution. Even those based on familiar technologies are subject to wide variation.

Table 5.1 WHO estimates of water and sanitation investment costs and benefits ($US billion per annum)

Goal	Cost	Benefits	Benefit/cost ratio
Halving the population with access to suitable water and sanitation: The Millennium Development Goal target	11.3	84.4	7.5
All population with access to suitable water and sanitation	22.6	262.9	11.6
All population plus water treatment with chlorine and safe storage	24.6	344.1	14.0
All population plus in-house piped water plus in-house sewerage and partial treatment	136.5	555.9	4.1

Source: Hutton and Haller (2004). Investment costs are annualized over 20 to 40 years depending on the nature of the investment. Curiously, no discount rate is stated.

Provisional estimates prepared for the World Bank suggest that meeting the MDG targets for water and sanitation could save the lives of up to 1 billion children under 5 years of age over the period 2015-20.[106] The latter study's estimates of costs are more than twice those shown in Table 5.1, at $26 billion. Comparison is difficult because slightly different definitions and target dates are used. Nonetheless, even if the higher cost figure is substituted in Table 5.1, the benefit-cost ratio would still be 3.2 to 1, a substantial excess of benefits over costs. If the WHO figures are more accurate, then benefit-cost ratios range from 4 to 14, making the investments extremely attractive from a social standpoint.[107]

Energy

Surprisingly, the Millennium Development Goals have no explicit target for energy supply or energy "quality" for the poor.[108] As noted above, it is hard to imagine poverty alleviation without significant changes in the quantity of energy consumed by the poor, together with qualitative changes through the use of more efficient and less polluting energy sources. There is evidence to suggest that households would be willing to pay for cleaner and

[106] Martin-Hurtado (2002). This document uses slightly different measures of the target for water and sanitation.

[107] Note this does not mean that such investments would be provided by the private market, since the benefits accrue to individuals other than the investor and cannot be recouped by them. This explains why the market will not provide such investments and why government intervention is needed.

[108] Energy is affected indirectly by Target 27, which requires increases in GDP per unit energy, and Target 28, which requires reductions in greenhouse gas emissions.

more convenient fuels if they were available.[109] Table 5.2 shows the International Energy Agency's estimates of electricity investment, which they argues is consistent with the MDG goal of halving extreme poverty by 2015.

Table 5.2 suggests that some $17 billion per annum over a 12-year period ($202 billion divided by 12) would give an additional 500 million people access to electricity by 2015 – over and above those expected to have electricity with ongoing programs – so as to be consistent with the overall MDG poverty goal.

Table 5.2 International Energy Agency estimates of electricity investment costs to meet the overall MDG poverty goal ($US billion)

	Population without electricity in 2015, in millions	**Population without electricity if MDG poverty goal is met, in millions**	**Investment need 2003-15 in $billions**
Africa (largely SSA)	601	453	46
S Asia	773	417	104
E Asia and China	127	100	22
Latin America	27	5	28
Middle East	9	5	3
TOTAL	**1537**	**981**	**202**

Source: International Energy Agency (2004), Table 10.8

Added to the costs of further electrification, the earlier discussion noted the need to replace most of the traditional fuels used by the poor for cooking and heating. Such a replacement would have triple benefits to human health, avoid deforestation and improve soil quality. The International Energy Agency predicts that, without further action, some 2.5 billion people will still be relying on traditional biomass fuels in 2015.[110] Taking an estimate by the World Energy Council that basic energy needs can be met by 1 GJ of *useful* energy per capita per annum, the requirement would be for about 2.6 EJ of *delivered* energy, per annum, or some 125 MTOE.[111] The cost of, say, kerosene as a substitute would be around $37.5 billion p.a. plus distribution costs and costs of appliances.[112] Taking a rough figure of $50 billion p.a., a fraction of this would be needed to meet the MDG poverty goal. In the absence of other information, the same assumption as for electricity in Table 5.2 can be

[109] Thus, Laxmi et al. (2003) found that one-third of a sample of households surveyed in Northern India would be willing to buy kerosene even at above prevailing market prices, if it were available.

[110] International Energy Agency (2004), p.352.

[111] World Energy Council (1999) as cited in Sagar (2005) and adjusting Sagar's population of 2 billion people up to 2.5 billion in line with the IEA's estimate of those relying on traditional fuels.

[112] At $40 BBL of oil x 1.3 to allow for refining costs x 7.5 BBl/TOE = $37.5 billion p.a.

made, i.e., some 550 million people would need to benefit. In practice, it seems likely that it would need to be more than this. At a minimum, then, some $11 billion p.a. would be consistent with the overall MDG goal.[113]

Climate change

Numerous studies have estimated the costs of tackling climate change. Costs clearly vary with assumptions about the least-cost combination of emission-reduction or sequestration technologies, the potential for "win-win" policies such as energy efficiency, the timing of such measures, the targets assumed, what policy instruments are in place, and the way in which measures change energy prices.[114] Unsurprisingly, therefore, there are numerous estimates of costs.[115]

The costs of complying with the Kyoto Protocol

Table 5.3 provides some recent estimates of the costs of complying with the Kyoto Protocol.[116] The figures are heavily influenced by assumptions about the extent of emissions trading. Global trading is very unlikely to happen before the compliance period. Limited trading already exists, however, e.g., the European Union carbon trading scheme started in 2005.

Table 5.3 Costs of complying with the Kyoto Protocol $(2000) billion per annum

	No trading	Limited trading	Global trading
Annual costs 2001-15	253	108	49

Source: Martin-Hurtado (2002)

The Kyoto Protocol is universally acknowledged to be the first step in a series of protocols to the Framework Convention on Climate Change. By itself, the Kyoto Protocol has little effect on rates of warming.[117] Several studies find that the Protocol itself does not pass a cost-benefit test, i.e., its rate of return is negative.[118] However, if the Protocol is a first step, then it makes more sense to look at the costs and benefits of meeting longer-run targets.

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[113] 550/2500 million x $50 billion p.a.

[114] For example, radical measures to reduce fossil fuel energy consumption in compliance countries may reduce energy prices, which may then induce non-compliance countries to increase their energy consumption and emissions – the "leakage" effect. Even in compliance countries, there is evidence that large-scale energy efficiency measures lower the effective price of energy with users taking the benefits in the form of increased energy comfort, e.g., higher household temperatures – the "rebound" effect.

[115] A neglected issue is whether, given the disproportionate impact of global warming on poor countries, it is better to spend scarce resources on mitigating emissions or expanding aid to those countries. Tol (2005) argues that the rate of return to expanding development aid is probably significantly higher than the return to the developing world from reducing emissions.

[116] Martin-Hurtado (2002).

[117] See Wigley (1998) for a demonstration of this.

[118] For example, see Nordhaus and Boyer (2000).

Costs of meeting the 550 ppm target

Although there are alternative "stabilization" targets (in atmospheric concentrations of greenhouse gases), a goal of 550 ppm has been adopted in several policy arenas.[119] The Intergovernmental Panel on Climate Change has estimated the costs of meeting this goal.[120] Table 5.4 estimates annual costs of meeting the 550 ppm target, based on the IPCC data. The wide range – from $2 to 17 trillion in present value – partly reflects the fact that there are different emission control paths to secure the target. Table 5.4 indicates annual costs, ranging from $78 billion up to $1.1 trillion. In terms of *current* world income, the range is 0.2 percent to 3.1 percent of world GDP. In costs of control, the estimates mentioned are consistent with marginal costs of around $20 to $80 per ton of carbon. Chapter 6 looks in more detail at the likely cost-benefit ratio for securing this target.

Table 5.4 Costs of meeting a 550 ppm atmospheric greenhouse gas concentration target

Present value of cost $2005 trillion	**Annual cost if borne in first 50 years, $2005 billion (as a % of global GDP now, and in 50 years time)**	**Annual cost if borne in first 20 years, , $2005 billion (as a % global GDP now, and in 20 years time)**
2	78 (0.2%, 0.05%)	134 (0.4%, 0.2%)
17	661 (1.9%, 0.4%)	1141 (3.1%, 1.7%)

Source: adapted from data in IPCC (2001). Note: For the 50-year time horizon and a discount rate of 3 percent, divide the Present Value by 25.7. For 20 years, divide by 14.9.

Land degradation

Table 5.5 shows some very rough estimates of the costs and benefits of combating land degradation ("desertification").[121] Considerable caution is needed in using these figures. First, the costs are probably serious underestimates. Second, the benefits may also be understated since they relate only to on-site productivity losses; the associated social, global and off-site costs are not included. Third, any program to halt desertification is unlikely to halt all desertification and certainly would not have immediate effects.

[119] Notably the European Union.

[120] IPCC (2001).

[121] Martin-Hurtado (2002).

Table 5.5 Costs and benefits of reducing desertification. $2000 billion, per annum.

	Costs of a 15-year program	Benefits = avoided production losses	Benefit-cost ratio
Total cost	15.9 to 35.7	52.5	1.5 to 3.3
Of which:			
Met from own resources	6.4 to 12.4		
Met from aid	9.6 to 23.3		

Source: Martin-Hurtado (2002).

Protected Areas

Protected Areas (PAs) present several problems in both biodiversity conservation and targeting poverty reduction. Doubts have been expressed as to the conservation effectiveness of PAs, although designating areas for conservation may have the effect of excluding the poor from traditional access to environmental assets – so-called "evictions in Eden"[122] (see Box 5.1). In environmental effectiveness, one estimate suggests that the world is designating protected areas at a rate of 40 million hectares per annum and deforesting land at perhaps 16 million hectares per annum, a net gain of 24 million hectares per annum.[123] However, PAs under IUCN Management Categories I to VI account for only 10 percent of land in developing countries and 12 percent in developed countries.[124] Moreover, well over one-half of all protected areas occur in nations where governance is weak. Weak governance shows up as poor management, neglect and, in many cases, corruption. Some protected areas may, therefore, be "paper parks," protected in name but not in reality. Many tropical rain forest reserves are in a poor state, suffering from a combination of lack of resources, lack of commitment, lack of knowledge and corruption.[125] Investments in PAs, therefore, need to take account of the measures needed to ensure that existing PAs become environmentally effective. *One critical requirement for ensuring effectiveness is that both existing and new PAs properly compensate those whose resource access is disrupted.*[126]

Tables 5.6 shows varying estimates of the costs of securing existing PAs and an hypothetical expansion from the 13.2 million km^2 in 1999 to 20.6 million km^2. The costs allow for the fact that many existing PAs have not provided compensation to those who have been displaced by them. Moreover, these compensation sums are likely to be underestimates. Most compensation, even when it does occur, makes no allowance for the need to establish a proper asset base for the displaced households and enterprises, i.e., compensation tends to be based

[122] Geisler (2003).

[123] Pearce (2006b)

[124] World Resources Institute (2003).

[125] van Schaik et al. (1997)

[126] On the general requirements for increasing the effectiveness of PAs, see Chape et al. (2005).

on forgone income rather than forgone assets.[127] The derivation of the estimates in Table 5.6 is not always clear. The revised estimates suggest a global cost of, say, $25 billion per annum for terrestrial conservation. The cost relating to developing economy PAs might be some $15 billion p.a. Such an estimate is not dissimilar from other estimates for creating new PAs in developing countries (i.e., ignoring compensation needs for existing PAs) of some $20 billion.[128] However, the other source cited suggests very much higher costs at more than $90 per ha. p.a. for expanded areas, 10 times the developing country estimate in Table 5.6.[129]

Table 5.6 Estimates of Protected Area costs: developing countries only ($2004) billion per annum

	Total costs	**Required expend-iture**	**Shortfall**
LDC costs			
Management costs	0.8	2.1	1.3
Opportunity costs	n.a	n.a.	n.a
Total	n.a	n.a	n.a
Hypothetical expansion 3.4 million km^2			
Management costs		1.8	1.8
Opportunity costs		4.5	4.5
Total		6.3	6.3
Total financing needs (ignoring retrospective compensation for existing PAs)			**7.6**

Source: Adapted from Bruner et al. (2004) which updates earlier estimates in James et al. (1999), Balmford et al. (2002) and some other sources. Opportunity costs for the expanded area relate to compensation needed for displacement, etc. This will tend to understate true compensation needs, which should be based on replacing lost environmental assets. Compensation costs are recorded as $9 billion p.a. for 10 years in Bruner et al. (2004): These have been convertedg to an annual sum over 30 years for the sake of comparison with the management costs.

[127] Pearce and Swanson (2005)

[128] World Bank (2002)

[129] World Bank (2002). The World Bank estimates relate to a 2 million km^2 expansion in critical forest areas only, compared to 7.4 million km^2 in Table 5.6. The Bank estimates also include some "high cost" acquisitions. Nonetheless, per hectare costs are very different.

Box 5.1 Protected Areas and the poor: a conservation dilemma?

The Millennium Development Goals speak of progress toward ending poverty and also conserving biodiversity. This suggests a strong synergy between the two goals. One historically popular means of biodiversity conservation is the establishment of Protected Areas. But "protection" can mean restricting the access of local communities to the Protected Area to ensure against unsustainable extraction of natural resources. Communities previously relying on the Protected Area as an asset may then suffer significant losses, exacerbating poverty unless there is an adequate means of compensation. The loss of assets shows up as:

- Loss of cash income from sales of marketable products previously harvested from the PA.
- Loss of directly consumed products.
- Loss of land that might now be designated to be within the PA.

Responses to these losses may actually cause environmental damage elsewhere and conflict by:

- Extracting similar or other products from adjacent areas
- Illegally entering the PA.
- Suffering damage from the associated increase in wildlife in the PA.

For example, in the Lake Mburo National Park in Uganda the local community received in a single year (1998) some $230,000 from the national park. But its measured losses amounted to some $700,000, producing a benefit-cost ratio for them of just 0.3. They were worse off with the Park than without it. In other cases, the PA may well generate sufficient revenue to make all parties better off, but the poor may still lose out if their voices are not heard. In the Western Serengeti in Tanzania, local communities received just $75,000 of the substantial revenues derived from tourism, but suffered $1 million of damage due to wildlife, a benefit-cost ratio for the local community of 0.07. In India's Bhadra tiger reserve, compensation for livestock loss due to tigers amounted to just 5 percent of the livestock value. Compensation for crop loss due to elephants was just 14 percent. The community benefit-cost ratios were, therefore, 0.05 and 0.14, respectively. In the Bénoué Wildlife Conservation Area in Cameroon, 86 percent of interviewees reported suffering crop damage from wildlife and 28 percent experienced livestock loss. A detailed cost-benefit study for Marovoay Protected Area, Northern Madagascar shows modest net benefits for the less poor and modest but significant losses for the poorest households affected. By offsetting the damage to poor households, through asset creation (planting trees), the poor households could share in the modest gains from conservation. A study in China showed that the Chinese government's new focus on biodiversity conservation through protected areas could seriously harm the well-being of those who have legal or traditional rights to the areas. But willingness to pay by people outside the Protected Area for biodiversity conservation exceeds the losses to local people, suggesting that some procedure for "capturing" this willingness to pay and using it for compensation to the affected parties would help to resolve the problem.

The basic requirement for minimizing conflict and ensuring that all parties adopt the same conservation goals is for the benefit-cost ratio for each party to be greater than unity with the PA. This means:

- Ensuring that the PA as a whole passes a cost-benefit test;
- Ensuring that the costs and benefits are distributed in such a way that each party is better off with the PA than without it.

A study of giant panda conservation in China shows how these conditions might be met. The study set out deliberately to identify the various parties whose costs and benefits needed to be considered. These were: (a) tourists to panda reserves, (b) tourists to China who were willing to

contribute financially to panda conservation but did not wish to visit the reserves, (c) the managers of the reserve and local and international conservationists, (d) the local, and extremely poor, farmers who lost cultivable land because of its protected status, and (e) the poorly paid wardens who protect the wild pandas but who are strongly resented by the farmers. Careful studies of tourists' willingness to pay for conservation by (a) raising entrance fees to the reserves and (b) paying for a "panda stamp" on visas issued by the government showed that substantial sums could be raised, in the tens of millions of dollars each year. The current budget of the reserve was just a quarter of a million dollars per year. Since the tourists were willing to pay these sums, they would be no worse off with the payments than without them: Their "benefit" is the knowledge that they are contributing to conservation of the pandas. Conservationists would be better off since they would have more funds for conservation. The studies also showed that tourists were willing to pay further modest increments in return for knowing that these sums would be used to compensate the farmers. Hence, the farmers would also be better off. Finally, the sums involved would permit wardens to be paid more, while the farmers' compensation should remove the resentment felt toward wardens. Carefully managed, conservation pays and the poor gain too.

Getting the various parties to agree to such solutions is not easy. The first step is to identify the stakeholders. The second is to ensure that there is some alignment of incentives that will make each party better off with the PA than without it. In keeping with the general theme of this report, benefit-sharing must be based on asset creation. Simply sharing revenues may not compensate for what is in reality the loss of a real asset to local communities. It may not always be possible to allocate benefits in this way, and it may work best when there is some charismatic species or ecosystem involved because revenues are likely to be more assured. But the principles of benefit-sharing are sound.

Much can be learned from past experience. In the 1980s and early 1990s a model that was supposed to combine poverty reduction and biodiversity conservation was the Integrated Conservation and Development Project (ICDP). ICDPs focused on protected areas but sought to generate local income through sustainable extraction and management of natural resources. Although the aspiration was sound, many ICDPs have not worked. Lack of funding has been one major problem – see the estimates of resource needs in this chapter. But there have been many problems of design and incentives. Local communities have not always shown themselves to have conservation as a dominant motive, incentive structures have been weak, and some projects have acted as a magnet for outsiders who add to the pressure for land conversion. Powerful interests have also taken over in some cases, and bureaucracies have grown up that "dissipate the rents" from the natural resources. The debate over ICDPs continues. Are they fundamentally flawed or simply in need of redesign and sensible funding? Those who argue the former, tend to favor far more direct approaches to paying for conservation (see Chapter 7 on Payments for Environmental Services).

Sources: The Lake Mburo study is in Emerton (2000) and Western Serengeti case study is in Emerton and Mfunda (1999). The Bhadra tiger reserve study is in Madhusudhan (2003). For an even more dramatic story involving major displacement in India due to the establishment of a tiger reserve, see Ghate (2003). The Chinese example of local losses due to Protected Areas is in Gong (2004). The case study for the giant panda is in Swanson and Kontoleon (2000). The Cameroon study is in Weladji and Tchamba (2003). The Marovoay, Madagascar study is in Sander and Zeller (2004). The ICDP experience is analyzed in detail in Wells and Brandon (1992) and criticisms are summarized in Simpson (2004).

Slum dwellings

The Millennium Development Goals require that, by 2020, there should be a significant improvement in the lives of at least 100 million slum dwellers. The World Bank and UNCHS have estimated the costs of upgrading slum dwellings at some $500 per person in a slum dwelling.[130] This suggests a cost for the minimum target of 100 million slum dwellers of $50 billion or around $4 billion per annum. The 100 million target is, however, modest when account is taken of likely "trends continued" in the rate of formation of slum dwellings. One influential report suggests that the 870 million people who currently occupy slum dwellings will rise to 1,400 million [1.4 billion?] in 2020 without action, an increase of more than 500 million.[131] If the target is rephrased as 770 million people remaining in slums in 2020 (870 minus the 100 target), then action would be needed to address the situation of more than 600 million slum dwellers, a very much larger goal that would require six times the suggested budget, or roughly $24 billion per annum.

5.3 Summary of investment needs

Table 5.7 draws together the various estimates of investment need. It is tempting to add the figures up, but it needs to be remembered that the MDGs are not precise as to actual targets so there is room for interpretation of what the goals mean quantitatively. Also, some of the costs probably overlap – e.g., improved access to water and sanitation tends to be part of the costs of upgrading housing for slum dwellers. Overall, however, and ignoring climate change for the moment, the sum required over the coming 15 to 20 years to meet MDG7 (or goals consistent with MDG7) is probably between $60 billion and $90 billion per annum.

The picture changes dramatically with the addition of actions to address climate change. Since it is widely accepted that "Kyoto alone" will not address global warming risks, the more meaningful range of figures relate to the 550 ppm target. Even the lowest estimate for this target requires another $78 billion per annum, effectively doubling the cost of all the other actions. At worst, the high cost estimate for addressing climate change, assuming a 20-year transition period, would dwarf all other costs.

[130] World Bank and UNCHS (Habitat) (2000).

[131] Sachs (2005).

Table 5.7 Summary investments needs for environmentally induced poverty reduction. $ billion per annum

Sector	MDG7 Goal	Other goals	Comment
Water and sanitation	11-26	Up to $136 billion	Lower end MDG7 range due to WHO, upper end to Martin-Hurtado (2002)
Energy	28		$17 billion p.a. electricity – IEA estimate, plus $11 billion p.a. replacing biomass fuels
Climate change		49- 253 Kyoto 78-1141 550ppm	Low end of ranges similar due to long-run target being achieved with investments over 50 years.
Land degradation	10-23		Aid component only, annual for 15 years.
Protected areas	8		Terrestrial only, LDCs only. Doubling for marine areas?
Reduced slums	4		"Cities without slums" estimate

However, *for the near term*, global warming control costs will be borne by the developed economies of the world. They will show up in only a limited fashion in additions to foreign aid. Hence, there are two perspectives on the global environmental control costs:

- The $60 billion to $90 billion per annum or so that will mainly show up as increased foreign aid and domestic investment;
- The $140 billion (at least) per annum that can be thought of as a *global environmental budget*, inclusive of climate change.

Because effective control of greenhouse gas emissions must soon take account of developing country emissions (due to their rapid rate of growth), the larger of the two budgets becomes the relevant one in the years following the first Kyoto compliance period (from 2012). Sizable parts of that larger budget will still fall on the developed economies, the share depending on how the international community addresses the issue after Kyoto, and $140 billion is approximately 0.5 percent of current developed country national income. Although it is well below the 0.7 percent aid target that has been an aspiration for a considerable period of time, and which has been reiterated as a target by the United Nations,[132] it needs to be recalled that the costs identified here relate only to the MDGs that directly bear on the environment.

[132] The call is for the 0.7 percent target to be achieved by all donor countries by 2015, with 0.5 percent being reached by 2009. See United Nations (2005a).

6 Rates of Return To Environmental Investments

6.1 Measuring economic rates of return

Estimating an "investment need" is not the same thing as determining whether those investments will be justified by a comparison of benefits and costs. Passing a cost-benefit test might be thought irrelevant: The goal is poverty reduction, the rich world is very rich, and requiring that some minimum rate of return be achieved may seem to deny the moral urgency of immediate action. But having some idea of costs and benefits is important:

- If the costs of a particular investment significantly outweigh benefits that is an indication that funds might be better spent in some other way to achieve the same goal;

- Although the costs of meeting the MDGs may seem eminently "affordable" when measured against the benchmark of current aid budgets or developed country income, it is likely that donor countries and agencies will seek some idea of priorities. Benefit-cost ratios offer one guide to priority setting.

- Rate of return analysis is needed to counter the view that, even if investments in environmental assets do have benefits greater than costs, other uses of the resources will yield even higher rates of return.

Of course, no one would argue that environmental investments have absolute priority as a means of addressing poverty. The investment needs of the poor are diverse and include actions to cover short-term coping strategies and longer-term requirements, such as education, health and infrastructure. Arguments were presented in Chapters 2 and 3 as to why environmental degradation cannot be regarded as a short-term sacrifice for long-term benefit. Nonetheless, the perception remains that limited development finance should not be allocated to environmental assets because, as worthy as such investments may be, they generate a lower rate of return than investments in other assets.

The discussion of poverty-environment linkages shows, however, just how multifaceted the returns to environmental expenditures can be. Economists have taken huge strides in demonstrating the benefits of environmental investments monetarily. Surprisingly, far fewer exercises exist which compare those benefits to costs.[133] Until now, it has not been easy to assess the rate of return to environmental investments, compared to other pro-poor investment opportunities.[134] This section provides a more comprehensive database of environmental investment returns than has been gathered before, to our knowledge.

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[133] The literature on ecosystem benefit estimates is surveyed in EFTEC (2005). However, the report rarely addresses the issue of the opportunity costs of conservation, i.e., what is sacrificed.

[134] Unfortunately, the issue is slightly technical. A rate of return is expressed as a percentage and should be computed as an "internal rate of return" – the rate of discount that makes the present value of benefits equal to the present value of costs. This percentage should then be compared to "the social discount rate", the rate at which society as a whole discounts the future. The latter can be computed in various ways: as a "social time preference rate"; as the rate of return on investments, usually in the private sector; or as some combination of the two. Views differ as to which should be chosen, so that there is not always one measure of the social discount rate. Suppose the internal rate of return on an environmental project is 10 percent and the social discount rate is 4 percent, then the environmental project would pass a cost-benefit test. Moreover, it could be argued that it is better to invest in this project than in, say, the private sector, because the private sector rate of return is given by the 4 percent figure – i.e., what could be obtained on the last worthwhile project in the private sector. But it can be seen that comparing environment investments with other investments is not at all straightforward.

6.2 The economic importance of environmental assets

There are various ways of measuring the economic importance of environmental assets:

i. Measuring the flow of market and non-market income that derives from environmental assets and expressing this as a fraction of GDP. Since GDP should (but often does not) include all forms of market income (e.g., forest products sold on the market), care must be taken to determine whether some "environmental income" is already included in existing national economic accounts. Measures of this kind are increasingly familiar in *green income accounts*, i.e., measures of national income (GDP) adjusted for flows of non-market environmental income.[135] Sometimes the obverse of the contribution of environmental assets to income is used. In other words, the depreciation of environmental assets – i.e., pollution damage and resource loss – is expressed as a fraction of GDP. A full set of green accounts would include both aspects of environmental assets – i.e., the positive contribution they make to GDP and the negative contribution due to resource loss and pollution. Green accounts do not answer the question of what the rate of return is for environmental assets, but they are often used to demonstrate the relative importance of natural resources at a national level.

ii. A variant of the first approach is to measure the market and non-market flows of income from environmental assets and express this as a percentage of the incomes of the poor. The result is a *green poverty account*. Chapter 3 showed some of these indicators. Poverty accounts are important for showing how the environment interacts with the livelihood prospects of the poor.

iii. Measuring the value of the asset itself. The value of the asset will have some relationship with the expected flows of goods and services (the income) from the asset.[136] This is *wealth accounting*. Chapter 3 explained why wealth accounting is important, since it is changes in wealth (per capita) that matter as the indicator of sustainable development. However, wealth accounting will again not convey information about the relative size of costs and benefits and rarely accounts for the share of wealth accruing to the poor.

iv. Measuring rates of return to investments in environmental assets. This approach requires an estimate of the cost of an investment, the benefits obtained and must also deduct any forgone net benefits from alternative uses of the resource. For example, investing in afforestation uses land that could otherwise be used for, say, agriculture. These forgone returns are known as the *opportunity cost* of the investment. Rates of return may be expressed in percentages, or as ratios of benefit to cost.[137] It is this approach that defines the *rate of return approach*.

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[135] There is a large literature on green accounts. Useful case studies can be found in Lange et al.(2003), and a USA study can be found in Nordhaus et al. (1999).

[136] Technically, the value of the asset should equal the sum of the discounted values of the flows of goods and services.

[137] Ideally, the percentage rate of return is the "internal rate of return" – that discount rate that makes the present value of costs equal to the present value of benefits. In practice, many variants of this ideal measure are used. Benefit-cost ratios can be expressed as the ratio of the present value of benefits to the present value of costs. An alternative is to convert the present values to annual sums ("annuities") and take the ratio of benefits per year to costs per year.

A technical note on poverty-weighted rates of return[138]

In what follows, rates of return are reported in conventional terms, either as a ratio of money values of benefits to money values of costs, or as a percentage rate of return. Benefit-cost ratios greater than unity show that the investment generates a positive rate of return. Percentage rates of return can be expressed in various ways but should, technically, be expressed as an "internal rate of return" – i.e., the rate of interest that makes the present value of benefits equal to the present value of costs. In both cases, the attractiveness of the investment depends on the benchmark rate of interest that is regarded as the minimum acceptable rate. For example, if the prevailing market rate of interest in the economy is 10 percent per annum (expressed in "real" terms, i.e., after deducting the rate of price inflation), then this rate of interest (the "discount rate") is used to calculate the present value of benefits and costs in the benefit-cost ratio approach. For the percentage rate of return approach, the estimated rate of return from the investment needs to be compared to the 10 percent discount rate. The larger the difference between the rate of return and the 10 percent rate, the more attractive the investment.

It follows that simply reporting benefit-cost ratios and rates of return is not quite enough to show that investments are attractive. The general rule is that the higher the benefit-cost ratio, the better. Similarly, the higher the percentage rate of return the better. But it may still be the case that non-environment investments do even better. Moreover, since there are no hard and fast rules about the choice of the cut-off discount rate for individual countries, ratios greater than unity and positive rates of return still need to be compared to the ruling discount rates and profitability of other investments in the country in question. Such detailed comparisons are not possible here, so judgment is used to say whether the reported benefit-cost ratios and rates of return are likely to be attractive relative to other uses of investment funds.

Two other comments are appropriate. The first is that the relevant measure of benefits and costs should relate to the nation as a whole. *Financial* rates of return are what a private investor would secure, but this need not be the same as what society at large gets, especially if some of the benefits accrue in non-market form, as is the case with most environmental investments, or if the market prices of some important inputs or outputs are distorted due to government policies (e.g., subsidies). As far as possible, social rates of return and benefit-cost ratios are reported.

A second caveat is also important. The focus of this report is on environmental investments that benefit the very poor. The rates of return and benefit-cost ratios reported in the literature almost exclusively assume that $1 to the poor is as valuable as $1 to a richer person. This is self-evidently not the case. Ideally, the benefits to the very poor should be weighted more highly than those to the richer parts of society, to produce a modified benefit-cost ratio or rate of return. One dollar to the very poor would therefore be weighted by a factor above unity to indicate that it is more important than $1 to a richer person. These weighting procedures were once common in cost-benefit appraisal, went out of fashion, and now have resurfaced. *The critical point is that the measures reported in this chapter do not adopt this weighting approach, and, hence, the social rate of return is highly likely to be underestimated*. This bias does not matter much if the implicit comparison is with other non-environmental investments that have a similar "profile" for who gains or loses. However, weighting might also have the effect of altering the *structure* of environmental investments, if the distributional incidence of those investments varies by type of investment,[139]

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[138] This section can be ignored by the general reader. It does, however, contain some potentially important points that technical readers will want to consider. The weighting procedures are discussed extensively in Serret and Johnstone (2005).

[139] For an assessment of how the benefit-cost ratios of 30 World Bank environmental investments might change when income-weighting is used, see Bucknall et al. (2001).

6.3 Rates of return to environmental asset investment by sector

Water and sanitation

Chapter 5 detailed WHO estimates of the rate of return to investments in water and sanitation. Table 5.1 suggested that not only does the Millennium Development Goal for water and sanitation achieve a very high rate of return (benefit/cost ratio of 7.5:1) but comprehensive coverage inclusive of water treatment and storage would raise that return even further (benefit-cost ratio of 14:1). There is substantial regional variation about this average. For the MDG goal only, the ratios are: Africa 11:1, Central and Latin America 10:1, Eastern Mediterranean 35:1, and SE Asia 3:1. In short, *the benefit-cost ratios for investments in water and sanitation reveal very high rates of return*.

Energy

Chapter 5 considered two major program of investment: the first to extend electricity to more than 500 million people by 2015, the second to provide modern cooking and heating fuels to perhaps 700 million people by the same date. No attempt appears to have been made to estimate the benefits of such measures. Taking the aggregate cost of $28 billion p.a. (see Table 5.7), and a coverage of 500 million to 700 million people for these hypothetical programs, benefits would have to be of the order of $40 to $56 per person per annum for benefits just to offset costs. For the "$1 a day" group this would amount to 10 percent to 15 percent of per capita income, for the "$2 a day" group this would be about 5 percent to 8 percent of income, and for average low- and medium-income countries (at around $1,250 p.a.) the fraction would be 3 percent to 5 percent of income. Although no benefit estimates have been found, Table 6.1 records actual energy expenditures in a selection of developing countries. It can be seen that the average $40 to $56 per person per annum is less than 10 percent of the combined rural average expenditure on energy, and only 3 percent of combined urban average expenditures (where electricity may already be present anyway and where substituting biomass fuels will also be far less relevant).[140]

A study of household stove improvement sets out a methodology for estimating the net benefits of such measures in terms of children's and women's health, using established epidemiological dose-response relationships.[141] The study, for Kenya and Guatemala, suggests that very large benefit-cost ratios would ensue from a program of stove improvement. The benefit-cost ratio for Kenya is 47 to 118 (the range depending on the cost of the stoves) and for Guatemala 7.

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[140] The hypothetical energy investment program is derived from that in International Energy Agency (2004). However, there is an argument that investments and policies might equally be directed at ensuring sustainable sources of biomass energy. This would address some of the environmental costs of unsustainable use – deforestation and diversion of biomass from being a soil nutrient – but it would need to be linked to fuel efficient stoves to reduce the impacts of indoor pollution. On the economics of continued biomass use versus substitution by conventional fuels, see Armitage and Schramm (1989).

[141] Larson and Rosen (2000). See also Annex D of von Schirnding et al. (2002). A dose-response relationship shows how the incidence of premature mortality and morbidity varies with levels of certain air pollutants. See also Mehta and Shahpar (2004) who discuss fuel replacement, noting that the use of kerosene may increase risks of accidents.

Table 6.1 Average per capita expenditures on energy. $ per annum

Country	Urban	Rural
Brazil	6390	1905
Nicaragua	950	460
South Africa	3210	1065
Vietnam	405	180
Guatemala	1550	560
Ghana	880	504
Nepal	245	113
India	275	142
AVERAGE	**1740**	**615**
$40-$56 as % of average energy expenditure	**2.2 to 3.2**	**6.5 to 9.1**

Source: ESMAP (2003).

Although estimates of monetized benefits are not generally available for the hypothetical programs of energy investment discussed in Chapter 5, their costs amount to less than 10 percent of the existing household energy expenditures in developing countries. It can be safely concluded that such investments would very probably have significantly positive benefit-cost ratios. Available studies for stove improvement, as opposed to fuel replacement, suggest very high rates of return indeed, allowing only for human health effects.

Air pollution control

Numerous studies exist of the benefits of controlling air pollution in cities in developing countries, but few estimate the respective costs of control.[142] Table 6.2 assembles the results of those studies where costs and benefits are estimated. The ratios are seen to be high and even then tend to focus on health effects only, with limited attention being paid to reduced acidification of ecosystems. Hence, true benefit-cost ratios are likely to be even higher than shown in Table 6.2.

[142] The situation is better for developed economies, but the focus here is in developing countries. Benefit-cost ratios for air pollution control tend to be high in studies for the European Union and the United States. See Pearce (2000). For a review of benefit estimates in developing countries, see Pearce (1996).

Are such investments pro-poor? The studies tend not to detail the incidence of pollution reduction by socio-economic grouping. In so far as the poor are likely to live in more polluted areas, air pollution control should be "pro poor" if the worst polluted areas are tackled first. The limited power and "voice" of the poor may, however, mean that the policy process is "captured" by the better-off, with improvements benefiting richer areas first.

Table 6.2 Benefit-cost ratios for air pollution control in developing countries

Country	Types of measure	Benefit-cost ratio	Source
Santiago, Chile	Control of fixed sources Gasoline vehicles Buses Trucks	2.4 2.4 1.2 1.8	World Bank (1994)
Kyonggi Province, Korea	Control of fixed and mobile sources	0.2 to 0.7	Joh (2000)
Shanghai, China,	Control of power station emissions Control of industrial emissions	0.9 to5.6 2.5 to 15.1	Li et al. (2004)

Climate change

Chapter 5 acknowledged that the Kyoto Protocol might not pass a cost-benefit test, because its effects on levels and rates of warming are negligible. But it was also argued that, since Kyoto is only a "first step," the more relevant comparison is between the costs and benefits of the long-run goal of 550 ppm atmospheric concentrations. Chapter 5 suggested that the cost per reduced ton of carbon associated with the 550 ppm target would be $20 to $80 per ton carbon (tC). The wide range reflects the uncertainties in the cost data and the potential for approaching the 550 ppm target along different emission reduction paths. A rough cost-benefit test can be conducted by comparing these cost figures with estimates of the damage done by global warming. Recent surveys of these damages suggest a fairly wide range.[143] However, an upper bound on the current estimates appears to be some $50 tC.[144]

[143] The magnitude measured is the damage to the world as a whole from releasing one more ton of carbon (equivalent) today. This is known as the marginal damage, or "social cost of carbon." Reviews can be found in Tol (2005) and Pearce (2005b). Both reviews probably understate damages due to the difficulties of incorporating large-scale singular events in the estimates (e.g., reversal of the thermohaline circulation).

[144] Tol (2005). Note that these estimates tend to be "equity weighted," i.e., damages to the poorer countries have already been increased relative to damages to poor countries.

Strictly, the $50 tC cannot be compared to the range $20 to $80 tC for the costs of reducing emissions.[145] But, allowing for omitted impacts in the estimates of damage, it is possible that the long-run climate change target passes a cost-benefit test.

Slowing land degradation

Chapter 5 showed estimates of the costs and benefits of a program to slow land degradation. Table 5.5 indicated benefit-cost ratios in the range of 1.5 to 3.3 but with the suggestion that these might be understatements.

A survey of rates of return to soil conservation technologies suggests that measures vary according to their profitability. Agronomic measures such as tied ridges, contour planting, intercropping, no till, etc., generally (10 of the 12 studies) had benefit-cost ratios greater than unity (benefits exceed costs). The percentage passing a cost-benefit test thereafter fell to around 50 percent for vegetative measures (alley cropping, farm forestry, vetiver, gum Arabic, shelter belts, etc.), structural measures (rock dams, bunds, terraces) and management measures (animal traction, fodder banks, etc.).[146] Soil conservation measures may, however, be discouraged by high discount rates, underlining the need for access to credit to ensure that longer-term perspectives can be taken. If the discount rates of the poor are high (see Chapter 4, Table 4.1), and if investments in soil productivity are likely to generate returns in the medium[intermediate?] to long-run future, the poor are unlikely to engage in the "right" amount of soil conservation. This observation would be consistent with estimates of agricultural output loss from soil erosion.[147] However, it seems clear that a complex set of issues influence decisions about soil conservation:

- High labor costs of conservation can be important.
- Conservation may take land out of production which, for the poorer farmers, may result in substantial short-term forgone output and income.
- Up-front capital costs may be beyond the reach of farmers, especially where access to credit is limited.

A survey of soil conservation measures in the Caribbean and Central America reveals mixed results, shown in Table 6.3. This study suggests that rates of return can be very high. In a few cases, however, rates of return are below the discount rate used in the study (20 percent, which itself is high), and in two of the Costa Rica sites, the rate of return is negative. Here, erosion rates are very high but the soils are very deep, so that erosion has little or no impact on current levels of productivity, and conservation measures simply reduce crop output by diverting land from crops to protective measures.

If the studies for Central America and the Caribbean are representative, they suggest that the aggregate net benefits found in Table 5.5 (Chapter 5) disguise a widely varying and context-specific picture. Evidence that the scale of returns in other geographic regions is similar appears not to have been systematically documented, but partial surveys suggest that the picture is similar to that shown in Table 6.3.[148]

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[145] The issue is slightly technical. The $20 to $80 tC figure is an *average* cost of control. The $50 tC upper limit damage figure is a *marginal* figure. Marginal cost needs to be compared to marginal benefit (damage reduced) and there are reasons to suppose marginal cost will exceed average cost, so that the $20 to $80 range may understate the marginal cost.

[146] Knowler (2004).

[147] Various estimates have been made of the costs of erosion – see Lipper and Osgood (2002). FAO estimates suggest that 23 percent of all lands in forestry, agriculture and pasture are degraded to some degree.

[148] For example, see Bishop (2002) and UNEP (1991).

Table 6.3 Rates of return to soil conservation measures in Caribbean and C. America

Country	Conservation measure	Crop	Rate of return %
Cost Rica			
Barva	Diversion ditches	Coffee	Negative
Tierra Blanca	Diversion ditches	Potatoes	Negative
Turrubares	Diversion ditches	Coco yam	84
Turrubares	Terraces	Coco yam	60
Dominican Republic			
El Naranjal	Diversion ditches	Peas, peanuts, beans	17
Guatemala			
Patzité	Terraces	Corn	17
Haiti			
Maissade	*Ramp pay*	Corn, sorghum	Very large
	Rock walls	Corn, sorghum	Very large
Honduras			
Tatumbla	Diversion ditches	Corn	57
Yorito	Diversion ditches	Corn	22
Panama			
Coclé	Terraces	Rice, corn, beans	27

Source: Lutz et al. (1994). The rates of return are internal rates of return measured by changes in crop productivity. It should be noted that slowing land degradation is likely to have many other benefits, including global benefits for biodiversity and reduced global warming, see Pagiola (1999) and Gisladottir and Stocking (2005) for a discussion..

A detailed econometric study has shown that soil quality significantly affects the productivity of agricultural labor.[149] Good soils and climate generate a 28 percent increase in output per worker relative to poor soils and climate in sub-Saharan Africa, a 34 percent increase in Asia, and a 22 percent increase in high-income countries. The global average effect is 13 percent. The relevance here is that land degradation has the effect of lowering soil quality, so significant reductions in output can be expected, as is generally confirmed by other studies and by data such as those in Table 6.3.

Terrestrial ecosystem conservation

Whereas reversing land degradation involves remedial measures to land that has already been damaged, terrestrial ecosystem conservation aims to resist the pressures to convert land with generally diverse features and species to uses that result in less diversity (e.g., mono-cropping). Studies that allow for costs *and* benefits of Protected Areas or other conserved land (or marine) areas are few. At least two recent surveys have claimed that the benefits of conservation exceed the costs of conservation.[150] Unfortunately, the claims rest on unwarranted generalizations from very few case studies and other studies that use discredited methodologies.[151]

Forests: the role of carbon values

Table 6.4 summarizes the findings of a meta-analysis of forest ecosystem values. The survey suggests that the dominant economic value of forests lies in carbon storage and sequestration. Present values of carbon storage of $360 to 2,200 per hectare would more than compensate for many, although not all, conversion values for tropical forests, i.e., conservation would pass a cost-benefit test. The role of carbon payments in raising the returns to conservation has been shown to be crucial in a number of studies. The idea here is that payments would be made to communities that convert forest land to other uses in return for the value of the carbon saved. Table 6.5 summarizes the results of studies that estimate "switchover" values for carbon, –,i.e., the minimum value per ton of carbon that would have to be paid to prevent the land being converted. The carbon values shown are, therefore, the difference between the profits from converting the land and the profits from conserving it, allowing, as far as possible, for the costs of managing the conserved areas. The sums are fairly consistent and suggest that payments up to around $30 tC would make a considerable difference to the comparative economics of conservation and conversion.[152]

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[149] Wiebe et al. (2000).

[150] Balmford et al. (2002) and Turner et al.(2003).

[151] The Balmford et al. (2002) study concludes that "our synthesis indicates that, at present, conversion of remaining habitat for agriculture, aquaculture, or forestry often does not make sense from the perspective of global sustainability." The paper surveyed more than 300 case studies but found only five in which the information permitted a valid comparison of costs and benefits, i.e., the net benefits of conservation compared to the net benefits of land conversion. Thus this conclusion rests on just five papers, one of which relates to Canada. The paper then makes use of a discredited study – Costanza et al. (1997) – which sought to estimate money values for most of the world's ecosystems. Critiques of this study can be found in Pearce (1998), Toman (1998) and Bockstael et al. (2000). Unfortunately, Balmford et al. (2002) further use the Costanza et al. estimates to claim that an expanded protected area regime costing $45 billion p.a would be a "a strikingly good bargain."

[152] Smith and Scherr (2002) identify other studies where the cost of "supplying" carbon, i.e., the value of crops and other outputs forgone if carbon is conserved, might be up to $50 tC. Thus the economics will be location-specific.

Table 6.4 Summary economic values for forest services ($ ha/pa unless otherwise stated)

Forest good or service	Value in tropical forests
Timber	
conventional logging	200 to4400 (NPV)[1]
sustainable	300 to2660 (NPV)[1]
conventional logging	20 to 440[2]
sustainable	30 to 266[2]
Fuelwood	40
NTFPs	0- 100
Genetic information	0-3000
Recreation	2 to 470 (general) 750 (forests near towns) 1000 (unique forests)
Watershed benefits	15 to 850
Climate benefits	360 to 2200 (GPV)[3]
Non-use values	
Option values	n.a.
Existence values	2 to12 4400 (unique areas)

Notes: 1 Net present value; 2 annuitized NPV at 10 percent for illustration. 3 assumes compensation for carbon is a one-off payment in the initial period and, hence, is treated as a present value. It is a gross value (gross present value) since no costs are deducted. *Source*: Pearce and Pearce (2001)

Table 6.5 Illustrative switchover values for carbon to make conservation profitable

Type of project	Switchover value $ tC	Comment
Agro-forestry, Peruvian Amazon	8-31	Assumes farmers would forgo some payment in return for non-carbon forest environmental services.
Agroforestry, Mexico	15-31	For enriched fallows
Agroforestry, Sumatra	3-11	Lower bound required to compensate for forgone cassava production, upper bound for palm oil
Agroforestry, Brazil, Cameroon, Indonesia	< 11	
Protected area farms, Brazilian Amazon	15	One-off payment for carbon stock

Source: Smith and Scherr (2002)

Carbon storage and sequestration benefits could make forest conservation worthwhile relative to alternative uses of the land. The conclusion underlines the need to ensure that these benefits are fully accounted for in international greenhouse gas regulation regimes, e.g., through carbon trading markets and that the economic value of the carbon benefits is shared fairly with local communities.

Costs and benefits of forest conversion

Some attempt can be made to look at the likely costs and benefits of converting existing forests to alternative uses. A review of the available case studies suggests the following conclusions:[153]

- First, converting primary forest to any use other than agro-forestry or high-value timber extraction is likely to fail a cost-benefit test.

- Second, the conversion of secondary forest to the "cycle" of logging, crops and ranching could make *prima facie* economic sense. As with the primary forest conversion, however, it needs to be borne in mind that the "sequence" of land uses does not always occur and many conversions to slash-and-burn agriculture would make little economic sense.

- Third, the conversion of secondary forest and open forest to agro-forestry appears to make economic sense, assuming that most of the forest's services (including biodiversity) are retained.

[153] Pearce and Pearce (2001), and Chomitz and Kumari (1998).

- Fourth, for conservation to perform better than conversion, non-market values must generally be captured through some market-creation mechanism, i.e., non-cash flows of benefits are turned into cash flows.

- Fifth, the non-market values almost certainly fail to capture the economic value of biodiversity which, apart from the value of genetic information, tends to be omitted from the analyses.

- Sixth, carbon storage is of considerable importance to the economic case for forest conservation.

- Seventh, the benefits of ecosystem services from conserved forests may not all be lost when conversion takes place: It depends on what the forest is converted to. Hydrological benefits may not be very different if conversion is to plantations, for example.

Table 6.6 lists the results of various studies that record costs and benefits. Some studies show significant benefit-cost ratios from conservation or sustainable use, but others suggest that conversion may be profitable. This is likely to be the case, especially when the alternatives being considered are conventional logging/agriculture versus sustainable timber management (see following table for further analysis). Domestic benefits alone may not justify forest conservation: They need to be supplemented by other payments for environmental services, especially biodiversity and carbon.[154]

[154] Chomitz and Kumari (2003) conclude from this that the Global Environment Facility has an especially important role to play.

Table 6.6 Costs and benefits of conserving forest land

"Development" use of land	Benefit-cost ratio Conservation to Development	Comment	Source
Timber, Sinharaja, Sri Lanka	0.13-0.16	Development pays	Batagoda et al. 2000
Tea, Sinharaja, Sri Lanka	0.03-0.04	Development pays	Batagoda et al. 2000
Small farming, Mt. Cameroon,	0.7 to 3.1	Conservation pays	Yaron, 2002
Oil palm, Mt. Cameroon,	-	Conservation pays – PV of oil palm negative	Yaron, 2002
Cattle ranching, Costa Rica Atlantic region South North	 0.8 to 1.1 0.9 to 1.1 0.8 to 1.3	 Conservation allows for sustainable timber only, conservation can pay	 Howard and Valerio, 1996
Bean crops, Costa Rica South North	 0.6 to 0.7 0.4 to 0.7	 Development pays but conservation allows for sustainable timber only	 Howard and Valerio, 1996
Costa Rica, Corn, Atlantic	0.5 to 0.7	Development pays but conservation allows for sustainable timber only	Howard and Valerio, 1996
Ranching, Amazonian Ecuador	4 to 51	Non-timber forest products pay	Grimes et al.1994
Timber, Amazonian Ecuador	7 to 15	Non-timber forest products pay	Grimes et al.1994
Costa Rica, ranching	0.6	Development pays but conservation allows for sustainable timber only	Kishor and Constantino, 1993
Costa Rica, clear felling Costa Rica, plantations	0.7	Ditto	Kishor and Constantino, 1993
Veracruz, Mexico, cattle ranching,	0.3	Ditto	Kishor and Constantino, 1993
Cambodia, unsustainable logging	>1.0	Non-timber forest products pay	Ricker et al., 1999
Peruvian Amazon, slash and burn,	2.7	Conservation pays provided payments made for carbon	Bann 2002a
Malaysia, unsustainable logging.	>1		Smith et al. 1997
Madagascar, forest use	1.2	Assumes high damage from logging	Kumari 1996
Haiti, forest use	1.2	Conservation = Protected Area system	Carret and Loyer 2003
Kenya, use of forest for agriculture	0.8 to 3.75 >1.1	Conservation pays Omitted benefits means B/C ratio significantly higher	World Bank 1996 Emerton (2000c)
Indonesia, Leuser national park	1.4	Conservation pays relative to deforestation	van Beukering et al.

Table 6.6 omits some ecosystem services that have been considered in the literature to be potentially important. Biodiversity values have generally only been addressed by looking at global willingness to pay either through tourism or through payments into hypothetical funds. Expressed in per hectare terms, these values have tended to be small. But the economic valuation of biodiversity benefits is generally unsatisfactory – the issue is addressed later.

Table 6.6 shows that forest conservation may not always be beneficial. However, the alternative land use is important. The contexts where conversion clearly pays tend to be ones where the conservation option is sustainable timber management. As shown below, sustainable forestry systems are often less profitable financially than conventional logging systems. For the sustainable option to be *socially* preferable, non-timber benefits need to be monetized, shown to be larger than the financial deficit between the two systems, and the difference captured in market terms. The current state of information does not permit a clear conclusion on this issue. Some authors are very skeptical of the role that non-timber product extraction can play in justifying conservation. They argue that extraction is labor intensive and typically of low economic value.[155] However, only further collection of data on individual case studies can determine the extent to which this pessimistic view is correct. Table 6.4 suggests that there are some significant rates of return to be earned.

Forests and genetic information

For some considerable time it was argued that forest conservation could be justified economically because of the returns to investing in the genetic information contained in the forests, so-called "bioprospecting." Unfortunately, few attempts have been made to compare the economic values of bioprospecting with the alternative uses of the forest land. Most of the emphasis has been on the potential pharmaceutical information. Table 6.7 summarizes the available estimates in "dollars-per-hectare" format. The estimates differ substantially. If the lower estimates are correct, then pharmaceutical information has little value, even in the most genetically diverse forest areas. If the upper estimates are taken, then some of these values could compete with alternative land uses, especially agriculture and, to a lesser extent, forestry. Unfortunately, the debate over the values has not been resolved. Where previously it was thought that the way the studies model the "search" process by pharmaceutical companies explained the different estimates, it is now thought that the results differ because of different assumptions about the values of certain parameters.[156]

The "jury is out" on the economic value of genetic information in forests. The real test will be the actions of pharmaceutical companies in entering into contracts with governments and local communities to "bioprospect."[157]

[155] E.g., Wunder (2001).

[156] Costello and Ward (2003).

[157] Examples of such contracts can be found in ten Kate and Laird (1999).

Table 6.7 Estimates of the pharmaceutical value of "hot spot" land areas (maximum willingness to pay by bioprospectors, $ per hectare)

Area	Simpson *et al.* (1996)	Rausser & Small (2000)
Western Ecuador	20.6	9,177
Southwestern Sri Lanka	16.8	7,463
New Caledonia	12.4	5,473
Madagascar	6.9	2,961
Western Ghats of India	4.8	2,026
Philippines	4.7	1,973
Atlantic Coast Brazil	4.4	1,867
Uplands of western Amazonia	2.6	1,043
Tanzania	2.1	811
Cape Floristic Province, S. Africa	1.7	632
Peninsular Malaysia	1.5	539
Southwestern Australia	1.2	435
Ivory Coast	1.1	394
Northern Borneo	1.0	332
Eastern Himalayas	1.0	332
Colombian Choco	0.8	231
Central Chile	0.7	231
California Floristic Province	0.2	0

Source: Simpson et al., 1996; Rausser and Small, 2000.

Sustainable forestry and agro-forestry

A number of studies seek to establish the financial and economic profitability of sustainable forestry relative to conventional logging practices. The profitability of uncontrolled logging can be a significant obstacle to sustainable forest management, especially in the tropics.[158] Timber logging also attracts "rent-seekers" in several of the major forest nations, resulting in corrupt practices that further accelerate the removal of tree cover and neglect of investment in forest renewal. Many forest conservation options incorporate measures aimed at sustainable forestry.

Rates of return to sustainable forest management (SFM) have been extensively reviewed, and it is clear that sustainable forest management can provide reasonable rates of return.[159] But conventional timber harvesting is often more profitable still. This implies that without additional incentives, one cannot expect forest companies to adopt sustainable management practices. Those incentives require either (a) that consumers pay a premium on the price of sustainably logged timber, such that the premium compensates for the forgone rate of return, and/or (b) other forest services are brought within the scope of created markets, i.e., forest ecosystem services are paid for. In the absence of such incentives, the myopia (high discount rates) of many loggers, the low rate of growth of natural forests, the slow rise in international timber prices, political uncertainty, and tenure insecurity tend to reinforce the financial non-viability of SFM. SFM tends to perform better in terms of carbon storage and biodiversity conservation than in conventional logging, as well as producing more timber.[160]

Several case studies of the costs and benefits of agro-forestry are summarized in Table 6.8. The Sudan and Nigeria cases compare agro-forestry with crop schemes that do not integrate trees. The Peruvian study compares slash-and-burn agriculture with agro-forestry.

Table 6.8 Costs and benefits of agro-forestry schemes.

Scheme	**Rate of return (%)**
Sudan: *Acacia Senegal* with crops (Barbier 1992)	Positive for all regions. *A. Senegal* yields gum Arabic, fixes nitrogen and provides fuelwood. Acts as risk aversion strategy.
Kano, Nigeria: Shelterbelts Farm forestry (Anderson 1987)	 B/C ratios 1.7 to 2.9 B/C ratios 2.3 to 6.1
Peruvian Amazon (Mourato and Smith 2003)	Agro-forestry systems generate worse returns than slash-and-burn agriculture if time horizons are limited to a few years, but higher net returns over longer periods. High discount rates lead farmers to take a short-term view. Once account is taken of the value of forest services to farmers and of the potential for global payments for carbon storage, the returns to agro-forestry can exceed those of slash and burn. Carbon payments of $8-$31 tC would be needed to tip the balance.

[158] Definitions of sustainable forestry vary. Conventional timber harvesting is taken to refer to existing practice, which typically pays little attention to maintaining long-term timber supply. Sustainable timber management implies taking steps to ensure forests continue to produce timber in the longer term. Sustainable forest management also includes maintaining the environmental services and non-timber forest products, as well as consideration of social impacts.

[159] See Pearce at al. (2002a, 2002b) and Pearce (2003)

[160] The contrary view has been expressed by Rice et al. (1997) but on the basis of a small sample of forest areas.

Coral reefs

As with other ecosystems, considerable effort is being made to estimate the economic benefits of coral reef protection. Estimates suggest that, already, some 27 percent of all corals have been destroyed. But the same story emerges – few of the available studies consider the returns to the activities that destroy the reefs. An exception is a comprehensive study for Indonesia.[161] Table 6.9 shows the results. It suggests a considerable rate of return to conservation compared to current practices, which are degrading the reef. A study of coral reef *improvement* for Montego Bay, Jamaica, suggested that an "optimal" level of increased coral abundance would be some 13 percent compared to the current situation, environmental and tourist benefits being compared with the costs of sewage outfall control, waste aeration, and control of hotel and municipal waste.[162]

One attempt has been made to estimate the capital value of the world's coral reefs. Such procedures are hazardous since conservation of all reefs would alter prices and, hence, the valuation of the reefs. Moreover, the estimates extrapolate from a few studies. For what they are worth, Table 6.10 reports these global values.

Table 6.9 Costs and benefits of reef conservation in Indonesia. Present value. $000 per km²

Activity threatening the reefs	Forgone benefits of conservation = costs of conservation	Benefits of conservation[1]	Benefit-cost ratio of conservation
Poison fishing	33	43-476	1.3 to 14.4
Blast fishing	15	98-761	6.5 to 50.7
Mining	121	176-903	1.5 to 7.5
Sedimentation due to logging	98	273	2.8
Over-fishing	39	109	2.8

Notes: 1 – fisheries, coastal protection, tourism and other. Biodiversity benefits not estimated. Source: Cesar (1996).

[161] Cesar (1996).

[162] Ruitenbeek and Cartier (1999).

Table 6.10 Possible global values for the world's coral reefs ($ million)

	SE Asia	Caribb-ean	Indian Ocean	Pacific	Japan	USA	Austral-asia	World
Reef area 000km²	89	19	54	67	3	3	49	284
Fisheries $ million	2281	391	969	1060	89	70	858	5718
Coastal protection $ million	5047	720	1595	579	268	172	629	9009
Tourism $ million	4872	663	1408	269	779	483	1147	9621
Biodiversity $ million	458	79	199	172	529	401	3645	5483
Total annual value $ billion	12.7	1.9	4.2	2.1	1.7	1.1	6.3	29.8
Asset value $ billion	338	495	111	56	45	30	168	797

Source: Cesar et al.(2003).

Table 6.10 suggests that of the $30 billion or so *potential* annual economic value of coral reefs, some two-thirds would accrue to developing economies in SE Asia, the Caribbean, Indian Ocean and the Pacific. Two issues of relevance for pro-poor development arise:

- First, that potential value has to be realized.
- Second, once realized, it has to result in significant parts of the benefits accruing to the poorer communities.

Given the substantial size of potential conservation benefits, the question arises as to why reef-users do not cease their destructive activities and invest in the sustainable use of the reefs. The relevant factors are (a) many reefs are *de facto* open access resources, so that resource-rights regimes would first need to be established, (b) current users of the reef are not necessarily the same as the beneficiaries of reef conservation, e.g., coral mining would have to cease and alternative employment provided, and (c) attitudes to risk and discounting the future will also bias current users toward destructive activities – they will "mine" the reef rather than use it sustainably. Investing in conservation requires that net benefits from sustainable uses are first realized and then distributed so as to make current reef users no worse off with conservation than they were without it.

Just as potential benefit may not be realized for the reasons mentioned, so further preventable degradation of an existing valuable resource may also occur. A study of coral reefs in the Caribbean indicates that *existing*

revenues from the reefs are substantial. Sustainable harvest of coral-related fish is estimated at $300 million p.a., tourism benefits (especially dive tourism) at $2.1 billion, and shoreline protection at $0.7 to $2.2 billion. But the total benefit of $3.1 to $4.6 billion p.a. is threatened by reef degradation and losses totaling $350 to $870 million p.a. are estimated if current trends continue.[163]

A study of a coral reef marine reserve in Malaysia shows clearly that careful design of entry fees to the reserve would enable significant sums of money to be raised for conservation.[164] Estimated mean per person willingness to pay to enter the reserve was 20 ringits for foreign tourists and 9 ringits for local tourists, suggesting a two-tiered pricing system would extract the largest revenues. Taking an average of 16 ringits per person, the total revenue raised would be 1.5 million ringits, or about $0.4 million per annum. The main cost (not estimated) of the conservation area would be a sewage disposal system.

Wetlands and mangroves

Table 6.11 assembles the results of some case studies of mangrove and other wetland conservation. Table 6.11 suggests that the net benefits of wetland conservation exceed the net benefits of conversion to other uses. There are two caveats to this conclusion: (a) studies might suffer a "censoring" bias whereby wetlands with costs and benefits that are unlikely to favor conservation either tend not to be studied or might not be published, and (b), in one case (the Kuantu wetland in Taiwan), the value of the alternative use is measured by the cost to the government of purchasing the wetland: This may not be the same as the value in alternative use.[165]

Other studies of wetlands have focused on the nature of property rights and the value of the wetland. Thus, a wetland may appear to have a low asset value because existing property rights have resulted in the loss of component assets within the ecosystem. One study found, for example, that open access conditions in a Mexican wetland resulted in over-fishing, which had the effect of reducing the economic value of the wetland by over one-third.[166] The example underlines the importance of valuing assets according to their *potential* value when a rational resource-rights regime is in place, rather than their *observed* value when a non-sustainable regime is in place.

[163] Burke et al. (2004).

[164] Yeo (2002).

[165] The second point is acknowledged in the study in question.

[166] Barbier and Strand (1998).

Table 6.11 Cost-benefit ratios for wetlands conservation

Study	Scenario	Benefit-cost ratio	Source
Cambodia:			
Ream National Park	Sustainable use vs. depletion of resources	1.2	Estimated from De Lopez et al. 2003, Emerton et al. 2002.
Koh Kong mangroves	Conservation vs. shrimp farms	Shrimp farming unprofitable	Bann 2002b
Cameroon:			
Waza Lagone flood plain	Re-inundation of the floodplain, damaged by dam building	4.7 to 6.6 2.0	IUCN 2001 Loth 2004
Thailand mangroves	Conservation vs. shrimp farms	3.0	Sathirathai 1998
Philippines mangroves	Conservation vs. aquaculture	Negligible. Biodiversity benefits not valued	Janssen and Padilla 1999
El Salvador mangroves	Sustainable management vs. partial conversion or business as usual	1.4 to 2.3	Gammage 1994
Nigeria, Hadejia-Jam'are floodplain	Reversal of irrigation schemes which damage floodplain benefits	5.9 to 30.6	Barbier and Thompson 1998
Saemangeum wetland, Korea	Encroachment and conversion of wetland	1.2	Bae 2002
Indonesia, Bintuni Bay mangroves	Mangroves threatened by woodchip exports	1.0 to 1.2 (Assumes strong ecological linkages)	Ruitenbeek 1994
Kenya, Yala swamp	Conversion to agriculture	Negative returns to conversion	Ayoo 1998
Taiwan, Kuantu wetland	General development pressures	0.3 to 2.0	Hammitt et al. 2001
Uganda, Navikubo swamp	General development pressures	4.3 to 7.4	Emerton et al. 1999
Zambia, Barotse Floodplain	Agricultural conversion	1.03-1.04	Turpie et al. 1999

Fisheries

Like many other renewable resources, fisheries tend to be open access or common property assets. Unless communal management is strictly enforced, the *de facto* situation is one of open access and the consequence is over-fishing.[167] It is estimated that some 25 percent of the world's fisheries have stocks below the level corresponding to maximum sustainable yield, indicating sustainability, but 47 percent at are maximum sustainable yield, and 28 percent are above this level. Thus, a quarter of the world's fisheries are seriously over-fished, and a further half is on the verge of being over-fished.[168] Most fishermen are poor, and around 20 percent of the world's fisheries are fished by small-scale household and communal enterprises. Many fisheries are actively managed by communal interests, but even where Exclusive Economic Zones (EEZs) have been used to control access to marine fisheries, over-fishing still occurs, showing that proper national and communal management is still wanting. Policies to control fishing effort take many forms, including controls on mesh size, seasonality of fishing effort, and tradable quotas ("individual transferable fishing quotas"). Thus over-fishing is a problem shared in rich and poor countries, but rich countries have also sought access to developing country waters, generating a conflict with local fishermen. Much-needed licence revenues for coastal states come at the price of added pressure on limited fisheries. The incentive to over-fish is made all the worse by extensive subsidies to developed country fishing fleets, notably in the European Union.[169]

Cost-benefit studies of fisheries compare the benefits of better management regimes with the costs of establishing those regimes. Since sustainable management regimes for currently over-fished stocks will necessarily involve reductions in fishing effort, the costs of such regimes tend to show up as unemployment among fishermen. One study of marine fisheries in the Philippines that directly estimates the unemployment effect is illustrative. The study showed that significant over-fishing exists, and a substantial reduction in catch effort of some 65 percent would be required to secure maximum profits of around 20 billion pesos (around $670 million).[170] But some 466,000 fishermen would become unemployed due to the reduced harvesting. The cost of this unemployment would have to be greater than $1,400 per fisherman for costs to exceed benefits. As a reference point, income per capita (in 1994) was some $800. No policy that generated this much unemployment would be feasible. Instead, a gradual policy is required, involving (a) establishment of a strong monitoring and licensing regime; (b) efforts to prevent recruitment into the industry growing, so that retirements result in a gradual decline in fishermen numbers; and (c) possibly a transferable quota scheme to encourage high-cost fishermen to sell quotas to low-cost fishermen and to exit the industry.

An example of a successful state/fishing industry partnership to overcome over-fishing problems, and embracing new institutions of the kind discussed above, is the shrimp fishery of Madagascar.[171] In response to widespread concerns about the state of the fishery, a new set of long-term, tradable licences was established in 2000. The shrimping industry has benefited, and there are signs that sound sustainable management regimes are in place. An approximate evaluation of the scheme suggests a very acceptable benefit-cost ratio of 1.5.

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[167] "Over-fishing" has several meanings. In the ecological sense, it refers to a situation in which harvests exceed natural growth, risking extinction of the resource. In the economic sense, it means that existing harvesting effort makes the aggregate economic return from the fishery substantially less than it could be if effort was reduced. Open access conditions risk extinction of the resource but not necessarily. There is an "equilibrium" in which each user makes just enough profit to remain in the industry.

[168] FAO data – see www.fao.org/sof/sofia/index_en.htm.

[169] See WWF (1998).

[170] Israel and Banzon 1998). The monetary estimate is in 1994 prices.

[171] Rojat et al. (2004).

Wildlife

Investing in wildlife can help the poor in two ways. First, the development of wildlife tourism can generate significant revenues that can benefit the poor *provided* that benefits are shared fairly. Various property rights regimes may operate for such investments: Ownership may be by the state, by private sector interests or by local communities. In turn, ownership may be divorced or partially divorced from management: State-owned areas might be leased or licensed to local communities or to private sector interests. Second, the poor in many areas – rural and urban – depend heavily on bush-meat. Bush-meat tends to be hunted under de facto open access conditions, risking the local extinction of the food species. Hence, investment in licensing and resource-rights regimes could help to ensure a sustainable supply of bush-meat.

As with other investments in environmental assets, what matters is the overall rate of return to wildlife conservation and the way in which net returns are distributed among various stakeholders. The basic requirement is familiar: Unless local communities are actively involved in the schemes and do not lose because of them, there will be disaffection and potential conflict over the wildlife resource. Box 6.1 illustrates the problem.

Box 6.1 Does wildlife conservation pay at the national level?

Kenya is rich in wildlife and has invested heavily in the provision of tourist infrastructure to support wildlife-based tourism. But wildlife occupies land that could be used for crops and livestock. Hence, the benefits of wildlife conservation should be compared to the costs of administering and managing wildlife areas, any damage done by wildlife, and the forgone GDP due to the displacement of food production. One study in the early 1990s estimated that Kenya's "profit" from wildlife conservation amounted to only $42 million per annum compared to the forgone GDP of $203 million,[172] a benefit-cost ratio of just 0.2. A study for the Kruger National Park in South Africa suggests the opposite conclusion, with benefits exceeding forgone output and a benefit-cost ratio of nearly 18.[173] There are several reasons for the difference. First, much of the revenue from wildlife in Kenya goes out of the country to outside licensees. Second, the Kruger Park has limited alternative agricultural productivity, although land disputes are nonetheless not uncommon. Third, willingness to pay to see Kenya's wildlife is substantial, so that part of the problem is that only part of this willingness to pay is being captured in game park charges. A separate study placed this aggregate willingness to pay at $450 million p.a.[174] If all this willingness to pay could be captured, the Kenyan benefit-cost ratio would change from 0.2 to 2.2. This suggests careful analysis of park fees with a view to "extracting" more of the willingness to pay. Since these studies, entry fees have indeed been raised. The analysis shows the importance of measuring benefits rather than simply counting current revenues. There are implications too for looking at the structure of ownership and licensing within the resource-rich country, with a view to encouraging local entrepreneurs, so long as this can be done without damaging the wildlife asset. A study of Zambia's Protected Area estate suggests that current revenues of about $3.5 million p.a. are significantly less than current costs of $5 to $6 million p.a., producing a financial benefit-cost ratio of 0.6 to 0.7. But current lack of profitability tends to reflect the earlier stage of development of the park system, with revenues per hectare being far less than in more tourist-mature countries. This suggests that infrastructure development and good marketing could make the park system highly profitable for Zambia.[175]

[172] Norton-Griffiths and Southey (1995).

[173] Engelbrecht and van der Walt (1993).

[174] Moran (1994).

[175] Development Services and Initiatives (2004).

Table 6.12 assembles some of the information on rates of return to wildlife conservation. Conservation is construed widely. For example, crocodile farms have as their main justification skins and flesh from the crocodiles themselves, plus some associated tourism. However, by diverting attention away from wild crocodiles, farms may also reduce the pressure on wild populations.

Table 6.12 Rates of return to wildlife conservation ventures

Country and venture	Source	Rate of return or benefit-cost ratio	Comment
Namibia	Pearce (1999)		
Farm scale mixed wildlife/livestock.		3.9-5.8%	Financial internal rate of return: various studies. Low returns.
Game viewing.		4.2%	
Conservancies.	Barnes et al.(2002)	8 to 19%	Financial rate of return
		22 to 131%	High economic rate of return
		23 to 230%	Rate of return to communities
Botswana	Barnes (2002)		
Tourist lodge		27.5%	Very attractive return
Ostrich farming		11.0%	
Crocodile farming		19.0%	
Safari hunting		38.0%	Very high return
Game harvesting/trophies		28.0%	
Comparator investment - cattle		2.0%	Many wildlife ventures more profitable than cattle
Zimbabwe	Pearce (1999)		
Wildlife ranch		21.5%	Many wildlife ventures more profitable than cattle
Comparator investment - cattle		13.1%	
Kenya			
Community wildlife sanctuaries	Mburu and Birner (2002)	0.8 to 1.5 (B/C)	Some economic values transferred from other studies
State managed national parks		0.6 to 8.9 (B/C)	

Note: Where possible economic as opposed to financial rates of return have been estimated. Economic rates of return allow for distortions in exchange rates, etc.

Estimating rates of return provides only limited information on the returns to the poor. As noted above, benefit sharing is very important. All too often, wildlife conservation does not benefit the local community. For example, it is estimated that less than 1 percent of tourism revenues in the Maasai Mara National Reserve in Kenya accrue to local Maasai.[176] Reference was made earlier to conflicts between local communities and conservation authorities because of inadequate revenue-sharing and because of livestock and crop damage due to wildlife. Even where revenue-sharing is practiced, neglect of the reasons why local communities may not be motivated to conserve wildlife in the first place can put such schemes at risk. If the asset base of the poor is low, wildlife will tend to be seen as an exploitable resource. If conservation benefits are received in the form of social infrastructure this will benefit the poor if they can make use of it but will often not do much for the underlying reasons that poverty persists. Participating in community-based wildlife schemes may also come at the cost of forgone productive activity. In short, simply making reference to "benefit-sharing" as a precondition of sustainable wildlife investment is insufficient. Great care is needed in designing the schemes and ensuring that the asset base of the poor is enhanced rather than reduced by the schemes.[177]

A study of community-based wildlife conservancies in Namibia shows who has gained and lost from wildlife conservation.[178] First, the conservancies have improved local well-being through cash and non-cash income (especially meat distribution) and through community benefits. Second, in some cases, the poor have gained proportionately more than the less poor. In other cases, the benefits have been neutral with respect to income groups. Third, those who participate in the schemes have gained but not significantly more than those who did not participate. Fourth, the early conservancies have attracted most participation and local benefit, suggesting that as awareness increases and experience is gained, local benefits will increase. The analysis shows that such schemes can be designed to be at least "poor neutral" but with the possibility for them to be pro-poor as well. Table 6.10 shows the very high rates of return that have been earned on most of the conservancy schemes in Namibia. The returns to local communities are especially noteworthy.

The evidence suggests that wildlife conservation can certainly generate positive rates of return. Table 6.12 suggests that for Africa those rates of return exceed the more traditional forms of land use, such as cattle ranching. Recognition of this fact explains why a number of major conversion activities have taken place in Southern Africa, away from cattle to mixed ranching and tourist-based conservation. But the story on benefit-sharing is not so clear. As with the previous discussion of Protected Areas, conservation schemes can harm local communities. The issues that matter are:

- ensuring that local communities are at least no worse off than before the conservation project, making full allowance for shared revenues and losses from wildlife damage.

- Ensuring as far as possible that the asset base on local communities is enhanced.

- Paying careful attention to the form of any asset-base increase, i.e., increasing assets that give the poorest in the community help to generate future income.

[176] Emerton (2001a).

[177] For an extensive discussion, see Emerton (2001a).

[178] Bandyopadhyay et al. (2004.)

Far less attention has been paid by economists to the bush-meat trade. Yet the problems associated with the trade are very serious.

- First, the poor rely extensively on bush-meat. In equatorial Africa it is estimated that some 1.2 million tons of bush-meat are consumed each year, equivalent to 35 kilos per capita.[179]

- Second, although bush-meat hunting is ostensibly licensed in some countries, the *de facto* situation is that it is an open-access resource, so that the prospects of sustainable hunting are very low and risks of some of the larger species (e.g., great apes) becoming extinct are correspondingly high.

Efforts to control the trade, both within national borders and across them, are under way.[180] However, there are formidable problems of:

- Knowing just what trade is going on.

- Counteracting current preferences of consumers for bush-meat over farmed meat, especially given price differences.

- Inducing changed behavior by hunters, given that it is a low-cost, potentially high-return activity. Not "compensating" hunters will render conservation efforts very unlikely to work.

- Farming of the most desired species, which has not always been successful.

- Policing the very large area of land (and water) that is involved.

- Implementing any viable compliance scheme.

- Securing the collaboration of the various agents involved, ranging from the hunters themselves, intermediaries and retailers, the consumers, forest authorities and local government.

- Implementing community-based schemes when those outside the community are involved in hunting. Outsiders do not face community incentives to cooperate.

- Invoking any legislation that may exist.

- Established international controls via Convention on International Trade in Endangered Species of Wild Flora and Fauna (CITES) operate only when cross-border trade occurs.

No cost-benefit studies of bushmeat control measures have been identified.

Ecosystems, diversity and resilience

Although ecologists have long considered the relationship between biodiversity and the ability of ecosystems to respond to external shocks and stresses ("resilience"), economic analysis has been slow to respond to the challenge of assessing the economic importance of diversity per se. In the view of some, the main consequences of biodiversity loss lie in the loss of resilience that in turn will show up mainly in losses to local communities rather than to the global community. Moreover, once the focus is on the way ecosystems change in response to

[179] DfID (2002b). Equatorial Africa is Cameroon, Central African Republic, Democratic Republic of Congo, equatorial Guinea, Gabon and the Republic of Congo.

[180] For a brief review, see DfID (2002b).

stresses and shocks, it is important to note that the processes of change may not be "linear." For example, a modest change may result in some dramatic effect rather than an equally modest one. The process of change is marked by *discontinuities* and potential *irreversibilities*. Equally, some major changes may have little effect on the system. Resilience measures the degree of shock or stress that the system can absorb before moving from one state to another very different one. Diversity, it is argued, stimulates resilience perhaps because individual species threatened or affected by change can have their roles taken over by other species in the same system. The smaller the array of species, the less chance there is of this substitution process taking place.

From an economic standpoint, the issue is one of identifying and measuring this insurance value. Unfortunately, neither is easy. Identifying how close a system might be to collapse of some or all functions is itself extremely difficult, yet one would expect willingness to pay to avoid that collapse to be related in some way to the chances that the collapse will occur. If the chances are known, the value sought is then the premium that would be paid to conserve resilience. Suggestions include the entire cost of managing non-resilient systems, since these costs would be avoided if more diverse and more resilient systems are adopted. In the agricultural context, for example, this would make the premium equal to the entire cost of ensuring that intensive agriculture is maintained, including such things as fertilizer and pesticide costs. Inverting the process, it could be argued that the premium is approximated by the cost of all the losses incurred by maintaining a resilient system. If, as is sometimes argued, diverse/resilient systems are lower productivity systems, then the loss of productivity from maintaining a resilient system might be thought of as the economic value of resilience, i.e., as the resources that have to be sacrificed to maintain diversity.

At the moment, no major effort has been undertaken to value diversity and resilience economically. This is unfortunate, given that loss of resilience is likely to be a cost borne by the poor. Essentially, this bias will arise because richer households can afford to sustain losses whereas the poor cannot. Richer people can also afford a wider portfolio of assets. The poor cannot. If the argument that resilience is very often a local benefit rather than a global benefit is correct, then it is local communities that will suffer most.

7 Policies for Successful Environmental Investment

7.1 Financing investment needs

Environmental investment does not just happen. Most of the return accruing to environmental investments does not show up in the marketplace, unless markets are created for the benefits in question. Hence, the free market will tend to under-invest in environmental assets. This suggests two broad policy implications:

- Governments, global agencies and NGOs must finance many of the required investments. More rigorous studies of the likely social rates of return to those investments will help justify investment decisions. Government involvement will be all the more necessary given that, along with other market imperfections, individual, household and corporate discount rates will militate against such investments. Additionally, many of the investments will have strong "public good" characteristics, which means that private interests are even less likely to result in the right amount of investment.[181] This underlines the traditional role of the bilateral and multilateral agencies but with the emphasis firmly on creating and protecting environmental assets that generate benefits for the poor. It would further confirm the role of the Global Environment Facility as the major agency investing in assets that generate *global* benefits. Debt-for-nature swaps are further instances of bilateral and multilateral investments. Also within this category would be included NGO payments for environmental services, where NGOs act on behalf of their membership or on behalf of "the global citizen."

- Private sector interests could invest in some of the environmental "sectors" if suitable markets could be created in the assets in question. Indeed, one of the major challenges is to attract private sector investment into environmental-asset creation. Obvious examples already occurring include carbon offsets and trading, eco-tourism, downstream investments to protect upstream assets (e.g., hydropower companies paying for forest conservation), sales of intellectual assets (e.g., forest genetic information), etc.

Whether the investing agent is governmental, NGO or private sector, investment will not occur without the right conditions being present. Investments frequently "fail" – what looks good on paper often ends up not working. All kinds of reasons explain this "investment failure." Major concerns relate to political and financial risks in the host country, corruption as a factor that dissipates rates of return to the investing agent and to the targeted beneficiaries, and risks that the benefits of investments will be directed away from the poor. In this last respect, secure property rights to the benefits must be established. The targeted poor must also have a "voice," for fair redress of grievances and must be an integral part of the design of investments. None of this is new and the obstacles to sustainable investment have long been familiar. The difference is that the prior issue of showing such investments to be worthwhile still needs to be brought to the fore.

The sections that follow are organized as follows:

- Sections 7.2, 7.3, 7.4 and 7.5 discuss policy, social capital, governance and resource rights;

- Sections 7.6, 7.7 and 7.8 discuss market-based approaches to environmental improvement, either changing current prices or by creating markets in environmental assets;

- Sections 7.9, 7.10 and 7.11 discuss credit, insurance and financing of environmental investment.

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[181] A "public good" is one that when provided to one person tends to be provided to another, without the consumption of the first person affecting the consumption of the second. Clean air would be an obvious example. The geographical extent of the "publicness" will vary – clean air may affect one household (e.g., indoor air), hundreds, thousands or hundreds of thousands of people. Climate change control will affect billions of people.

7.2 Assets and policy

Chapter 5 outlined the nature of the investment challenge to meet MDG 7 or associated goals. Investment creates assets, and assets offer the opportunity to escape poverty, providing other conditions hold. For investments to work, the right policy context must be in place – i.e., there must be a capacity to manage the investments, ensure that they continue beyond the period of involvement of any aid or government agency, and are not distorted by prices that markedly diverge from the true costs of production.

Chapter 2 suggested that the poor are poor because they do not accumulate assets, where assets need to be very broadly construed in social, man-made capital, environmental and human capital terms. Much of the evidence suggests that the most important asset is human, i.e., education and health status.[182] But such an emphasis should not lead to neglect of other assets, especially environmental assets.

- *Chapters 3 and 4 argued that environmental assets are an important part of household wealth – e.g., access to forests and wetlands, the protective functions of many ecosystems (watershed regulation, for example), and the role of these assets as insurance in times of economic distress.*

- *The different assets interact. Access to natural resources and environmental quality are vital ingredients of human health, and ,hence, human capital.[183] Resource scarcity and poor environmental quality add to the chances of morbidity and early mortality. There may be other, more complex, links – land degradation and low productivity may force families to withdraw children from school to work on the land or collect natural resources, thus impairing human capital. In short, asset formation cannot be seen in terms of isolating "the" highest return asset since, even if human capital does dominate in social rates of return, environmental (and other) assets influence human capital formation.*

The next question is why is it so often the case that the poor do not accumulate assets? The poor face a substantial array of perverse incentives that force them into the "non-accumulation" mode. Incomes can be thought of as depending on:

- The ownership or access to capital assets;
- The rate at which those assets are used to generate income;
- The market value (price) of income-generating assets;
- The non-market (in kind) value of the non-market assets (especially social and environmental assets); and
- Any income transfers.[184]

Anything that adversely affects these determinants will adversely affect asset accumulation. In the poorest communities, there is a combination of factors that drive asset formation down to subsistence level. However,

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[182] For example, see Attanasio and Szekeley (2001).

[183] It seems fair to say that environmental economists have not paid enough attention to demonstrating the quantitative effects of resource scarcity and environmental quality on labor productivity via the human health link. For an attempt see Bhargava et al. (2000), who find a clear link between health and growth in low-income countries.

[184] This is a slight reformulation of the function suggested in Attanasio and Szekeley (2001) that excludes the non-market environmental assets.

focus on the last – income transfers – is unlikely to be a sustainable poverty-reduction strategy since it ignores asset formation. Indeed, such transfers might (understandably) be taken up as additional consumption in contexts where discount rates are high and access to credit and insurance is low.

This chapter looks at some of the main "contextual" factors affecting the profitability and sustainability of investments.

7.3 Social capital

Social capital is the most difficult capital asset to measure. Social capital relates to sets of interpersonal and inter-institutional relationships in society. The better these relationships, the greater the degree of trust, the lower the transactions costs of economic exchange and, therefore, potentially, the higher the chances of sustained development. In the absence of trust, any contract between different agents in the economy will be subject to uncertainties about completion. Distrust, therefore, requires institutions and the rule of law to ensure that contracts are honored. Valuable resources are devoted to these monitoring and enforcement activities rather than to wealth creation itself. As such, there should be a positive association between social capital and economic development. The available literature is inconclusive on this link: Some authors find distinct and significant effects on economic growth; others find limited evidence to support the view that social capital matters. Even less appears to be known about the links between social capital and poverty reduction.[185]

Numerous indicators have been suggested for measuring social capital. Social capital may often be recognized through indicators of its decay – e.g., crime rates – as measures of social insecurity. Even expenditures on policing might give some measure of social insecurity. At the political level, there are now quite widely used indicators of political freedoms, corruption and good governance. These tend to rank whole countries, and various statistical efforts have been made to determine the role that they play in securing or inhibiting rising living standards. Widely used indicators of social capital come from international social surveys that include standard questions about the degree of trust among individuals. Finally, the early literature identified the number and population density of voluntary organizations as an indicator.

Social capital is readily destroyed by perverse incentives. For example, subsidies constitute rents and rents generate "rent-seeking," a process whereby interest groups seek to maximize their share of the rents rather than engaging in any economic activity that increases overall well-being. Rent seeking involves lobbying and, ultimately, corruption. In turn, corruption destroys trust in institutions: People no longer trust governments, regulators and government agencies, knowing them to be overly influenced by those who can exercise political power and influence. Bribes become central to the "working" of bureaucracies and the less privileged have less capacity to pay the bribes. Thus there is both an overall economic inefficiency – a diversion of resources into unproductive activity – and an equity issue: The poor are generally excluded from the process that allocates the resources.

Environmental degradation is also linked to the destruction of social capital. Where communal management works, environmental assets are frequently well managed through local associations and community groups. As resource scarcity and environmental degradation set in, community cohesiveness comes under strain and there is a temptation to abandon the rules governing access and use of communal environmental assets and to pursue individual gain at the expense of the group as a whole. In this way, social capital tends to break down under conditions of environmental degradation. In turn, losing social capital amounts to losing the relationships of care and concern for fellow human beings. Societies that are more selfish also tend to be less caring of the

[185] The early, non-quantitative essays linking social capital to development were Putnam et al. (1993) and Fukuyama (1995). Strong quantitative links among measures of trust (as expressed in international social surveys) were found by Knack and Keefer (1997). Later work found the linkages to be complex, so that the existence of a positive effect tended to depend on the presence of other factors ("conditioning variables") – see Beugelsdijk et al. (2002).

natural environment. Although these may be the anticipated relationships, empirical links between social capital and environmental quality have been difficult to determine. Analysis of the formation of collective action suggest the rapid growth of groups dedicated to environmental improvement, while other communal arrangements have been destroyed by various factors, including nationalization and privatization of resources.[186] The policy lesson relates to what can be learned from these gains and losses in social organization. In Nepal and India, for example, the granting of access rights and concessions to forest use produced more than 20,000 user groups, i.e., a reallocation of resource rights produced the social capital necessary to protect and manage those rights.[187] Others have questioned whether there is any significant link between social capital and environmental quality.[188]

Can social capital be created by policy? Here again, the messages seem fairly similar to those for institutions and property rights in general. There are no "blueprints" that can be imposed from the outside. Recognition that there is an environmental problem may bring a society closer together – a problem shared might be a problem lessened. But there will also be the risk of a "race to the bottom" as people chase after what is left of increasingly scarce assets. Creating a collective interest in resource conservation – a form of collectively agreed mutual coercion – is thus very difficult. Analysis of the history of cooperative movements suggests that governments have no advantage in "stimulating" social capital, and efforts at intervention may in fact be counterproductive[189]. "Bottom-up" cooperation, emerging on a voluntary basis, tends to be more sustainable than "top down" initiatives, which may work initially but tend to be short-lived. If this is correct, and that part of the literature that addresses the issue of "creating" social capital tends to suggest it is,[190] then social capital formation is a slow and long process, and not something that can be enforced or even stimulated significantly by external forces. But the Nepal example and others show that *removing obstacles* to communal organization can generate spontaneous formation of social capital. In short, government actions are best focused on creating the right conditions for communal management, rather than looking for ways of actively producing local entrepreneurs and community spirit.

7.4 Governance

It is now widely accepted that governance matters for effective policies to address poverty, and that it matters for the efficiency and sustainability of investments.[191] The more democratic the institutions, the more likely it is that economies will respond to external shocks and crises.[192] Thus, democracy facilitates any change in political rule, enables politicians to listen to popular concerns, without which any new regime will face further instability, and gives the greatest assurance of a consensus. Corruption militates against any sense of fairness and injustice, prompting instability or inviting the non-corrupt to adopt the same behavior. Corruption implies that substantial efforts are being made by the corrupt to secure larger shares of the available resources, rather than devoting that effort to improving the scale of the resources available to everyone.

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[186] See Pretty and Ward (2001).

[187] On this and other examples, see Pretty and Ward (2001).

[188] See Grafton and Knowles (2004).

[189] Paldam and Svendsen (2000).

[190] Putnam et al. (1993); Paldam and Svendsen (2000).

[191] On political instability and economic growth see, for example, Perotti (1996). On corruption and growth see Mauro (1995). One study finds that investment performance is positively linked to civil liberties but not to political liberties – see Islam et al.1995.

[192] See Rodrik (2000).

Indicators of governance have been developed and tend to include:[193]

- Corruption and anti-corruption measures;
- "Voice" and accountability, e.g., the extent of human rights;
- Political instability;
- Violence;
- Effectiveness of governments – quality of public services, competence of the bureaucracy;
- Quality of regulation – the extent to which regulations inhibit market forces;
- Rule of law.

For current purposes, what matters is the extent to which the quality of governance affects the effectiveness of pro-poor investments and pro-poor policy. One obvious way in which poor governance inhibits pro-poor policy is through the creation of rents arising from investments and which are then captured by the better-off. The degree of capture will be greater the more corrupt the political system. In the extreme, some investments may never actually be "delivered" at all if the finance is diverted elsewhere.

On a more positive note, all the studies of governance and income growth support the view that better governance is strongly associated with higher income growth. In so far as income growth "trickles down" to the poor, then the poor will benefit from better governance. The issue is complicated by the fact that the causal association works both ways: Better governance creates a better policy environment, which enables opportunities for asset formation to increase, but higher incomes generate a demand for better governance as well. But the available evidence seems to suggest that the former causal link is stronger than the latter. The intuitive judgment that governance matters for economic development is borne out by the evidence.

7.5 Resource rights and institutions

"Institutions" refer to the social and legal norms of behavior in a society. These norms, and the ways in which they are enforced, determine the extent to which individuals combine to undertake collective action. If institutions are inefficient and cannot cope with changing conditions, then societies cannot adapt and what may already be a situation of poverty may simply get worse. This was the essence of the "Lopez model" outlined in Chapter 4. In the environmental context, the most obvious issue is the presence of "open access" conditions for many natural resources, i.e., conditions in which no one owns or collectively manages the resource in question. Institutionally, there are no rules to restrict exploitative behavior to the resources. If there were, open access would be converted to communal or private property. Provided the rules can then be maintained and enforced, they may enable the resource to be used sustainably. For this to happen, however, mechanisms are needed for dealing with rapid population growth (natural or migratory), which can quickly return the resource to open-access status. In short, institutions must emerge to change the resource rights and to enforce them.[194]

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[193] Kaufman et al. (2005)

[194] The usual term for resource rights is property rights. Resource rights is the term generally used here since it makes it clear (a) that rights extend over a very wide range of assets, and (b) ownership is not always involved. More relevant than ownership is control. Ownership without control is ineffective. Control without ownership can be effective.

The relevant rules for managing natural resources will comprise:

- Access rules – these regulate who can use the resource, the relative shares of effort that might be used to exploit the resource, and the ways in which the resulting output might be shared;

- Conservation rules – rules about the maintenance of the resource, including new investment (e.g., expanding fish stocks, growing trees).

Clearly, both are vital if the household environment asset base (its share of the communal asset) is to expand. Again, since the resource itself tends to be finite, rapid population growth not only makes it difficult to increase any one household's share of the communal asset, it also threatens the rules of behavior necessary to manage the resource. Moreover, common property by itself is not sufficient for sustainable management – many environmental assets are held "in common" but without regulations on use being in place.[195] Other forms of resource-rights regimes are, of course, possible. But experience with state regimes (nationalization) has been discouraging: The state, after all, has no more comparative advantage in managing natural assets than the community in general. As is well known, *de jure* state property, as with many forests, quickly becomes *de facto* open access (a) because the state has no means of enforcing regulations, even if they exist, and (b) because rent-seeking and corruption quickly take over. Privatization may be warranted in other cases, e.g., game parks, where specialist expertise in management is needed. But, like state ownership, privatization can quickly be captured by special interests to the detriment of the poor. Box 7.1 looks at the links between resource-rights regimes and incentives to invest in assets.

[195] Baland and Platteau (1996) distinguish regulated and unregulated common property to underline this distinction.

Box 7.1 Resource-rights regimes and the incentive to invest

Which resource-rights regime is best for environmental improvement? In some cases environmental assets are public goods with a broad geographic domain. A public good is one that when provided to one person tends to be provided to all ("non-rivalry") and where the ability to exclude individuals from sharing the benefit is small or non-existent ("non-exclusion"). Clean outdoor air would be an example. Accordingly, households and communities tend not to be able to provide clean air. It is provided by the state or perhaps by local government. At one extreme, avoiding the damage done by climate change is an example of a global public good, and this can only be provided by the world community in general. No single government can provide it. But many environmental goods are localized public goods or have public good characteristics up to some point when the good becomes congested. A local fishery is an example. It is a public good in that a number of fishermen can exploit it without reducing the catch of any one fisherman. But as more fishermen are added, the stock of fish begins to deplete and the catch of any one person is at the expense of the catch of others. The table below outlines the incentives that individuals have to invest in capital assets under various resource-rights regimes.

Regime	**Man-made capital**	**Human capital**	**Social capital**	**Natural capital**
Open access	Risk of "stranded capital" if lose right of access	Resource scarcity may divert children from school, reducing human capital	Likely to decline as conflict grows over scarce resources	Low to zero incentive to conserve resource
Common property	Collective ownership, e.g., of farm machinery	Community may encourage education, etc.	Strong communal incentive to maintain rules, etc. Greater equity is likely.	Common interest in resource conservation
Private ownership	Profit motive dominates and returns may be higher than under alternative regimes	Security of revenues should encourage investment in human capital	Strong demand for rule of law to protect property.	Risk of "resource grabs" by elites. Need for laws to cope with externalities.
State ownership	Depends on sensitivity to public opinion: many state enterprises under-invest.	Strong if state has long-run goals on public goods and is sensitive to public opinion.	State can do little to create social capital, but may enable conditions for encouraging it.	State has no comparative advantage in managing natural assets. Might lease to private sector/ community.

All this points to the *prima facie* desirability of well-enforced communal resource rights. The huge literature on common property finds that many of these regimes are very successful, but many fail. A full understanding of what determines success and failure is still wanting.[196] More importantly, what can policy do to assist the emergence of efficient common property institutions? Surveys of resource-rights regimes point to salient factors that are probably involved in successful regimes:[197]

- The smaller the community, the better.
- Enforcement of access and sharing rules is quite subtle and non-punitive – negotiation with and persuasion of offenders is common.
- The gains from cooperation need to be large relative to the "go it alone" (non-cooperation) strategy embodied in open access.
- State intervention is usually destructive of common property – as noted above, the state has no comparative advantage in resource management and will usually lack local knowledge.
- More equitable sharing of benefits probably contributes to trust and, hence, to stable management. In some cases, those who appropriate major shares of the resource benefits may nonetheless be induced to provide others with reasonable shares of the resource.

Probably the most important finding is that, if the common property regime works – i.e., there is reasonable satisfaction with it, and resources are being used sustainably, policy-makers should leave it alone. It is more likely that institutions will evolve "naturally" without the help of policy than with it. This does not mean that whatever institutions do or do not emerge are "optimal" – risks of breakdown will remain. It simply means that the risks may be greater with outside intervention than without it. Nonetheless, there will be a role for recognizing and supporting local management rules and regulations, perhaps legally. There is also a major role for consultative and educative programs where open-access regimes are clearly failing, so long as these take the participants to the point where they recognize the scarcity problem they face, understand that unregulated access is a cause, and willingly cooperate to solve it. It seems very unlikely that any regime can be imposed from the outside: The common property literature is very clear that what works in one location may well not work in another.

Land rights are correlated with income growth, i.e., higher incomes are linked to land assets. Where land is abundant, its commercial price will be low, and households will tend to invest in assets that use abundant land, e.g., livestock. Resource-rights regimes will tend more toward open access. Where land is scarce, the land itself has high market value, and resource-rights regimes will tend more to private ownership. As is well known, the true range of resource rights is extremely varied – outright ownership, rights to resources but not the land, rights to some resources but not others, time-of-year access rights, restrictions on whom rights can be sold to, and so on. Again, these rights have evolved with time and, hence, they have their own rationale. Redesigning the land-rights system because asset formation appears not to be advancing is thus fraught with difficulty.[198] Nonetheless, it cannot be assumed either that what has evolved is "optimal" – many factors may inhibit the right kind of adjustment to changing conditions, especially resource scarcity. As an example, the community itself

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[196] Game theory provides many of the insights but also shows that it is hard to predict how the "players" (the households, in this case) will respond to changes in incentives. For extensive reviews of the workings of common property regimes, see Berkes (1989), Stevenson (1991), Baland and Platteua (1999) and Ostrom (1990).

[197] This list is taken from Heltberg (2002).

[198] One school of thought would argue that it is not even necessary to intervene at all. As population expands, resource scarcity will become apparent, and institutions will adapt without help. This is the view associated with Esther Boserup – see Chapter 3.

may not recognize the factors that have generated the scarcity. Again, intervention needs to have a "light touch" – gently probing the problem and the community's responses to that problem, being sure to bring the community to its own solution rather than an externally imposed one.

Land titling may often be a requirement for better resource management. Secure titles can provide security for investments in soil and water conservation, provide collateral for credit (see below) and encourage land to move to its highest product use if a land market develops. Although this is the theory, practice has not always produced these results and policy-makers need to understand why.[199] In other cases, titling, or the prospect of it, may actually encourage squatters and migrants to take over land in the expectation of being granted rights to it, producing all kinds of tensions and conflicts.

The general outcome is that the whole issue of resource rights, and land rights in particular, is complex and almost certainly location specific. It does seem clear that some policy measures are needed – the argument that resource-rights regimes will simply evolve in the face of environmental and resource scarcity problems to be "optimal" is hardly credible. But intervention has to be tuned to the community's needs, culture and history as far as possible, and, above all, the community has to be encouraged to generate its own solutions once the scarcity problem has been clarified.

Conclusions of this kind may seem frustrating. There is a demand for policy prescriptions on institutions that are generalizable and easily reduced to several propositions. But what is known about institutions and economic development suggests that *institutional diversity* exists, i.e., several different kinds of institutions are consistent with the same goal, and there may be as yet untried institutions that will do even better.[200] This does not mean that *any* set of institutions will suffice. Experience with state ownership suggests that market-based approaches that rely on private property rights are generally much better, but there must be strong public institutions, and there is a diversity of institutions that can fit the bill. If the economy is not already market-based, then changing it to one oriented to free markets means making sure that any changes are consistent with the prevailing institutions. Finally, even these prescriptions are directed at securing *overall* economic development. Ensuring that development is pro-poor means ensuring that both markets and public institutions are sensitive to the needs of the poor. This point was emphasized in Section 7.4 in respect to environmental policy instruments: Transposing them from one context to another without ensuring they fit both market characteristics and existing institutions is a recipe for failure.

7.6 Subsidies and trade protection

Subsidies form one substantial part of the general problem of inefficient pricing in poor countries. But inefficient pricing is not confined to the poor world, and international trade means that the poor are also affected by perverse pricing in the rich countries. By and large, the subsidy story is well known and has been extensively reviewed.[201]

Table 7.1 summarizes some estimates of the scale of subsidies at the global level. This table suggests that globally subsidies run at more than $1 trillion per annum. Table 7.2 presents data on subsidies as a percentage of the relevant national incomes. This table shows clearly that Eastern Europe had the highest level of subsidies relative to GDP in the 1980s. The situation since then has changed rapidly as subsidy regimes are being reduced. Significantly, after Eastern Europe the European Union has the highest share of subsidies to GDP.

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[199] For a useful discussion, see Heltberg (2002).

[200] See Rodrik (2000)

[201] See for example, OECD (1996, 1997, 1998); de Moor and Calamai, 1997; Myers and Kent, 1998; van Beers and de Moor, 2001; van Beers and van den Bergh, 2001; Porter, 2002).

Table 7.1 Global subsidies 1994-8 ($ billion per annum)

	OECD	Non-OECD	World	OECD subsidies as % of World subsidies
Natural resource sectors:				
Agriculture	335	65	400	84
Water	15	45	60	25
Forestry	5	30	35	4
Fisheries	10	10	20	50
Mining	25	5	30	83
Energy and industry sectors:				
Energy	80	160	240	33
Road transport	200	25	225	89
Manufacturing	55	negligible	55	100
Total	**725**	**340**	**1065**	**68**
Total as % GDP	3.4	6.3	4.0	

Source: van Beers and de Moor (2001), p. 32

Table 7.2 Subsidies as a proportion of GDP 1983-90

All countries	2.5
Industrialized countries	2.9
European Union	3.6
Developing countries	1.5
Africa	1.6
Asia	1.1
Middle East and N Africa	2.7
Western Hemisphere	1.0
Eastern Europe	8.4

Source: Schwartz and Clements (1999)

Two broad effects of subsidies are relevant:

- Subsidies on traded goods produced in developed economies adversely affect production in poor countries;

- Subsidies in poor countries frequently degrade the environment by making the subsidized resource artificially cheap, contributing directly to environmental asset poverty and the negative interactive effects on human capital noted above.

The poor are often not the beneficiaries of developing country subsidies, which tend to be "captured" by richer groups.

Effects of developed country subsidies

Although a substantial part of the benefit of OECD-country subsidy removal (mainly agricultural subsidies as Table 7.1 shows) would accrue to the OECD countries themselves, removal would also generally benefit the developing world, and, according to several sources, particularly sub-Saharan Africa.[202] What is not always recognized is that this formidable income loss – roughly twice the level of official foreign aid to developing countries – itself has environmental consequences. As Chapter 4 detailed, poverty itself is directly linked to environmental degradation as economic agents seek to utilize the "free" resources of nature to supplement meager incomes. Local people will also have to switch to more marginal environmental resources if they cannot compete with subsidized exploitation of more plentiful resources by protected rich countries, a feature that is especially important in fisheries.

Table 7.3 summarizes one estimate of the losses to developing countries from subsidies and protectionist policies in both rich and poor countries.

Table 7.3 Effects of protectionist policies on developing countries (losses, $ billion per annum)

Benefiting region	Liberalising region	Textiles, clothing	Other manufactures	Agriculture and food	Other primary markets	Total
Developing countries	Rich	9.0	22.3	11.6	0.1	43.0
	Developing countries	3.6	27.6	31.4	2.5	65.1
	Total	12.6	49.9	43.0	2.6	108.1

Source: Anderson et al. (2001)

[202] Anderson et al. (2001); Tokarick (2005). Sub-Saharan Africa countries do secure some gains from subsidized access to European Union markets.

An example of a far more complex set of subsidies in rich countries that harm poor countries' well-being is fisheries. Table 7.1 suggests that global fishery subsidies amount to around $20 billion p.a. Only about 5 percent of these subsidies support conservation measures – 95 percent directly or indirectly encourage overexploitation. Although many of the subsidies in rich countries have negative effects on fish stocks in those countries, some of the subsidies encourage over-fishing in developing countries' waters by rich country fleets. The European Union, for example, has agreements with a number of developing countries to fish in their coastal waters. Payments for access are below the full value of the economic resource and tend to deprive local fishermen of the resource and of the markets they could otherwise exploit. The subsidies benefit the fishermen of the industrial countries and deny trade opportunities to fish exporters in the developing countries.

Effects of developing country subsidies

Table 7.3 suggests that perhaps two-thirds of the losses in developing countries arise from subsidies in the developing world itself. These losses do not include environmental impacts. Nor do many of them support the incomes of low-income or vulnerable groups in society. In the context of water subsidies in the developing world, for example, where the "protect the poor" argument is frequently voiced, some authors point to the "hydraulic law of subsidies" – the rich gain from the subsidies, not the poor.[203] Below-cost tariffs result in losses for public water utilities that cannot then invest in proper services, lowering man-made capital assets, or their quality. The scramble for the supplies that are provided results in the better-off securing supplies, and the poor often having to resort to high-cost private water vendors. The subsidies themselves actually produce the failure to protect the poor, however their objective is first formulated. That subsidies affect the environment is well documented: Irrigation subsidies contribute to water-logging and compaction and saline intrusion of soils; subsidies to timber production and agriculture contribute to deforestation; energy subsidies contribute to wasteful use of energy, and so on.[204]

Although the general direction of the effects of subsidies appears well known, actual quantification of the environmental effects has proved far more difficult. This is not surprising, given the problems of defining and measuring subsidies, and the problems of modeling subsidy impacts when so many other variables are involved in determining environmental change. Table 7.4 assembles some of the available estimates which, tend to focus on greenhouse gas emissions and air pollution. However, the estimates are clear in showing that subsidy removal would result in substantial gains to air quality and the global atmosphere.

[203] E.g., Briscoe (1997)

[204] On the environmental effect of subsidies generally, see de Moor and Calamai (1997). On energy subsidies, see von Moltke et al. (2003); on subsidies and deforestation, see Sizer (2000); on subsidies and over-fishing, see Milazzo (1998); and on water and irrigation, see Porter (2003).

Table 7.4 Some environmental effects of subsidies or subsidy removal

Study	Nature of scenario	Environmental impacts
Cristofaro et al. 1995 USA	Removal of $8.5 billion energy subsidies. Removal of $15.4 billion energy subsidies.	- 10 mtC by 2010 - 37 mtC by 2035 - 64 mtC by 2010
Gurvich et al. 1995 Russia	Removal of energy subsidies: effects in 2010	76% reduction in TSP 39% reduction in CO2 43% reduction in NOx 66% reduction in SOx
IEA, 1999	Removal of consumer subsidies in Russia, China and 6 other countries	16% reduction in CO2
Larsen and Shah, 1994	Removal of world energy subsidies of $230 billion	21% reduction in CO2
GREEN in Michaelis 1996	Removal of global subsidies of $235 billion	- 15 billion tons CO2 in 2050
DRI in Michaelis 1996	Removal of coal subsidies in Europe and Japan	- 10 to -50 mtCO2

Source: Pearce (2002) which also references the original studies

Policy on subsidies

In policy, The Earth Summit of 2002 called for reductions and the eventual removal of rich country subsidies in the name of developing country progress. Although the policy goal is fairly easily stated, far less attention has been paid to the ways in which subsidy removal might be effected in practice.[205] Since subsidy regimes are entrenched in rich countries, they have attracted considerable lobby groups in their favor. Removal almost certainly requires a long educative process, political trading among countries, and even paying off subsidy holders through some form of "compensation." Box 7.2 provides some discussion.

[205] For a discussion, see Pearce and Finck von Finckenstein (1999).

Box 7.2 Phasing subsidies out.

Reforming subsidy regimes that damage the prospects for sustainable development is immensely complex. Simply calling for subsidy removal is unlikely to succeed. The complexity arises from the fact that subsidies are manifestations of rent-seeking, which, in turn, is part of a wider category of unproductive activity in economic systems. Rent-seeking involves redirecting economic resources to special interest groups rather than using resources productively. Interest groups then use those resources to reinforce their privileged positions, and reform will inevitably conflict with those special interests. The idea that subsidy reform is a "win-win" policy is , therefore, misleading – there will always be losers, even if they deserve to lose. In many cases, the most harmful subsidies will be those that are least easy to remove. The extreme slow and painful changes in the European Union Common Agricultural Policy testifies to the difficulties of reform, even though the countries in question are well aware of the costs to EU taxpayers and consumers, and, more importantly, the deleterious effect on the trading opportunities of the developing world.

Subsidy reform is about dissipating rents and has to be part of a wider program of macroeconomic and political reform. Subsidies are often linked to corruption, thus emphasizing the difficulty of securing the political changes that are needed. Moreover, instituting democratic reform is not sufficient either: Democratic societies have even larger subsidy regimes than less democratic societies, as Table 7.1 shows. Political change has to be combined with economic reform. Some have advocated "sudden shocks," whereby dramatic events are seized as an opportunity to institute reform. There is some evidence to suggest that if a crisis does occur, it may be best to implement subsidy reform along with other transitional measures in one large package. An alternative is to let the almost inevitable growth of subsidies produce economic bankruptcy and then institute reform. But many societies have proved surprisingly resilient while sustaining extensive subsidy regimes, and the costs of waiting may not be acceptable anyway.

In the absence of crisis, a gradual approach is best. Policies need to be pre-announced and gradual subsidy reduction needs to be combined with careful public awareness campaigns and efforts at political transparency and accountability. Bilateral and multilateral lenders have a strong role to play, even though reforming subsidies as part of a conditionality package is still controversial. Reform almost inevitably involves competition since exposure to market forces is essential for rent dissipation. Nonetheless, reform is complex, and its success is difficult to guarantee. For example, privatization may simply shift rents from the public to the private sector. Subsidy regimes seem peculiarly resilient to change. But there are hopeful signs: Fuel subsidies have been reduced dramatically in many rich countries, while New Zealand instituted a wholesale reform of agricultural subsidies to the country's benefit.

Source: Pearce and Finck von Finckenstein (1999)

7.7 Making the polluter pay

Phasing out subsidies that harm the environment and the poor is the first stage of "getting prices right." Few now argue that aligning prices with the "true" costs of production will, on its own, achieve sustainable development. It is even less true that an exclusive policy of this kind will help the poor. Nonetheless, gradual reform in pricing is an essential component of a pro-poor development process. The ultimate goal is that prices should reflect the true costs of production, including environmental impacts. This means that resource prices should reflect the costs incurred in extracting and processing resources, and product prices should in turn reflect those resource costs plus any environmental damage associated with the use of the product.[206] This is the

[206] For resources in finite supply, one should also add a scarcity premium (or user cost) element to prices.

"polluter pays principle." The polluter pays principle is consistent with almost any form of regulation that imposes a cost on the polluter (or resource user). In theory, that cost can be avoided by not polluting and, hence, there is an incentive for the polluter to change behavior. The same applies to consumers who, through the act of consuming products, are themselves polluters. However, a very large literature has been devoted to the choice of "efficient" policy instruments that make the polluter pay, with, in general, a preference being shown for those instruments that affect prices in some direct way. An environmental tax is such an instrument, as is a tradable quota (which, although it acts on a quantity by setting a cap on pollution, produces a price in a traded asset – the pollution certificate).

But how relevant are these market-based instruments to developing economies? Those who argue in their favor offer one or more of the following arguments in support:

- Developing countries tend to have as their highest policy priority the growth of the economy and reductions in poverty. This suggests that their concerns for environmental improvement are not strong as in rich countries: They will have a lower willingness to pay for environmental controls. Market-based policy instruments can be adapted to this lower willingness to pay. The alternative approach, usually based on requiring particular technologies to be adopted, focuses on abatement technologies suited to levels of emission control in rich countries. These amount to over-control of pollution in countries with lower willingness to pay for that control.

- Some market-based instruments, such as taxes, raise revenues, and this can be very important in a context where there is a narrow tax base and a limited ability to collect conventional taxes. Environmental taxes, assuming they are easier to impose and collect, may usefully supplement low tax revenues and help to ameliorate traditional prevailing government revenue deficits.

- Technology-based solutions tend to involve a demand for considerable technical expertise in abatement technology, which developing countries do not have. Technology solutions also tend to be "end of pipe," i.e., involving abatement equipment which very often will have to be imported, with significant foreign exchange cost.

- Legal enforcement in many developing countries is weak, and this means that systems of fines for exceeding environmental standards or court action to enforce compliance is unlikely to be forthcoming. Of course, many market-based approaches may also fail this test as well.

- Capital is scarce in developing countries and capital markets are generally imperfect and/or exhibit high interest rates. This means that policy instruments that impose a significant "up front" cost to polluters or resource users will be strongly resisted and are likely to fail. Regulations that impose "best available technologies" will , therefore, not work well. On the other hand, market-based instruments can be introduced at modest levels and gradually changed to induce low-level abatement.

- Developing countries do not have large environmental bureaucracies or a legacy of past regulations. "Regulatory capture" – the process whereby polluters manage to control the political process underlying the regulations – may , therefore, be low and there could be a "clean slate" for the introduction of new instruments.

- Developing countries tend to have large informal sectors and these will be extremely difficult to regulate. They tend not to be monitored, but collectively they are often a large employer with political power to resist regulation. Even modest regulatory costs can be a large fraction of net income. Environmental charges on products would be difficult for the informal sector to avoid.[207]

[207] This summary is based on Sterner (2003) and Panayotou (1998).

Recently there has been some questioning of this "consensus" view of the market-based approach.[208] The critics argue that:

- Market-based instrument advocates tend to exaggerate the role played by these measures in developed economies. It is claimed that substantial opposition to them remains in these countries.

- Some emissions are extremely expensive to monitor, so that emissions trading programs and emissions taxes are of limited relevance to poor countries.

- Many of the existing instruments in rich countries have had low impacts due to tax levels being set too low. Some have not even explicitly been introduced as environmental taxes, but rather as means of raising revenues – although this is likely to be an advantage in developing economies.

- Environmental taxes have not taken hold in transitional countries, despite the fact that many of them have long had environmental charges and fines in place.

- Transitional countries and some developing countries may not be motivated by market forces in all contexts. Firms may not be obliged to make profits, there is often no stock exchanges and no Western-style accounting principles. These features are often essential to the sound workings of market-based approaches.

- Trading schemes and taxes only work if polluters are aware of the costs of abatement, otherwise, they cannot react to the signal being sent out. But in most developing countries this requirement is simply not met. Cost accounting procedures alone do not exist. The culture of minimizing costs may also not exist, so that the very basis of the market-based approach – that it is cheaper than traditional regulation – will not register with polluters as a reason to accept them.

- Resource rights may not exist or may be imperfectly defined. It is hard to introduce a tax or permit system without resource rights being clear and enforceable.

- The revenue-raising argument is exaggerated as most taxes raise only fractions of overall government revenue. Moreover, for most environmental taxes, collecting the revenue is no easier than collecting labor or profits taxes.

- Environmental taxes are hard enough to introduce in rich countries. It is difficult to imagine developing country governments introducing them. Efforts to reduce subsidies to food or energy in developing economies have, for example, frequently provoked political unrest.

- There is little (reliable) evidence that those developing economies that have introduced EIs have achieved any success in altering polluter or resource user behavior. In part, it is suggested that this is because the truth about these programs has been suppressed. Those reporting on the experiences generally have a vested interest in the schemes being successful.

Whatever the debate, many market-based policy instruments have been introduced in developing economies, especially charges for use of natural resources and pollution taxes. The institutional sophistication needed for tradable quota schemes might be thought to be a serious obstacle to their introduction. Nonetheless, some local fishery quota schemes exist (Madagascar), as does trading in water rights (Chile, Mexico) and in air pollution quotas (Chile). Market-based approaches may, therefore, be thought of as part of a broader menu of environmental policy instruments that developing economies can introduce as institutions develop.

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[208] Russell and Powell (1996), Greenspan Bell and Russell (2002, 2003).

How do market-based approaches, such as environmental taxes, affect the poor? The fact that tax burden may be a larger proportion of income for the poor than for the relatively rich is an obstacle to the introduction of such measures in rich countries, let alone developing ones. To some extent, however, this problem of distributional incidence is illusory. The alternative to a tax or charge is not doing nothing, but doing something else. All regulation imposes costs and the costs of the alternative regulations may be even higher than using the market-based approach. In turn, cost burdens on firms will tend to be passed forward to consumers, assuming there are competitive markets. The cost to the poor may, therefore, be lower under the market-based approach. Nonetheless, such cost burdens are widely perceived as being unacceptable. Other solutions then have to be found, including looking at special dispensations for poorer groups – as is done with water and energy tariffs in many countries, for example.

7.8 Paying for environmental services

There is now an extensive literature on "market creation" for environmental assets and their beneficial flows.[209] Markets may be created in what are otherwise non-market environmental assets (e.g., carbon storage and sequestration) either by having the "polluter pay" or the "beneficiary pay." In the former case, policy instruments such as pollution and resource depletion taxes are imposed and the presumption is that those who suffer the environmental detriment have the property rights (the right not to be polluted. etc.) (see Section 7.5).

The latter case – in which the beneficiary pays – is far more relevant to the very poorest of the population.

- First, the poor may act as guardians of environmental assets or may indeed have the rights to them. If the assets are valued by others, then those beneficiaries should pay for the benefits they receive. Suitably managed, payments, or at least part of the payments, should then accrue to the poor.

- Second, in other circumstances, the poor will be the beneficiaries of ecosystem services, which are at risk of destruction, i.e., they have no rights of any kind to the asset. They are the beneficiaries of conservation but lack the means to make payments to the owners of the resource rights. The polluter pays principle may also not apply if polluters have the resource rights. In this case, the direction of payment needs to be different, from the state, as guardian of the interests of the poor, to the resource owner, or from the global community to the resource owners.

In the case of global benefits various parties may act as agents of the global community: The Global Environment Facility (GEF) already does this, governments acting in concert may do this (e.g., the Paris Club of bilateral lenders facilitates debt-for-nature swaps), and NGOs may also make direct payments or be party to GEF and debt-for-nature swaps (Conservation International and WWF are significant players in this respect). Box 7.2 indicates the approximate scale of GEF and debt-for-nature financial flows.

[209] For example, Scherr et al. (2004); Pagiola et al. (2002); Pagiola et al. (2004); Pearce (2004); Pagiola et al. (2005); Wunder (2005)

Box 7.2 Financial flows for global environmental benefits

Developing countries have sovereign rights to their natural resources. Environmental protection is often not their priority concern, although the arguments in this report suggest that they should have a far higher profile than is often the case. Yet developing countries are also the repository of many resources that have global benefit – biodiversity and carbon storage are two clear examples. The rest of the world should , therefore, be willing to pay the developing nations to conserve the natural assets that generate these global benefits. Two major examples of this willingness to pay are the Global Environment Facility (GEF) and debt-for-nature swaps (DfNSs). In the former case, the GEF pays host nations the "incremental cost" of changing an investment, so that it confers global benefits. Thus the incremental cost of using a renewable energy source compared to, say, coal would be paid by the GEF. The world would gain because of the avoided carbon dioxide emissions. DfNSs involve secondary debt – the external indebtedness of poor countries, denominated in scarce foreign exchange – which is sold at a discount on a secondary market. (The discount arises because there is a probability less than one that the indebted country will be able to repay it). Holders of this debt can seek to convert it to domestic debt, to the benefit of the host country. In return, they seek an agreement that some environmental asset is conserved. If DfNSs and GEF payments are carefully structured, everyone benefits. The environment improves (or does not degrade relative to the baseline situation), finance flows to the host country, and the world secures a global benefit it is willing to pay for. The following estimates indicate the scale of the relevant financial flows.

Debt-for-Nature Swaps $ million p.a.	GEF Biodiversity $ million p.a.	GEF All areas $ million p.a.
140	315	1000

Source: Pearce (2004b**)**

How pro-poor are these financial flows? As with PES in general, the primary purpose of these payments is not poverty reduction but environmental improvement. Nonetheless, considerable scope exists to integrate the two goals.

The first step in deciding whether a payment for environmental service (PES) deal might be struck is to identify the "demanders," or beneficiaries, of the ecosystem services. The second is to identify the "sellers," or suppliers, of the services.

The demand for environmental services

Many ecosystem services benefit local communities, e.g. downstream farmers may benefit from watershed services generated by upstream forest conservation. A purely local bargain may be struck, with beneficiaries paying the suppliers of the services. But the beneficiaries may be wider than this, e.g., a corporation in a rich country may wish to engage in "carbon neutral" measures, looking to offset its emissions by sequestering carbon in an afforestation project. Here the beneficiary is the company and, hence, the financial flow should be from company to local community, with payments being some sum (or in-kind benefit) greater than the opportunity costs of sequestration (the value of the land in an alternative use). Such bargains are now commonplace and tend to be facilitated by intermediaries (brokers) who may in turn be private entities or

bodies such as the World Bank (e.g., through its Carbon Funds). Payments may also be made for biodiversity conservation as a premium on such carbon offsets (i.e., more is paid if biodiversity benefits also accrue), or corporations may be interested in paying directly for biodiversity conservation. The motivations for such payments include "green image," corporate social responsibility or even pure self-interest if green image is capitalized into the corporation's share price.

The global community in general has an interest in such deals through the Framework Convention on Climate Change and the Kyoto Protocol, and this is recognized in the growing number of projects under the Clean Development mechanism and Joint Implementation. Similarly, international financing of biodiversity conservation occurs under the Convention on Biological Diversity. The Global Environment Facility acts as the financing agency of the Conventions and facilitates many projects whereby the incremental cost of conservation and emission reduction and sequestration is paid from global funds, supported by rich country governments.

The examples are sufficient to show that the "demand" for ecosystem services ranges from the purely local through the national to the global and from single corporations to the global community. In many respects, a combination of the market and professional judgment can be relied upon to identify demanders – they will "emerge" once the potential deals have been identified by brokers or will themselves initiate the deals.[210] The science of economic valuation can help, however, by identifying the quantitative benefits in use values (e.g., watershed benefits) and non-use values (a willingness to pay on the part of agents who nonetheless make no use of the asset, simply wanting it to exist).[211]

The supply of environmental services

On the supply side, the first requirement is to identify who owns the land (or water) generating the ecosystem services, or, if tenants – legal or customary – how secure their tenure is. Second, it is necessary to estimate what the matrix of costs and benefits will be if payments are made. This in turn involves identifying the opportunity costs of conservation measures. Again, the simple rule is that each party affected by a PES scheme must be better off with the scheme than without it.[212] Third, there may be complex effects from PES itself. Rather like subsidies, payments can be "rents" in the eyes of the more powerful, and they may seek to buy up the relevant land to get the payments. Hence, it is also necessary to anticipate who the ultimate sellers of ecosystem services might be. Fourth, although the "bargain" identifies the two main players, there will be others who gain and lose from the PES, agricultural workers and forest users, for example. Their gains and losses need to be accounted for if the goal is poverty reduction. They are not sellers as such, but are nonetheless affected by the deal. Finally, it has to be borne in mind that if PES cannot achieve the dual role of poverty reduction and environmental conservation, that does not make such approaches undesirable. It may still be beneficial to pay richer landowners if the value of conservation is higher than their opportunity costs.

The intermediaries

Where deals are mutually beneficial to buyer and seller, intermediaries or brokers will emerge naturally. Brokers should minimize the costs of engaging in the deal – the transactions costs – which might otherwise be prohibitive.

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[210] National and global communities are often the main beneficiaries of conservation, although local communities can be the losers through being excluded from use of the conserved asset. Hence, the deals have to be designed to correct this asymmetry. See Balmford and Whitten (2003).

[211] The literature of economic valuation is huge. For its application to environmental assets in developing countries, see Pearce et al. (2002).

[212] See the matrix of gains and losses classified by affected party in Pagiola et al. (2005), Table 1.

More relevant from the policy standpoint is the extent to which government intervention is required in the deals. If the beneficiary-pays principle is at work, and if markets are fairly freely functioning, then any payment for environmental services should be mutually advantageous and there would not be any apparent role for government. Transaction costs could be minimized by brokers without government being involved. But there are problems in assuming that mutually advantageous bargains will simply emerge. The downstream farmer may not be able to anticipate the effects of upstream deforestation, i.e., there may be uncertainty about the benefits. Most importantly, the downstream farmer may be too poor to pay the forest owner's minimum requirement for compensation. If so, from the standpoint of the parties jointly, the bargain should not occur. But since that risks the livelihood of the poor, an equity issue arises. Since legal contracts are involved, it may also be necessary to have government (local or central) sanction the deal. Finally, there may be problems of getting the downstream farmers to act collectively, given that the benefits are shared among them (the benefits take on the form of a "public good"). These factors – uncertainty, legality, publicness, and equity – are the justifications for government intervention in PES schemes.

So long as PES takes the form of a "pure bargain," both the resource owner and the beneficiary should be better off with PES than without it. If so, one could conclude that the rate of return to the resulting conservation activity is "high" in the sense that each party is willing to make the bargain.[213] Once governments act as intermediaries, this outcome is less guaranteed since governments may themselves be influenced by special interests: If the poor are the owners or guardians of assets, they may have less power to bargain for more than the minimum value of their assets. If the poor are the non-paying beneficiaries, the asset owner may use any influence to extract higher payments from the government than are warranted by the true asset value. Until a systematic databank of PES schemes is established it will be hard to know just how socially beneficial such approaches are.

A matrix of PES

Actual mechanisms of payments for environmental services (PES) have already been developed, on a case–by-case basis, for:[214]

- Carbon storage – e.g., avoided deforestation.
- Carbon sequestration – e.g., from afforestation and reforestation.
- Watershed regulation – e.g., avoided downstream effects of upstream deforestation or agro-chemical use.
- Biodiversity-friendly agricultural products (e.g., shade-grown coffee, etc.), the mechanism here usually being the payment of a price premium on the final sale of the product.
- Conservation activity via direct payment.
- Offsets (tradable development rights).

In most cases, reducing poverty is not the prime motive for the market creation. The motive is to secure environmental benefits. But as PES has evolved, even over a short period of a few decades, the issue of how they can be managed to benefit the poor has also become important.

[213] This argument can be found in Pagiola et al. (2005).

[214] For an extensive discussion of the various applications, see OECD (2004).

The elements of efficient design of a PES scheme that serve both environmental and poverty reduction goals are beginning to emerge. Most schemes relate to upland-lowland relationships, i.e., upland land owners providing ecosystem services to lowland beneficiaries. So long as the upland owners are the poor, they stand to benefit from payments so long as the payments exceed the opportunity cost of conservation (e.g., what they would get by removing or reducing tree cover for timber, ranching or agriculture). If the poor are the downstream inhabitants, they will be no worse off with a PES provided the payments made by government prevent them suffering damage from loss of ecosystem services. They could well be better off if the PES focuses on *improving* upland services. There tends to be a presumption that upland dwellers will be poorer than lowland dwellers, but there is a need to establish this.

Table 7.5 provides a matrix of PES schemes, showing how they vary according to the targeting of payments and who the demander is likely to be.

Table 7.5 Classification of environmental benefit payment schemes

Nature of market	Examples	Who pays?
Existing	NTFPs, fisheries, etc. Hunting Ecotourism	Local, national, international users
Existing and emerging	Bioprospecting	Corporations
New: payments for attenuating resource management practice – payments must exceed incremental cost	Sustainable forestry Switching to cleaner energy Agro-forestry rather than slash and burn	Timber consumers via price premia GEF GEF
New: payments for opportunity cost of conservation	Many PES schemes, e.g., Costa Rica Forest Law	Varies, e.g., vehicle users pay gasoline tax, revenues used to pay forest owners (Cost Rica); hydroelectric companies pay forest owners.
Existing and new: Indirect payments: payment shows up as forgone debt.	Debt-for-nature swaps	NGOs, bilateral governments
New: Direct payments conditional on delivering conservation products		NGOs, e.g., Conservation International
Existing and new: purchase of the asset	E.g., outright purchase of land	Local NGO, local government, international private individuals

Source: developed from Ferraro and Kiss (1992).

Are existing examples of PES pro poor?

Like so many policies, how far they serve multiple goals depends on their design and implementation. The evidence on the pro-poor nature of PES schemes is limited. Self-evidently, if the poor are poor because of their limited resource rights, they may have no assets to sell to beneficiaries. They simply do not participate, and a biased picture can then emerge because the PES that are observed must necessarily be confined to those with resource rights, unless the government acts as intermediary. If the poor have low opportunity costs, then one might expect PES to gravitate naturally toward them rather than to those richer landowners who will need large payments to offset their opportunity costs. Some surveys find that PES payments constitute significant fractions of poor household income, but information on opportunity costs (what they give up to get the payments) is often not known.[215] As such, the net gain to these households is also not known, and it is this that matters. On the other hand, money flows are not necessarily the only benefit to the seller of services: Land security may be increased and social capital is increased because sellers learn to bargain collectively.

How far PESs should actively *target* the poor is debated in the literature. On one view, the primary purpose of PESs is not to reduce poverty. As such, it should only be a consideration where there are obvious synergies. In another view, securing such synergies is a matter of targeting and design and PES should have a dual goal. Much of the recent focus on PESs is now about the design of the contracts in the complex contexts where resource rights are not well defined or, if defined, not readily enforced.[216] Considerable effort is needed to ensure that the poor secure access to the resulting markets, which may be complex to understand and have high information costs (there is some evidence of this for carbon markets, for example). The role of NGOs and other intermediaries in conveying the information and assisting poorer households to benefit from such deals is, therefore, potentially very important.[217] There is a need to impart bargaining skills, provide some up-front financing to cover transactions costs, lobby local and central governments, and encourage cooperative efforts to secure equitable shares in any contracts.

Cautions about the impact of PES schemes are reinforced by a study of the Costa Rican PES program in one watershed[218] and by an econometric analysis of participation (see Box 7.3). By and large, recipients of payments were relatively wealthy landowners with other incomes, e.g., as professional lawyers and engineers. The opportunity cost of the PES scheme was high, so that some landowners did not switch to PES because payments did not compensate them for the foregone uses of the land. Although the environmental impacts were positive, there was little impact on poverty reduction. A related study also found that small farmers in another region were not eligible for participation in the PES scheme there. In contrast, a study of a Nicaraguan small farmer cooperative supplying "fair trade" and organic coffee found that these farmers were better off compared to the alternative of competing in unstable world markets for conventionally traded coffee. The study underlines the need for social capital to bond individual farmers in their efforts to exploit consumers' willingness to pay for products with social and environmental characteristics.[219]

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[215] See Wunder (2005)

[216] Using the case of Indonesia where many resource rights have been decentralized to local communities, Engel and Palmer (2005) show how difficult it is to devise effective contracts between local communities as service providers and those who benefit, given the demands of logging companies. Previous contracts providing timber rights for payments to the communities resulted in substantial deforestation. There are currently no PESs in Indonesia, but they are actively being discussed. Pagiola et al. (2004) discuss the lessons learned from GEF-sponsored PESs in South America.

[217] For a discussion, see Gutman (2003), pp 35-38.

[218] Miranda et al. (2003).

[219] Bacon (2005).

Box 7.3 Who participates in the Costa Rican PES Program?

Studies of participation in Costa Rica's *Pagos de Servicios Ambientales* (PSA: Payment for Environmental Services) program suggest that, to date, those receiving payments are primarily large-scale farmers and forest owners. Between 1997 and 2001, some 4,460 beneficiaries received payments. Most of the payments were for forest protection (more than 84 percent of the land area affected), with about 10 percent of the land being devoted to sustainable management and the remainder (about 7 percent) to reforestation. An econometric investigation showed that participation in the PSA was heavily influenced by farm size, the educational level of recipients, the extent of farm debt, on and off-farm income, and the extent to which participants had either attended informational and promotional meetings or were approached by intermediaries acting for the program. The influence of farm size suggests that there are "economies of scale" in PES – the costs of transacting the deal are spread over a larger area, lowering average costs per hectare. The influence of farm debt suggests that the certainty of the payments acts as a form of insurance against uncertain returns from agriculture or forestry. Recipients who have off-farm incomes and who enjoy secure title to their lands are far more likely to participate.

One problem with these studies is that they focus on who receives payments rather than who benefits from the resulting ecosystem conservation. If the poor are the primary beneficiaries, then there is still a good case to be made for regarding the program as pro-poor. Otherwise, the program needs to look at how poorer people can be encouraged to participate as recipients of payments.

See Zbinden and Lee (2005)

7.9 Credit

Improved access to credit is widely advocated as a means of overcoming the "naturally" high discount rates that the poor appear to have and to facilitate investment. Box 7.1 briefly surveys some of the complex issues involved in credit markets. The central concern is that many of the poor simply have no access to credit, whether formal or informal, i.e., credit markets exist but the asset base of the poor makes it difficult for them to secure access. Even where credit is available and accessible, it has to be associated with the loans going into investment, rather than consumption, if the household asset base is to increase. Moreover, the investments in question have to yield rates of return greater than the cost of the loans.

Box 7.1 The credit problem and some solutions

Development economists have made extensive studies of credit markets in poor countries. The low asset base of the very poor severely restricts their ability to secure credit. Much of the demand for credit is to finance consumption during periods when incomes are very low – e.g., before the harvest or when demand for labor is weak. This is "consumption smoothing" or "income smoothing." This form of borrowing nonetheless serves a useful function from the standpoint of wealth creation, since it helps the poor avoid making forced asset sales at times of lower-than-normal income. Some of the demand is for working capital, and some is for longer-term investment. In general, if the asset base of the poor is to grow, credit must be directed at working capital and fixed capital formation.

Credit comes from two main sources: formal credit markets (e.g., banks) and informal markets (e.g., moneylenders). The former tends to be less expensive than the latter but there are many reasons why informal markets prevail, even though effective interest rates may often be very high. Any lender will want *collateral* – an asset that can be secured in the event of default by the borrower on the loan. But the poor have few assets, and what they have may not be of interest to a formal lender. For example, it may be costly for a bank to secure a piece of land and resell it. Sometimes the only asset the borrower has is his or her labor, and the formal market generally has no interest in this as collateral. But a landlord lending to a tenant may find the offer of labor quite acceptable. In the same way, a trader may find being repaid in agricultural produce acceptable; a bank generally will not. Moneylenders, therefore, have an advantage over formal finance institutions – they have better knowledge of their borrowers – so-called "micro-information" – and frequently spend long periods scrutinizing any new borrowers with whom they are not familiar. As a result, well organized money-lending markets exhibit quite low default rates. The history of credit markets suggests that lenders prefer to lend to someone who has already borrowed in the past and repaid successfully. The result is another vicious circle in which an initial failure to access the market is compounded.

Nor is formal credit necessarily the best form of credit. Moneylenders are likely to know far more about the borrower's creditworthiness than a more distant bank. Indeed, some moneylenders borrow from the formal sector and lend to local borrowers. Efforts to subsidize the formal credit market, while making it a condition of their practice that they lend to the very poor, may not, therefore, work. The rates of interest charged in informal markets may seem extortionate in some cases, and some are. But in general, the high rates charged reflect the risks involved. Lenders do not wish their borrowers to default, but default rates are often high (as one would expect if borrower discount rates are very high), making lending a risky activity. In a great many cases, borrowers seem to get by using the informal market. To a considerable extent, then, informal credit markets "work." From the standpoint of the very poor, however, the issue is not just the high rates of interest, but that there is often no access at all to such markets.

How then are the very poor to gain access to credit? If informal markets are efficient, then one solution is to encourage informal moneylenders to borrow from the formal sector against collateral recognized by the latter, and then lend to small-scale borrowers. The use of cooperatives as the borrower from the formal sector, perhaps at subsidized rates of interest, is one such option that has been attempted. But the intermediaries may be traders, crop processors (e.g., millers) or providers of inputs as well. The second major effort to get credit to the very poor has been via "micro-finance." The most famous example of this is the Grameen Bank in Bangladesh, which lends to small groups for small amounts of money against no collateral. In so doing, it tries to imitate the features and advantages of the informal sector, i.e., close knowledge of the borrower. Significantly, the main borrowers from the Grameen Bank are women. The structure of incentives reveals how careful design of credit contracts can overcome many of the problems. For example, if a group defaults, then no member of the group can borrow again. This makes the group vigilant of each individual's behavior and responsibility for repayment (shifting the burden of monitoring and enforcement in this way is known as "self-selection"). The Grameen Bank is one of many micro-finance organizations that have emerged in the last few decades. No one pretends that micro-finance is without problems but experience to date demonstrates that the poor can be reached and afforded a chance to invest in their asset base.

Note: A very detailed survey of incentive structures for effective credit can be found in Ray (1998).

Directing credit to investment thus means finding out why households might divert loans into consumption. The answers may lie in the uncertainty attached to investment returns, problems with the scale of the investment, and the fact that income needs are more pressing than anything else, especially in times of crisis. Since the focus here is on environmental assets, the issue becomes one of ensuring that such investments are secure and yield sensible rates of return. Property rights to the environmental asset obviously contribute to security – ownership of land, livestock or other assets provides collateral for any loan. But resource rights may also mean rights to some off-take from the natural resource – e.g., access to a protected area in order to secure ecosystem services on a sustainable basis. Where there is ownership – individual or communal – payment for environmental services has the potential to provide incentives for careful management of the resource, since payment ceases if the service is not provided.

In short, simply providing credit in an accessible and affordable form does not resolve the poverty problem unless that credit is directed to asset formation. To reduce the risks of diversion of the credit to consumption, it may be necessary to provide temporary income transfers, but it will also be necessary to devise incentives to get the credit allocated to investment. Such incentives include establishing property and access rights and paying for hitherto non-marketed ecosystem services under the control of the poor.

7.10 Insurance

Like everyone else, the poor face insurance problems. They are averse to risk and, because they have a low asset base, are particularly vulnerable to everyday risks, such as shortfalls of income during crop growing seasons and to more singular risks, such as droughts and civil strife. Liquidation of assets is the clearest form of *self-insurance*. Cattle may be sold, jewelry pawned, cash reserves used. These assets function like credit enabling households to "smooth" consumption and income from one period to the next. Another form of self-insurance involves diversifying economic activities – farm and off-farm work, for example – to insure against the risks that any one source of income will fall. *Mutual insurance* arises when households agree collectively to make up any shortfall in any one household's income. So long as they do not all suffer a loss at the same time (in which case, their incomes are correlated and insurance "fails") mutual insurance is mutually beneficial. *Formal insurance* involves separate agents who undertake the issue of insurance policies that households can take up for the payment of a premium. In poor societies, formal markets are unlikely to exist, so self-insurance and mutual insurance are what matter. For the very poor, self-insurance will also be limited because of the problem of low savings.

Whereas mutual insurance operates with a promise that others will pay the shortfall resulting from any one household's losses, formal insurance operates through markets in which prices (premia) are charged. Mutual insurance thus rests on an agreement about common interests – it is to each household's advantage to agree to the contingent payments. It follows that the stronger the *social capital* base, the more likely that mutual insurance will work. There will be greater flows of information about those at risk, and there will be stronger bonds of trust. All kinds of factors can affect this relationship of trust: Migration in and out of the community will tend to lower social capital, and the larger the population involved the less social capital there may be. Social capital also lowers *moral hazard* – the process whereby the insured event could be affected by the behavior of the insured. The greater the flows of information in the community, the less likely it is that any one householder will adopt behavior that deliberately risks losing output (because he or she knows they are insured). Finally, the stronger the social capital, the more likely it is that participants to a mutual insurance scheme will abide by the rules. Defection would mean social sanctions and, presumably, exclusion from future insurance arrangements.

Like credit – which has many similarities with insurance – self-insurance and mutual insurance operate extensively in developing economies. As such, targeting insurance schemes as a policy measure may seem misguided: They already work and, in many cases, work well. The problem is that it is quite easy for mutual insurance schemes to break down. As noted, they will if social capital becomes degraded. There are other reasons for insurance failure – e.g., incentives not to comply may grow if payments into the "fund" systematically come from a few sources and the beneficiaries are the same year after year. *But the dominant message is that the factors degrading social capital are also likely to make insurance difficult, placing the poor at further risk.*

How do environmental assets fit into the picture of the insurance needs of the poor? The answer is that environmental assets frequently function as risk-reducing assets. Various studies have shown that, as subsistence agricultural income falls due to expected and unexpected risks, so environmental assets may be exploited to smooth the fluctuations in income. Box 7.2 illustrates with an example from the Brazilian Amazon.

Box 7.2 "Natural insurance" in the Brazilian Amazon[220]

The role played by non-timber forest products (NTFPs) in supplementing the incomes of the poor has already been discussed. But not only do forests act as providers of general income supplements, they also serve an important function in "smoothing" income and consumption. As agricultural incomes fall, so households resort to gathering more forest products. The reductions in agricultural income may be anticipated, e.g., during the crop growing season, or unanticipated, as with a sudden weather crisis or external event. Hence,, if forests act as "natural insurance" one would expect to see a pattern of forest use corresponding to fluctuations in agricultural income. A study of farming households in the Tapajós National Forest in the Brazilian Amazon showed exactly this relationship. These communities are isolated from markets but households nonetheless collect forest products for resale –vines, honey, *sucuba* soap – and for their own consumption – nuts, fruits, bark and sap. Fluctuations in agricultural income arise from variations in rainfall, variations in soil quality, and invasions of leafcutter ants. When incomes fall, mutual insurance schemes operate in the sense that families and friends pool resources. There is no access to credit because the farmers are not landowners and are thus excluded from official credit schemes. The study hypothesized that wealthier households would practice more self-insurance and would not need to rely on the forest as insurance. But this proved to be correct only for wealth measured by livestock holdings. Wealth as number of possessions was not associated with forest use in this way. This suggests livestock is the "smoothing" mechanism for livestock-owning households, whereas forest use is the mechanism for other households. Older people collected more forest products, perhaps because they know the forest better, both in where to look and what to look for. Trips to the forest were closely correlated (negatively) with changes in agricultural income as the insurance hypothesis suggests.

7.11 Sustainable finance

Asset creation requires investment and investment requires finance. Several sources note that finance for environmental and natural resource investments have become more, not less, difficult in the recent decade or so.[221] The hoped-for expansion of official aid announced at the G8 Summit in Edinburgh, 2005, might spill over into increased financing. Otherwise, innovative forms of finance, such as payments for environmental services, will be needed on a larger and larger scale. But one feature of many investments is that the associated finance is not "sustainable." The costs that are met by donors tend to be the set-up costs and some operating costs for a short period of time. Long-term financing is frequently ignored, perhaps because there is a presumption that projects will become self-financing fairly quickly. Unfortunately, this assumption is often groundless. Project finance needs to be far more attentive to what happens after the project is set up, e.g., by laying the foundations for continuous payments for the service generated by the created assets.

[220] This example is taken from Pattanayak and Sills (2001).

[221] See, for example, Gutman (2003).

Filling The Knowledge Gaps

8.1 Research versus action?

In many respects, this report shows that a great deal is known about poverty-environment relationships and the ways in which policies and investments directed at environmental and resource improvement can reduce poverty. But substantial information gaps remain, and they suggest the need for continuing research. "Research needs" must never be allowed to divert attention from taking action now, even where there is uncertainty about the nature of the required policies and their effectiveness. There is no reason to postpone policy while better information is gathered, not least because the policy interventions are themselves one of the main ways in which the required information is generated. For example, the wildlife conservancies in Namibia (see Chapter 6) started out as experiments that learned from similar kinds of measures elsewhere in Africa. But they did have experimental features about them, enabling "learning by doing" to occur and the consequent improvement of design and benefit-sharing characteristics.

8.2 Some information needs

Several information gaps were identified in the text. These are:

- Where the poor live. Although the broad dimensions of the location of the poor are known, poverty maps are emerging rapidly and, increasingly, they will refine knowledge about where the poor live. Poverty maps then need to evolve into Geographical Information Systems so that the correlation among poverty, environmental quality and degradation can be made.

- Complex though it is, the very large variety of resource rights need to be mapped along with poverty. Ownership is but one form of right, and even here the distribution of ownership over environmental assets is not known in any detail.

- Wealth accounting promises to provide further insights into both the asset base of the development process and the policy measures needed to improve the asset base. In particular, wealth accounting enables some reasonable "rules of thumb" for deciding when a nation's economic progress is illusory, i.e., when income growth is achieved at the expense of "mining" the asset base. It has also enabled better formulations of the rules for investing the "rents" from natural resources. The evidence does suggest that resource-rich countries may nonetheless be low-growth economies, denying the poor the benefits of more rapid growth. If so, the investment rules become all the more important. But even at this aggregate level, much more needs to be known about the services provided by environmental assets and about the damage being done to them.

- As wealth accounts develop, they need to be extended to household wealth accounts. Still too little is known about households' direct and indirect use of environmental assets. The kind of information emerging for forest wealth, which shows just how important that wealth is for poor and the less poor alike, needs to be replicated for other ecosystem assets.

- The report has assembled more information on "environmental rates of return" than can be found anywhere else. Although not all the evidence is reassuring, most of it is, and it shows that investing in the environment makes sound economic sense for nations and for their poor. But environmental economists need far more focus on benefits and costs, rather than just benefits.

- It remains the case that biodiversity and its benefits are under-researched, and the links to poverty not well understood. The issue here is not so much biodiversity as biological resources: There is a growing literature on the value of ecosystem services and products and, to a far lesser extent, who benefits from them. The issue is the diversity itself, its link to ecosystem resilience and the benefits of resilience for the poor.

8.3 Policy design

The "menu" of policy instruments available to decision-makers and advisers is generally very well known. Perhaps the major challenge is how to adapt those policy instruments to developing country institutional capabilities. As institutions evolve, so a greater range of instruments can be employed. In the meantime, caution is needed in assuming that what works in wealthy countries will also work in less wealthy ones. It may be, for example, that market-based approaches (environmental taxes, tradable permits and quotas, negotiated agreements, liability systems, etc.) will have to wait for some time in many countries before they can be employed. In large part, these instruments require reasonably competitive markets to be efficient, and markets in turn require extended resource rights. Neither condition will be present in many cases. In the meantime, more traditional policy measures are still needed. Nonetheless, some uses are already being made of such instruments.

8.4 Global public goods

The example of global warming shows how the fate of the poor is likely to be affected by global issues well beyond the control of a single country, rich or poor. The world has demonstrated some resolve in attempting to tackle global warming through the Framework Convention on Climate Change and the Kyoto Protocol. But the evidence suggests strongly that, if *mitigation* (emissions reduction) is to have any effect on rates of warming, dramatically more robust measures are needed. The complex challenge is that, although historical responsibility for warming rests firmly with the rich world, failure to induce at least the largest developing nations – China and India – to reduce future emissions will make warming control virtually impossible, as was acknowledged in the G8 Summit in 2005.

One of the themes of this report has been that policy design must employ incentives to make the affected parties better off than they would have been without policy action. That involves a substantial effort at conveying information about the consequences of climate change and at ensuring the responsibility for damage is fully understood. The policy literature on global warming is beginning to suggest that further efforts to set emission limits beyond Kyoto may not meet this test, since they rely heavily on individual participants accepting sacrifice for a distant global good. Alternative post-Kyoto "architectures" are being discussed with the explicit goal of making cooperation by developing countries something that will benefit them. Agreements about low- and non-carbon technologies and their diffusion to the developing world may turn out to be a better basis for effective warming control. If so, international negotiators would need to rethink their current preoccupation with emissions reductions through target-setting.

Whatever form mitigation efforts take in the future, it is clear that far more attention needs to be paid to the effects of global warming on the world's poor and on ways of helping them adapt to such change. Adaptive investments include protection from sea-level rise but also the diffusion of seed and water technologies that take account of the probable very varied geographical impacts of climate change on different regions of the world.

8.5 What makes common property work?

There is already a substantial body of literature that documents various common property arrangements. Despite this wealth of description and analysis it still is not wholly clear why some regimes work and some do not. Section 4.3 sets out the reasons why open-access regimes evolve toward common property and excusive rights regimes, but the analysis showed how dangerous it is to assume that resource scarcity will always be met by institutional change that adapts appropriately to that scarcity. Some open-access regimes simply collapse, and the fate of many of the world's fisheries is testament to this. Others would argue that entire civilizations have also disappeared because of a failure to adapt to resource scarcity. Hence, the priority has to be a better understanding of the conditions for successful adaptation to resource scarcity, so that open-access regimes can be modified by policy. A related issue is the stability of common-property regimes. Historical analyses can help to pinpoint factors that lead to the failure of common-property regimes, and the factors that sustain successful regimes.

8.6 Environmental effects of subsidy regimes

Subsidies unquestionably harm the environment and unquestionably harm the poor. But quantification of these effects is still primitive, and far more needs to be known. Most appears to be known about the effects of energy subsidies, no doubt because quantitative responses to price changes have been routinely estimated ("price elasticities"). Similar information about the effects of subsidies to water, fisheries and land conversion are also needed.

8.7 Distributional incidence of policies and investments

This report has demonstrated that a lot is known about the links between environment and poverty where the latter is measured in terms of poor nations. Far less is known about the effects of policies and investments on poverty *within* nations. In many cases, this lack of knowledge simply reflects the fact that the original purpose of policies was not poverty reduction. The various payment-for-environmental services schemes are cases in point. But given the scale of the global poverty problem, it is essential that every opportunity for synergy is exploited. That means understanding far better what the distributional incidence of policies and projects actually is. Moreover, as the report has highlighted in several places, distributional analysis helps to identify the net gains or losses of the various stakeholders. Those who lose, even if they are the poor, can readily inhibit efficient implementation of investments and policies. Measuring distributional incidence is thus not only a matter of equity and fairness, it is also a matter of efficiency.

8.8 Links among different forms of capital

This report has argued strongly for an "asset focus" in understanding the poverty and environment linkage. One risk in this is the temptation to treat the assets as being wholly separable. This tends to prompt arguments about which asset is more important. Indeed, because of the perception that environmental assets are widely perceived as not being as important as other assets, the report has also had to "defend" environmental investment as a priority. But the reality is that the various assets are interdependent. Some of these interdependencies underline the importance of environmental assets. As Chapter 4 argued, human capital responds to environmental investments and policies through the effect of the latter on health and on schooling. The further stage is to estimate how these interactive effects show up in forgone productivity and aggregate output.

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