Chapter 3

Sustainable Development: Some Critical Areas

3.1 In this chapter we take up the challenge of devising sustainable development strategies in a number of vital areas: energy, land and agriculture, biodiversity, water, oceans and forests. We realise, of course, that these areas are not exclusive and that many others are important. But in a Report which cannot cover everything, we have chosen to focus on those areas which we believe are of fundamental importance to the environment and to development.

Energy Resources and Use

3.2 The energy sector is crucial to both. It is not only responsible for about half the greenhouse gas emissions causing global warming but is the major source of sulphur dioxide emissions which return to the earth as acid rain. It also contaminates the atmosphere with toxic metals such as lead and mercury. The achievement of sustainable development faces its sternest task in meeting the energy needs of the world in a manner which does not destroy local and global environments.

Global energy use

3.3 The present pattern of world demand for commercial energy (petroleum, gas, coal, nuclear and hydro) is depicted in Table 3.1 (page 35). This shows that developing countries accounted for 26 per cent of the total demand in 1990, when their per capita use was only 7 per cent of that of the USA and 15 per cent of that of Western Europe. Energy development and use in the industrial countries have accounted for most of the greenhouse gases which have accumulated in the atmosphere over several decades. The

Table 3.1
Consumption of Commercial Energy

By economic grouping (million barrels of oil equivalent energy per day)			Per capita (barrels of oil equivalent energy per year)	Ratio relative to US (per cent)
	1990*		1990*	
OECD	85	USA	58	100
Developing Countries	45	Western Europe	26	45
Eastern Europe & USSR	40	Developing countries	4	7
		Eastern Europe & USSR	36	62
	170			

* Estimates

Source: Dennis Anderson[1]

Intergovernmental Panel on Climate Change developed several scenarios of future carbon dioxide (CO_2) emissions from the energy sector. The scenario projecting the largest increases in energy consumption and emissions in the future was called the 'reference scenario'. The gross CO_2 emissions in various regions from the energy sector alone—projected to the year 2025—are given in Table 3.2 (page 36). In this projection, 44 per cent of total CO_2 emissions from the energy sector would be in developing countries by 2025, in contrast to 26 per cent in 1985. Per capita CO_2 emissions from the energy sector would rise from 3.12 to 4.65 (tonnes, carbon) in developed countries, and from 0.36 to 0.84 in developing countries.

3.4 The more than doubling of energy consumption by 2025 implied in Table 3.2 could be considered unsustainable both economically and environmentally. The IPCC thus developed several other possible scenarios of future CO_2 emissions from the energy sector, on the basis of various assumptions about the degrees of reduction in emissions as a result of government and private sector actions to improve energy-efficiency and switch to fuels which emit less CO_2.

3.5 Given the great existing disparities in energy consumption and the pressing need to relieve poverty and bring about the structural changes necessary to raise incomes and create jobs, developing countries obviously have a rapidly growing demand for energy services. But a rise of the magnitude implied in Table 3.2 would pose difficulties, for developing countries and for the world as a whole. It would be difficult to finance, it would lead to unacceptable local environmental pressures, it would possibly increase the risk of

Table 3.2
Gross Emissions of Carbon Dioxide from the Energy Sector*
(From the Reference Scenario)

	(billion tonnes carbon/year)					
	1985	*%*	*2000*	*%*	*2025*	*%*
Global total	5.15	(100)	7.30	(100)	12.43	(100)
Industrialised countries	3.83	(74)	4.95	(68)	6.95	(56)
North America	1.34	(26)	1.71	(23)	2.37	(19)
Western Europe	0.85	(16)	0.98	(13)	1.19	(10)
OEDC Pacific	0.31	(6)	0.48	(7)	0.62	(5)
Centrally Planned Europe	1.33	(26)	1.78	(24)	2.77	(22)
Developing countries	1.33	(26)	2.35	(32)	5.48	(44)
Africa	0.17	(3)	0.28	(4)	0.80	(6)
Centrally Planned Asia	0.54	(10)	0.88	(12)	1.80	(14)
Latin America	0.22	(4)	0.31	(4)	0.65	(5)
Middle East	0.13	(3)	0.31	(4)	0.67	(5)
South and East Asia	0.27	(5)	0.56	(8)	1.55	(12)

	1985		*2000*		*2025*	
	PC **	*CI* ***	*PC*	*CI*	*PC*	*CI*
Global total	1.06	15.7	1.22	15.8	1.56	16.0
Industrialised countries	3.12	16.3	3.65	16.1	4.65	16.0
North America	5.08	15.7	5.75	15.8	7.12	16.6
Western Europe	2.14	15.6	2.29	15.1	2.69	14.6
OECD Pacific	2.14	16.1	3.01	16.1	3.68	14.8
Non OECD Europe	3.19	17.5	3.78	16.9	5.02	16.4
Developing countries	0.36	14.2	0.51	15.2	0.84	16.0
Africa	0.29	12.3	0.32	13.2	0.54	15.2
Centrally Planned Asia	0.47	17.3	0.68	18.8	1.15	19.6
Latin America	0.55	11.5	0.61	11.4	0.91	11.8
Middle East	1.20	16.7	1.79	16.1	2.41	15.5
South and East Asia	0.19	12.3	0.32	14.3	0.64	15.6

* This table presents regional gross CO_2 emissions and does not include CFCs, methane, ozone, nitrous oxide and the effects of carbon sinks. Climate change critically depends on all greenhouse gas emissions from all economic sectors. *The table should therefore be interpreted with care.*

** PC – Per capita carbon emissions in tonnes carbon per person.

***CI – Carbon Intensity in kilograms carbon per gigajoule.

Source: IPCC[2]

environmental hazards, and it would aggravate the problem of global warming.

Funding constraints

3.6 Developing countries would find it difficult to obtain the economic and financial resources necessary to increase the output of energy from conventional sources at projected rates. At the World Energy Conference in Montreal in 1989 the capital resources projected to be demanded by the energy sector of developing countries were estimated to be four to five times greater than those likely to be available.

3.7 This is particularly true of electric power. Power projects have recently accounted for a quarter of public capital investments in developing countries, 2 per cent of their annual GNP. In 1986 the debt of developing country power utilities was $180 billion, one-fifth of developing countries' total debt. Servicing even that amount of borrowing is proving difficult.

3.8 Added to the high capital requirements of power systems are their heavy financial demands on the current account of the balance of payments where capital equipment and fossil fuel are purchased abroad. Many power utilities are in financial difficulties, and a burden on government budgets. In recent years the cost of servicing their growing debts has been aggravated by high interest rates and high fuel costs. Power tariffs are rarely increased to cover full costs, often as deliberate government policy to provide cheap energy for industry and agriculture. Moreover, some potential revenue is forfeited through failures in collection. In short, as the World Bank has pointed out, "The power sector is a voracious consumer of investment capital and it is expensive to operate"[3].

3.9 The problems of trying to continue to expand the power system at past rates are confronting many countries. In Pakistan, for example, the consumption of electricity has recently been growing at a rate whose continuation would imply increasing capacity from 7,000 MW at present to 35,000 MW in 2010, and require investment of $20 billion in hydro resources alone. This would absorb a large amount of investment capital which would be difficult to raise in view of Pakistan's present foreign exchange position and limitations on its foreign borrowing and access to aid. Hence Pakistan's interest in energy efficiency measures (see Box 3.1 overleaf).

Local environmental pressures

3.10 The supply and use of energy cause serious local environmental problems. The exploration, extraction, transport and refining of petroleum and coal have drastic environmental consequences. The burning of petrol in auto-

Box 3.1

Improving Energy Efficiency in Pakistan

Pakistan's power is supplied by two integrated utilities, the Karachi Electric Supply Company—which is based entirely on oil and gas—and the Water and Power Development Authority—which has 45 per cent of its capacity as hydro. The current trend growth of demand is 9 per cent per year. At this rate, demand would rise from 7000 MW to 35000 MW by 2010. Expanding supply to meet this projected level of demand would require unrealistically large foreign aid and borrowing. Increasing hydro capacity would also run into environmental objections and would require careful balancing of water use between the power and irrigation sectors.

A study by consultants has identified a number of areas where the supply of and demand for power could be better managed, providing substantial savings compared with the options of investing in new thermal or hydro capacity. The average capital cost of power from seven major new hydro schemes would be $1,400/kW, from new thermal generation units $850-1,000/kW, and from combined cycle plant $750/kW. In comparison, the rehabilitation of older thermal plant could recover 275 MW of capacity at a cost of $233/kW. Converting existing gas turbine plants to combined cycle operations through retrofitting steam cycle equipment could gain 163 MW at a cost of $515/kW. Improving the coordination of thermal and hydro systems, and integrating the operations of the two national systems could produce savings in the range of $50-100 million.

Losses in transmission and distribution waste 21 per cent of generated energy. Although this is lower than in many countries, it could be reduced to 10-15 per cent through such measures as improved reactive power compensation, uprating distribution transformers, improving customers' load factors, etc—all of which would effectively increase present capacity at less than the investment cost for new plant. There is also scope for adjusting tariffs to encourage energy conservation and shift peak load to off-peak times. Finally, the owners of private generators (including many industrial companies) could be encouraged to sell surplus power back to the grid by formulating suitable buy-back tariffs.

Source: Tony Wheeler[4]

mobiles causes local air pollution, including photochemical smog, in many cities, as well as contributing to global warming.

3.11 The generation of power by thermal, hydro or nuclear processes can have equally serious effects. Major hydroelectric schemes preempt large areas of land, cause resettlement and displacement of people and wildlife, irrevocably alter landscapes, change water regimes, etc. Thermal power stations cause local air and water pollution and acid rain. The various kinds of air pollution have been implicated in damage to health, the corrosion of materials and declining yields from agriculture, forestry and fisheries. Thermal power plants are major sources of sulphur dioxide and nitrogen oxide, and of toxic substances as well as particulates.

3.12 Apart from energy used in generating power, industry and motor transport, the use of wood is widespread, and causes its own set of environmental problems. In Africa woodfuel supplies much more than half of household energy needs. Cutting wood for rural use or for sale in cities is a major source of deforestation in arid and semi-arid areas of Africa and South Asia.

Regional environmental emergencies

3.13 The energy sector is a major cause of environmental hazards. Of particular concern at present are the oil well fires in Kuwait where about 5 million barrels of crude petroleum are burning each day. This is resulting in serious disruption of the regional climate due to huge clouds of smoke, as well as major emissions of CO_2, thereby contributing to the global atmospheric burden of greenhouse gases. It is also having serious effects on health and will impose economic and social costs for a long time to come.

3.14 The exploitation and transport of energy resources can cause serious environmental problems and emergencies. Oil spills from tankers and discharges of other contaminants are particularly damaging to island countries, many of which are in the Commonwealth. Contamination of beaches which sustain tourism and the destruction of aquatic ecosystems are some of the more serious effects. Many small states do not have the resources or the capability for pollution prevention and clean-up measures to cope with these hazards when they occur. *We therefore recommend that Commonwealth countries should examine ways of co-operating, on a regional basis, to prevent oil and toxic chemical spills, and to minimise the damage done when these emergencies occur. They should also support the relevant efforts of UN and other international agencies in this field.*

Global warming

3.15 Present trends in energy use are unsustainable because they imply

unacceptable risks to the global climate. Energy use is currently responsible for about half of global warming.

3.16 The contribution of different greenhouse gases to global warming depends on the rate at which they are emitted, and the lifetime of each gas, among other factors. It has been estimated that the relative cumulative effects of 1990 emissions on 'global warming potential' over 100 years for the different gases is: carbon dioxide 61 per cent; methane 15 per cent; nitrous oxide 4 per cent, CFCs and hydrochlorofluorocarbons (HCFCs) 11.5 per cent in total, and others 8.5 per cent.

3.17 The current contribution to global warming can be summed up as follows: energy use (direct and indirect) 46 per cent, deforestation 18 per cent, agriculture 9 per cent, and industry (mainly CFCs) 24 per cent[5]. Gross emissions of carbon dioxide from the energy sector are heavily concentrated in developed and industrialising countries: North America (26 per cent), the USSR and Eastern Europe (26 per cent), Western Europe (16 per cent), China (10 per cent) and Japan (6 per cent).

3.18 Developing countries, apart from China, contributed only 16 per cent in 1985. However, this is changing as these countries industrialise and increase their per capita energy use.

3.19 The Second World Climate Conference, taking into account the work of the IPCC, estimated that stabilising the atmospheric concentrations of CO_2 at about 50 per cent above pre-industrial concentrations by the middle of the next century would require continuous reductions of net global emissions by 1-2 per cent per year starting now. Since developing countries still account for a minor part of these emissions, the immediate onus for action falls on developed countries. They are by far the greater emitters, they are better able to absorb any net costs of remedial actions, and they have a stronger base for developing the required technological response. In Chapter 4 we make specific calls for leadership by developed countries in respect of action on global warming.

3.20 *We cannot stress too strongly the responsibilities of the developed countries for taking immediate action to reduce their own use of energy; encourage energy conservation; develop energy-efficient technologies; and facilitate the transfer, on concessional and preferential terms, of such technologies to developing countries. The developed countries should recognise their prime responsibility for global warming and create the 'headroom' needed to enable developing countries to achieve a rate of energy consumption consonant with higher living standards.*

3.21 Both regulatory and market or tax mechanisms must be considered by developed countries. Their governments should use the price mechanism not

only to reduce their countries' consumption of energy but to generate sufficient resources to provide much greater help to developing countries so that these countries can expand their use of commercial energy at a rate which increases living standards while using energy more efficiently. *We agree with those who advocate an international carbon tax in this connection. Its implementation must, however, recognise the relative responsibilities of developed and developing countries for accumulated greenhouse gas emissions and the priority that must be given to economic growth in developing countries.*

Energy efficiency

3.22 If past trends continue, it is likely that attempts to perpetuate present demand patterns and supply technologies in developing countries would become increasingly unviable, causing reduced economic growth and frustrated demand from all quarters. However, we believe there is great scope for alleviating future energy problems by improving the efficiency with which energy is supplied and used.

3.23 Although historically, growth in GNP has been correlated with growing energy use per head, the link has been broken in some developed countries. In the United States, per capita energy use fell by 12 per cent between 1973 and 1985 at a time when GNP rose by 17 per cent. In Britain, too, there was a similar occurrence. The means exist for developing countries to practise 'leap-frogging' by adopting state-of-the-art machinery and processes and conservation measures which reduce the energy input into GNP. But this is contingent on their having adequate and additional financial resources and access to the relevant technologies on affordable terms. One study found that the use of more efficient end-use technology by a typical developing country whose need for energy services were similar to those of Western Europe in the 1970s would lead to a total final energy use per head of 1 kilowatt, only 20 per cent more than the developing country average in 1980.[6]

3.24 In developing countries electricity has been the most rapidly growing form of energy consumption, responding to rising incomes, urbanisation, and industrialisation; currently it supplies about one-quarter of their final commercial energy demand. Improvements in housing conditions, and the acquisition of electrical consumer durables, translate into increasing demand for power. The growing urbanisation of populations increases the demand for power disproportionately, as does the growth of industry relative to agriculture.

3.25 These are natural developments, associated with necessary structural changes and rising living standards. In many situations there are good reasons for encouraging the further substitution of electricity for other kinds

of energy, including human effort, e.g. the use of electric pumps for irrigation and drinking water supply. Experience in some developing countries has shown that some of these needs can be met by local generation of electricity through such means as solar, wind, and mini-hydro power, which being potentially modular, have the advantage that capital inputs can be incremental.

3.26 There are often sound environmental and public health-related reasons for welcoming the substitution of commercial fuels for wood and cattle dung used for heating and cooking. Kerosene and liquefied petroleum gas (LPG) and biogas offer means for more efficient cooking and heating without the household pollution that risks family health, especially of women and children. Where such fuels can be made competitive with wood and charcoal, pressures for deforestation are reduced. If farmers can be provided with fuels superior to animal dung at prices which are affordable, the dung can be returned to the ground for improving soil fertility. Given such measures, the wider use of LPG in Nigeria, for example, would have major environmental and human benefits[7]. The wider availability of commercial fuels would be of great benefit in poor and populous countries such as Bangladesh, where the shortage of biomass limits the amount of cooking that takes place, with obvious effects on nutrition and health.

3.27 We believe these are powerful reasons for encouraging the use of various alternative energy supply techniques to meet some of the legitimate needs in developing countries. Over time and with adequate and additional resources, the growing need for energy can be reconciled with financial constraints and environmental pressures. Boxes 3.1 and 3.2 (pages 38 and 43) illustrate the scope for encouraging sustainable energy use and supply in two populous Commonwealth countries.

3.28 In the electric power sector, measures can be broadly divided into those concerned with the efficient use of power, and those focused on its more efficient production. We believe there is considerable room for improved end-use efficiency in both developing and developed countries. Industry is the largest user of power in developing countries and a major consumer in developed countries. The scope for energy-saving varies across sub-sectors. A new generation of energy-efficient industrial motors is available, and savings are possible from using motor speed controls. Low-cost energy-saving measures could save 2-4 per cent of costs in smelting aluminium, and 10-20 per cent for producing cement. Retrofitting and process improvements could produce cost savings of 5-13 per cent for smelting steel, and up to 85 per cent for processing sugar. Energy use in the fertilizer industry could also be reduced, by about 15 per cent. All these investments would have rapid pay-back periods[9].

3.29 In the commercial and residential areas the best scope for improving

Box 3.2

DEFENDUS Scenario in Karnataka, India

This energy scenario was produced as a response to an estimate of the cost of meeting Karnataka's power needs, assuming a continuation of present trends and use patterns. This estimate, contained in the Long-Range Plan for Power Projects in Karnataka (LRPPP), projected a need for 9.4 gigawatts of power by 2000, requiring the State to spend $17.4 billion, or 25 times its annual budget. The sum entailed, and the scale of the construction programme required, were clearly excessive, and the Plan was rejected by the State.

The DEFENDUS approach is development-focused, end use-oriented, and service-directed, blending conservation and local renewable sources into a least-cost mix. It is based on electrifying all homes in the State, the widespread installation of electric irrigation pumps, setting up decentralised energy centres in villages, and promoting industries to provide jobs. Even so, its needs for energy and power by the year 2000 would be only 38 per cent and 42 per cent respectively, of the LRPPP projections.

The savings would be achieved by a range of measures. Inefficient motors and incandescent bulbs would be replaced with more efficient motors and compact fluorescent lamps. Electric water heaters and stoves would be replaced by solar-powered water heaters and LPG stoves. Irrigation pump systems would be retrofitted with frictionless foot valves and better piping.

The generation of power would be by a least-cost mix of large conventional units and decentralised units, including some of a non-conventional nature. Mini-hydro plants and biomass-based rural energy centres would have an important place in the system, and major new investment in nuclear power stations, coal-fired thermal generators and major dams would be avoided. The system would draw entirely on proven, off-the-shelf technologies.

The DEFENDUS scenario would provide for Karnataka's needs at one-third the cost of the LRPPP, would deliver the energy sooner, more equitably, with less harm to the State's environment, and with a fraction of its emissions of greenhouse gases.

Source: Reddy and Goldemberg[8]

energy efficiency lies in lighting, air conditioning, insulation of buildings, water pumping and refrigeration. In water pumping, to take one example, the range of measures includes installing high efficiency motors, low-resistance foot valves, proper sizing of motors and pumps, electronic speed controls, efficient hydraulic parts, irrigation load management and improved maintenance.

3.30 A study by the Tata Energy Research Institute (TERI) in India demonstrated the sizable impact of merely changing light bulbs on the power situation in Bombay. Lighting is the major contributor to peak load demand for power. Incandescent bulbs are the least energy-efficient source of lighting, but are heavily used in residential quarters. The TERI estimated that replacing incandescent bulbs with 20 watt compact fluorescent bulbs would reduce peak load demand by 40 per cent, displacing the equivalent of 5000 MW and eliminating the need for load restrictions. The cost of the conversion would be handsomely rewarded by a rate of return of 50-55 per cent[10], although the higher costs of fluorescent bulbs would have to be taken into account, perhaps initially by a subsidy.

3.31 The more efficient use of fuel for household use would serve a number of valuable purposes. Better stoves, which used less energy to produce a given amount of heat, would lighten the workload of women, reduce household air pollution and thus benefit the health of women and their families, and reduce pressure for the deforestation of surrounding areas. At present the collection of firewood can absorb several hours per day of the time of women in poor communities.

3.32 Automobiles and trucks are substantial sources of greenhouse gas emissions (accounting for a quarter of the total in some countries), causes of photochemical smog and carriers of toxic trace metals. With rapidly growing numbers of vehicles, measures to reduce these emissions assume increasing importance. The most effective and feasible means of achieving such a goal is greatly to improve the efficiency of new vehicles in the market place through a combination of government regulations, price and tax policies. In North America, for example, most vehicle manufacturers have well-tested prototypes which sacrifice little comfort or safety, and which use less than half of the fuel used by currently available new vehicles. Increased support for public transport could also help to reduce emissions by lowering the number of engines in use.

3.33 The developing countries should be enabled to meet their growing needs for energy in more sustainable ways, which impose less damage on the local environment, are affordable, and which can deliver energy more efficiently and without sacrificing economic growth. Most of these countries can tap a range of measures to improve the efficiency with which energy is supplied and used, which are more cost-effective than previous supply

investments. In developed countries, energy-efficiency measures will have a much greater effect in improving global environmental conditions because of these countries' much larger use of energy.

3.34 *In order to improve energy efficiency, we recommend that:*

- *the price of energy should be adjusted to reflect better its true economic and environmental costs in supply and use. This would discourage wasteful use and encourage efficiency;*

- *national electric power and gas utilities should see their role increasingly as promoting energy efficiency, as opposed to maximising the supply and sale of electricity and gas. Utilities should evolve into energy-service companies advising on energy saving and encouraging consumers to use more efficient appliances, by grants, leasing or subsidised loans;*

- *energy supply programmes should be reoriented. Instead of focusing on specific supply-based projects, they should support goal-oriented programmes, such as electrifying more villages and households;*

- *developed countries should facilitate the transfer of energy-efficient technologies to, and between, developing countries by increasing their bilateral aid provision for this purpose, funded if necessary on a specific basis such as through a special carbon tax; and*

- *international aid agencies and national development banks should be much more ready to assist energy-efficiency projects, as compared to centralised energy supply schemes. At present concessional funding tends to go to the latter, leaving the former competing for funds on commercial terms.*

Renewable energy sources

3.35 Compared to the use of fossil fuels, renewable energy sources are, by definition, sustainable, and they contribute little, if anything, to global warming. The local environmental effect of, say, wind and solar schemes is minor compared to thermal or large-scale hydro-power generation. So far, however, wind and solar systems have had only isolated commercial applications in developing countries. But especially in island small states the natural conditions for producing these resources of energy are favourable and the costs of conventional energy and power are relatively high. Energy from biomass sources, such as farm crops and wastes, and timber , is more widely used in Africa, and methane production from cow dung is common in South Asia. Solar, wind, ocean-based and certain biomass energy technologies are becoming technically and commercially viable for developing countries on a much wider scale. One authoritative view is that "Electricity from wind, solar-thermal and biomass technologies is likely to be cost-competitive in the

1990s; electricity from photovoltaics and liquid fuels from biomass should be so by the turn of the century."[11]

3.36 We summarise the prospects for these renewable sources of energy (and mini-hydro schemes) in Annex 2 on page 152. Our conclusion is that the development of renewable energy sources should be given a major boost. We realise that fossil fuels and major hydroelectric schemes will continue to be relied on for satisfying large parts of demand for energy, but it is vital to increase the market share of energy based on solar, wind, ocean, biomass and mini-hydro sources. In many situations the technologies for producing such forms of energy are competitive with conventional types: given further research and development, and the more intensive exchange of data and experience, these non-conventional sources could make much deeper inroads into the market, with savings in both financial and environmental costs. Many of the methods would bring benefits to women, particularly in developing countries, enabling the substitution of commercial energy for the human effort which in many respects is provided largely by women. Some of them are specifically relevant to the needs of small and island states.

3.37 *We believe that the use of renewable energy resources should be encouraged. We recommend that:*

- *in energy planning, renewable sources should always be explored as the first choice to meet additional energy needs;*

- *governments should facilitate the adoption of renewable energy schemes, especially decentralised ones, through promoting their use in public buildings, offering tax relief to firms and households using renewable energy technologies, and freely exchanging information and experience with other countries;*

- *power and energy utilities should increasingly support and adopt renewable energy schemes. Countries with relevant know-how and experience should enter twinning arrangements with utilities in other Commonwealth countries;*

- *aid agencies should be more forthcoming in their support of renewable energy technologies, recognising their strong environmental attractions, their rapidly improving economic and commercial viability; and the reduced need for expensive fuel imports; and*

- *the prices, taxes and subsidies applying to the different types of energy sources and technologies should reflect their relative environmental, as well as economic and social, costs and benefits; where appropriate, duties on renewable energy technologies should be removed.*

Land Use and Degradation

3.38 Most of the developing world's population are directly dependent on the productivity of land for food, jobs and income, and the remainder depend on it for food and life-support. Although there has been progress in raising the productivity of land in some cases, in many important respects its potential for supporting growing populations has been reduced. Even today hundreds of millions of people receive inadequate nutrition, and grave doubts must be entertained about the ability of current land use practices to supply enough food to give future generations even minimum levels of nutrition.

3.39 Over the last forty years it has been estimated that the world has lost almost one-fifth of the topsoil from its cropland, one-fifth of its tropical rainforests (the destruction of temperate forests has been taking place for a far longer period and has been proportionately much greater), and tens of thousands of its plant and animal species. Yields in many important irrigated areas are falling, and the food situation in Africa has clearly deteriorated—grain production per head is 20 per cent below its 1967 level[12]. Good farm land is steadily being lost to the encroachment of cities, which is especially serious when the cities are located near prime agricultural land (e.g. Dhaka, Calcutta, Delhi).

3.40 A large part of the world's land is degraded. One estimate of the proportions involved is reproduced in Box 3.3 (overleaf). Moderate and severe land degradation, defined as a reduction in potential yield of 10-50 per cent and more than 50 per cent, respectively, affects 40 per cent of agricultural land in Africa and 44 per cent in Asia. The more developed regions are equally prone to degradation, especially Australia.

3.41 It has been estimated that in the 1980s the world's farmers lost a net amount of 240 billion tons of topsoil from cropped areas, which is equivalent to half the topsoil on US farms. If present trends continue, Africa would lose a quarter of its 1975 level of agricultural production by the year 2000[14].

3.42 In the long term the use of the earth's land resources needs to be optimised in relation to the many demands that will be placed on them. More immediately, and without losing sight of this aim, the current processes of degradation need to be halted and reversed. Although certain general causes are at work, there are many local factors that need to be taken into account.

3.43 This section examines the reasons for degradation in three important categories of land—watersheds and hilly areas, irrigated areas, and drylands—and in each it recommends measures to preserve and enhance the land's productive potential. Although the main focus of the discussion is on securing food supplies, this is not to ignore the function of land in providing income, jobs and industrial raw materials, which are touched on more briefly.

Box 3.3

Categories of Agricultural Land and Estimated Degradation in the Late 1970s

Agricultural land has been grouped into three categories according to its degree of degradation. The definition of 'slight' degradation is the reduction of its potential yield by less than 10 per cent; 'moderate' degradation is a reduction of 10-50 per cent; 'severe' degradation is a reduced potential of more than 50 per cent. The results, by major region, are set out below:

Continent	Slight	Moderate	Severe	Total
		(percent of land surface)		
Africa	60	23	17	100
Asia	56	28	16	100
Australia	38	55	7	100
Europe	69	25	6	100
N. America	70	23	7	100
S. America	73	17	10	100

Source: Lester R Brown[13].

Nor is it to ignore other matters such as gender roles which have important, if often underlying, influences as the following paragraph explains.

3.44 Where land use is small scale and community based, the relationship of the different community members to the environment and their interactions with it are often influenced by the gender roles assigned to them. Any land use or environmental projects therefore need to take gender roles and responsibilities into account. Male roles are typically specialised, usually as economic producers including paid workers, as leaders and as political agents for the family. Female roles are typically multi-skilled and overlapping, including paid and unpaid roles as caregivers, caretakers and educators. All roles are involved with direct personal relations and most of them are likely not to involve scientific or economic training. The implications of this divergence of responsibilities between the genders are that for integrated environmental management, men in general require access to education on human relationships and household economics; women on economic resource management, available technology and finance, and on ecology. Both require education in decision-making processes.

Watersheds and hilly areas

3.45 About half the world's population are potentially affected by watershed degradation—the 10 per cent who live on the slopes concerned, and the 40 per cent who occupy the adjacent lowland areas. In the tropical regions of the Western Hemisphere, for instance, between a quarter and a third of the population live on farms in hillside zones, and half these farms are on slopes greater than 20 degrees. Likewise the mountainous slopes of South-East Asia, the Himalayas, East and Central Africa and elsewhere are of vital agricultural importance to their respective countries.

3.46 Watersheds are threatened by many factors. The encroachment of farm populations, livestock grazing, firewood collection, commercial logging, major civil works such as dams and highways, and the conversion of forest to plantations are the major ones.

3.47 Serious erosion normally results from a change in vegetation cover, e.g. from deforestation, conversion from perennial to annual crops, grazing by livestock, etc. Gully erosion and soil creep have more dramatic effects and are typically caused by road building across slopes, careless logging, and a change in cropping from deep- to shallow-rooted varieties. Landslides are an extreme form, risking damage to property and loss of life and livestock as well as agricultural and sedimentation costs.

3.48 Many tropical hilly areas contain low productivity subsistence agriculture carried out amidst rapid population growth, poverty, and economic marginality. These rural populations are often difficult to reach with normal public services. The problem has been encapsulated as follows: "..environmental degradation is so widespread in hillside areas because the social and economic factors associated with underdevelopment are there combined with a land resource subject to rapid deterioration under improper human use"[15].

3.49 Poor people gravitate towards watersheds where they subsist on the margins of cultivation. Population pressure may add to this trend in countries where the density of settlement is already high and the cities cannot absorb all the migrants looking for work. Anything that reduces the capacity of existing cultivated areas to hold population and offer employment will also expel farmers to the marginal limits. The development of large-scale farming systems (e.g. by subsidies and tax incentives) and the substitution of capital for labour in agriculture (e.g. by tax incentives and artificially cheap imports of machinery) will have this effect.

3.50 Degradation is often prevalent in frontier conditions. Clearing land of its original vegetation is usually the surest way of staking claim to it and is thus a more profitable way of securing cultivable land than investing in conservation measures on existing plots. Government settlement and coloni-

sation policies have also been responsible for locating small farmers in unsuitable areas with inadequate support, with the result that land is degraded and then abandoned.

3.51 Small farmers often find it difficult to get access to good land in 'safe' ecological areas, because of a lack of cash, credit, or local political connections. Hence the people forced on to slopes subject to erosion are frequently those least able to take the longer view entailed in carrying out conservation measures.

3.52 Those areas that are better integrated with the national market respond most readily to policy and market signals which may themselves encourage degrading farm practices. This is important for crops which are potentially erosive. The decision whether or not to grow such crops (e.g. maize, cassava and tobacco) on slopes rather than crops less liable to cause erosion (e.g. tree crops, terraced rice) will depend heavily on their relative prices. These in turn may depend on official price-fixing, import controls, and (in the case of exports or import substitutes) the exchange rate.

3.53 Farm policies can strongly reinforce soil conservation. In Java, a densely farmed island with a high degree of commercial penetration typical of some other regions of Asia, it has been argued that: "Manipulation of selected non-staple prices would be a cost-effective means of encouraging more profitable and sustainable upland farming to complement stronger programmes for research, extension and credit. Continuation of restrictive import policies for perennial fruits and animal husbandry products will spread agro-forestry and forage systems. Price support or buffer stock schemes for tradeable crops such as cloves and coffee would also have a positive impact on soil conservation"[16]. Such interventions are, however, difficult to manage successfully.

3.54 Security of tenure is an obvious precondition of farmers taking the long-term perspective necessary for managing their land sustainably. As we note in Chapter 6, women may face special obstacles in obtaining security of tenure or access to land. Tenant farmers are less likely than freeholders, and squatters less likely than leaseholders, to make long-term investments in their land. Open access land is especially liable to be overused and eroded, where traditional and communal control is lacking, or has been undermined. Privatizing common property resources is not always the answer, since it often deprives poor people of access to vital inputs and forces them into a vicious circle of degradation elsewhere.

3.55 Although the traditional methods of managing common property resources are often adequate to ensure sustainable practices, this is not true of all forms of traditional landholding. In some South Pacific countries land held under customary ownership is showing signs of degradation, and

governments need to bring appropriate influence to bear, seeking the support and co-operation of land-owners in the preparation and implementation of land-use plans.

3.56 Labour used for conservation work (e.g. terracing, bunding) usually has an opportunity cost, either in the value of crops and livestock it could have produced, or in the off-farm wage employment it could have obtained. Where off-farm employment is plentiful, interest in conservation measures may be reduced. However, if farmers rely heavily on off-farm jobs, they may favour less labour-intensive techniques on their own farms, and consequently grow more perennial crops and trees. This is another good reason for promoting off-farm employment to help the environment.

3.57 *This brief review of land degradation in watersheds and hilly areas leads us to make a number of recommendations to help stem the problem and enhance the potential of such land. Action should be taken urgently as land degradation in these areas is the largest single pollutant of fresh and coastal waters. It is thus a global issue. We recommend that:*

- *each government should seek to complete a land resource audit and compile a prospective plan for land usage;*

- *land conservation schemes should be undertaken, maximising the incentives of villagers and farmers to take part. Governments should exchange information and experience about successful conservation schemes;*

- *construction projects in fragile environments should contain a high degree of environmental protection, and transport systems for logging operations should be carefully supervised;*

- *off-farm employment should be encouraged as a way of relieving rural poverty and providing incentives and resources for land conservation;*

- *security of tenure should be improved, by land reform, offering leases to squatters, and confirming users' rights to land;*

- *farm policies, such as relative crop prices, export taxes, import controls, and input subsidies, should be framed in a way that recognises that certain crops are potentially more degrading than others;*

- *encroachment on common property areas, such as grazing land and forest, should be discouraged;*

- *tax incentives and subsidies offered to commercial farmers, ranchers and loggers should be carefully examined for their potential environmental effects, including their repercussions on small farmers; and*

– *aid agencies should support studies into maximising the long-term potential of land for food production.*

Irrigated areas

3.58 One-third of the world's food is grown on the 17 per cent of its arable area (250 million hectares) that is irrigated. Many countries, including some populous ones such as India and Pakistan, rely on irrigation for more than half their food supplies.

3.59 The rapid expansion of the irrigated area witnessed over the last 30 years is unlikely to be repeated—the most suitable areas have already been irrigated and future schemes will incur increasing costs. Currently irrigated areas are performing well below their potential, because of poor management and design, and the waste of water. The scope this gives for improving the use of existing schemes could be a sign of hope.

3.60 Various levels of technology can be employed in irrigation schemes. In countries with low labour costs, low levels of technology are sometimes the best option, being capable of use on a small scale and being built up incrementally. The comparative costs and benefits of various types of technology in constructing irrigation schemes are worthy of further examination.

3.61 Salinity and waterlogging are seriously reducing the fertility of large areas of irrigated land. Salinity has reduced yields on 20 million hectares in India and has caused the abandonment of a further 7 million hectares. In Pakistan, salinity and/or waterlogging affect three-quarters of the irrigated area. The rise of the water-table is caused by various factors. The design of schemes and the way on-farm development is carried out may make it difficult for farmers to control the optimal timing and quantities of water used. There is excessive application by certain farmers with privileged access to supplies. This causes salinity as well as public health problems. It is encouraged by gross under-pricing of water and poor revenue collection techniques. There is widespread leakage during distribution, and inadequate drainage. The lack of financial autonomy of many public schemes, with the Treasury siphoning off whatever revenue is collected, is a common reason for the neglect of maintenance on irrigation structures. Overall, it is possible that three-fifths of the world's irrigated area is in need of upgrading.

3.62 Inadequate drainage can usually be traced to the low priority given to this aspect when irrigation schemes are designed. Major drainage works are often not required until some time after a scheme has been completed, but the situation needs to be carefully monitored and financial provision made for it.

3.63 An improvement in the financial position of irrigation authorities is urgently needed. Ideally they should be able to recover the full costs (includ-

ing capital) of irrigation and drainage schemes, but they should at least be able to fund essential maintenance and operating outlays. Increasing charges, relating water costs to usage, and improving revenue collection methods would signal the real cost of the water, though we do not underestimate the political problems of raising charges.

3.64 Agro-chemicals used as pesticides for the control of weeds and insects may accumulate in the topsoil, and harmfully affect plants. The use of such chemicals is not confined to irrigated farms, but their abuse is a major environmental issue in these areas. It can cause occupational diseases to the workers handling them, and to their families. Local atmospheric pollution from crop spraying affects a wider circle of people. The build up of chemical residues in the soil and on plants may then enter the food chain, and thence to all consumers of the foodstuffs. It is estimated that 10,000 people die and 400,000 suffer acutely from pesticide poisoning every year in developing countries—though not all these are on irrigation schemes. Most are farm-workers handling the chemicals, who suffer skin, eye and respiratory complaints, but the contamination easily spreads to their families and other villagers. Deformities in unborn children and breast-fed infants have been traced to the intake of pesticides by their mothers.

3.65 Many countries ban the use of the more dangerous chemicals, but such bans are widely evaded by farmers and plantation companies concerned to protect their investments. The use of pesticides is sometimes encouraged by government subsidies. A survey of pesticides in nine developing countries showed an average subsidy equivalent to 44 per cent of retail costs, while in some countries the proportion was over 80 per cent[17]. Pesticide requirements tend to increase over time, as their targets develop resistance. The vicious circle can, however, be broken by various forms of integrated pest management, which are much gentler in their environmental effects.

3.66 *To enable irrigation schemes to produce at nearer their true capacity, and to help arrest the decline in soil fertility, we see a need for:*

- *improved design and operation of irrigation schemes, including proper drainage, canal lining, field levelling and other aspects of on-farm development, to reduce the waste of water, seepage, and waterlogging, and to help farmers have more control over the application of their water;*

- *better financial arrangements—adequate funding, levying and collecting water charges at a rate sufficient to secure the cost of operation and maintenance, and eventually to fund drainage measures. This implies a degree of financial autonomy for the irrigation sector;*

- *adequate maintenance capability, preferably with some responsibility devolved to the users;*

- *a judicious balance between central direction and control, on the one hand, and the involvement of farmers and communities, on the other. The larger the scheme, the more important, and difficult, it is to get the balance right. Privately-owned and small schemes are easier to manage than publicly-owned and large schemes, respectively; and*

- *promotion of natural methods of pest control through integrated pest management, better husbandry, a reduction of subsidies on pesticides, and a ban on the production of the more persistent and dangerous types.*

Drylands

3.67 Drylands, normally defined as those receiving annual rainfall of 300-1500 mm, range from areas where one rain-fed arable crop per year can be expected, to areas on the fringes of the desert where supplementary sources of water would normally be needed to sustain regular farming. In 1975 it was estimated that the population of arid areas was 132 million, and that of semi-arid areas was 314 million. Both numbers would have risen since. Most of the people are very poor.

3.68 Deserts, on the other hand, receive less than 100 mm. of rainfall per year, and rain-fed farming is not normally feasible. Although even these areas sustain some wildlife and nomadic peoples, they are less important than drylands as life-support systems. Semi-arid areas are more important as human environments, and are often of political and strategic significance.

3.69 The evidence and causes of desertification are still under debate[18]. What is not in dispute is that there has been sizable local degradation from concentrations of people and animals. Drylands are particularly important for supporting cattle, but their ability to continue to cater for expanding numbers of livestock is in doubt. In Africa, it is estimated that the livestock population has risen to 543 million, compared to 272 million in 1950. In India the demand for fodder is expected soon to outstrip supply, affecting the condition and survival prospects of large numbers of cattle. Recently certain local governments in India have set up fodder relief camps for cattle threatened with starvation.

3.70 Climatic changes are partly responsible for the degradation which has occurred—by historical standards the last two decades have been unusually dry in Africa's Sahel, though it is too soon to conclude that this is the start of a long-term trend towards greater aridity. Population growth and migration are other potent causes. In the past population has adjusted to the carrying capacity of the land by temporary or permanent migrations, and by use of the bush fallow system. But recently, this process has been affected by large movements of refugees, especially in the Sahel, and by projects to stabilise populations in unsuitable areas.

3.71 The encroachment of arable cultivation into marginal areas has often resulted from population pressure and the resettlement of farmers on land really only suitable for livestock. The inappropriate introduction of mechanised farming has exposed land to the risk of wind erosion in several major areas.

3.72 Livestock often bring on desertification, by destroying young trees, overgrazing sparse pasture and treading down vegetation around water points and along trails. Although livestock numbers often adjust to carrying capacity, there is evidence of long-term increases in some countries (e.g. western Sudan, Zimbabwe, Lesotho). Control of the rinderpest disease has also tended to increase livestock numbers in previously infested areas. Many well-intentioned livestock projects have had undesirable local environmental effects, because they increased concentrations of livestock, even if only temporarily.

3.73 The destruction of trees for use as fuelwood is a cause of much degradation. As fuelwood becomes scarcer, crop residues and animal dung may be diverted from fertilising soil, and used as fuel. Soil yields decline, leading to less vegetation, and the use of crop residues to feed livestock. Soil fertility declines further and erosion sets in.

3.74 The above processes are often caused or aggravated by a breakdown in traditional methods of conservation and adaptive husbandry. One example is the decline of the bush-fallow system resulting from such factors as population pressure, war, drought, and refugee movements. In some cases governments remove powers and responsibility from local people, or undermine the authority of traditional leaders. Many of these difficulties have been exacerbated by artificial political boundaries and the privation brought about by war.

3.75 Large areas of dryland have also been degraded by the inappropriate encouragement of commercial farming. The subsidised import of machinery at heavily overvalued exchange rates and tax incentives on farm income have led to large areas of dryland being ploughed up, farmed for a few years, and then abandoned in the face of declining soil fertility.

3.76 We are persuaded that relative prices are a powerful influence on the balance of crops grown in an area. There may sometimes be a conflict of interest between incentive prices and sound resource management. The 'commercialisation' of agriculture in places like the Sahel bears a share of the responsibility for dryland degradation. Farmers have been growing export crops (cotton, groundnuts, etc.) to meet the cash needs of their households. Apart from any direct effects which such cultivation has on the soil, it reduces the scope for dry-season grazing, with its valuable manuring. In some cases cash cropping leads to the neglect of food production which is

largely carried out by women and small farmers. The result may be shifts in the distribution of income, to the detriment of households headed by women, and of women and children in other families.

3.77 Fuelwood pricing usually encourages the continued cutting of trees for wood and charcoal, compared with alternative fuels that are less environmentally damaging. Fees and charges levied on firewood and charcoal traders hardly ever cover the real cost of replacing and managing the forest resources. In most countries the prices of firewood and charcoal fail to signal their eventual long-term scarcity, which is concealed by periodic gluts of wood as new areas are opened up.

3.78 Drylands, containing as they do areas of great human poverty, have witnessed many well-intentioned aid projects. Very few of these appear to have been successful, and many have actually harmed the environment. *We urge governments to recognise the importance of mobile pastoralism and of transhumance for the preservation of dryland vegetation. In countries where traditional pastoralism is, or until recently was, practiced, future rural activities should be based on utilising and developing the knowledge of the local people.*

3.79 *New approaches to improving the welfare of those living on drylands are also needed, urgently. We recommend the:*

- *stimulation of alternative livelihoods for marginal farmers, either on- or off-farm;*
- *development of credit programmes, bearing in mind the specific needs of women, to help avoid the immiserating behaviour of farmers pressed for ready cash;*
- *restoration of powers of land management and control to local communities;*
- *design of aid projects which give more emphasis to small irrigation schemes, social forestry, water harvesting, pastoral restocking, and seed banks;*
- *preparation of drought preparedness schemes in all drylands; and*
- *encouragement of new or existing small scale projects, especially those initiated, controlled and managed by local communities and supported by NGOs.*

Biodiversity

3.80 Biological diversity encompasses variability in terms of genetics, species, and habitats. It is important to sustainable development for two

reasons. First, because a habitat containing many species and many strains of one species is more resilient to environmental shock, especially temperature change and water stress; and, secondly, because a diverse habitat provides a store of genetic material that has been of enormous importance to agriculture and animal husbandry, as well as to medicine and industry. Selective breeding of crops and livestock has improved yield and quality of many species, and the development of varieties with new desirable characteristics, such as resistance to disease, tolerance of temperature change, even production of new substances, depends on the maintenance of a widely diverse pool of genes. At present these genes reside for the most part in natural ecosystems. They cannot effectively be replaced by stored germ-plasm, and in any case, the countries of origin of the germ-plasm must be enabled to retain control over its use.

3.81 Genetic manipulation is replacing selective breeding in the rapid introduction of 'tailor made' varieties, and even of new species. Gene banks are maintained almost exclusively in developed countries. This is undesirable as it will lead to plant and animal breeders in these countries dominating world production of new varieties and species.

3.82 Commonwealth countries should initiate and support international measures to minimise patenting of organisms produced by genetic manipulation, and developing countries should be supported in carrying out their own plant and animal breeding, and genetic manipulation research. (The UNIDO International Centre for Genetic Engineering and Biotechnology could provide assistance.) Information on the scope and implications of genetic manipulation should be made available in popular form, together with information on expected and actual problems.

3.83 The costs and benefits of maintaining biodiversity fall on different people. A vivid example of this is where the pressure to save a threatened species of animal comes from groups in affluent countries, but where the cost of conserving it would be borne by poor farmers who need the land for subsistence. In some cases, these costs could be manageable, with suitable aid and adjustment. For example, the cost of conserving turtles in the Seychelles has been identified as falling on the few people involved in hunting and in processing the shells; a modest amount of aid through the Global Environment Facility could compensate them. But in other cases, the costs would be substantial.

3.84 *We believe it is in the common interest of developed and developing countries to arrest the loss of biodiversity. We recommend:*

- *Commonwealth governments to participate in the negotiation of the international convention to conserve biodiversity and ensure its rational use. Adequate provision should be made to meet the costs both of conserving*

biodiversity and of the opportunities forgone by such conservation, especially in developing countries;

- *an intensification of research into setting priorities for the conservation and sustainable utilisation of biodiversity between and within countries. This would recognise the costs to local communities in many cases from forfeiting alternative uses of the resources;*

- *further work on the economic and financial values of biological resources to local users, and to science;*

- *the pooling of experience of mechanisms for returning to local communities the value of the biodiversity of their habitats, as a means of improving their incentive to care for these resources; and*

- *governments to seek new partners, e.g. multinational companies, NGOs, charities, tourist enterprises, etc., to raise awareness and increase funding for the conservation and sustainable utilisation of biodiversity.*

Water Resources

3.85 Water occupies a unique position in environmental issues. Apart from being the environmental medium which is the 'sink' of all pollutants, water also has the greatest purifying capacity. But it can also be a virulent vehicle for the transmission of diseases, and in the developing countries up to 80 per cent of these are water-related. The availability of adequate quantities of water is the basic prerequisite for most socio-economic development—agriculture, industry, infrastructure, aquaculture, navigation, power generation, etc. The problem here is not so much one of water quantity in total, as of its unequal distribution across countries and continents. Many Commonwealth countries are already suffering from serious water shortages in terms of quantity; but they are also experiencing deficiencies in quality, level of service and coverage, as well as problems concerning costs.

3.86 Water scarcity is increasing, several developing countries now having less than 200 cubic metres of renewable water per person per year. The problem is not so much how much is needed but, rather, how much water is really available and how best to manage this beneficially. Only efficient use of water in all sectors can ensure sustainability. Reduction of leakages, recycling, the efficient allocation between competitive uses, and water source protection are all viable and necessary strategies. Regarding source protection, for instance, groundwater is the largest and least contaminated water source. Every effort should be made to preserve its quality by avoiding overpumping which may lead to salt intrusion and, as a result, more expensive treatment and supply.

3.87 Interbasin water transfers are being considered as a serious option for the augmentation of water resources in some Commonwealth countries. Where this is the case, it is important that the project is planned, implemented and managed in an environmentally sustainable manner.

3.88 The allocation of water is on occasion a source of serious tensions. Within countries it often causes the poor to lose out against the rich and it is therefore important that all environment impact assessments should include social implications. Between countries it may have important political implications. The division of the Nile waters, the use of the Euphrates, the sharing of the Indus, Brahmaputra and Zambesi flows have all required delicate negotiations, which will continue as the waters are used more and more intensively by partners. More than one-third of the 200 largest international river basins are not covered by international agreements and fewer than 30 have co-operative institutional arrangements.

Water pollution

3.89 The danger to the water environment emanates not only from quantity but also from quality. In the developing countries, water quality is threatened particularly from indiscriminate disposal of wastes and wastewaters from agriculture, industry and households. Because of the lack of pollution control infrastructures such as sewage treatment works and wastewater drainage systems, 'non-point sources' pose the major danger to polluting limited water sources. Nutrient enrichment of water sources which precipitate eutrophication is increasing in many tropical water bodies.

3.90 Many developing and some developed Commonwealth countries are not equipped with the necessary data base to assess water pollution. Legislative machinery and adequately trained technical manpower are also lacking for its effective control.

3.91 'Prevention is better than cure' is the rational operational principle in water pollution control. Many governments cannot afford the huge financial expenses associated with cleaning up polluted water. Policies to control water pollution must incorporate the 'polluter must pay' principle in order to ensure the efficient management of water resources.

3.92 There are few national schemes for taxing pollution, as opposed to administrative means for regulating it, backed up with adequate monitoring devices, fines and charges. Several West European countries have pollution taxes, with rebates for firms that clean up the effluent themselves. Some developing countries have administrative schemes and at least one—Thailand—is considering an innovative approach.

Water supply and sanitation

3.93 We are convinced that the supply and use of water is going to be a dominant issue in development during the 1990s. Water is vital for life-support, as an input to production, as a medium for assimilating waste, as a means of climatic regulation, and as a source of amenity and aesthetic pleasure. Yet serious problems are arising in its use, as are shown in Box 3.4 (page 61).

3.94 Although our viewpoint is mainly that of the need to obtain sufficient safe water and dispose of it safely after human use, we do not lose sight of other aspects of the water problem. The development of water systems has potentially major environmental impacts on all sectors—notably agriculture, industry, tourism, fisheries, and transport. Large dams, for instance, have a profound impact on the environment. Likewise, pollution affects health, biodiversity, fisheries and amenities, as well as water supply. This makes it important for water projects of all kinds to be accompanied by an environmental impact assessment that gives full weight to all environmental and social costs and benefits.

3.95 We recognise three main dimensions to the water problem. First, a sizable part of the present global population has unsatisfactory water supply and sanitation. There is thus a substantial backlog of provision in this sector. Secondly, existing use patterns for present populations are proving unsustainable, as we have pointed out earlier. But, thirdly, the growing needs of future populations—eventually perhaps three times the current size—have to be anticipated.

3.96 Despite progress made during the UN's International Decade for Drinking Water Supply and Sanitation, demographic and other factors have left many people still without access to water supply and basic sanitation. Worldwide, the UN estimated that in 1990, 243 million people in urban areas had no satisfactory water supply, and 377 million were without sanitation. Among the rural population the numbers were much higher, 989 million and 1,364 million, respectively.

3.97 Roughly three-quarters of the urban populations of Africa and the Western Pacific are provided with water supply and about two-thirds of those in South and East Asia. For urban sanitation, Africa is 80 per cent covered, the Western Pacific 94 per cent, but in South and East Asia the proportion is only about one-third. In rural areas the situation is much worse: in Africa only 27 per cent of the population has access to water supply, and 16 per cent to sanitation; in South and East Asia the respective proportions were 62 per cent and 13 per cent, and in the Western Pacific 52 per cent and 67 per cent[19].

Box 3.4

Water—a Universal Problem

* Growing water shortages in arid and semi-arid countries, e.g. in the Middle East and Mediterranean regions. Israel, Jordan and Egypt are expected to fully consume their renewable supplies before the year 2000. Conflicts between water use in the agriculture, household and tourism sectors are causing strains in Cyprus and Malta. Eighty countries are already said to be suffering from water shortages (Brundtland Report, 1987).

* Growing urban areas are able to satisfy their water needs with increasing difficulty and cost. Many major cities have depleted their aquifers to dangerously low levels, risking contamination, saline intrusion, and subsidence (Manila, Bangkok, Mexico City, Beijing). Sources of water for urban areas are having to be brought from further and further afield, at high cost, and with serious environmental consequences.

* In small islands, especially coral atolls, water is obtained partly from underground freshwater lenses. As these are drawn down, and as the sea encroaches (e.g. due to global warming) they become saline and eventually unusable. The problem is becoming acute in the Maldives and certain South Pacific islands.

* In irrigated areas the misuse of water and the absence of proper drainage has led to salination and water-logging, affecting the fertility of large areas vital for food supplies (e.g. the Indus Valley).

* In the course of global warming, the pattern of precipitation will change, evaporation will increase, and climatic variations increase. Water shortages in certain regions will be heightened. Most developing countries, being in the warmer climatic zones, could be net losers, especially when allowance is made for the effect of rising sea levels destroying fresh-water sources.

* The release of untreated waste water, household discharges, industrial effluent and agricultural run-off are causing pollution almost everywhere. Pollution has a direct effect on supply, where the contaminated water becomes unusable for drinking or irrigation, without expensive treatment.

3.98 Catching up with this backlog will confer important benefits to health and productivity. Women particularly will benefit, since they bear the brunt of collecting water and using it for washing and cooking for their families. According to one estimate by the World Bank some African women expend 40 per cent of their daily nutritional intake travelling to collect water. The absence of proper sanitation causes a high incidence of intestinal and other diseases. To illustrate the enormity of the backlog, less than 7 per cent of India's 3,119 towns and cities have sewerage and sewage treatment facilities, and only eight have full services.

3.99 Low-cost technologies for water supply, sanitation and sewage treatment exist and are well-tried. Their wider application has, in our view, been held up by national priorities, lack of funding, and problems in recovering costs.

3.100 There is substantial wastage of water in all countries. This is particularly scandalous in societies where wasteful consumption coexists with glaring shortage. Reducing waste is in most cases a far more cost-effective way of increasing effective supply than creating new supply systems, and it helps to conserve water resources where these are being depleted.

3.101 We believe that the greatest scope for economies lies in agriculture, which accounts for around 70 per cent of total water use. The waste of water on its way to farmers is excessively high in many schemes. Less than half of the water diverted from the Indus region reaches farmers' crops; some is lost from evaporation or seepage from unlined canals, and much of the rest leaks from village watercourses. We have already listed the causes.

3.102 Water is a commodity with enormous political, social and economic overtones, and we do not underestimate the difficulties of bringing about needed reforms in this sector. However, there are useful lessons to be learned from the experiences of developed countries with advanced irrigation sectors, such as Australia and the United States. Trading water is a case in point. Here farmers and other users with entrenched entitlements can trade their water rights with other farmers or users in other sectors where the water would have greater economic value. In this way, all parties benefit and scarce water is used to its full potential.

3.103 There is also typically a high level of water losses in municipal supply systems. The World Bank's experience is that in developing countries, technical losses in the transmission and distribution of water are often in the range 25-50 per cent, even without allowing for theft and faulty metering. In a reasonably efficient system such losses should normally be less than 20 per cent of gross production[20]. This differential illustrates the considerable scope for rehabilitating water supply systems and reforming institutions in this sector.

3.104 *We cannot overstress the importance of Commonwealth members taking stock of their water resources, identifying future strains, and sharing experience in the various methods of tackling the problems. Specifically, we recommend that:*

- *all governments should develop comprehensive long-term national plans for water management and conservation (the potential impact of global warming and climate change on water availability makes this imperative). The integrated management of water resources should be a central feature of development policy, and in many countries this might be accompanied by the formation of a unified agency. At an international level, consideration should be given to new institutional means to co-ordinate assessment and action on a global basis. The establishment of an International Water Council within the United Nations system is one possibility which might be examined;*

- *all governments should undertake systematic and comprehensive inventories of existing water resources. There should be continuous monitoring of the quantity and quality of all sizeable sources of water, using standard methods (especially important for shared resources);*

- *governments should give high priority to reducing the backlog in the provision of water supply and basic sanitation, following measures recommended during the UN's International Drinking Water Supply and Sanitation Decade;*

- *to this end, Commonwealth governments should consider requesting the Commonwealth Secretariat to help member countries to develop legislation for the management of water resources and control of water pollution; introduce appropriate technologies, especially for waste management; and establish institutions to enhance the implementation of their water supply and sanitation programmes. Knowledge of technologies for rain-water harvesting, and of the use of solar power for water pumping, purification and desalination, important in many member countries, should be shared on a systematic basis;*

- *governments should make specific budgetary allocations for schemes to improve the efficiency with which water is supplied and used;*

- *changes in the level and structure of water charges, and the development of water markets, should be pursued in order to promote the highest social value for water use;*

- *all effective methods for tackling pollution should be pursued, including regulation, charges, and innovative devices for controlling pollution, where appropriate. The experience of member countries in these areas should be exchanged on a systematic basis;*

- *developers should be required to include provision for adequate sewage and waste water facilities in every project plan, whether in rural or urban areas; and*

- *industrial users of water should be required to recycle it to the maximum extent technically feasible.*

Oceans

3.105 The ocean is the ultimate sink for whatever runs off the land or is circulated through the atmosphere as a result of human and other activities. Increasing pollution threatens the health of the oceans and of those communities who depend on the sea for their livelihood.

3.106 Oceans play a critical role in influencing both weather and climate patterns and changes. For island small states the ocean has also played a critical role in determining both the type and the diversity of biota that colonise and evolve in their territories. Rapid changes in both the quality of the ocean and its physical characteristics, including temperature, volume and wave size, profoundly affect not only the sensitive biota but also the human communities of island small states and coastal areas of larger land masses. For Pacific island peoples, for example, the ocean comprises by far the greater proportion of their physical environment, the land to water ratio being 1:55.6.

3.107 The ocean environment, particularly the ocean depths, remain little explored. The wasteful exploitation and excessive utilisation of ocean resources could destroy its biodiversity with untold effects. We refer to these issues in Chapter 5 on small states.

Coastal Zone Management

3.108 Coastal zones are significant areas of economic activity in all countries which border the sea but in those where the ratio of coastlines to land area is high (as in small islands) or where their coastlines are long (as in Australia and Canada), these zones are especially important. We consider the issues of coastal zone management in Chapter 5, but we should emphasise here their importance in all coastal states. Some face special problems as a result of their vulnerability to environmental changes such as sea-level rise. This would be extremely serious for those countries, such as Bangladesh, Guyana and the Netherlands, whose coastal zones are largely at or below mean sea level.

Forests

3.109 The destruction of natural forests is running far ahead of new plantings and the growth of secondary forests on cleared areas. Tropical moist closed forest currently covers about 1.2 billion hectares, half of it in the

Amazon basin. It is being removed at an average rate of almost 14 million hectares per year. We find this of grave concern, not only in terms of local environmental degradation but for its effect on the global climate. Temperate and boreal forests have been depleted to an even greater degree, with similar effects on the global climate.

3.110 Deforestation has several causes. In temperate and boreal zones it started even before the industrial revolution two hundred or more years ago and is still continuing. In South Asia it is mainly due to fuelwood gathering and overgrazing. In continental South-East Asia trees are lost mainly because of the expansion of agriculture from heavily populated rice-growing areas, and temporary cultivation by hill tribes. In certain countries in this region commercial logging is the prime culprit, reinforced by pioneering settlement. In Africa, deforestation is primarily due to the expansion of agricultural areas, the practice of temporary cultivation in areas of plentiful land, the uncontrolled grazing of livestock, and the collection of fuelwood, especially for urban use. In the tropical parts of Latin America the activities of cultivators and clearances by land-hungry peasants have been accompanied by government-inspired programmes of highway construction, frontier settlement, cattle ranching and commercial timber concessions.

3.111 In practical terms, the loss of primary forests is almost irreversible, since trees take 50-100 years to mature, and the original balance of species is unlikely to be recaptured by the growth of secondary forest on cleared areas. The impoverishment and loss of soils and destruction of biodiversity could be permanent, as well as leading to the dispersal and extinction of indigenous communities.

Forests and the environment

3.112 Much of the recent discussion of tropical deforestation has arisen from international concern about its effect on global climate and on biodiversity. This concern was reflected in the establishment of the Tropical Forestry Action Plan (TFAP) endorsed by Commonwealth Heads of Government in the Langkawi Declaration. The TFAP is being strengthened and we suggest that similar arrangements should be made for the exploitation of temperate and boreal forests.

3.113 But we would also emphasise the importance of the sustainable management of forests for the welfare of local people and the benefits this would bring to their national governments. Caring for the forests can also serve international purposes. The accruing mutual benefits are a strong argument for enhancing the flow of resources into this sector, both through national aid programmes and through new and additional financial mechanisms. In this regard we commend the President of Guyana for his offer of an area of tropical forest in that country for a pilot project, under

Commonwealth auspices, to demonstrate methods of sustainable tropical forestry and of conserving biodiversity. We welcome the progress being made by the Government of Guyana and the Commonwealth Secretariat, in collaboration with other international organisation and donors, in implementing this project (see Box 3.5 on page 67) and urge strong international support for it.

3.114 At this point we feel that it is worth briefly recapitulating the many ways in which forests benefit the environment—climatic regulation, watershed protection, the supply of subsistence and commercial products, havens for biodiversity, etc.

3.115 Trees and forest soils hold 20 to 100 times more carbon than the crops and soils that replace them. This is released into the atmosphere when forests are burned. Deforestation not only affects the global climate; it can also result in micro climatic effects locally.

3.116 Forest cover helps to preserve the stability of slopes, inhibits soil erosion, encourages cloud formation and precipitation, regulates water flows and moderates downstream deposition and silting. Logging, even on a selective basis, can aggravate soil erosion through the construction of tracks and clearings.

3.117 Forests help to retain tropical soils and nourish them in other ways. Many of these soils are thin and barren and the trees growing in them store a high proportion of total nutrients above ground in their own biomass. Such forests are an efficient way of creating biomass from unpromising soils. Their removal to make way for crops or pasture often causes rapid soil degradation and the failure of these alternative land-use regimes.

3.118 As we noted earlier, tropical forests contain an enormous diversity of plant and animal species. Most of these species are practically unknown, yet where they have been analysed, important gains to science, medicine, and agriculture have been made. A quarter of all prescribed drugs sold in the United States are based on tropical plants. Most of the 1,300 or so medicinal plants known to Amazon Indians remain unknown to outside scientists. They constitute a potentially rich store of genetic material for pharmaceuticals and other medical products, as well as products and pest-control methods for agriculture. Two dozen major crops have already been improved with wild germplasm, mainly to make them more disease resistant.

3.119 Forests are the home to millions of people, and satisfy most of their needs. The livelihoods of many rural women depend on forest products. For those who have no regular contact with official or commercial society the loss of the forest can cut them off from their means of livelihood. Many fail to make the adjustment to a new way of life, and either die or are pauperised.

Box 3.5

The Commonwealth-Government of Guyana Programme for Sustainable Tropical Forestry

The Commonwealth Group of Experts appointed to explore the offer made by President Hoyte at the Commonwealth Heads of Government Meeting in Malaysia in 1989, proposed that the 360,000 hectares of rainforest offered, be used both for sustainable development and conservation. The Programme recommended, which is now being implemented, has the following goals :

- The maintenance of about two-fifths of the project area as a wilderness preserve. The preservation of the forest in its pristine purity would provide opportunities to study the natural processes through which biological diversity evolves in a tropical rainforest.

- The management—on the basis of ecological sustainability and environmental accounting—of the remainder of the project area to provide economic benefits in the form of forest products, mining, medicinal and industrial raw materials, and eco-tourism.

- The organisation of an International Centre for Research and Training in the sustainable management of tropical rainforests.

- The promotion of environmental literacy through formal and non-formal means, particularly on the symbiotic linkages between forests and the quality of life on earth.

The Commonwealth Secretariat and the Government of Guyana are coordinating an international collaborative effort to implement the Programme, which has the potential to yield many insights of benefit to other tropical countries.

Forest products can be important to household food security. They diversify the diet, provide minerals and nutrients, fodder for livestock and fuel for cooking, and provide seasonal balance in food supplies. In South-East Asia there are almost 30 million forest-dwellers who are vitally dependent on non-timber forest products[21]. The growth of nature-based tourism could also be an important alternative source of income in certain regions.

3.120 The value of tropical timber exports has distracted attention from the many other forest products that are collected and sold, often for export.

These products include essential oils, resins, medical substances, rattan, rubber, flowers, bamboo, tannin, gums, honey and beeswax. Their export earns a significant proportion of the foreign exchange receipts of several Asian countries.

3.121 Deforestation to accommodate population pressure and the expansion of subsistence agriculture is a deep-seated problem. But where farmers and settlers are induced to encroach on virgin forest this may indicate a failure of agricultural strategy. It points to the need for rethinking a complex of issues, including tenure, pricing, and credit, that lie behind the presence of farmers at the cultivable margins.

3.122 In semi-arid areas much deforestation is due to the use of fuelwood. In Africa, the overwhelming proportion of households use wood for cooking, and in the poorer countries household consumption of energy from fuelwood is up to ten times that from commercial sources. The collection of fuelwood over and above that of dead trees and branches will continue until its price rises relative to that of commercial substitutes, though improved heating and cooking devices will also be necessary.

3.123 Many countries grant title to land only when claimants can demonstrate that they have cleared it of trees. This is a perverse incentive, which can—and on occasions should—be changed. We would stress the positive importance of tenure in forestry management. If settlers have property rights to a forest they have some incentive to look after it. But often these rights are lost or overridden, as in the nationalisation of forests. This may be done in order to protect the trees, but its effect is often to accelerate the degradation of the forest, since management is neglected, and encroachments go unpunished. Nationalised forests all too often become open-access areas, and degradation is inevitable.

3.124 The destruction of forests for unsustainable commercial logging and ranching is largely a product of government concessions and incentives. Fiscal and credit incentives to ranchers and large-scale farmers may make clearance of large areas of forest inevitable. The terms of timber concessions are often highly advantageous to the concession holder and offer strong incentives to cut down trees. The stumpage value of a tree—the value of standing timber before any cutting, transport or processing costs are incurred—is a form of economic rent. Only rarely do forestry revenue systems appropriate anything near this rent, so heavy exploitation continues to be profitable. The structure of royalties usually encourages concessionaires to 'high-grade' their tracts, extracting only high value timber but devastating the rest to get to it. Concessions of limited duration, less than the natural regeneration cycle, deprive timber companies of any incentive to take a longer view and harvest their tracts on a sustainable basis. Ghana's royalty structure is one of the few that encourages careful and selective cutting.

3.125 Trade barriers imposed by developed countries on imports of processed tropical timber have encouraged the unsustainable investment and patterns of exploitation in timber producing countries. Tariff escalation (successively higher rates of duty on higher levels of processing) together with non-tariff measures have discouraged the development of efficient timber processing operations in the countries of origin. One result has been the artificial growth of processing industries behind tariff barriers in the developed countries themselves, entailing much waste of timber. Removal of tariff and other trade barriers on processed timber by developed countries would mean that developing countries could increase their unit price and thus reduce the area of forest logged for export and still obtain the same quantum of receipts.

3.126 Foresters are actively exploring the scope for 'sustainable yield management' of remaining forest tracts. At present Queensland, Australia, offers one of the few successful examples of this practice. A broader concept—multiple use management, or MUM—may be more appropriate where the local community has strong interests at stake. MUM would entail recognising the interests of local people, involving them in decisions affecting the forest, preserving the resource base that yields non-timber products, and helping the local collection and marketing of these items.

3.127 The most satisfactory way of ensuring the participation and involvement of local people in land-use development projects is to give legal recognition to their traditional claims to ownership of the land and its resources. The failure to recognise these rights and claims can have serious social and political repercussions. Similar considerations apply in the establishment of national parks. Here governments should take steps to recognise and take account of the needs of local people, and we are pleased to hear that these procedures are already underway in Nigeria, Papua New Guinea and Zambia, among other countries.

3.128 *Taking account of these and other factors leads us to recommend that:*

- *all governments should seek to maintain a regularly updated audit of their forest resources and attempt to estimate the minimum viable limit below which native forest cover should not be allowed to fall; reforestation and afforestation should be undertaken where necessary and consideration given to planting trees in urban areas to reduce air pollution and provide other benefits;*

- *the many sources of value—local, national and global—of tropical, temperate and boreal forests should be estimated and brought into consideration before any decisions are taken on converting such forests for other*

use. The value of services supplied by standing forests should be taken fully into account;

- *governments should review the terms of logging concessions to ensure that companies pay amounts which fully reflect the environmental costs of deforestation. At the very least these companies should pay the full stumpage value, and the structure of the fee should encourage careful and selective exploitation;*

- *import barriers by consumer countries which presently discourage adding value to tropical timber in developing countries should be abolished so that the increased revenues so derived could provide these timber producing countries with an incentive to reduce to a minimum the area of natural forest set aside for timber harvesting;*

- *the experiences of Commonwealth countries with pilot schemes for the sustainable yield management of forests (e.g. Australia, Malaysia, Ghana) should be exchanged with others, and the system for such exchanges should be strengthened through the Commonwealth Forestry Association;*

- *adequate resources should be mobilised to support the implementation of the Commonwealth-Government of Guyana Programme for Sustainable Tropical Forestry;*

- *where the conservation of timber confers important international benefits (e.g. for biodiversity and climate protection), this should be recognised in additional aid flows. It may require the establishment of new and additional financial mechanisms; and*

- *governments establishing national parks should pay due regard to the needs of local people and of their potential role as conservers of the habitat.*

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