

Chapter 4

Policy Responses to Climate Change and Sea-Level Rise

Introduction: Approaches to Policy

4.1 Our Group was established because the Commonwealth Heads of Government considered that there was a prima facie case for reviewing their policies so as to protect their nations against possible difficulties created by climate change and sea level rise, and to enhance international co-operation within the Commonwealth and on a wider scale. Our terms of reference specifically require us to review the measures countries should take to protect themselves against disasters and to plan forward so as to avoid problems. We were also instructed to consider how countries most likely to face adverse effects could be assisted; how the international community could review unresolved scientific and policy questions; and how international action could limit man-made climate change by acting on underlying causes.

4.2 These terms of reference, and our own analyses, combine to lead us to reject a policy of doing nothing while waiting to see whether climate change or sea level rise manifest themselves so obviously that response is inevitable. Such an approach has been followed all too often by governments in the past (for example over acid rain and motor vehicle emissions). We reject it here for five reasons:

- (a) there are some signs, reviewed in Chapter 2, that these changes are already happening;
- (b) it is clear that the delays in the system between the initiation of control action and the elimination of an effect will be measured in decades, and delay now can only magnify the scale of the ultimate damage and emergency and the attendant costs;

- (c) it is also clear that public concern has reached the point at which it would be politically difficult for governments to remain inactive even if they were to deduce that current uncertainties are too great to bear the costs (which inevitably occur sooner rather than later) of taking preventive measures;
- (d) international policies are already being pursued on an increasing scale: the need is to co-ordinate them and make them more effective, not to delay them;
- (e) most of the actions advocated for coping with climate change have other benefits that make them desirable in their own right, and justifiable even under present circumstances of uncertainty.

4.3 We are encouraged in this approach by the fact that virtually all the analyses we have seen, from both governmental and non-governmental sources, concur in their basic assessments and in their advocacy of action now to prepare adaptation strategies, policies to limit greenhouse gas emissions, and enhancement of the machinery for international evaluation and co-operative action (e.g. UNEP/Beijer Institute, 1989; Woods Hole, 1989; Mintzer 1987; EPA 1989; Boyle 1988; NRDC, 1989).

4.4 We believe that new and bold policies, backed by more resources than hitherto, are expected by the governments and peoples of the world and that it is our part to propose these for the Commonwealth in terms that are forward looking but realistic. We believe that we should especially emphasise actions that can be taken now, within existing national and international machinery (especially in the Commonwealth). Of course, the nations of the Commonwealth together contribute only a small part of the greenhouse effect, but action by those countries is worthwhile because of the benefits they will secure through preparedness and the influence they can exert if they pursue a well-informed and consistent line. The Commonwealth is an unusual assemblage of nations in that its membership cuts across the major regional groups and its members could therefore promote a harmonised approach in the several groups.

4.5 In the remainder of this Chapter we suggest a number of measures that Commonwealth governments could take. They fall under three thematic headings:

- (a) Measures to enhance knowledge, understanding and awareness;
- (b) Measures to avoid the worst impacts of climate change and sea level rise, and to adapt to those that cannot be avoided;
- (c) Measures to deal with the causes of these changes, thereby slowing and eventually halting them.

4.6 Action within the first of these themes should concentrate especially on the reduction of uncertainty, through the acquisition of better data about weather and climate, better science, more advanced models, and predictions that are more sharply focussed. We are, at present, advocating action within an envelope of uncertainty. That uncertainty must be reduced, so that the action is increasingly fitted to need. At the same time, we are very conscious that many of the statements made today are alarming to a public that is insufficiently aware of the scientific facts. That is why we advocate action to disseminate the best information available among governments and public, so that social decisions carry the broadest possible consensus.

4.7 Action within the second theme is essentially precautionary. It involves assessment of the vulnerability of national environments to the most probable projections of climate change and sea level rise, and a judgement of how far public and private actions should be modified to avoid undue risk. In contrast, action within the third theme is remedial: it involves measures to reduce emissions of greenhouse gases.

4.8 Action in respect of all three themes will need to be taken at national and international level. We deal with both categories under our three main headings. But there are particular actions that need to be taken at the level of the Commonwealth as a whole, or in still wider international fora, and we address these in a separate section at the end of this Chapter.

4.9 While we place research, leading to the reduction of uncertainty, high on our list of priorities, we are clear that action cannot wait on the deliberations of science. As in the case of international agreements to phase out the manufacture and use of chlorofluorocarbons, control action and further scientific and technical research have to proceed side by side, but in mutual awareness. Policies must be capable of adaptation to take account of the latest results of research and monitoring, while the scientific programmes must be responsive to policy needs. This argues for flexibility in the management of both action and research, and good communication between the agents of both.

MEASURES TO ENHANCE KNOWLEDGE, UNDERSTANDING AND AWARENESS

National and International Research and Monitoring

4.10 For governments to develop and apply sensible policies, they need to be informed themselves. It is important that, acting collectively and individually, they are all able to contribute to, and draw on, research and monitoring of their own climate. As we stressed in Chapter

2, the regional or national impact of global climate change may vary considerably and little can usefully be said at present about the implications for particular countries. Only by better research and modelling will a clearer picture emerge. This needs to be done at national level and *every country should take adequate steps to monitor and evaluate its own climate conditions*. This is particularly important in relation to sea level rise, where the implications for particular communities can be more exactly assessed provided that there is knowledge of unique features of topography, tidal patterns, and land subsidence or elevation which have to be evaluated locally; we have described in Box 4.1, in relation to Kiribati, the kind of data collection and analysis that may be necessary for one small state. We have also endeavoured to indicate in Box 4.2 some particular information needs in the Commonwealth at large. We appreciate that many developing countries have only small meteorological services and scientific communities and *we recommend that assistance be made available to them to strengthen their capacity to undertake such work*.

4.11 At the same time, care of historic archives of observational data is crucial, since these provide a background against which future change can be evaluated. There is an international project on Data Rescue (DARE) which is collecting such information and ensuring its long-term preservation and *we recommend that all Commonwealth countries should collaborate in this venture*.

4.12 National research and monitoring clearly needs to be designed and coordinated so that the resulting data and evaluations fit together on a regional or wider international scale. The periodic conferences of Commonwealth Meteorological Officers and the Commonwealth Secretariat have important parts to play here. *We recommend that the capacity of the Secretariat be strengthened in order to facilitate this co-operation. We also recommend that Commonwealth members be encouraged, and, where necessary assisted, to participate effectively in the WMO CLICOM project, which provides both a comprehensive system for monitoring climate change and a network linking national data management centres*.

4.13 Many governments are in the process of establishing National Environmental Data Centres to hold information about environmental resources and trends. Others (such as Canada) have a series of linked centres holding various kinds of specialised information. The establishment of centres is being discussed in Bangladesh, Kenya, Uganda and as a joint venture between Botswana, Zambia and Zimbabwe. *We recommend that governments establishing such centres incorporate data on useful indicators of environmental change and link them to National Climate Monitoring Centres so that correlations can be established*.

**Box 4.1: Data Priorities: Needs of Low Lying Atoll Islands
—The Case of Kiribati**

Although the potential consequences of sea level rise are serious, the present situation is not an immediate crisis as some of the effects will take decades to have a major impact on any but the most vulnerable islands. An early priority however is to ensure that the islanders and their government are fully informed as to the changes taking place. The following is a suggested programme of action that is specific but has a wider applicability than for Kiribati alone:

1. Further analysis of the tide gauge records in the Gilbert, Phoenix and Line Islands should be carried out in order to determine whether the sea has been or is rising in Kiribati.
2. In order to get a longer record of recent water level changes, studies should be carried out on certain living corals, such as the *Porites* microatolls, which are sensitive to water level changes. These should be calibrated with the tide gauge records.
3. Much more extensive surveys, involving measurements of elevations and water levels, further to this study, should be undertaken, and the methodology developed in this report applied to determine the relative vulnerability of all the islands in Kiribati.
4. Island groundwater resources should be surveyed and evaluated. Such an evaluation should aim to determine the size of the potable water resource and its variability over time. These surveys to be carried out in conjunction with the topographic surveys mentioned above and with land resources surveys.
5. The present land use and environmental data base is inadequate for planning purposes e.g. topographic maps do not exist for all islands. Attention should be given to the establishment of an environmental monitoring and evaluation section within the government to inventory the existing material, co-ordinate resources, and to identify additional requirements for planning and management purposes.

Source: McLean (1989).

4.14 Monitoring needs to be linked to evaluation at the international level. In Chapter 1 and Annex 3 we refer to several of the exercises now afoot, and especially to the Intergovernmental Panel on Climate Change (IPCC). The process of consultation in the IPCC is designed to

Box 4.2: Current Commonwealth Capabilities and Needs in Respect of Climate Monitoring

Climatological Networks and Data Processing

All Commonwealth countries have an observing network with data fed into the Global Telecommunications System. The only countries considered as not needing technical assistance to improve their operations are Australia, Canada, New Zealand, Trinidad and Tobago and the UK. Several are scheduled for training and new installations under the CLICOM systems in 1988/89: Barbados, Belize, Botswana, Jamaica, Lesotho, Malawi, Malaysia, Mauritius, Seychelles, Sierra Leone, Sri Lanka, Swaziland, Tanzania, Vanuatu, Zambia and Zimbabwe. The following Commonwealth countries will not have CLICOM systems by the end of 1989: Antigua and Barbuda, Bahamas, Bangladesh, Cyprus, Grenada, Guyana, India, Kiribati, Nauru, St Kitts and Nevis, St Lucia, St Vincent and the Grenadines, Singapore, Solomon Islands, Tonga, Tuvalu and Western Samoa.

Ozone and Greenhouse Gas Monitoring (Global Atmosphere Watch—WMO)

Assistance is suggested to enable a growing number of sites to carry out surface ozone analysis at low cost. Existing centres suggested as a basis for this work are in India (Ahmedabad, Kodaikanal); Australia (Hobart, Macquarie Island); New Zealand (Christchurch); Seychelles (Mahè); Kenya (Nairobi); Singapore; UK (Eskdalemuir, Lerwick); St Helena. A number of sites in tropical regions are needed to fill major gaps in networks for measuring GHGs.

Sea Level Observations

The IOC's Global Sea Level Observing System (GLOSS) is designed to provide a comprehensive range of sea level data. In addition to uncompleted stations in the territory of Australia, New Zealand and the UK (Antarctic), help may be needed to complete the network by implementing planned stations in *inter alia*: Tanzania (Mtwara, Ihambane, Pemba); Seychelles (Agalega Is.); Mauritius (Rodrigues); India (Port Blair—Andamans, Minicoy—Laccadives); PNG (Alotau, Vanimo, Dani); Jamaica (Port Royal), Bahamas (Bimini); Ghana (Tema); Nigeria (Lagos).

Cyclone Warning

The following are considered to need assistance in establishing or improving national tropical cyclone warning systems.

Malaysia
Bangladesh

Malawi
Mauritius

Source: The above assessments have been made by the World

Maldives	Seychelles
Sri Lanka	Swaziland
	United Republic of Tanzania
	Zimbabwe
Papua New Guinea	Bahamas
Solomon Islands	Barbados
Vanuatu	Belize
Kiribati	British Caribbean Territories*
Tonga	Dominica
Tuvalu	Jamaica
Western Samoa	St Lucia
Cook Islands	Trinidad and Tobago
Niue	Antigua and Barbuda
Pitcairn	Grenada
Tokelau	St Christopher and Nevis
	St Vincent and Grenadines

*comprises Anguilla, Cayman Islands, Montserrat, Turks and Caicos, British Virgin Islands

Flood Warning

The following are considered in particular need of help in regard to flood forecasting and warning: Gambia, Malawi, Belize, Bangladesh, Sri Lanka, Jamaica, Mauritius and the Caribbean (cyclone related flash floods); and PNG (but considerable help being received).

World Climate Research Programme Data

The following priority requirements have been identified from strategically located Commonwealth countries:

- INSAAT Data (Satellite monitoring data by India)
- Radiation Climatology Baseline Stations (needed for monitoring—recommended in Australia, Canada, New Zealand)
- Rainfall validation (sites recommended in Australia and UK)
- Tropical Ocean—Global Atmosphere upper-air station network (work to be strengthened in Cook Island and Sri Lanka and initiated in Pitcairn Is.)
- Tropical Ocean-Global Atmosphere tidal gauge network (strengthen work programme/new equipment in India, Bahamas, Turks & Caicos)

produce a comprehensive review of existing research and an evaluation of its implications. The IPCC is also the proper forum in which governments should identify priority areas for strengthened and coordinated international research and monitoring on the greenhouse gas issue, and the socio-economic impacts of global warming and sea level rise. We are confident that the IPCC itself will, in its deliberations, take full account of the work of other international scientific fora such as the World Climate Programme and the non-governmental International Geosphere Biosphere Programme. We shall not try to second-guess the Panel. *We recommend that all Commonwealth governments collaborate with the IPCC and encourage participation of their national professional experts in its work, and that the Commonwealth should establish a mechanism in the shape of the Standing Group discussed in para. 4.68 in the proposed Commonwealth Plan of Action and by the strengthening of the Secretariat, so that the implications of the IPCC's findings for member countries can be discussed in a Commonwealth context.*

Enhancing Public Awareness

4.15 The evidence summarized in Chapter 2 and 3 indicates that societies will have to adjust to climate change at a much greater speed than in the past. Significant changes will be needed both at the level of individuals—in diet, farming practices, consumption and energy use patterns, and the home, work and travel environment—and of governments, the latter particularly in respect of policies to maintain large-scale infrastructure such as coastal defences, forest management, agricultural support, fresh water supply, energy generation and health care. The magnitude of the adjustments required is unpredictable, so there is, at present, little by way of precise indicators on which governments can base anticipatory adjustment policies. Moreover, these policies are unlikely to address climate change and sea level rise in isolation from the other major environmental changes arising from mounting human pressures on natural resources and leading to such phenomena as soil loss and erosion, desertification and deforestation. Whatever the context, however, essential action is unlikely to be taken without political will, and this must in turn depend on public commitment. Action by consumers will be needed on many fronts, for example to demand energy-efficient vehicles, well-insulated homes, 'clean' energy supplies and reforestation.

4.16 Public co-operation and support are more likely if there is a balanced, long-term, campaign to build public awareness of the implications of climate change and sea level rise and of the actions needing to be taken to respond to them. International action is more likely to be effective if information flows smoothly between governments. Interna-

tional organisations, especially United Nations bodies like UNEP, UNESCO and WMO and world-wide non-governmental organisations like IUCN, can do much more than at present to state the case for the concerted international action that the world needs. *We recommend:*

- (a) *That Commonwealth governments, national media, national NGOs and educational institutions review and where necessary enhance their machinery for informing the public in their countries of the facts relating to climate change and sea level rise, and the actions citizens should take in response;*
- (b) *That Commonwealth governments should exchange data, assessments and plans for responding to climate change and sea level rise, including making use of the machinery of the Secretariat for this purpose;*
- (c) *That Commonwealth governments should press the various international organisations to develop and publicise positive programmes and assessments that will promote concerted international action to combat climate change and sea level rise.*

MEASURES TO ADAPT

4.17 Most countries have national development strategies, commonly backed by more specific environment or conservation strategies and regional or local plans. These are commonly based on the assumption that the climate in the next two or three decades will remain the same as in the decades just past. Yet development strategies commonly depend for their sustainability on water supplies, river flow and other factors which are in fact highly sensitive to climate. There is now good evidence that in many regions of the world climate change and sea level rise are highly likely. There must be consequent implications for national plans and strategies of many kinds, and for the detailed policies adopted for sectors of the national economy such as agriculture, forestry, fishery, soil and ecosystem conservation, tourism, energy generation, water resource management, housing, transport and health care. Revision of such plans and policies may avert wasted investment, damage through the misuse of resources, and human suffering. The purpose of this section of the report is to evaluate the case for changes of policy, both generally and sectorally.

National Strategies and Plans

4.18 The existing national plans and national Conservation Strategies, the latter prepared as a consequence of the World Conservation Strategy; (IUCN, UNEP and WWF, 1980) are essentially compendia of knowledge about national environmental resources, and statements of

priority for their sustainable use. In this respect they give effect also to the recommendation of the World Commission on Environment and Development (WCED, 1987) that a broad philosophy of sustainable development should be translated into practical measures designed to meet the needs of local communities (who must participate in the process of formulation). Such Strategies have been prepared, or are in preparation, for 23 Commonwealth countries. Virtually all members of the Commonwealth have other national plans or strategies. A few (such as New Zealand) have already embarked on an analysis of how climate change and sea level rise may affect their national situation (Royal Society of New Zealand, 1988). *We recommend that Commonwealth governments examine the sensitivity of the assumptions underlying their national environmental, conservation, development, resource management and land use strategies and plans to the most plausible new scenarios of climate-change and sea level rise, and make adjustments where these would clearly be prudent. Assistance will be necessary to allow some Commonwealth members to undertake this task.*

4.19 Such national evaluation needs to be paralleled locally and within the private sector. Vast sums are involved, in aggregate, in site-specific decisions to invest in sea defences or drainage systems and factories, homes, roads and other facilities. Private investors in domestic property commonly take out mortgages on the assumption that the value of their purchases will at least remain stable (in real terms) over a period of decades. Public authorities also invest in reservoirs, roads and other structures on the assumption of a design life of at least 50 years. Climate change and sea level rise could bring the validity of such assumptions into question unless the issue is faced at the outset and structures are either sited to avoid problems or designed to withstand plausible change. We recognise, however, that substantial difficulties could well arise in practice. Should zoning regulations provide for rising sea level for example? If the regulations underestimate the extent of future changes, then loss of property and, possibly, life would result; if they over-estimate it, then losses could be inflicted as a result of costs unnecessarily incurred in resettlement, or by property owners from blight and unrealised development potential. Another question is how long term investment decisions can be adapted in a consistent way to reflect the success or failure of measures to control greenhouse gases. A haphazard and ad hoc approach by private and public agencies to long term investment decisions could result in much confusion and inefficiency. *We recommend that both in respect of approaches to land-use planning and criteria for long term investment decisions, governments review the procedures that their agencies, local authorities and the private sector should adopt. These national procedures should be developed in dialogue with the professions and communities affected, so that they carry as much consensus as possible. We*

further recommend that Commonwealth governments exchange the results of their national analyses using the Secretariat as appropriate.

Measures to Safeguard Biological Diversity and Natural Forests

4.20 We have stressed in Chapter 3 that rapid climate change could inflict severe damage on natural forests and other ecosystems because of the inability of species to redistribute themselves fast enough, or the lack of contiguous potential habitats. The consequence could be an acceleration in the already worrying rate of loss of the earth's biological diversity, including species of potential economic significance. The loss of forests could be particularly damaging both because of the value of their produce when managed for sustainable yield and if the result was the accelerated run-off of water and increased incidence of flash floods. Forest conservation and, where practicable, extension, is in any event, desirable because of the contribution that forests make to reducing the 'greenhouse effect' by abstracting and holding carbon. *We recommend that the authorities in those countries whose major forest ecosystems could be seriously affected by climate change should promote research on the adaptability of tree species and consider measures, including assistance to promote the redistribution of key species, so that damage is minimised.* We recommend that national conservation authorities, with the assistance of the International Union for Conservation of Nature and Natural Resources (IUCN) evaluate the adequacy of national protected area networks to conserve their floras and faunas under likely future climate regimes, adjusting these networks where need arises and adjustment is practicable. *We urge member governments of the Commonwealth, in this connection, to give support to the World Conference on Protected Areas, to be held by IUCN in 1992, and to the negotiation of an International Convention on the Conservation of Biological Diversity, being prepared by IUCN and UNEP.*

4.21 A particular responsibility falls on public authorities responsible for maintaining National Parks, Nature Reserves and other protected areas, and for nature conservation generally, especially in the tropical developing countries. As we explain in Chapter 3, these protected areas are crucial to the conservation of the earth's biological (including ecological and genetic) diversity, but few of them are large enough or sufficiently varied topographically to retain the full range of species for which they were established in the face of substantial climate change. It is unrealistic to expect a substantial expansion of these protected areas, given the human pressure on natural resources that has already made a number of them islands of habitat in a transformed landscape. Accordingly, it is important also to develop sustainable development processes in the adjacent regions which allow pockets of semi-natural habitat and

species that are not in direct conflict with human activities to persist there.

Agriculture

4.22 For many farmers—at least those who are well informed about the changes that are taking place and who have the resources to adapt—gradual adjustment will be a feasible option. Except for forestry and some tree crops the investment cycle is short and farmers should be able to switch cropping patterns: that is, changing the mix of crops and planting varieties with better characteristics. But climate change will still pose considerable problems for agriculture, especially rainfed marginal farming. Our analysis (for example in East Africa) suggests that such agriculture is particularly vulnerable to climatic variability and it would be very difficult to adapt through progressive adjustment to an increasing frequency of extreme events (Mascarenhas, 1989). This underlines the importance of enhancing research work on crops like sorghum, millet and cassava that have good properties in helping subsistence farmers cope with climatic variability (for example by improving sorghum dehulling and milling technology) and on drought-tolerant cash crops like sunflowers and finding cheap feeds for livestock in drought-prone areas. Furthermore existing technologies and management practices may be insufficient in some contexts and new options required. Agricultural research and development has a long lead time: perhaps 20 to 40 years for establishing a major new crop: 7 to 9 years for a new variety achieved through genetic development; 15 to 50 years for new forage varieties (Decker et al, 1985). Adjustment options also depend on the availability of a wide variety of crop varieties which is, currently, in danger of contracting through processes of agricultural specialisation and species extinction. *We recommend that, in order to maintain maximum flexibility, priority should be given by national, regional and global agricultural research programmes to enlarging long term options for adjustment to changing climate, and gathering and conserving genetic materials and knowledge of plants, animals and agricultural practices that have been valuable under conditions of uncertainty and climatic variability. A particular focus of research could be on varieties that could derive maximum benefit from higher CO₂ concentrations in the atmosphere.*

4.23 It is not only in respect of new or more appropriate crop varieties that long term research is required. Radical changes of land use—from, say, crops to grazing land—that may result from greater vulnerability to climatic variation will require long term planning, re-equipment and restructuring unless major distress is to occur in farming communities. Also, the time horizons for the training of new generations of agricultural extension workers are quite long. *We recommend that govern-*

ments should incorporate into their agricultural extension, training and credit schemes a greater awareness of the implications of climatic change. This would include a closer study of how farmers can be helped to cope with climatic variability through farm management techniques that incorporate efficient use of water and soil, and aggregate crop diversification.

4.24 Greater climatic variability and changing climate will lead to new patterns of food production and, for some countries, greater dependence on imported supplies. The resultant uncertainties underline the importance of adequate national and international systems of buffer stocking and other forms of food security (Slater and Lewin, 1981). The experience of famine in Africa in the 1980s has graphically underlined the vulnerability of poor, marginal, farmers engaged in rain-fed agriculture and nomadic pastoralism and the importance of stronger food security systems. The experience of Zimbabwe in withstanding three years of drought without loss of life and little or no food imports attests to the value of strategic reserves. *We recommend that such food security systems be strengthened and take into account the additional demands that may be placed on them by climate change.* Box 4.3 illustrates some of the initiatives now being taken.

4.25 An underlying theme of our analysis in Chapter 3 is that low income developing countries are likely to find the process of adjustment to climate change particularly difficult since a much higher proportion of the population depends on agriculture and other climate-sensitive, resource-based activities and since both individuals and governments have fewer resources to invest in long term adjustment strategies rather than the pursuit of short term survival. Unless there is an active, internationally supported programme to strengthen it, work on the particular needs of tropical agricultural systems will be neglected. Further, future climate change is but one of several factors that need to be taken into consideration in looking at policies to ensure the long term sustainability of agriculture. A good policy environment that provides farmers in these conditions with incentives both to produce more and to adopt sound conservational practices is obviously necessary to ensure that they are well placed to cope with changing climatic conditions.

Coastal Zone Management and Sea Level Rise

4.26 The effects of rising sea level on coastal systems are complex and include temporary and permanent flooding, increased risks of storm surge damage, saline intrusion and increased erosion. At risk are estuaries and coastal wetlands, mangroves, coral atolls, beaches, as well as human land uses as described in the various studies carried out for

**Box 4.3: African Government Responses to Disasters,
Food Insecurities and Climate Hazards**

Several African countries have now developed strategies for handling climate extremes in the aftermath of the disasters of the 1980s.

1. **The Ethiopian Drought Early Warning System** is targeted for three critical roles and types of users:
 - farmers and farm support agencies to help them make early adjustments in response to climate;
 - relief workers, to prepare early food distribution to vulnerable group
 - those analysing past crises.

2. **The SADCC Regional Early Warning System** aims to
 - co-ordinate early warning activities among government agencies;
 - improve objective measurement of crop area and yields;
 - install a system for monitoring food crop conditions during the cropping season as well as for monitoring the general food situation;
 - provide SADCC with regional food security information based on data from national units.

3. **Agro-meteorology** plans are underway to incorporate agro-meteorological data in forecasting using satellite imagery and computer based analysis. National units exist in **Tanzania, Zambia and Botswana**.

4. Kenya, too, has made a significant response to the impacts of climate variability. **The Sessional Paper on Food Policy** has among its objectives.
 - emphasising drought-resistant crops such as sorghum and millet;
 - improved monitoring and forecasting of weather conditions;
 - improved dissemination of weather trends.

Source: Mascarenhas (1989).

this report (see Chapter 3). These studies show why even a small sea level rise of say 20 to 30 cms by 2030 could have very significant implications for some countries. It should be stressed however that sea level rise is only one factor that influences coastal zones and various human activities—such as mining or dynamiting coral reefs—can also be extremely damaging as well as making coasts more vulnerable to rising sea level. Because of the interaction between these various factors, natural occurrences such as land subsidence and elevation, the specific ways that rising sea level will be manifest and the places that are vulnerable are not yet well defined. Nor are the range of options available to prevent or adapt to such changes, and their costs and benefits, clearly identified. Often in countries presently experiencing problems of relative sea level rise, the response proceeds piecemeal, with little attention to long-term planning for the preservation and development of coastal resources. We therefore recommend two major activities that individual nations could undertake to improve planning. *First, all governments should endeavour to identify—and developing countries should be helped to identify—areas of vulnerability to the effects of sea level rise based on detailed survey data and plausible global assumptions about the likely rise. Second, all governments should take initiatives to develop national coastal zone management policy. This should include consideration of sea level rise analysis leading to a full range of options (including land use regulation, engineering works, managed flooding) that could be implemented to deal with the future threat.* Guidance in development of comprehensive coastal zone management policy will be necessary and the Commonwealth Science Council, among other agencies, can provide assistance.

4.27 One option that might well emerge from such an assessment is to prevent loss of settled and cultivated land, and this will require coastal defence measures. Various steps are involved in planning, including consideration of types of sea defences, their dimensions, construction materials and phasing; water resource management (gravity or pump drainage); design of ports and navigation systems and avoidance of damage to natural sea defences such as coral reefs, mangroves, marshes, and dune and shingle systems. The case study prepared for the Secretariat on Guyana provides an example of the kind of exercise governments might embark upon at this stage as a precursor to detailed engineering studies (see Box 4.4). This study underlines two key points of importance. The first is that anticipatory planning and a staged programme of works accompanied by continued monitoring and feasibility analysis are much preferable both to doing nothing—and suffering the costs of flooding—or to belated, once and for all, construction projects. Second, it is possible, using local experience and expertise in constructing sea defence and drainage systems, to improvise relatively

Box 4.4: Sea Defence Options for Low Lying States: Guyana

An engineering and economic survey was carried out for Guyana on the assumption of a 0.25 metres sea rise by 2020; 0.50 metres by 2040 and 1.5 metres by 2090.

It concluded that without a long term—30 to 40 year—programme for raising and strengthening coastal protection and improved drainage, there could be a serious loss of agricultural land, agro-industry, housing and infrastructure. Most of the population lives 0.50 metres above mean sea level. Retreat to higher land is not seen as providing a rapid solution but will take place gradually over a long period.

A phased programme of work is recommended as follows:

- * careful monitoring of sea level, detailed hydrographic and hydrological surveys and a full feasibility study for a long term programme
- * short term (5 year) construction programme for enhancing flood protection and drainage programmes. This involves land acquisition; building new embankments; raising and strengthening existing embankments including remodelling and raising existing sea walls. An outline estimate of a five year programme, including feasibility analysis, puts the cost at \$22 mn (US)
- * strengthening embankments further with boulder revetments
- * after the five year programme, enhancing the existing gravity drainage system by, for example, rehabilitating and remodelling outfall sluices
- * in the longer term, 20 to 25 years hence, extending pumped drainage and installing new and larger pumping systems.

Source: Camacho (1988).

inexpensive, but effective, protection. While Guyana's future sea defences will rely heavily on major investments undertaken in the past, it is possible to suggest how the system can be modestly improved. The Guyana first stage programme is costed at \$22 million over 5 years. This is a very large sum for Guyana but it contrasts with the current programme in the Netherlands, where defences for a similar, dyke-protected, low lying industrial country are costed at \$8 billion. *We*

recommend that low lying developing countries should try to draw on the experience of other developing countries in relation to sea defences rather than necessarily accept design specifications based on industrial country experience. The Commonwealth and other international organizations could facilitate such "South-South" transfer of knowledge.

4.28 In some cases, particularly *small low lying coral atolls*, sea defences are not a cost-effective option even if they are technically feasible, which may be in doubt (in many cases the sea would simply rise through the porous rock of the islands themselves). In relation to the Maldives for example extensive sea defence systems are seen as technically dubious and economically unjustifiable (Edwards, 1989). Similarly, the papers commissioned on Tuvalu, Tonga and Kiribati (Lewis 1988; Maclean, 1989) see little merit in what Lewis disapprovingly calls "citadels in the sea". *We recommend therefore that small island states consider proposals for major sea defence systems with extreme caution and only proceed when all other options are exhausted and a positive social and economic benefit-cost outcome is demonstrated.*

4.29 Our analysis of vulnerable low lying states suggests to us that there are a good many, low cost, adaptation mechanisms that could provide a viable option for the foreseeable future unless the more extreme forecasts are realised (see Box 4.5). Such strategies should always include an assessment of the potential for maintaining natural defences with their own economic value in the shape of mangroves, reefs and marshes. *We recommend that such states be encouraged and assisted to devise adaptation strategies in such fields as beach management to maintain natural sediment replenishment, crop diversification, modified construction standards, rainwater collection, improved environmental health programmes, in-filling low lying lagoons and pits, prevention of erosion and efficient disaster preparedness systems.* In many instances indigenous foods and medicines, building forms and societal structures are well adapted to the needs of climatic adjustment and are underused.

4.30 A similar conclusion emerges from the study of vulnerable *deltaic areas* of which the most seriously threatened—by a combination of river and sea flooding—is Bangladesh (Mahtab, 1989; Brammer, 1987). Experience has shown that flood protection through constructing new and modified embankments can often be extremely expensive and ineffective, or even counter productive. At best it provides a partial solution. The Bangladesh study by Mahtab (1989) recommends *allowing low lying land to be flooded on a controlled basis to accelerate the siltation/land accretion process.* *We would commend that this option be investigated in detail as a basis for strategic planning.*

Box 4.5: A Strategy for Adjustment to Sea Level Rise: A Pacific Atoll

A Secretariat study of Pacific atolls predicts a serious deterioration in the quality of life on some low lying atolls (Tuvalu, Kiribati, Tonga) and greater proneness to disasters in the event of significant sea level rise. Abandonment of low lying islands is regarded as unacceptable except in *extremis* and probably unnecessary. Large scale sea defences are regarded as too expensive and simply inappropriate. In any event, the uncertainties about the magnitude of future sea level rise underline the need for considering modest steps that could be taken now and may be attractive on broader grounds. An adaptation strategy has been recommended on the following lines for Tuvalu but has wider application:

- * diversify *food supply* from traditional pulaka, taro and other crops grown in pits to sweet potatoes, fish and vegetables
- * revise *construction* standards to incorporate raised floors and better wind resistance
- * replace ground water dependence with better *water* collection from rain (UNDP and Save the Children Fund are already assisting)
- * to anticipate growing *health* hazards, improve preventive health programmes and improve storage facilities to lessen dependence on salt
- * *land filling* of waste pits and inland lagoons to create land (and reduce health hazards)
- * stabilise and strengthen the *tropical cyclone* protection bank
- * stronger commitment to protect *coral reefs* and prevent *coast erosion*
- * *information and training* are needed to raise local consciousness (already quite strong) of the dangers, and also of ameliorative options
- * modest and gradual *emigration* (not abandonment) to relieve population pressure
- * increase tropical cyclone *early warning and preparedness* capability.

If sea level rise is no more than, say, 50 cm by the middle of next century, Tuvalu and other islands could adjust, by means of self help together with aid from supportive donors.

Source: Lewis (1988b).

In practice a combination of techniques will have to be adopted including embankments to protect urban areas. If controlled flooding were to be used, in the flood plains and low lying coastal areas (including the Sunderbans mangrove forest), a major network of sluice gates, fish passes and drainage pumps will be needed to permit maximum possible siltation with minimum flood damage. *We recommend that Bangladesh's aid donors should consider with the Bangladesh Government whether such a programme is feasible and how it might be organised and funded.*

4.31 We have already emphasised the importance of protecting natural systems that provide resilience to coastal areas such as coral, mangrove, coastal dunes and wetlands. This may well involve action to prevent interference with these natural systems by—for example—the use of explosives or coral mining on reefs, dredging or in-filling swamp areas or cutting of mangroves. It may also involve enhancing their ability to keep pace with a rising sea by hydrologically sound management of coastal sediment movements. Finally, it may demand curbs on encroachment by development from the landward side of the zones occupied by these formations. These are important elements in an integrated approach to coastal zone management which governments should endeavour to adopt.

4.32 If a decision is made to retreat from some or all of a threatened area, a policy framework will need to be designed which incorporates land use planning to inhibit (or prevent) new development in the area, resettlement of those displaced, rebuilding of facilities and compensation to assist resettlement. It is recognised that while, in industrial countries, this problem can be dealt with on a planned basis using zoning controls, in developing countries there is much spontaneous, technically illegal, squatting in coastal and riverine margins, marsh and waterlogged areas, coastal plains and deltas and it is these people who are at greatest risk. Our studies have identified vulnerable coastal areas of Bangladesh, and possibly some small islands, as areas where some resettlement is likely to be necessary and *we recommend that the governments concerned start to plan the process, with a view to seeking overseas assistance both for finance and help with resettling any displaced population.* We emphasise the need to handle resettlement projects with immense sensitivity to the feelings of the people concerned, recognising the need for full dialogue and training in the new life styles relocation may involve and careful integration of those moved into the communities with which they are associated. We would however stress that, for most low-lying states total abandonment of land is a very long term option and probably unnecessary. The scenario of countries such as Maldives, Kiribati and Tuvalu having to be given up for habitation is only relevant on the most extreme and long term

forecasts and careless use of these scenarios is a source of unnecessary alarm.

Disaster Management

4.33 We have argued that global warming—accompanied by greater climatic variability—could be the cause of more severe disasters: drought, hurricanes, and storm surges causing sea flooding (there is an unresolved controversy over whether greater severity or frequency is more likely). Adaptation could take two forms. One is to reduce vulnerability to disasters through careful attention to building design, the location of settlements and economic diversification. The other is to ensure that when disaster strikes there is adequate shelter; services are capable of being maintained and mobilised quickly; food and medical equipment are available to be brought to the scene; and rapid rehabilitation arranged. There is now a lot of experience of managing disasters and there is good appreciation of the best practices that should be followed. While adequate warning systems for tropical cyclones, storm surges and floods require *regional* co-operation, for example within WMO's five regional tropical cyclone bodies, preparedness systems must be developed at a national level. *We recommend that all governments of countries prone to climate-related disasters should review and improve or institute comprehensive systems of disaster warnings and preparedness. International agencies including the Commonwealth Secretariat, should be prepared to give well co-ordinated assistance in formulating such systems as well as in disaster relief and rehabilitation.* The impending International Decade for Natural Disaster Reduction (1990-99) should be a focus of these efforts.

4.34 In preparing international support for disaster management, an underlying assumption must be that—with the important exception of Bangladesh which has a uniquely high level of disaster vulnerability—the most serious *proportional* impact of natural disasters is in small states, some of which have seen well over half their housing stock and crops wiped out by hurricanes. And particularly in relation to sea level rise and associated flooding, it is simply a matter of arithmetic that the ratio of threatened circumference to surface area is highest in small island states. Particularly in the light of the Commonwealth's distinctive membership, *we recommend that high priority be given to disaster warning and preparedness in small island states, as well as to the great needs of Bangladesh.*

PREVENTIVE MEASURES FOR GREENHOUSE GAS EMISSIONS

Policy Scenarios

4.35 How willing governments are to deal with global warming by

preventive action naturally depends on their own political priorities and their ability to extract themselves from short term preoccupations. We believe however that, globally, *there should be two over-riding policy objectives. The first is to maintain a brisk tempo of economic growth targeted to overcome third world poverty.* The World Commission on Environment and Development (WCED, 1987) argued that developing countries should realistically aim for 5 per cent GDP growth—averaging 3 per cent per capita growth—and that seems to us of the right order of magnitude. Industrial countries, including Eastern Europe, will probably wish to continue growth in excess of 2 per cent, and nearer 3 per cent a year, provided this growth can be put on a sustainable basis. But a *second objective must be to reduce substantially the commitment to global warming implied by the continuing emission of greenhouse gases.* It has been suggested (by the Toronto Conference) that a target rate of warming of 0.1°C per decade should be adopted—about a third of the expected rate of warming by 2030. This seems to us on the one hand unduly arbitrary and precise given the uncertainties in the scientific predictions, and on the other, only acceptable as an interim target pending measures that will bring the process of warming to a halt. But of the need to cut the warming commitment substantially, there is no doubt. The issue is how rapidly it can be reduced and the level of ultimate stability.

4.36 One approach is to look at some of the scenarios currently being considered by the international community. The Expert Group on Emission Scenarios of the IPCC's Response Strategies Working Group has been working on three alternative scenarios:

- a) an increase in the greenhouse effect equivalent to a doubling of pre-industrial CO₂ concentration by 2030;
- b) a doubling equivalent by 2060;
- c) a doubling equivalent by 2090.

In each case, approximate stability is achieved thereafter.

4.37 The models developed by the group incorporated the effect of estimated change in population, GNP, energy demand and supply, control technology, CFC controls, deforestation and agriculture and, for each year, provided an analysis based on higher or lower rates of economic growth. The results demonstrate that the targets set by the Group could in theory be attained by a number of different routes. A key challenge is to break the link between high rates of economic growth and high greenhouse gas emission. Timing is crucial: if measures to meet the

2090 target begin in 2000 a gradual CO₂ reduction of about 20 per cent will suffice whereas if controls do not begin until 2020, a 75 per cent reduction would be needed.

4.38 Specifically, how can rapid growth and moderated global warming be achieved simultaneously? The clue lies in energy efficiency and the shift in aggregate consumption between developed and developing countries. In developing countries energy consumption is bound to rise rapidly with increasing growth and development since development is strongly linked to primary production and because of the substitution of non-commercial by commercial energy (a process which—in the case of wood burning in particular—is environmentally desirable in itself). By contrast, growth in developed countries should become less energy intensive with the spread of information technology. The scenario of ‘climate stabilisation’ described in Box 4.6 seeks to reconcile our two major objectives set out above (the CO₂ doubling envisaged there is between (b) and (c) on the IPCC scale of possibilities). The conditions required are however severe: an unprecedented intensification of energy efficiency; phasing out both CFC and eventually coal use entirely; much higher real energy prices; and a much bigger role for renewable fuels and nuclear. On the other hand, the price of inaction has been assessed by the same author, who suggests, that with unchanged policy from today, the additional global warming commitment by 2075 could be as much as 2.5 to 8°C. While we do not necessarily endorse all the details of the scenario suggested, it seems to us to suggest an approach consistent with a desirable outcome.

4.39 While we do not underestimate the importance of greenhouse gases other than CO₂, especially the CFCs, it is clear that the focus of any preventive policies must be CO₂ emissions, and the energy sector, which are (both) expected to contribute over 50 per cent of global warming in the 1980-2030 period (see Ch 2). Various long term energy scenarios have been suggested based on different assumptions (see Table 4.1). Of these, those that lead to global energy consumption of much over 15TW by 2030 (from the base level of around 10TW) are not consistent with a moderation of global warming. Those that assume a global per capita income growth of under 2 per cent, or even 2.5 per cent, are not consistent with development and a reduction in third world poverty. Only one of the scenarios satisfies both conditions (Goldenberg *et al*, 1987) and, like the scenario in Box 4.6, assumes a sharp reduction in per capita, and total, energy consumption in industrial countries due to a combination of energy efficiency and a shift in the structure of developed countries’ economies away from high energy consuming industries towards information based industry and services. At the same time there is some increase (by 25 per cent) in per capita energy consumption in the developing world—leading the developing world to overtake the industrial world as energy consumers

Box 4.6: A Climate Stabilisation Scenario

There are many possible long term climate change scenarios. While we have no particular commitment to the arithmetic of this one, we are attracted to its underlying assumptions which provide for rapid growth in the developing world and a significant slowing down of global warming. The details are less important than the broad thrust of policy proposed.

The underlying policy objectives of the scenario are:

- * to maintain rapid economic growth globally, and strongly rising per capita incomes in the third world. Global per capita income continues to rise by 2.7 per cent per annum. Global population is held to a 'low' projection of 8 billion by 2075 from 5 billion today. Average per capita incomes in developing countries reaches current Western European levels by 2025/2030.
- * to slow down global warming to 'acceptable' limits, doubling of CO₂ is postponed beyond 2075. The scenario assumes equilibrium warming of only 0.6 to 1.7°C from *additional* activities by 2060 (on top of warming already committed).

To realise these ambitious objectives, the scenario author calculates that the following conditions need to be met:

- * annual growth in energy efficiency of roughly 1.7 to 2.4 per cent in industrial countries and 1.4 to 2.3 per cent in developing countries. This is about double the rate of growth of energy efficiency in the last decade (1 per cent).
- * specifically in industrial countries, energy efficiency of transport is assumed to improve 50 to 60 per cent by 2025; the energy intensity of industry to fall by 15-50 per cent; household and office building energy intensity to fall by 45-75 per cent. Overall, per capita energy use in industrial countries falls at 0.35 per cent per annum; rises in developing countries by 0.8 per cent; and rises globally by 0.7 per cent per annum.
- * Coal prices and/or taxes rise sharply and use of coal as thermal power fuel ceases by 2075 to be replaced by natural gas, hydro, biomass, solar or nuclear energy. Gas and oil prices rise four times in real terms.
- * Deforestation slows and is reversed by 2025.
- * The Montreal Protocol is extended to reduce industrial country CFC use to zero by 2020 and developing country use to zero by 2050.

Source: Mintzer (1989).

within the next 30 years. But, even at that point, their per capita energy consumption is still well under half that of the industrial world. Table 4.2 shows the large discrepancy in per capita energy consumption between developed and developing countries, particularly for commercial energy. Development is bound to reduce that disparity as developing countries industrialise, replace non-commercial by commercial energy and extend to all their citizens some of the basic amenities—such as domestic lighting and commercial energy for cooking—that richer countries have long taken for granted.

4.40 The conclusion that clearly emerges is that, if room is to be left for adequate economic growth, particularly in developing countries, effective action to halt the greenhouse effect requires a much more stringent approach to energy conservation and a greater emphasis on non-fossil fuels.

National Options for Reducing CO₂ Emissions

4.41 Recent analyses for the United Kingdom—see Box 4.7—have examined how far it might be possible to reduce national carbon emissions to 50 per cent of the 1988 levels by 2020 which means a reduction of 130 million tonnes per annum from the projected level of 210 m.t. assuming continuing growth in energy consumption. In one of the exercises, the options examined appear together to be capable of delivering this target, but it must be emphasised that there are complex interactions between the options, and may present practical, economic and presentational difficulties. There are also different combinations possible, depending on the willingness to use more nuclear power. These conclusions parallel assessments made for other developed countries. For example, in the United States, the NRDC (1987) assessment of the means for reducing national CO₂ emissions by 20 per cent by 2000 comes up with a mixture of enhancement of efficiency of energy use in building, lighting, appliances, industry and vehicles (14.8 per cent), use of renewable energy (2.8 per cent) and forestry and urban tree planting (4.5 per cent), giving a total of 22.1 per cent saving which could rise rapidly to over 30 per cent by energetic pursuit of the same basket of options. Clearly some options are capable of substantially contributing to reduction of CO₂ emissions, but all need thorough world analysis from a technical and economic standpoint as well as from that of public acceptability. *We recommend that all developed countries in the Commonwealth conduct such analyses and discuss the conclusions that result.*

Energy Efficiency and Conservation

4.42 It is clear from virtually all the analyses that have been undertaken that the prospect for a major economy in CO₂ emissions lies in greater efficiency in the production of energy and its end use. This, therefore, is a good place to start since it has benefits other than its

contribution to alleviating the ‘greenhouse gas problem’: also reducing problems of ‘acid rain’ and pollution more generally. There is little debate over the general desirability of energy efficiency, though there is debate over its technical and economic feasibility and over the contribution from different sectors.

Table 4.1: A Comparison of Selected Global Energy Studies

		1980 (base year)	1	2	3	4	5	6
	GDP Growth per capita per cent	-	3.0	1.1	1.2	1.6	2.0	2.1
Total primary Energy consumption (TW/Yr)	World	10.3	11.2	5.3	14.4	18.8	24.7	35.2
	Industrial countries	7.0	3.9	3.6	7.2	12.7	14.8	20.1
Per capita Energy consumption (TW/Yr)	World	2.3	1.61	0.65	1.81	2.55	3.2	4.41
	Industrial countries	6.3	3.15	2.28	4.64	8.52	9.67	12.9
	World Population (bn.)	4.43	6.95	7.98	7.98	7.36	7.72	7.98
	Projection Year	-	2020	2030	2030	2025	2020	2030

Note: Data selected from Goldenberg, *J et al*, (1985).

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4.43 Substantial improvements have already occurred—at least, in developed countries, where energy saving technologies have been

Table 4.2: Global Distribution of Energy^a

Region/Country	Per Capita Energy Use—Commercial											Total Energy Commercial (million Tons Coal Equiv)	Non-Commercial Energy Use ^c (as of total energy use)
	Liquids ^b		Gases ^c		Solids ^d		Hydro and Nuclear			Kg Coal Equiv			
	Kg Coal Equiv	Percentage of Total	Kg Coal Equiv	Percentage of Total	Kg Coal Equiv	Percentage of Total	Kg Coal Equiv	Percentage of Total	Percentage of Total				
											Percentage of Total		
<i>World</i>	4,919.5	40	425	22	627	33	90	5	1,896	9,332	15		
<i>Industrial Market Economies</i>	797.2	47	1,275	22	1,445	25	375	6	5,770	4,600	-		
United States	240.1	45	2,360	25	2,490	26	390	4	9,489	2,278	2		
Western Europe	353.2	48	840	19	1,050	24	360	8	4,298	1,518	-		
Japan	121.4	56	466	13	858	24	259	7	3,625	440	-		
<i>Centrally Planned Europe</i>	397.2	26	2,130	34	2,290	37	150	2	6,220	2,469	-		
<i>Developing Market Economies</i>	2,583.9	53	82	14	160	28	28	5	578	1,493	52		
Brazil	138.5	61	27	4	97	13	172	22	760	105	34		
India	772.6	69	9	4	185	68	9	3	272	210	52		
Bangladesh	100.8	22	35	40	62	2	1	1	62	6	69		
Africa ^f	539.7	64	63	25	16	6	11	5	252	136	80		
China	1,057.2	97	18	3	580	82	11	2	706	743	36		

^a Unless otherwise indicated, data is from United Nations "Energy Statistics Yearbook," 1986; U.N. 1988. Is for commercial energy only.

^b Liquids are composed of consumption of energy petroleum products including feedstocks, natural gasoline, condensate, refinery gas and input of crude petroleum to thermal power plants.

^c Gases include the consumption of natural gas, net imports and changes in stocks of gas-works and coke-oven gas.

^d Solids comprise primary forms of solid fuel (hard coal lignite, peat and shale, net imports and changes in stocks of secondary fuels).

^e Estimated based on 1980 figures. (Hall Bennard and Moss. Biomass for Energy in Developing Countries.)

^f excludes South Africa.

Box 4.7: Options for Reducing British CO₂ Emissions

Target: 50 per cent reduction in 1988 emissions over the period, 1988–2020
(reduction from projected 210 million tonnes per annum in 2020 to 80 million)

<i>Option</i>	<i>Estimate 1 % of target</i>	<i>Estimate 2 % of target</i>
1. Reforestation (area increased from 10 per cent of the UK to 25 per cent)	2	2
2. Generate energy from organic wastes	2	1
3. Energy conservation (better building insulation; more efficient lighting; more efficient motors; more efficient vehicle design; improved building and process control; combined heat and power)	40	40
4. Less CO ₂ -producing fuels use in transport (conversion to gas)	11	5
5. Remove CO ₂ from power station fumes (not yet proven)	2	2
6. Renewable energy sources (bio fuels, wind, hydro, tidal, waves, geothermal)	7	7
7. Nuclear	22	11
8. Fuel substitution (e.g. gas for coal)	14	12
9. Unaccounted for	–	20

Source: Currie, 1989; Dale 1989

available and affordable. Between 1973 and 1985, total energy use per capita in OECD countries fell 6 per cent while per capita GDP rose 21 per cent. In Japan, there was a fall in per capita energy use of 6 per cent while per capita GDP rose 46 per cent. Provided high, real, energy prices continue to provide an energy-saving incentive, the US Department of Energy has argued that increasing energy efficiency could reduce CO₂ emissions by 60 per cent by 2050—around 1 per cent

a year—and other widely quoted studies suggest a 70 per cent cut is feasible by 2030—that is by 2 per cent a year, as in the decade after the oil crisis (Lovings, 1981). This is consistent with the ‘stabilisation’ scenario sketched earlier but goes beyond the data for the UK in Box 4.7. A potential for further, large energy saving exists in power plant technology (mainly from cogeneration of heat and power); a switch in economic structure to less energy-intensive high-tech industries and services; more energy-efficient homes and offices (ranging from energy efficient light bulbs to better heat insulation) and less-fuel-consuming cars and domestic appliances.

4.44 In developing countries, however, there has been no discernible slowdown in energy consumption per unit of GDP since the 1970’s oil price increase. Per capita energy use has grown by 3.5 per cent per annum since the mid-1970s. In part, this reflects healthy developments: rapid economic growth in Asia; reduced reliance on non-commercial, mainly wood, fuel; increased industrialisation; economic diversification. But future energy consumption growth of this order (which would take developing country consumption from 2 TW to 15 TW in 2020) will be difficult to sustain economically even if it were acceptable environmentally. It relies primarily on fossil fuels. Moreover, there is abundant evidence of wasteful energy production, transmission and use, whether by highly inefficient wood burners in poor households or energy intensive industrial processes. In industry, in particular, there is scope for substantial improvement. By contrast, households generally need more energy for lighting, cooling and refrigeration—even if some economies are possible. It has been estimated that a recognised basket of basic needs in developing countries could be met with an increase of only 20 per cent in per capita energy use if efficient methods were used, whereas without them the increase would have to be 100 per cent (Goldenberg *et al*, 1987).

4.45 We accept the weight of evidence which suggests that improved energy efficiency can play a key role in reducing CO₂ emissions in developed and developing countries. But without active support for energy-saving technologies—in terms of R&D, promotion, extension services and, in some cases, use of tax incentives or direct subsidisation—the adoption of better practices will lag well behind technical possibilities. *We strongly recommend, therefore, that all governments should give energy conservation and efficiency high priority in policy and planning; provide direct support or fiscal incentives to research, development and applications of energy conservation and low energy technology; and in some cases impose technical standards that will compel greater energy efficiency. Further, given the growing importance of developing countries in CO₂ emissions, we also believe it is vital to give*

priority to ways of helping them to adopt energy efficient methods through capital aid and technical assistance. A particular focus of technical assistance might be training in designing energy efficient systems for agriculture, industry, construction and commercial building.

Taxes, Prices and CO₂

4.46 An important ingredient in policies designed to encourage energy efficiency and substitution of fossil fuels by other forms of energy could be the use of taxes and/or user charges designed to curb the consumption of CO₂ emitting fuels and to finance alternatives. In addition, the windfall gains—or economic ‘rents’—from higher energy prices would accrue to non-fossil fuel producers and thereby act as an incentive to them to increase their activities. Some consideration is already being given in some countries to the idea of a ‘carbon tax’, or variants of it, to be introduced either nationally or as part of a multilateral approach. We do not believe that the analysis has yet come to the point at which a major new initiative of this kind could win general acceptance. But energy pricing policies and fiscal measures can undoubtedly be used in a more general way to provide a major incentive for energy efficiency.

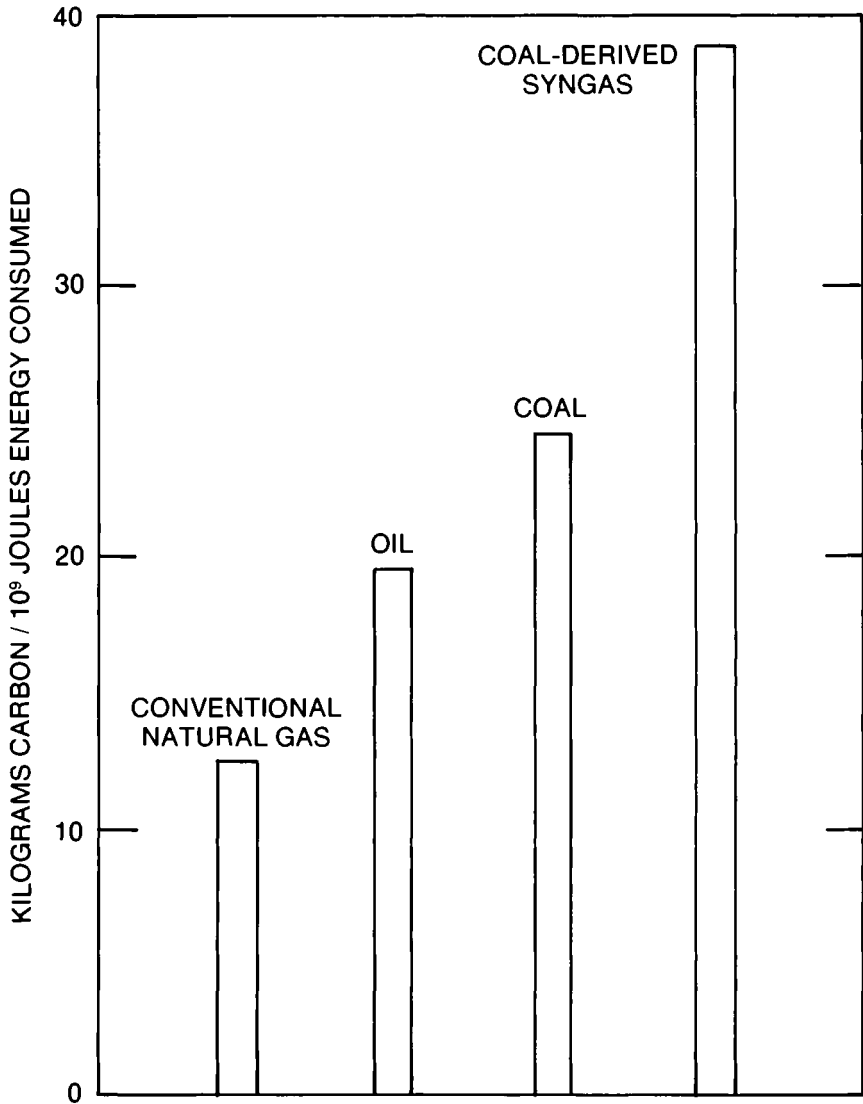
Energy Generation with Reduced CO₂ Emission

4.47 In our judgement, energy conservation is the most efficient and economic way of reducing carbon dioxide emissions. But another approach is to generate electricity using techniques that emit less, or no, CO₂. The options here are:

- (a) the increased use of fuels that emit less CO₂ per unit of energy produced than coal;
- (b) the increased use of ‘renewable’ sources of energy;
- (c) the increased use of nuclear power.

4.48 For a given amount of energy generated, natural gas produces 60 per cent and oil 80 per cent of the carbon dioxide that coal does (Figure 4.1). However, substitution is only practicable if natural gas is available on economically favourable terms. Where this is the case, such substitution is obviously desirable, especially to avoid the waste of energy and needless augmentation of the greenhouse effect that occurs when gas emitted as a by-product of oil extraction is ‘flared’ (or burned) off. Some developing countries, notably India, are now actively seeking to maximise the use of such natural gas for power generation and industrial purposes. *We recommend that Commonwealth countries should, where practicable, substitute natural gas for coal as a basis for energy*

Figure 4.1: Different Fuels and Carbon Emissions



Source: Koomanoff, F A (1988), US Department of Energy.

generation and should make special efforts to prevent flaring of such gas in significant quantities.

4.49 One possible way of reducing carbon dioxide emissions while maintaining the familiar and established use of fossil fuels to generate electricity would be to filter the CO₂ out of the flue gases prior to discharge. This is technically possible, but the carbon removed still has to be disposed of—for example by pumping or dumping a calcium carbonate slurry into the oceans or into cavities on land. Such disposal would present other environmental problems, and even sympathetic reviews of the likely technologies describe the cost as ‘astronomical’ (Simon, 1986). *We recommend that this option should not be given priority attention at the present time.*

4.50 The possibilities of using non-conventional energy sources—such as solar, wind, geothermal and tidal power—have been discussed extensively over the recent decades but they have yet to be adopted on a wide scale and most are only economic in particular local circumstances (wind power, for example, is most attractive on exposed coasts and islands). Advances are being made—the cost of photovoltaic cells has fallen to under a quarter of its 1980 level as production has multiplied tenfold; solar heating for domestic use is widely used in some countries (Cyprus, some Caribbean islands) and solar cookers have been designed and marketed in several developing countries—but not rapidly enough to alter the energy picture in this century at least. Of more traditional sources, major hydropower schemes provide energy on a substantial scale in some countries, but there are often major environmental arguments against extending its use. Geothermal sources have only proved attractive in a few restricted areas and commercial biomass utilisation (most commonly to produce alcohol used as a transport fuel) is practicable only in areas with a surplus of plant production. *We recommend that Commonwealth governments continue to develop a range of renewable energy sources, and to exchange knowledge of suitable technologies, but we emphasise that assistance will be required to enable many developing countries to apply these, especially where capital costs are high (as with major hydropower projects).*

4.51 The most difficult issues arise in connection with the substitution of nuclear power, which has no CO₂ (or SO₂ or NO_x) emissions. Despite these attractions, there is widespread public aversion and political resistance to nuclear power stations in many countries, especially in the aftermath of the Chernobyl disaster which demonstrated that a nuclear reactor failure—unlike that of any other energy source—could have a sudden and widespread impact on environment across a continent. Moreover, the disposal of nuclear wastes has still not been achieved to the satisfaction of public opinion. Granted the continuing spiral of investment in safety, there are doubts about the economic viability of additional nuclear capacity at the kind of energy price levels now

prevailing globally. How these safety, environmental, economic and other (e.g. security) factors should be weighed is a matter that calls for political as much as technical judgement, and remains a controversial issue in two Commonwealth countries: Canada and the UK. The view taken by the World Commission on Environment and Development and by the Toronto Conference was that nuclear power could play a part in reducing CO₂ emissions, if these problems of safety, waste disposal and prevention of nuclear weapons proliferation could be solved. We consider that such solutions (which must satisfy the informed public as well as experts) are unlikely in the short term. We also consider that nuclear power is unlikely to be a practical option in most developing countries because of the large initial investment and the continuing need for substantial resources of trained manpower (though we note that India has an expanding programme). Accordingly, we do not believe that nuclear energy will contribute on any large scale to the reduction in greenhouse gas emissions. *We recommend that those Commonwealth countries that are committed to the expansion of nuclear power pay added attention to the need to reassure their publics and international opinion by demonstrating the safety of reactors and of waste disposal systems.*

4.52 Our analyses indicate that humanity will have, as a matter of prudence, to stabilise its combustion of fossil fuels as one component of action to stabilise atmospheric greenhouse gas concentrations. The preceding paragraphs demonstrate, however, a dilemma summed up in the colloquial comment that ‘there’s no such thing as a free lunch’. There is no readily available cheap—let alone free—alternative energy available. Moreover, apart from energy conservation, which is clearly acceptable to everyone provided the price is tolerable, no alternative avoids opposition from some quarters. Nuclear power is the subject of widespread public concern, and among some sectors, hostility. Large hydropower schemes are opposed because they commonly inundate fertile lowlands or forests, intrude into cherished landscapes, and displace human communities. Estuarine tidal barrages are unpopular because of their impact on intertidal wetlands. Extensive use of wind generators would be likely to excite opposition because areas of high wind exposure are often also sites of high landscape quality. At present, fossil fuels, despite being the source of a range of major atmospheric pollutants (sulphur and nitrogen oxides, mercury and particulates as well as CO₂) are familiar and relatively cheap. Major industries (such as mining) depend on their continued use. Policies to reduce fossil fuel consumption have to be designed with the recognition that there are no easy alternatives. *We recommend that Commonwealth governments, as a part of the campaign of public awareness advocated above, hold informed debate on the optimal national energy generation policies, taking all the needs, costs and benefits into account.*

Reductions in CO₂ Concentrations Through Forests

4.53 Deforestation is said to be the source of between 10 per cent and 30 per cent of the carbon dioxide released annually to the atmosphere by human agency (Chapter 2). Halting—or slowing—the process is attractive for many reasons. First, a significant input of CO₂ would be reduced or stopped. Second, there are good reasons for believing that national economies in tropical forest countries would secure optimal economic returns, maintained indefinitely, from the sustainable use of forest as sources of selectively-extracted timber, nuts and other fruits, medicinal plants, wild animal protein and other products, while the retention of the forest also reduces water run-off and helps to stabilise river flow. Where forests have been cleared, cultivation has not been generally easy to sustain on the bare land, pasture production has been low, and soil erosion a problem. While there are, of course, tracts of land in many tropical countries where conversion to agriculture is inevitable and right, there are many other areas where national economic interest and the global interest in reducing greenhouse warming combine to favour forest retention. However, such policies are impracticable unless there is assistance for programmes of sustainable development that meet the needs of the growing numbers of poor people who are encroaching on the forest in the search for land to cultivate. *We recommend an increasing effort within the Commonwealth to maintain as much as possible of existing forest, and (except in areas designated for special protection) to utilise them in a sustainable way for the benefit of local and national communities.*

4.54 There are various estimates of the contribution that programmes of reforestation would make to halting global warming. These are based on calculations which suggest that 1–2 billion tonnes of carbon would be removed from the atmosphere annually for each 100 million hectares of forest planted, the process of extraction continuing for the 30 years or so during which the trees continued to grow actively (Myers, 1989). Such an area appears vast (it is equivalent to the UK, France and the Federal Republic of Germany added together) but is about equivalent to the amount of ‘wasted land’ already cleared but not settled within the tropical forest zone. Reforestation might well be the most economically productive use of such land. In addition, in many areas that are used and settled, agroforestry (a mingling of tree, bush and herbaceous crops) offers the attraction of high productivity, a wide range of useful produce, erosion control and enhanced CO₂ uptake. While we accept that reforestation cannot reach the immense scales suggested above in the foreseeable future, *we recommend that Commonwealth countries, as part of their national land use and conservation*

strategies, identify areas where reforestation is the most rational policy, and pursue it, with assistance where necessary.

Action Against Other Greenhouse Gases

4.55 The contribution of other 'greenhouse gases' to global warming has been emphasised in Chapter 2. By 2030, the combined warming effect of these gases—CFCs, nitrous oxide, tropospheric ozone and methane—could be as great as that of CO₂.

4.56 In respect of one group of these gases—the CFCs—a major step forward has been taken as a result of the Montreal Protocol which provides an international framework for regulatory measures to stabilise, then reduce, global production (Usher, 1989). The greenhouse gas role of CFCs was not specifically taken into account in the Protocol, under which CFC (and halon) regulation relates to their ozone depleting potential. Nonetheless, there is an indirect benefit from measures to reduce CFCs and the definition of 'acceptable' substitutes refers to their total environmental effect. *We recommend that the definition of acceptability of the substitutes should specifically take into account their potential contribution to global warming.*

4.57 It is too soon to judge the effectiveness of the Protocol. Conferences in London and Helsinki in 1989 have, however, agreed on the need for strengthening of the Protocol and the acceleration of its implementation, with the aim of the earliest practicable elimination of CFCs and other substances which deplete the ozone layer. Reservations have been voiced by several countries with regard to the disparity in the permissible levels of per capita consumption implicit in the Protocol and the inadequacy of arrangements for technology transfer. *We recommend that all governments ratify the Protocol, strengthened where necessary to ensure an equitable sharing of the costs of implementation, to provide effective financial and other arrangements for technology transfer, and to hasten the process of elimination of ozone-depleting, greenhouse-gas chemicals.*

4.58 Consideration of policy measures to address other greenhouse gases is much less advanced. For the main sources of methane emission—ruminant animals, rice paddies and marshes—little can be done without radical intervention in natural or agricultural processes that would scarcely be justified by the scale of the problems originating from this source. In some cases, intervention could be counter-productive in agricultural terms (reducing rice yields), or in environmental terms (eliminating ecologically beneficial marsh land). However, there are some useful initiatives that could be taken. In developed countries, considerable quantities of methane are emitted

from domestic and other refuse disposed of in landfill. If this organic waste or methane were utilised for energy generation or heating, coal would be saved and CO₂ dioxide emissions reduced. In the energy sector, methane emissions could be reduced and efficiency enhanced by reducing leakages from natural gas distribution systems. *We recommend that governments take appropriate measures to these ends, concentrating on methane losses from industry, refuse disposal and gas distribution.*

4.59 *Nitrous oxide* originates, in large part (about two thirds), in the burning of fossil fuels—where policy remedies parallel those related to CO₂. The remainder is due to woodburning and the use of mineral fertilizers. While lower fertilizer applications will usually result in lower farm yields, there is some agricultural research—which we believe should be encouraged—which suggests that additional chemicals (nitrapyrim) can suppress nitrous oxide emissions. *Tropospheric ozone* originates largely from chemical reactions involving unburnt or volatile hydrocarbons and nitrogen oxides in the presence of sunlight: emissions from gasoline-fuelled motor vehicles are believed to be a major source of these chemicals. Tropospheric ozone concentrations are increasing rapidly in many developed countries, where the gas is a cause of damage to trees and sensitive crops, and action is therefore doubly justifiable. Many countries are adopting catalytic converters which cut hydrocarbon and nitrogen oxide emissions from automobiles and this policy is to be welcomed. The ideal solution is one which combines this pollution control with enhanced vehicle fuel efficiency, thereby reducing carbon emissions. *We recommend Commonwealth governments to continue to support research on more economical and less polluting vehicles, and to press action forward by setting stringent standards in this field.*

Co-ordination of International Action to Combat Causes of Climate Change and Sea Level Rise

4.60 While action to curb emissions of greenhouse gases must be taken nationally, it needs to be planned and co-ordinated internationally, for this is a global problem that will only be solved by concerted action based on common commitment. The Montreal Protocol to the Vienna Convention on the Protection of the Ozone Layer provides for the control of the manufacture and use of CFCs, and we have already commented on that in paras 4.56 and 4.57.

4.61 The United Nations General Assembly, the Governing Council of UNEP, and the WMO Council have now all unanimously adopted resolutions which will lead to the negotiation of a Framework Convention on Climate. The Convention will be developed after the IPCC

Report is available in 1990, and it will be followed by specific Protocols dealing, *inter alia*, with action to curb emissions of greenhouse gases. All members of the Commonwealth have endorsed these actions by their participation in the unanimous adoption by the 43rd Session of the UN General Assembly of a resolution introduced by Malta and they will have every opportunity to participate in the subsequent negotiations. We welcome these signs of progress but emphasise that they should not delay action at national or international level to enhance knowledge of the greenhouse phenomenon, to evaluate its impact, and to develop and apply energy conservation and other measures that will reduce greenhouse gas emissions. The negotiation of specific Protocols that will apply quantitative limits to carbon dioxide emissions is likely to take time; there are potential conflicts of interest between different groups of energy producers; and more progress is needed in the development of new technologies. The funding of the transfer of such technology to the developing countries is also likely to demand protracted discussion. *We therefore recommend that while Commonwealth governments lend active support to the negotiation of the Framework Convention on Climate and its Protocols, they also press forward vigorously with the immediate actions proposed elsewhere in this report.*

The Special Role of the Commonwealth

4.62 We have considered the role that the Commonwealth can play, bearing in mind the need for the activities of international agencies to be co-ordinated and duplication avoided. We suggest that a positive role for the Commonwealth can be identified building on some of its unique characteristics, and especially the involvement of its members in all the major groups of nations within the UN and other systems.

4.63 The Commonwealth provides an informal network of political and professional contacts, covering a wide range of developed and developing countries, which can be used to stimulate and organise collaborative work and dialogue. The regular meetings of Commonwealth Meteorologists — a low key, low cost, affair supported by the UK Meteorological Office — is a good example of this kind of activity. *We welcome, in particular, the meeting of Commonwealth Meteorological Organisations to be held in advance of the 1990 World Climate Conference, and we recommend that similar meetings be held to exchange views in advance of other key meetings, such as those of the IPCC, in which Commonwealth governments are playing a leading part.*

4.64 We believe that environmental issues will continue to attract political attention at the highest level in the coming years and that climate change and sea level rise will figure prominently in those concerns. *We therefore recommend that Commonwealth Environment*

Ministers should also hold periodic meetings, to exchange views on matters of mutual concern, identify priorities for concerted action, and plan necessary measures.

4.65 The Commonwealth, and especially the Secretariat, has developed a particular focus of interest in the problems of small states. As we have seen, some small island states are especially vulnerable to rising sea level (and other natural disasters such as hurricanes). One affected Commonwealth member, Tuvalu, is one of the world's smallest states in population terms (though its exclusive economic zone puts it among the largest in the area). The Commonwealth can usefully serve as a forum where the concerns of such states are given true and proper consideration. *We recommend that the Commonwealth should deepen its work on the vulnerability of small states to give particular attention to problems resulting from climate change, sea level rise and related disasters. Particularly important is the work of the Science Council which has expanded its activities in this area (building on existing programmes in coastal zone management, disaster management and environmental assessment).*

4.66 Given the limited resources of the Secretariat, it is important that maximum synergy be achieved between its various activities. We suggest looking in particular at how its growing role in environmental issues (including climate) might be dovetailed with the ambitious programme of distance learning. *We recommend a close look at how distance learning in the Commonwealth can promote environmental education.*

4.67 The technical assistance arm of the Secretariat, the CFTC, has acquired a reputation for providing help to developing countries rapidly and with the minimum of red tape and also for promoting an exchange of expertise among Commonwealth developing countries (small scale solar energy is an example). There are several areas related to the impact of climate change where moderate amounts of timely assistance could have considerable benefits—for example a systems approach to energy conservation and non-conventional energy sources; the organisation of disaster management plans; training of meteorological personnel. *We have identified a detailed programme (Box 4.2), specifically in the meteorological field which could benefit both individual countries and global monitoring systems and we commend it as a basis for bilateral assistance or multilateral assistance through the CFTC. More generally, we recommend that the Commonwealth Secretary-General should investigate how the Commonwealth can best mobilise technical assistance in relation to climate change and sea level rise, bearing in mind the work of other agencies.*

4.68 Finally, we consider that the machinery of the Secretariat will need modest strengthening to respond to these new demands. We believe that it may also be helpful to establish a small non-representative Standing Expert Group to advise the Secretariat, evaluate particular issues as they arise, and carry forward our own work. *We recommend the creation of such a Standing Group, and the establishment of a post or posts in the Secretariat charged specifically with responsibility for environmental concerns.*

Conclusion

4.69 We are aware that the number and scope of our recommendations may appear daunting, and we do not pretend that all have the same immediacy or weight. We have summarized the key issues in the draft Action Plan for the Commonwealth which is attached to the Executive Summary of our Report. *We commend this Action Plan to the Commonwealth Heads of Government—for action!*