# Chapter 4

# Climate Change

4.1 The Commonwealth comprises countries from virtually every major climatic region. Climate change due to global warming will affect all its members, though not uniformly. Some effects, like sea-level rise, pose particularly serious dangers to island small states and countries with low-lying areas. These constitute a majority of the Commonwealth's membership. The 1989 Commonwealth Expert Group Report, "Climate Change—Meeting the Challenge", contributed to understanding the problems of climate change both from the Commonwealth's standpoint, and in a wider international context. Developments during the past two years have generally confirmed its prognosis on global warming and sea-level rise; its assessment of possible impacts of climate change; and the validity of its conclusions and recommendations for policy responses, both by the Commonwealth and by the wider international community. We have focused our attention selectively on some of the key developments and issues.

## Key Developments

4.2 Although uncertainties remain, there is now a much broader international scientific consensus that the problem of global warming is real. Its seriousness and the need for precautions warrant effective international responses. The latest in a series of international assessments of climate change was completed last year by the Intergovernmental Panel on Climate Change (IPCC), to whose work a number of Commonwealth countries made important contributions.

4.3 More than 300 leading scientists from around 50 countries working for the IPCC concluded that human activities are aggravating the greenhouse effect. This will result in additional warming of the earth's surface. Should global emissions continue to increase at existing rates—in other words, 'business as usual'—there would be a doubling of carbon dioxide ($CO_2$) concen-

trations from pre-industrial levels by about 2025, with continuing increases thereafter. The scientists predicted that the result would be an average global warming over the next century of 0.3°C per decade, ranging from 0.2°C to 0.5°C. It means the Earth would be 2°C to 5°C warmer by the end of the next century.

4.4 This rate of warming would be greater than that seen over the past 10,000 years. It could cause sea-levels to rise by around 30cm—100cm by the year 2100. The main scientific uncertainties are reflected in this range of predictions.[1] One of the most important uncertainties concerns the rate of uptake and release of $CO_2$ by the oceans and by land ecosystems, including forests and grasslands. In November 1990, scientists and specialists from 120 countries, participating in the scientific and technical sessions of the Second World Climate Conference (SWCC) in Geneva, agreed that the IPCC's scientific conclusions now reflect the international consensus.

4.5 There are likely to be significant regional variations in relation both to temperature increases and to the rise in sea-levels. The IPCC acknowledged that there are many uncertainties in some aspects, particularly with regard to the timing, magnitude and regional patterns of climate change. This is due to an incomplete understanding of the sources and sinks of greenhouse gases, which affect predictions of future concentrations; of clouds, which strongly influence the magnitude of climate change; of the oceans, which influence the timing and patterns of climate change; and of polar ice sheets, which affect predictions of sea-level rise. But the IPCC was confident that these uncertainties could gradually be reduced by further research, assuming that countries fully support international efforts in this field.

4.6 Some of these uncertainties may mean a warmer world than the averages predicted by the models. Scientists at the SWCC agreed that, "Although many of the response or feedback processes are poorly understood, it appears likely that, as climate warms, these feedbacks will lead to an overall increase rather than a decrease in greenhouse gas concentrations".[2] Expanding international research in order to reduce the uncertainties should therefore command a high priority. But the SWCC took the approach—which the Commonwealth Expert Group also favoured—that the world cannot afford to wait until all uncertainties have been resolved. It must take action sooner rather than later. The scientific session of the SWCC noted that in order to stabilise $CO_2$ concentrations by the middle of the twenty-first century at about 50 per cent above pre-industrial concentrations, a continuous world-wide reduction of net $CO_2$ emissions by 1 to 2 per cent per year, starting now, would be required. A 15 to 20 per cent total reduction in methane emissions would stabilise atmospheric concentrations of that gas.

4.7 Significantly, the SWCC concluded that "technically feasible and cost-effective opportunities exist to reduce $CO_2$ emissions in all countries. Such

opportunities for emissions reductions are sufficient to allow many industrialised countries to stabilise $CO_2$ emissions from the energy sector and to reduce these emissions by at least 20 per cent by 2005".[3] These opportunities are greatest in the energy sector. This sector accounted for almost half the increase in the greenhouse effect which took place in the 1980s due to human activities, and it will account for two-thirds after the virtual elimination of CFCs. There is much scope for increasing the efficiency of energy use and for developing renewable sources of energy (see Chapter 3).

4.8 The Action Plan for the Commonwealth proposed by the Expert Group[4] stressed that it was essential to develop national strategies to slow down the increases in atmospheric concentrations of greenhouse gases and eventually to bring them to stability. Chlorofluorocarbons (CFCs), which accounted for 24 per cent of the incremental greenhouse effect due to human activities in the 1980s, are now to be phased out by the year 2000 under amendments to the Montreal Protocol agreed in June 1990; so will halons and carbon tetrachloride. Methyl chloroform is to be phased out by 2005. Developing countries will be allowed an additional 10 years to achieve these targets. Recent observations which indicate that the rate of stratospheric ozone depletion over the northern hemisphere is about twice that calculated in earlier estimates, suggest that it would be desirable to speed up the phase out of CFCs. We believe that Commonwealth developed countries should therefore consider pressing for an earlier CFC phase out date at the next meeting of the parties to the Montreal Protocol in 1992. It will also be essential to ensure that CFC substitutes now being developed (e.g. HCFCs—hydrochlorofluorocarbons, and HFCs—hydrofluorocarbons) do not exacerbate global warming. There is mounting concern that the HCFCs and HFCs currently being developed by chemical industries will do more damage to the ozone layer and the atmosphere than was thought previously.

4.9 The Ministerial Declaration of the SWCC agreed that the ultimate objective should be to stabilise other greenhouse gas concentrations at a level that would prevent dangerous human interference with the climate. As a first step, emissions of gases not controlled by the Montreal Protocol need to be stabilised. Such commitments should be equitably differentiated according to countries' responsibilities and their levels of development. The Declaration urged all developed countries to establish targets, or feasible national strategies, to stabilise and then reduce their emissions of greenhouse gases by the time of the 1992 UNCED. We note that several industrial countries have committed themselves to stabilising $CO_2$ emissions at or below 1990 levels by the years 2000 or 2005. Among them, some—notably Germany, Australia, New Zealand and the Netherlands—have announced that they intend to reduce emissions by the year 2005, in Germany's case by 30 per cent (see Box 4.1 on p. 76).

4.10 Commonwealth developed countries are drawing up plans to achieve

**Box 4.1**

**Emission Reduction Targets Adopted by Industrial Countries (as at the end of 1990)**

| Country/ Organisation | Targets | $CO_2$ Emissions Total* (million tonnes C) | $CO_2$ Emissions Per capita** (tonnes C) |
|---|---|---|---|
| Australia | 20% cut of $CO_2$, & $N_2O$ and $CH_4$ from 1988 levels by 2005 | 55.4 | 3.5 |
| Austria | 20% cut in $CO_2$ from 1988 levels by 2005 | <50 | <1.0 |
| Belgium | 5% cut in $CO_2$ from 1990 levels by 2000 | <50 | <1.0 |
| Canada | Hold "net" $CO_2$ emissions at 1990 levels by 2000 | 82.9 | 3.2 |
| Denmark | 20% cut in $CO_2$ from 1988 level by 2000 | <50 | <1.0 |
| EC† | Hold $CO_2$ at 1990 levels by 2000 | | |
| EFTA† | Hold $CO_2$ at 1990 levels by 2000 | | |
| Finland | EFTA target | <50 | <1.0 |
| France | EC target | 108.5 | 2.0 |
| Germany*** | 30% cut in $CO_2$ from 1987 levels by 2005 | 272.8 | 8.3 |
| Greece | EC target | <50 | <1.0 |
| Ireland | EC target | <50 | <1.0 |
| Iceland | EFTA target | <50 | <1.0 |
| Italy | EC target | <98.1 | <1.7 |
| Japan | Hold per capita $CO_2$ at 1990 level by 2000 | 256.4 | 2.1 |

their targets. For instance, an Australian Senate Committee has formulated a 10-year action plan to cut emissions. This will work through improved energy efficiency and the development of alternative energy technologies. The plan includes fuel-efficiency standards and incentives for transport, industrial and domestic energy-use targets, and appliance labelling and stan-

| | | | |
|---|---|---|---|
| Luxemburg | Hold $CO_2$ at 1990 levels by 2000; 20% cut by 2005 | <50 | <1.0 |
| Netherlands | Hold $CO_2$ at 1989/1990 levels by 1994/1995; 3–5% cut from 1989/1990 levels by 2000 | 34.5 | 2.4 |
| New Zealand | 20% cut in $CO_2$ from 1990 levels by 2000 | <50 | <1.0 |
| Norway | Hold $CO_2$ at 1989 levels by 2000 | <50 | <1.0 |
| Portugal | EC target | <50 | <1.0 |
| Spain | EC target | 51.7 | 1.3 |
| Sweden | Hold $CO_2$ at 1987/1988 levels by 2000 | <50 | <1.0 |
| Switzerland | EFTA target | <50 | <1.0 |
| UK | Hold $CO_2$ at 1990 levels by 2005 | 154.0 | 2.7 |

**Notes:**

† The conclusions of the Second Ministerial Conference of EFTA and EC on the Environment, 5 November 1990, state: "Ministers and the Commissioner . . . invite all industrialized countries to take actions similar to those decided by the EC with its member states, by the EFTA countries and by certain other industrialized countries aimed at stabilizing $CO_2$ emissions by the year 2000 in general at the 1990 level, as expressed in the Noordwijk and Bergen Declarations."

* From W C Clark, ed., Usable Knowledge for Managing Global Climate Change, Stockholm Environment Institute, 1990, p74. These are preliminary estimates; mean annual release for 1980–1986 estimated as 5.0 Gt/year. Figures not given for emissions less than 1% of world total (50 million tonnes).

** Ibid, page 76. Mean annual release for 1980–1986.

*** Includes former German Democratic Republic (DDR).

Units: (1 metric tonne = 1.102 US ton).
The symbol < denotes 'less than'

Source: based on Atmosphere[5]

dards. There will also be tax incentives and low-interest loans to promote the development of renewable energy resources and of new energy-saving technologies.

4.11 New Zealand is also developing a strategy to reduce emissions from

the energy sector through a combination of instruments. These include carbon taxes and charges; tradeable permits; efficiency standards; and grants and subsidies. Canada is studying the feasibility of a 20 per cent cut in its $CO_2$ emissions by 2005. Its five-year 'Green Plan' proposes initiatives which will stabilise greenhouse gas emissions, and promote conservation and efficiency in energy use.

4.12 The British Government's recent White Paper on the Environment provides for specific measures to increase energy efficiency.[6] Among these are the promotion of combined heat and power schemes (co-generation), the use of energy-efficient lighting, and the encouragement of energy-labelling of houses and appliances. The White Paper will also stimulate the use of renewable energy resources.

4.13 These initiatives by Commonwealth and other industrial countries constitute a major step forward in developing an international response to global warming. But there is clearly a need for co-ordinated action. This is being concerted through negotiations on an international convention to protect the world's climate.

**Negotiations on a Global Convention on Climate Change**

4.14 In their Langkawi Declaration, Commonwealth leaders called for the early conclusion of an international convention to protect and conserve the global climate. They applauded the efforts of member governments which were helping to advance the negotiation of a framework convention under the UN's auspices. Some Commonwealth governments played pivotal roles in facilitating the decision by the UN General Assembly at its 45th session in 1990, to establish an Intergovernmental Negotiating Committee (INC), under the UN's auspices. Its mandate was to prepare "an effective framework convention on climate change, containing appropriate commitments, and any related instruments as might be agreed upon". The General Assembly considered that the INC's negotiations should be completed in time for a framework convention to be opened for signature at UNCED in June 1992.

4.15 The INC has agreed on its main tasks. It is to negotiate specific commitments to limit and reduce net emissions of $CO_2$ and other greenhouse gases; to protect and enhance natural sinks and reservoirs for carbon; to address the special situation of developing countries, taking into account their development needs; and to provide additional financial help to developing countries to meet the extra cost of fulfilling their commitments, and to facilitate transfers of technology to them on favourable terms. The INC will also negotiate the institutional and legal mechanisms needed to implement these commitments, as well as those in areas like scientific co-operation, monitor ing and information.

4.16 The INC's negotiations, which are now well underway, have revealed that a number of complex—and in many cases controversial—issues will need to be resolved. A fundamental one is whether specific obligations and commitments will be negotiated by mid-1992. A significant number of developed and developing countries are in favour of this. But some would prefer to defer the negotiation of specific commitments. Agreement must soon be reached upon several critical issues. They include: targets for stabilising and then reducing net emissions and a decision on whether they should address all greenhouse gases in aggregate or apply to each one individually;* the methodology for calculating and accounting for net emissions of individual countries; differentiating between the obligations of developed and developing countries; commitments on financial assistance and technology transfer to help developing countries; and whether, in view of the special role of forests in regulating the world's climate, an agreement on forests should be negotiated as part of a convention on climate change. There are differing views on this last point. Commonwealth governments could play a valuable role in facilitating the development of a consensus on these issues.

4.17 We do not propose to debate the specific pros and cons of alternative approaches to tackling them. We believe that the Commonwealth must continue to emphasise its support for early agreement on an international convention that is both effective in responding to the challenge of global warming and climate change, and equitable in distributing the burden of international response.

4.18 We reiterate the view taken by the Commonwealth Expert Group, that because developing countries need to achieve rapid and sustainable economic growth to address the immediate and immense task of reducing poverty which climate change could make more difficult, they cannot be expected to curb their economies in order to help alleviate a global problem which they have, in any event, done little to create. Their co-operation is, however, necessary. This should be encouraged by measures which increase their economic growth in ways which reduce energy consumption per unit of output. The burden of measures to reduce emissions will therefore fall overwhelmingly on the developed world, which is responsible for three-quarters of all emissions of greenhouse gases and an even larger proportion on a historically cumulative basis. To accommodate development needs, in developing countries with relatively low energy consumption, net emissions may have to increase in the short term. This will necessitate larger reductions of emissions in industrial countries. But, over time, increased restraint on emissions by developing countries—especially by those whose emissions are increasing at faster rates—will be essential for an effective and global response to climate change. Action by developing countries could be acceler-

* Recent scientific evidence suggests that the changes in the radiation balance caused by $CO_2$ have characteristics different from those caused by the trace greenhouse gases.[7]

ated if they are assisted with capital flows, and technology transfer to enable them to 'leap-frog' to more efficient energy-use.

4.19 A key factor influencing the degree to which this partnership can be secured will be the willingness and ability of industrial countries to take action. They need to mobilise adequate financial resources, additional to existing official development assistance, to help developing countries to finance initial capital costs and, where necessary, the incremental costs of taking action to reduce their greenhouse gas emissions and adapt to climate change; and to facilitate transfers from both developed and developing countries of the necessary technologies and "know how" which developing countries will need, particularly in the energy, industrial and agricultural sectors.

4.20 We believe that the establishment of the Interim Multilateral Fund, a modest effort to assist developing countries implement their obligations under the Montreal Protocol, is an important precedent for dealing with financial resources and technology transfer issues in relation to a convention on climate change. Further research is needed to estimate more precisely the sums involved, which would depend on the balance of policy measures and investment projects, the relative contributions of the public and private sectors, and how far this new spending displaced existing programmes, among other factors. Some of the additional resources needed could be mobilised by levying international taxes on carbon emissions. For instance it has been proposed that a levy of only $1 per barrel of oil-equivalent, or $6 per ton of coal equivalent, would generate an income of $50 billion per year which could be channelled to assist developing countries in achieving economic development while minimising their greenhouse gas emissions.[8] Norway's proposal to allocate part of the revenues raised through national carbon taxes in developed countries for a climate fund to help developing countries is another example. *We recommend that Commonwealth countries should support a tax on emissions and the need to transfer part of the resulting revenues to assist developing countries to meet the extra costs involved in adopting energy-saving methods and meet obligations that might be involved under a climate change convention.*

4.21 Financial, human resource and technical constraints are hindering effective participation by Commonwealth and other developing countries in the INC. The problems are particularly serious for small states and low income countries which are finding it difficult to ensure that their concerns receive adequate attention. The Commonwealth can help to alleviate some of these constraints. In Chapter 5 we have made a specific recommendation to promote effective participation of the Commonwealth's small member states in the INC process.

## Monitoring Climate Change

4.22 A particularly important element of the Action Plan for the Commonwealth is the need for co-operation in research, evaluation and monitoring of climate change and sea-level rise and their possible impacts. Such cooperation can reduce the uncertainty about how particular Commonwealth countries, or groups of countries, will be affected by them. Firmer knowledge is vital for the proper national planning of response and adaptation. Enhanced monitoring is essential not only for national planning, but also to improve the capacity of world climate models to predict changes at regional and national levels. Forecasting is currently hampered by the lack of climatological data and observations in many regions of the world, especially in the southern hemisphere.

4.23 The Commonwealth Report on Climate Change identified specific monitoring and information needs in several member countries. Some progress has been made in meeting those needs. For instance, in respect of climatological networks and data processing, out of the 17 Commonwealth countries listed as not having WMO-CLICOM systems by the end of 1989, in one country—Guyana—there are now firm plans to install one. The Bahamas, Cyprus and St Lucia have requested systems under the World Meteorological Organisation's (WMO's) Voluntary Co-operation Programme, and Antigua and Barbuda, and St Kitts and Nevis, have access to a CLICOM system based in Barbados. The expansion of the WMO-CLICOM system would make a significant improvement to the recording and processing of climatological data around the world.

4.24 Expansion of the WMO's network of Global Atmosphere Watch Stations for ozone and greenhouse gas monitoring is also important, both in the Commonwealth context and globally.

4.25 The WMO has recently opened a Special Fund for Climate and Atmospheric Environmental Studies to provide equipment and training to secure wider participation of developing countries in these and other climate monitoring and data collection activities under the World Climate Programme. The Fund should have adequate resources to meet priority needs. *We urge all Commonwealth and other industrial countries which have not already done so, to contribute to this Fund. We also recommend that all Commonwealth countries should participate in the new Global Climate Observing System (GCOS) which has been recently created to provide observations to monitor the climate system and detect climate change.* We urge*

* The GCOS, approved by the WMO's Eleventh Congress, will be based on an improved World Weather Watch network and a Global Ocean Observing System. The existing Global Sea-Level Observing System (GLOSS) will be an important component of the GCOS which will be co-ordinated by the WMO, UNESCO's Intergovernmental Oceanographic Commission (ICO) and the International Council of Scientific Unions (ICSU).

*all member Governments to use climatological information in their national development planning.*

4.26 Expanding the network of sea-level data gathering stations under the Global Sea-Level Observing System (which will be a component of the new GCOS) also deserves priority. All Commonwealth island small states and countries with low-lying areas must have the capability to monitor sea-level rise. They need to plan on the basis of reasonably reliable forecasts of rising sea levels. Many of them will need technical assistance and training to develop these capacities. *We recommend that the Commonwealth Secretariat should organise training workshops on sea-level rise monitoring for small island states and other countries with the greatest needs. These workshops could be run in collaboration with the international bodies concerned, such as the Intergovernmental Oceanographic Commission.*

4.27 *Member countries which have significant expertise in monitoring climate change and sea-level rise, and in climate impact assessment, could also consider providing more assistance on a bilateral and multilateral basis.* Some important initiatives have already been taken:

- Under a South Pacific Sea-level and Climate Monitoring project, the Australian Government is helping 11 South Pacific countries to install and operate sea-level monitoring equipment and has funded a 'Climate Change Information Officer' to provide expert advice to the South Pacific Forum countries. A Climate Monitoring and Impact Assessment Study is being undertaken by the WMO with Australian funding as a separate but complementary project.

- Pursuant to Prime Minister Hawke's initiative at the Kuala Lumpur Commonwealth summit, the Australian Government has launched a climate impact assessment and management programme for Commonwealth developing countries. Through a combination of study tours and courses, research programmes and workshops, the participating countries will develop a core of indigenous expertise in various aspects of climate modelling and impact assessment.

- Other Commonwealth countries, including India and Canada, could offer technical assistance in coastal zone management and climate-related issues.

4.28 Many Commonwealth and other developing countries currently lack the capacity to make proper assessments of their national net emissions of greenhouse gases. This is not only an obvious constraint on the ability of individual countries to plan their response strategies. It also impedes the development of an internationally acceptable data base on greenhouse gas

sources and sinks. There is therefore an urgent need to mobilise financial and technical assistance to help developing countries undertake such assessments. *We recommend that cooperation be strengthened among Commonwealth governments and institutions to carry out the research needed to develop more accurate estimates of the sources of, and costs of limiting, greenhouse gas emissions and adapting to climate change in individual countries. Studies have already been initiated in many Commonwealth countries.*

4.29 Further work in these areas is currently being conducted by the IPCC. It includes studies of different scenarios for greenhouse gas emissions, predictions of climate change at regional and national levels, and associated impact studies; energy and forestry-related issues; and sea-level rise and coastal zone management. In their Langkawi Declaration, Commonwealth governments agreed to support the work of the IPCC. This support should continue.

**Impacts of Climate Change and Planning of Adaptation Strategies**

4.30 Further research, and improved data collection and monitoring, will reduce uncertainties about the possible impacts of climate change. This will be particularly true at regional and national levels. But both the Commonwealth Report and the IPCC's First Assessment Report have given insights into the possible impacts at different levels, on agriculture and forestry, on natural terrestrial ecosystems, on water resources, on human settlements and infrastructure, and on ocean and coastal zones. Both reports also underscore the need to begin planning adaptation strategies. Some of these are in any case needed for other reasons. In many cases, the impacts of climate change are expected to be felt most severely in regions already under stress. These are mainly the developing countries, which are more dependent on agriculture and natural resources and have less capacity to adjust.

4.31 Because of the nature of the Commonwealth's membership, the possible impacts of climate change on small island and low-lying states have been of particular concern to us. As the Commonwealth Report pointed out, sea-level rise could have far-reaching social and economic effects on low-lying coastal areas, as in Guyana, Bangladesh, Maldives, Kiribati, Tuvalu and other countries, which would also be subject to flooding from storm surges (see Box 4.2 on p. 84). Fragile ecosystems like mangroves, coral reefs and marshes, which now protect coastal areas, would be threatened. A one metre rise in sea-level would flood 15 per cent of Bangladesh, directly affecting ten million people. Small island atolls which rarely exceed 2 to 3 metres in height face greater risk of inundation, erosion of barrier reefs and defences, and intrusion of saltwater in freshwater reserves. Low-lying coastal areas such as those of Guyana—where 90 per cent of the country's population live—are already at or below mean sea-level. They could face both flooding

**Box 4.2**

**Atolls Fear Ocean's Grim New Face**

Polynesians on the three atolls of the central Pacific territory of Tokelau noticed that the sea that they had known intimately for hundreds of years had begun to behave 'strangely'. Instead of gentle swells, the waves had become short and aggressive "as if they were taking bites out of the land", said a woman on Nukunono atoll, only 2.9 square miles in area. That night a cyclone struck and the waves covered virtually the entire atoll, only a few feet above sea level at its highest elevation. Huts of the several hundred inhabitants, the coconut palms, the breadfruit trees and the taro patches were washed away. "We went to the highest part of the island, which was the church, and crushed inside," said the island's schoolteacher. "We placed our children on our shoulders and some tried to pray. The water reached our chests, washing through the church, and we wondered if this was the end. But as day broke the waves began to recede—by then our homes had been wrecked."

Since that disaster in 1987, the islands were hit by another storm, Cyclone Ofa, in January 1990. According to Falani Aukuso, former director of education in Tokelau, although the natural catastrophes could not be directly attributed to global warming, the Tokelauans were concerned about the possible rising of sea levels. To the subsistence economies of the Pacific islands, he said, there are problems enough without facing a new fear. "People on the Tokelau atolls are frightened", he said. "They are afraid Tokelau will be one of the first island groups in the Pacific to disappear. Because of the general abuse of the ocean through pollution and use of pesticides, the older people are seeing seasonally irregular fish patterns and the unexplained dying of the coral," he said.

At the 22nd annual meeting of the 15-nation South Pacific Forum in July 1991, delegates described global warming and the rising sea level as "the most serious environmental threats to the Pacific region". Their Communiqué noted that: "The cultural, economic and physical survival of Pacific nations is at great risk." The Communiqué emphasised the urgency of securing international action to control the adverse effects of climate change by 'immediate' reductions in emissions of greenhouse gases like carbon dioxide. It noted the primary responsibility of industrial countries for reducing them.

Source: Based on Pringle[9]

and disruption of traditional drainage systems. In these low-lying countries, climate change and sea-level rise have serious implications not only for agriculture, but also for freshwater supplies and human settlements. Factories, power plants and airports, the disposal of hazardous wastes and tourism would all be affected. We take up these and other issues in Chapter 5.

*Protection against sea-level rise*

4.32 For these (and other) Commonwealth countries, we believe that the planning of adaptation strategies is particularly necessary in coastal zone management (see Chapter 5). Advance planning would help to avoid or mitigate adverse impacts which might occur in future. Even if the world did succeed in stabilising greenhouse gas concentrations by the year 2030, sea levels are predicted to continue to rise throughout the next century. The range of options in adjusting to rising sea-levels will need to be carefully assessed. Major new sea defences are likely to be very expensive and, in any event, impractical on small coral islands and in shifting deltas.

4.33 A study done by the IPCC estimated that the overall cost of protecting 360,000 km of coastline, worldwide, against a one metre rise in sea-level would be in excess of US$500 billion. Annual costs as a percentage of GNP for small islands, and small island groups, could be as high as 34 per cent of annual GNP.* Case studies prepared for the Commonwealth Expert Group on Climate Change suggested a variety of ways in which low-lying islands could adapt with external help. They would need a diversification of food supplies, improved water collection, re-design of dwellings, protection of their natural defences, and more effective preparation for disasters.

4.34 The IPCC has recommended an initial five-year international programme to help developing countries implement coastal zone management plans by the year 2000. We urge the international community to launch such a programme expeditiously. *We recommend that all the Commonwealth countries concerned should develop comprehensive coastal zone management plans, taking account of projections of sea-level rise and storm surges.* These should ensure that risks to populations are minimised and important coastal ecosystems are protected and maintained. They should also ensure that coastal development does not increase vulnerability to sea-level rise. Many Commonwealth developing countries will need external financial and technical assistance to develop these plans. *We recommend that the Commonwealth Science Council should strengthen its coastal zone management programmes.*

* The estimated total cost is not discounted and does not reflect present coastal defence needs or impacts of saltwater intrusion or flooding of unprotected lands.[10]

*Strengthening disaster preparedness and response*

4.35 The danger that global warming may increase the intensity and frequency of tropical storms, which only develop at present over seas that are warmer than about 26°C, also warrants the strengthening of precautions in low-lying countries. Although climate models still give no consistent indication about the impact of climate change on the intensity of tropical storms, recent events like the tropical cyclones which caused such devastation in Bangladesh in May 1991, have underscored the need for proper planning, regardless of uncertainties. The frequency of floods in some areas and of drought in others, related to climate change, also emphasise the need to improve preparedness for all types of disasters. This requires action in three areas: improving early-warning systems; reducing vulnerability to climate-related disasters through careful planning of human settlements and economic and other infrastructure in coastal areas; and improving national and international responses to provide immediate relief to affected populations when disasters strike, and strengthening the capacity of countries to cope with the longer-term consequences—especially economic—of such disasters. In some developing countries, the longer lasting economic effects of a single major disaster can set back economic progress by many years.

4.36 *We recommend that within the framework of the UN International Decade for Natural Disaster Reduction (IDNDR), all Commonwealth countries, by the year 2000, should have in place:*

- *national assessments of risk due to climate-related and other natural disasters;*

- *national and/or local plans for reducing vulnerability to disasters and mitigating their impact when they occur; and*

- *access to global, regional, national and local warning systems.*

4.37 *We also recommend that all Commonwealth countries which have not done so, should establish national committees to assist co-ordination and implementation of activities during the IDNDR. The Commonwealth Science Council's programme of workshops on disaster preparedness and mitigation, focusing on training and information-sharing should be strengthened in co-ordination with training programmes initiated during the IDNDR.*

*Adaptation in resource use and management*

4.38 It will be prudent for all countries to consider adaptation options which address the potential impacts of climate change on food security, water availability, natural and managed ecosystems, land, and biodiversity. The possible impacts of climate change on agriculture are a matter of particu-

lar concern. The majority of Commonwealth economies depend on the agricultural sector. This is particularly so for developing countries in semi-arid tropical areas and in regions where agriculture on marginal lands relies on rainfall levels and distribution.

4.39 Important uncertainties remain regarding predictions of the magnitude and nature of potential impacts of changing climate and higher $CO_2$ levels on food security, both globally and in specific regions. The two broad sets of regions which appear to be most vulnerable to climate variability and change are some semi-arid, tropical and subtropical regions, which include Commonwealth countries such as Botswana, Tanzania, India and Pakistan, and some humid tropical and equatorial regions. In addition, certain regions (e.g. central Canada and eastern Australia) that are currently net exporters of cereals could find their output reduced as a result of climate changes. Any decrease in production in these regions could have a marked effect on future global food prices and patterns of agricultural trade.[11]

4.40 The capacity of agriculture to adjust to climate change will vary considerably between different regions, countries and sectors. In regions where climate is already highly variable, farmers may be able to adjust more quickly than where it is more stable. But in developing countries, and especially in some marginal types of agriculture, such experience in adaptation may be much smaller. The availability of new varieties of crops is an important long-term factor which will affect the ability of farmers to adjust their cropping patterns. In Chapter 3 we discussed this in more detail in the context of biodiversity (see paras 3.80-3.84).

4.41 We need to know more about the potential impacts of climate change on agriculture and food security at regional and national levels. *We agree with the recommendation by the Commonwealth Expert Group on Climate Change, that priority should be given by national, regional and global agricultural research programmes to enlarging long-term options for adjustment to climate change.* We need to gather and conserve our knowledge of plants, animals and agricultural practices that have been valuable under conditions of uncertainty and climatic variability.

4.42 *Research should be focused in particular on crop varieties which could derive maximum benefit from higher $CO_2$ concentrations in the atmosphere. Furthermore, governments should incorporate a greater awareness of the implications of climate change in agricultural extension, training and credit schemes. Studies should be undertaken on how farmers can be helped to cope with climatic variability through farm management techniques that incorporate efficient use of water and soil, and which encourage crop diversification. Finally, in countries which are already at risk due to drought, the strengthening of early warning systems and food security systems, should command a high priority.*

4.43 We believe that institutions like the Commonwealth Agricultural Bureaux International (CABI) can serve as useful focal points to promote these activities in a Commonwealth context.

*Impacts on health*

4.44 The possible impacts of climate change on human health are also of concern. Global warming could spread airborne and water-borne communicable diseases. It could cause faster reproduction and survival of pathogenic bacteria, viruses, parasites and their vectors, in a wider geographical zone. Global warming may result in a poleward spread of diseases such as hookworm infections and river blindness. It could increase the occurrence of diseases like yellow fever and malaria at higher elevations in the tropics, and cause the emergence of new strains. For example, the warming of the Madagascar Highlands by an average 0.8°C may be one explanation for the emergence of a new type of malaria which has caused the deaths of thousands of people.

4.45 Many diseases are a side effect of malnutrition and dehydration. These could be aggravated by adverse impacts of climate change on water supply and agriculture, especially in developing countries where poverty and disease are already associated with adverse environmental conditions. Droughts, floods or other extreme events would make these problems worse. An increase in heat-related deaths and illnesses would also ensue if global warming were to lead to a greater number of heatwaves. Finally, global warming and atmospheric ozone depletion are likely to worsen air pollution, especially in populous and polluted urban areas. Changes in photochemical reaction rates amongst chemical pollutants in the atmosphere may increase oxidant levels, to the detriment of human health.[12]

4.46 *In view of these dangers related to the impact of climate change on health, we recommend greater research and the advance planning of suitable adaptation and response strategies.* Research should focus on the adaptability of vulnerable human populations, especially their more susceptible members, to the incidence of increased heat stress, and on the potential for vector-borne and viral diseases to spread geographically. In the most vulnerable countries and regions, national health planning should develop the capacity to respond to such contingencies, especially to the outbreak of new diseases.

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