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Chapter 13

Climate change and SIDS

Introduction

Rising concentrations of carbon dioxide, methane and other greenhouse gases are changing the world's climate. According to the Intergovernmental Panel on Climate Change (IPCC)[1], 11 out of the 12 years prior to 2006 rank in the 12 warmest years on the planet since records began in 1850 (IPCC, 2007). Gradual temperature increases are occurring around the world, but are highest in the more extreme latitudes and are greater on land than in the ocean regions. Meanwhile, ocean temperatures have increased up to a depth of 3,000 metres (IPCC, 2007). The greatest temperature rises have been found in the Arctic, where annual mean temperatures have increased at twice the rate of the world average.

Most of the evidence assembled by the IPCC suggests that human activity is responsible for the largest part of the increase in emissions of greenhouse gases. Anthropogenic carbon dioxide emissions have risen by 80 per cent between 1970 and 2004 (IPCC, 2007), while atmospheric concentrations of methane have more than doubled since the pre-industrial era, principally through agricultural and industrial activity. Atmospheric levels of nitrous oxide have also increased significantly over the same period and almost all the halocarbons in the atmosphere are the result of human activity. Although some individual countries have begun abating or controlling emissions, global emissions continue to rise, fuelled by population growth and economic activity.

Although there is still great uncertainty about the details of future climate trends, many SIDS appear to be extremely vulnerable to the effects of climate change. In this chapter we cover some of the main effects of climate change and their consequences for SIDS.

Climate change: Implications for SIDS

Small islands are scattered across the globe and their weather patterns vary. As a result the impact of climate change will not be felt in the same way by all SIDS. For instance, Caribbean islands typically have distinct wet and dry seasons, with rainfall usually much lower during the months of the northern winter. Mediterranean islands also tend to see distinct variation of precipitation across the year, but here it is the winter months that are wettest. The climate of these islands is heavily influenced by that of the neighbouring countries. For central Pacific islands, weather is shaped by trade winds and semi-permanent sub-tropical high pressure belts. In this region there is also considerable year-to-year variation in weather caused by the El Niño Southern Oscillation or ENSO. Normally, there is high pressure over the Pacific Ocean with lower pressure further to the west over northern Australia and Indonesia. Winds move from the Americas towards the west, bringing rainstorms to the western edges of the Pacific. Meanwhile, along the South American coast, cold water wells up to the surface. When El Niño occurs, air pressure patterns are reversed, reducing the easterly winds and cutting off the upwelling of cold water off Peru and Ecuador. Fish stocks fall and rainfall increases along the South American coast. In contrast to the west, in Australasia there can be lower temperatures, reduced rainfall and drought. In the Indian Ocean, the Asian monsoon is the major factor in seasonal variation and is linked with the ENSO (Mimura et al., 2007).

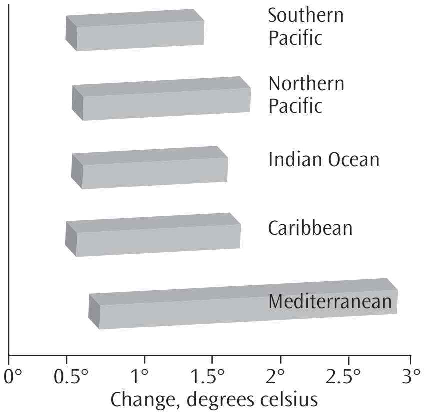
Much of the forecasting of the effects of higher greenhouse gas levels has been done at the regional or global level and has concentrated on:

- mean temperature rises;
- changes in average precipitation;
- changes in variability; and
- extreme events (cyclones or hurricanes).

One problem with accurately forecasting the impact of climate changes on SIDS is that the calculations required to estimate weather trends for small areas such as islands can be very imprecise. With their computer models, climate change scientists generally offer a range of estimates for the future, to emphasise current uncertainties. Some of these uncertainties are particularly apparent with SIDS, as the figures below make clear. Figure 13.1 shows the range of possible outcomes for mean annual temperatures for the next 30 years based on current understanding of emission trends and climate. For all the regions some rise in temperatures is anticipated, but in the Mediterranean the rise could be as high as 2.8 degrees or as low as 0.7 degrees.

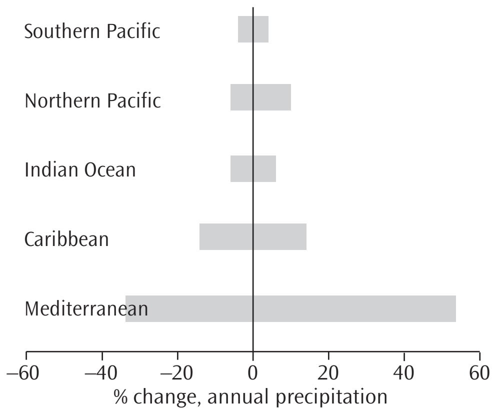
Figure 13.2 shows some summary predictions for rainfall over the same period. In all cases there is a possibility of a rise or a fall (or of course no significant change). For some regions the range of uncertainty is still large.

Figure 13.1. Projected increase in mean air temperature, 2010–2039



Source: Mimura et al., 2007, Table 16.1

Figure 13.2. Projected percentage change in annual precipitation, 2010–2039



Source: Mimura et al., 2007, Table 16.2

Temperature and rainfall changes beyond this time frame are even more unpredictable but all regions are expected to see some rise in mean temperature as long as the behaviour of the world's economies maintains its current trend (Mimura et al., 2007). The range of average temperature rises predicted for the Caribbean region is 0.94 to 4.18 for the years 2070–2099, while predictions of average precipitation run from -49.3 per cent to 28.9 per cent for the same period. Some of the uncertainties are due to human behaviour. A forecast of temperature many years in the future requires strong assumptions about economic activity and the size and date of emissions. In making its estimates, the IPCC panel considers a number of different futures for the world, including a 'business as usual' case, low and high growth, and rapid and slow changes in emissions intensities. IPCC forecasts for the next 20 or so years are not sensitive to the assumptions it makes about the economy and technology but with deeper movement into the future, forecasts become less certain and more dependent on the assumptions built into the model.

These charts omit predictions of the variance. For many countries, estimates of the variability are as important as predictions of the mean. Consider, for example, a country that faces no change in annual mean rainfall but because of climate change has no rainfall in 3 out of 6 years, and double the current rainfall in the other 3 years. The problems of adaptation faced by this country would be very different to those confronting a country with a small but predictable rise or fall in rainfall. Crop choices may vary, water storage facilities will need to be expanded and water conservation and flood protection measures enhanced. The consensus of the IPCC is that Mediterranean countries, including Cyprus and Malta, are very likely to face more episodes of drought in the future. More episodes of low rainfall are likely in the Caribbean. Conversely, the intensity of rainfall in the Indian Ocean monsoon is expected to rise, bringing with it the prospect of greater floods and disease.

We have already mentioned the key role played by ENSO in the weather of the Pacific and Indian Oceans. According to UNESCAP, each El Niño event has resulted in water shortages and drought in Papua New Guinea, Marshall Islands, Federated States of Micronesia, American Samoa, Samoa, Tonga, Kiribati and Fiji. More frequent El Niño events also bring an increased risk of tropical cyclones, particularly for Tuvalu, Samoa, Tonga, Cook Islands and French Polynesia[2]. What is not clear at the moment is whether climate change will alter the frequency or intensity of El Nino events. The IPCC offers no consensus on this important issue and current computer models of climate change do not give a consistent picture.

Many tropical SIDS face a regular annual threat of cyclones or hurricanes, and tropical storms at levels 4 or 5 (the most intense) have increased in frequency since the 1970s. As Table 13.1 illustrates for Grenada, these extreme events can have major and lasting economic impacts on island economies.

Some forecasts for the future have been made for this kind of extreme weather event. In its 2007 report, the IPCC states that is 'likely' that the intensity of tropical storms will increase over time, as measured both by maximum wind speeds and by precipitation rates, but it is less certain about the frequency of storms. There is some link between the ENSO and the location and strength of tropical storms in the Pacific and Indian Oceans (Landsea, 2000). Uncertainty over the future pattern of ENSOs therefore makes it harder to predict the frequency and intensity of cyclones.

Table 13.1. The cost of a hurricane: Ivan in Grenada in 2004 (Direct and indirect damages in millions of US dollars)

	Direct	Indirect	Total
Agriculture	20	17	37
Manufacturing	7	2	8
Tourism	113	37	150
Utilities (electricity, water/sewage, telecommunications and cable)	60	33	93
Education	72	1	73
Housing	508	3	511
Other (transport, wholesale industries and healthcare)	7	4	12
Total	**787**	**97**	**884**

Source: OECS, 2004

Sea-level rise

Climate change is very likely to raise sea levels worldwide through two main mechanisms. First, at normal sea temperatures a rise in temperatures leads to expansion of the water. Secondly, higher temperatures lead glaciers and other forms of ice to melt. If that ice is on land, then its melting eventually adds to the volume of water in the oceans, raising sea-levels. Though there is currently great uncertainty over how much land-based ice will melt in the future, it is relatively easy to estimate thermal expansion and the consequences of ice melting. What we can say, however, is that if, for example, all the ice in Greenland were to melt, sea levels would rise by around 7 metres (Gregory et al., 2004). Actual predictions for sea-level rise over the next 50 years are much more modest than this alarming figure. Over the period 1961–2003, sea levels rose at an average rate of 1.8 millimetres per year (IPCC, 2007). The IPCC's expectation is that rates of sea-level rise for the rest of the century will exceed this. Woodworth (2005) has suggested a figure of 0.5 metres as a sensible mid-level estimate for islands such as the Maldives. The range of figures for 2090–2099 is 0.19 to 0.58 metres (Mimura et al., 2007), but because of imperfect mixing and variable thermal expansion sea-level rises will vary across the globe.

A rise in sea levels associated with climate change can have devastating effects on low-lying areas. The most damaging outcomes are inundation, flooding, beach erosion and saltwater intrusion. The economic and human impacts of these changes could be considerable. In many SIDS a large proportion of the population lives close to the sea, often in low-lying areas threatened with flooding. Recent migration trends have raised the number of people living close to the shore, particularly in the Pacific Islands.

Some islands are more threatened than others by sea-level rise. Atoll islands built on coral reefs such as Tuvalu are extremely low lying and are exposed to wash-over during strong storms. Water is often supplied from rainfall or from shallow groundwater cappings which are at risk from salinisation. Islands that are on raised reefs and hardened limestone rock are generally less exposed to inundation, but still the majority of the population lives close to the shoreline. Even in the larger SIDS, the largest settlements and other social and economic infrastructure is on the coast.

Coral reef changes

Many of the world's most precious coral reefs can be found around tropical islands. Coral reefs provide a wide variety of economic and ecological functions including storm protection, biodiversity, and fisheries. Reefs provide a habitat for perhaps one quarter of all marine species and are therefore amongst the most diverse of all ecosystems (Pandolfi et al., 2003). Their diversity and beauty brings in tourists for snorkelling and scuba diving. Carleton and Lawrence (2005), estimate annual benefits to the Turks and Caicos Islands of US$47.3 million per year. Out of this total, tourism and diving accounted for $18.2m, coastal protection was worth $16.9m, fisheries contributed approximately $3.7m and biodiversity accounted for the remaining $4.7m.

Many reefs are potentially threatened by climate change. In theory, acidification (caused by higher CO_2 levels in the atmosphere) could damage coral, but there is presently no clear field data on this issue. An increase in the incidence or intensity of storms could also damage reef growth, but perhaps the greatest threat is from bleaching through higher temperatures. This effect is well-documented and a source of worry. If sub-sea temperatures consistently exceed 2°C above the average seasonal maxima, corals die. As shown in Figure 13.1, a 2°C rise is at the upper end of predicted changes in mean air temperatures over the next 30 years. However, a lower mean rise can bring with it extended periods of higher temperatures and it is this risk that threatens coral reefs in the short and medium term. With the death of coral, storm protection is reduced considerably, fish production falls and biodiversity collapses. As a consequence the associated tourism demand will fall.

The Kyoto Protocol

The current international agreement concerning greenhouse gas emissions is the Kyoto Protocol, first agreed in December, 1997. It focuses on abatement by the richer nations ('Annex 1') of the world by setting binding emissions targets for developed nations. For the EU this means that 2012 emission levels should be 8 per cent below the 1990 figures. The corresponding targets for the USA and Japan were 7 per cent and 6 per cent respectively while Russia was set a 'no change target' and Australia was allowed to increase its emissions by 10%. A variety of mechanisms were allowed, including activities that absorb carbon such as tree planting and emissions trading schemes. Countries with emissions targets can also get credit towards their targets through project-based emissions reductions in other such countries. Through the Clean Development Mechanism (CDM), developed countries can use certified emissions reductions from projects in developing countries to contribute to their targets. To enter into force, the Protocol had to be ratified by at least 55 countries, accounting for at least 55 per cent of the total 1990 carbon dioxide emissions of developed countries. After further negotiations in Bonn and Marrakech, concessions were given to Russia and Canada. Russia eventually signed and the treaty came into force. Most recently (2007), Australia has also ratified the Protocol, but it is unlikely that the USA will ratify the

Protocol, leaving it amongst the 20 or so countries such as Somalia and Afghanistan that have not joined.

The Kyoto Protocol has been widely criticised. The cap on emissions for richer countries is too weak to have a major impact on climate change. In fact, the Protocol does not stabilise emissions, in part because it does not place any obligation on any developing countries. China, for instance, is now the biggest emitter of greenhouse gases and is above the world average on a per capita basis, yet nothing is required of it. Furthermore, the international mechanisms for obtaining credit are hard to police and open to abuse. Finally, the collapse in manufacturing in transition economies has created perverse incentives to raise emissions (e.g. Japan buying unused credits from East European countries).

Negotiations about a replacement for the Kyoto Protocol have gone on in fits and starts, but have been largely stymied by the differing perspectives of the major players and by the apparently large scale of the cuts required to first halt and then reverse the rise in CO_2. A summary of a recent Ministerial meeting in Bangkok, April 2008, sums this up:

Box 13.1. Summary of a recent ministerial meeting in Bangkok, April 2008

The EU proposed reducing Annex I emissions by 30 per cent by 2020 and 60-80 per cent by 2050. Brazil highlighted burden sharing and historical responsibility. India identified similar commitments by all developed countries, including non-Kyoto parties, as a precondition for developing country action. They called for equal distribution and convergence of emission rights. Saudi Arabia called for a bottom-up approach in defining a long-term goal. The US emphasized the need for differentiation among parties, depending on changing social and economic conditions, as well as current emissions and emission trends. The African Group emphasized equal treatment of adaptation and mitigation, and the special needs of Africa, small island developing states (SIDS) and the LDCs. Bangladesh, Ghana, Egypt and others supported developing an adaptation protocol.

Source: http://www.iisd.ca/vol12/enb12362e.html

With slow progress at the global level, some countries have acted independently to set targets. The European Union, for instance, has set itself a 20 per cent reduction of greenhouse gas emissions (compared to 1990) for 2020 and some individual member states have gone further, setting targets for reductions of up to 50 per cent by 2050.

Adaptation and mitigation

Adaptation refers to policies that take climate change as a fact, but seek to adjust human behaviour. Mitigation refers to policies that reduce emissions of greenhouse gases. The size of SIDS means that their effective contribution to the climate change is minimal, so that while they can be expected to contribute to any global reduction in CO_2 emissions, this cannot have much of a positive impact on world emissions and global climate change.

Abating greenhouse gases is a global public good in that the benefits are non-rival and non-excludable. As such there is an incentive for countries to free-ride. This is one of the main reasons why international agreements are hard to sustain. On top of this, there is intergenerational conflict: most of the costs of dealing with carbon emissions must be met by older generations, but the benefits will largely accrue to the young and unborn. As a result, there is a persistent temptation to postpone action and leave the problem to the next generation.

Unlike mitigation, most of the benefits of adaptation are local public goods. At a national level, countries can undertake adaptation without having to worry too much about the external consequences of their actions.

Box 13.2. The Mauritius Declaration

The Declaration was agreed in Mauritius by SIDS nations meeting under the auspices of the United Nations in January 2005. The participants agreed that climate change represents a significant risk to SIDS and called on all nations of the world to stabilise carbon emissions at a level which stops major changes to the world's climate.

To deal with climate change, it advocates a number of measures, including:

- greater energy efficiency and development of renewable energy sources;
- dissemination of new technologies and ideas to SIDS;
- raising the scientific capacities of SIDS with the support of the IPCC; and
- greater investment in monitoring of global and local climate changes.

To deal with flooding and inundation, a number of policies can be tried, and these can be broadly grouped into retreat, accommodation and protection (Tompkins et al., 2005). With retreat, development is prevented near low-lying coastlines, subsidies for coastal development are withdrawn and infrastructure development, such as roads, is confined to higher ground. The sea is allowed to claim land as humans move to higher ground. Retreat is feasible when land is plentiful and there is little coastal development, but for some SIDS like Tuvalu and Tonga, retreat would mean abandoning large portions of available land. The highest point of Tuvalu is only 4.5m, while in Tongatapu (the largest island in Tonga) for instance, a 1m rise in the sea level would threaten 10.3km^2 of land. With storm surges of 1.5m, 37.3km^2 would face flooding – about 14 per cent of all the available area of the island (Mimura, 1999).

The most extreme form of retreat is island abandonment. The governments of some threatened countries, notably Tuvalu and the Maldives, have raised the possibility of mass evacuation in the face of sea-level rise.

Accommodation may come in many forms. If housing regularly faces the risk of flooding, then it may be wise to add storeys, so that citizens can move to higher floors during inundation. Concrete rather than wood can be used for construction; homes can be strengthened to withstand higher winds and electrical circuits moved away from ground level. Roads and storage facilities can also be raised and key aspects of infrastructure such as power sub-stations and water treatment works can be moved or given flood protection. Salt resistant crop varieties can be planted on low-level fields, or land close to the sea can be converted to grazing.

Protection is at the other end of the adaptation spectrum. It involves hard structures such as sea walls and flood barriers to protect against flooding. For some urban settlements, particularly in richer island countries, this is feasible and probably cost effective. However, hard structures at one point on a coastline can lead to faster erosion elsewhere. For this reason, sea walls are no panacea. Moreover, it is hard to protect against salinisation.

Some adaptation may be natural. According to the IPCC, some types of coral may be able to withstand higher temperatures while many types of coral can grow vertically, adapting to sea level rises. In a similar vein, the mangrove forests that provide storm protection and fisheries in many tropical and sub-tropical countries may move inland if their freedom to adapt is not constrained by buildings, sea defences and other hard structures (IPCC, 2007).

Adapting to other dimensions of climate change can also take many forms. In agriculture, adaptation may involve switching crop varieties, e.g. to drought-resistant types, or changing patterns of land use. At the same time, investment in water storage, irrigation systems and more efficient water management can provide a buffer against water shortages or erratic supply. The feasibility of internal population movement towards cooler areas and away from the shoreline may be limited because of the small size of many SIDS, but it may still ameliorate some of the most extreme impacts of climate change.

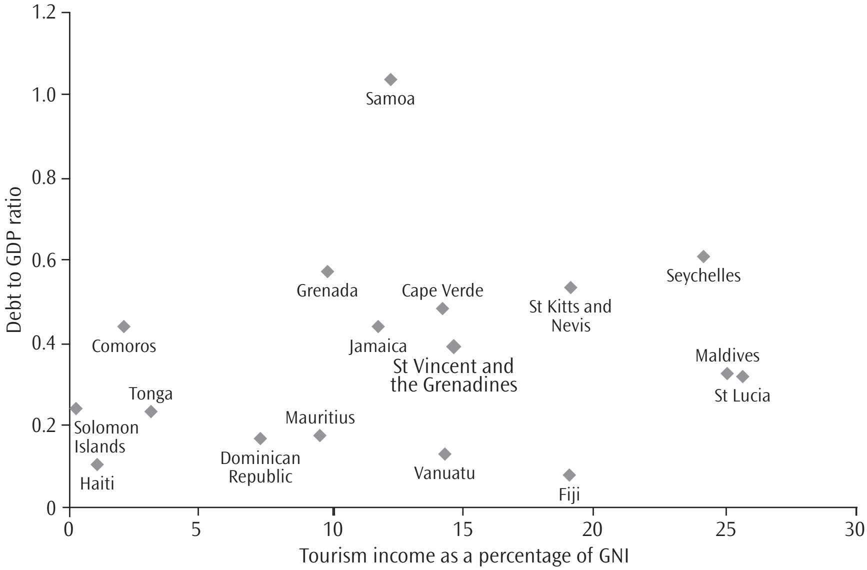
Higher temperatures may result in changes in biodiversity, particularly at higher latitudes, where some invasive species may become viable. Further, patterns of disease may change. Mimura, (2007), points to a higher risk of dengue fever, malaria and other tropical diseases, particularly in temperate countries. Here, adaptation may involve greater public health measures and stricter quarantine measures. Diseases such as dengue fever and other health risks can also rise in the wake of tropical storms. Thus one crucial part of adaptation may involve having a greater capacity to deal with health risks in the event of major disasters.

One economic instrument that has been discussed as a method of promoting adaptation is insurance. Insurance cannot solve a problem that occurs constantly, but it can provide an effective method of risk management for storm damage and other intermittent problems. When risks are priced by insurance markets, individuals and organisations have incentives to reduce such risks by changing behaviour (e.g. moving away from coastal zones), and also can smooth consumption in the face of shocks such as drought, floods and tropical cyclones. The isolation of SIDS often means that internal risk markets are poorly developed. In any event, such institutions would provide little cover for disasters that affect a whole island. Regional insurance markets (e.g. covering the islands of the Caribbean or the South Pacific), possibly supported by governments or international aid agencies, might be more feasible and have therefore been considered positively by some authors (e.g. Parry et al., 2005).

Tourism

As Figure 13.3 illustrates, using data for 2005, many island economies are heavily dependent on tourism as a source of income. In this important aspect of their economies SIDS face direct and indirect effects from climate change. The direct impact of climate

Figure 13.3. Economic vulnerability to tourism shocks



Source: World Bank and United Nations

change on tourism industries arises from the loss of amenities, such as coral reefs. Similarly, if temperature rises become too extreme or cyclone risk increases to an unacceptable level or freshwater availability is compromised, tourism demand may fall.

Many SIDS are long-haul destinations and this may make them vulnerable to the indirect effects of climate change. In particular, visitor numbers may be sensitive to the effects of mitigation policies taken by other countries. For instance, the EU has agreed to include aviation emissions in its cap and trade system for controlling carbon use. In the long run, this will raise the cost of fuel for airlines, raise ticket prices and reduce tourism demand. Efforts being made to change the psychology of consumption towards sustainable behaviour may also lead to a long- term trend away from long-haul holidays.

As Figure 13.3 suggests, the economic impact of climate change via tourism may vary considerably between SIDS. Tourism expenditure as a percentage of gross national income (GNI) is important but relatively low in some of the larger SIDS economies such as Mauritius or the Dominican Republic. Some of the countries in the figure also have relatively low debt to GDP ratios and are therefore better able to cope with adverse economic shocks. However, countries with high debt-to-GDP ratios and high tourism dependency ratios (e.g. the Seychelles) are less well placed to cope with a major downturn in tourism demand.

In the face of mitigating activities by other countries it is not clear what SIDS can or should do. One option is to make tourist activities 'greener' thus making them more attractive to eco-conscious travellers. For instance, many SIDS are heavily dependent on oil and gas to generate electricity. Switching to renewable sources of energy such as wind and solar power may have only a minimal impact on global mitigation of carbon emissions but it may help maintain tourism demand.

Conclusion

Many SIDS are highly exposed to the risks created by climate change. For low-lying atoll islands the risks from sea-level rise are particularly acute. At the same time, as small and often poor countries, SIDS are not in a position to exert much leverage over global policies towards the control of carbon emissions. They may also suffer from the consequences of the policy decisions taken by other countries, particularly if tourism demand weakens. As many countries around the world will discover, adapting to climate change takes time and considerable resources. The most economically efficient way of adapting may not involve hard structures or protecting existing infrastructure and lifestyles. Instead, retreat and accommodation may be more sensible (Mimura et al., 2007), particularly when population density is low or existing infrastructure is limited.

Further Reading

The most up-to-date consensus view on SIDS and climate change can be found in Mimura et al., 2007 which contains a wealth of detail. The manual by Tompkins et al., 2005, provides guidance to policy-makers on how to create an adaptation strategy.

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Notes

1 The IPCC is a body sponsored by the United Nations to come to a consensus view on the science of climate change. It brings together the work of many scientists from across the world and summarises the current state of knowledge every six years or so.

2 http://www.unescap.org/mced2000/pacific/background/climate.htm