SURVIVING

CLIMATE CHANGE

IN SMALL ISLANDS

A GUIDEBOOK

Surviving Climate Change in Small Islands – A guidebook

Emma L. Tompkins[1], Sophie A. Nicholson-Cole[1], Lisa-Ann Hurlston[2], Emily Boyd[1], Gina Brooks Hodge[3], Judi Clarke[4], Gerard Gray[5], Neville Trotz[4] and Lynda Varlack[6]

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October 2005

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1 Why be concerned about climate change?

Contents

- Why be concerned about climate change?
- Why adaptation to climate change is necessary in small islands
- How this guidebook can help you prepare for climate change

After working through this chapter you will be able to:

- Understand the risks climate change presents for small islands
- Understand why adapting to climate change is necessary now and in the future
- Use this guidebook and know how it can help you to prepare for climate change

1.1 Why be concerned about climate change?

1.1.1 Changing environmental risks

The Earth has experienced many changes during its 4.5 billion year life. There have been ice ages as well as periods of heat and low rainfall. The Earth is accustomed to experiencing wide-spread severe environmental change and it has always adapted to these changes. Since human beings have lived on this planet they have coped with earthquakes, volcanic eruptions, tsunami, droughts, floods, heat waves and mini-ice ages as well as numerous other forms of environmental hazards. Yet human beings have not had to cope with a warming of the planet at the speed and scale that is currently occurring and that is expected to increase over the coming decades and centuries.

Although the human race has experienced many environmental hazards over thousands of years, science cannot predict exactly when a hazard will occur, who it will affect or how severe the impacts will be. For example, if it were known that major tropical cyclones passed within 50 miles of your island, on average once in every 50 years, and a major cyclone passed within 50 miles of your island one year ago, would you do anything to prepare for another cyclone today? You know that one day another major cyclone will pass by, but you do not know:

- When;
- If you will be living on that island;
- If you are living there if you will be in a vulnerable location;
- If you will be affected at all by the hurricane;
- If it would be cheaper not to prepare and then to rely on the insurance to pay for the costs of recovery.

When considering these uncertainties some individuals choose not to prepare for the risks. Unfortunately when there are risks which we know will one day turn into realities, not preparing means suffering the consequences. There are many examples where much knowledge and awareness exists about the consequences of some environmental risks, yet no action is taken until the risk turns into a reality and disaster strikes.

Definition of environmental risk

Environmental risks occur when an environmental hazard has the potential to inflict harm.

Most people live with risk to some degree. We all take chances when we cross roads, drive or ride in a car, consume fatty foods, eat too much salt or sugar, drink alcohol or smoke cigarettes. Some people embrace risks and enjoy dangerous adrenalin sports, others are more risk averse. One thing is certain: we all face risks and we all have to choose how to respond to them. Doing nothing in the face of risk should only be an option when

you have considered all the consequences of this course of action. This guidebook will describe in detail the reasons why climate change is creating risks for small islands, why small islands need to address these risks and it offers methods for managing those risks.

The book 'Late Lessons from Early Warnings', published by the European Environment Agency provides 12 good examples from the past 100 years. See Chapter 6 for details.

1.1.2 Why small islands are vulnerable

Risks are only significant when there are costs associated with the risk. If a volcano erupts on an uninhabited island, this is not often considered a disaster. However, when a similar event happens on a highly populated or poor island, there are often significant consequences for its population. In other words, the pre-existing economic, social and physical conditions on the island will influence how it is affected by a hazard.

Small islands are often economically, socially and physically vulnerable by their very nature. Because they are unable to produce all the goods and services to meet domestic needs, they are often import-dependent. Many rely on tourism to generate foreign exchange to balance this demand for imported goods and services. Due to their small land masses, small islands are typically land-resource constrained. This means that there are limited places for people to live, space for infrastructure, areas for waste disposal, agricultural production, industrial development, etc.

Many small islands are already at risk from many environmental hazards, such as coastal, river and rain-induced flooding, tropical cyclones and storm surges. The battering received from many of these hazards can make islands particularly vulnerable to other changes. Knowing the existing risks and how they are changing should help those on small islands prepare for future hazards. In particular it is important to understand how existing vulnerabilities could exacerbate the impacts of other environmental hazards and what can be done to reduce the threat of disaster.

1.2 Why adaptation to climate change is necessary in small islands

1.2.1 Why we cannot stop climate change

Almost every person on the planet contributes to the climate change problem by driving our cars, using air-conditioning or heating, flying, buying goods that have been flown in from another country, taking holidays abroad, and travelling to work by car. Because of the way our global society has developed we rely on fossil fuels (oil, gas, and petroleum) which are extracted from the ground. These fossil fuels provide us with the energy that we consume to live our lives as we choose. Unfortunately, when we burn fossil fuels we create the greenhouse gases that are significantly changing the climate.

To solve the problem of climate change there are two main options:

i) *Produce less greenhouse gases*
This could be through either reducing our consumption of energy, specifically fossil fuels or changing our land-use practices: to discourage clearance of trees and other greenhouse gas-absorbing flora and to avoid disturbance of land that stores carbon, methane and other greenhouse gases. This is a massive challenge, and one that does not seem to be succeeding after 13 years of international agreement on the need to do so (in 1992 most of the world's governments signed up to the United Nations Framework Convention on Climate Change acknowledging that climate change is a problem).

ii) *Remove the greenhouse gases from the atmosphere*
Many macro-engineering solutions are being suggested, such as pumping carbon dioxide from the atmosphere into the Earths core or into the deep ocean.

Even if one of these two solutions is implemented tomorrow the Earth would not stop warming. Greenhouse gases have a lifetime in the atmosphere of between 10 and several thousand years. Hence, even if we stop increasing our emission of greenhouse gases today, we are committed to future warming and sea-level rise.

go to The scientific annex to this guidebook which explains in more detail what causes climate change and gives an overview of climate scenarios and uncertainty.

1.2.2 The expected impacts of climate change

The warming that we are experiencing is likely to bring about two main changes: a change in the average climate around the world, and a change in the incidence of extreme events. Warmer weather and seas will bring with them a range of impacts including: rising sea levels (from thermal expansion of the oceans), changing distribution of carriers of disease (such as mosquitoes), an increased incidence of hot days, changes in rainfall patterns (making it harder to plan for dry seasons), and a more acidic ocean. Extreme events such as storm surges, flash floods and tropical cyclones could all potentially be exacerbated by the other changes in the climate.

While there are regional differences in how climate change will manifest itself, in general it is likely that climate change will lead to both worse flooding in the rainy seasons, and worse droughts in the dry seasons. It is also likely to lead to more hot days which could affect the elderly, the poor and the sick. Sea-level rise is already affecting coastal infrastructure, coastal populations and increasing the pressure on scarce land resources.

1.2.3 Why small islands are vulnerable to climate change impacts

Climate change is expected to worsen existing vulnerabilities and create new vulnerabilities. Unfortunately, while small islands are not responsible for the causes of climate change, they are likely to be the first to experience the worst effects of climate change, particularly through sea-level rise on low lying islands or through water shortages on porous and low lying islands.

Clearly small islands, which are already vulnerable economically and physically, will be placed under increasing pressure by some of the impacts of climate change. Even if there is an immediate reduction in global levels of greenhouse gases, then small islands need to prepare for the consequences of global warming over the next 20 – 50 years. If there is no immediate reduction in the global level of greenhouse gases then small islands need to start preparing for the environmental risks associated with climate change for the next few centuries. Adaptation preparations to cope with the forthcoming risks are critical now.

1.3 How this guidebook can help you prepare for climate change

This guidebook contains information about the risks associated with climate change. It explains how existing social, economic and environmental vulnerability can magnify the risks associated with climate change and it describes actions that can be undertaken to prepare for climate change. Key terms and concepts are defined for those unfamiliar with climate change terminology.

Readers with no prior exposure to climate change issues are advised to read Chapters 1 and 2 before reading other sections of the guidebook. Once familiar with key terms and definitions readers will be much more able to extract the maximum benefit from the guidebook.

1.3.1 Who should use this guidebook

This guidebook provides information, ideas, tools and techniques for those who need to start taking action today to prepare for climate change. It is primarily aimed at government officers who would like to learn more about climate change, its impacts and preparedness options. It has been written to assist those with little knowledge of, or exposure to, climate change. An important message in this guidebook is that communities and governments can best prepare by building on their existing strengths and good practice.

While the guidebook has been prepared specifically for people on small islands, the general approach described herein may also be a useful approach for people in other geographic locations. Each location has different needs and resources, hence the

guidebook has been designed to be flexible in order to enable readers to apply the recommendations and develop their own climate change adaptation plans.

1.3.2 Structure of the guidebook

Chapter 2 outlines what small islands might be able to expect from climate change. It outlines why small islands are vulnerable to climate change, introducing the risks that climate changes pose and the hazards that they might expect. Methods of assessing vulnerability and climate impacts are presented in Chapter 3 and the process of managing the consequences of climate change through the development of an adaptation strategy is introduced. Chapter 4 outlines how you might go about starting the adaptation process, how to make risk management plans and how to link these with other planning processes. Chapter 5 guides you through a process of implementing an adaptation strategy outlining a number of important components including legislation and enforcement, and how to finance adaptation. The importance of continuing the adaptation process is also explained.

Chapter 6 includes a glossary containing definitions of the key words and scientific or unusual terms used throughout this guidebook. It also contains information about and links to further sources of information such as useful organisations and publications as well as a list of references to specific documents referenced in the text.

Some other learning aids are used throughout the guidebook. These include:

Definition boxes !

Definition boxes remind the reader of important definitions.

go to 'Go to' indicators point the reader to places of related interest in the guidebook

e.g. **Example boxes** are used throughout the guidebook to illustrate a point or to provide details of an aspect of a particular case study.

KEY message **Key messages highlight a key point or message.**

Summary pages
Summary pages at the end of each chapter review what has been achieved and guide the reader to additional sources of information.

1.3.3 An introduction to the case studies used

Most of the ideas used in the guidebook come from a three year collaborative project between the Tyndall Centre for Climate Change Research and the Cayman Islands' Government Department of Environment. This project explored how the Cayman Islands' Government developed its hurricane response strategy over a 15 year period.

Following from this work, the UK government, through its Overseas Territories Environment Programme, funded a project 'preparing for and adapting to climate change in the Caribbean'. The objective of this project was to build capacity in the UK overseas territories to enable them to prepare for and then respond to climate change.

The first phase of the project brought six individuals to the Tyndall Centre for Climate Change Research at the University of East Anglia, Norwich, UK for a one month period of self-study during September 2004. Five of the individuals were from the governments of Anguilla, British Virgin Islands, Cayman Islands, Montserrat and the Turks and Caicos Islands. The sixth was a representative of the Project Implementation Unit of the Caribbean based Adapting to Climate Change in the Caribbean (ACCC) project. During their time in the UK, the individuals produced reports on the likely impacts of climate change on their islands, and on potential adaptation strategies for their islands. These reports are sampled throughout this guidebook to ensure that the lessons learned by those in the UK Overseas Territories in the Caribbean can be transferred to others. Ideas and examples used in this guidebook are also drawn from the regional climate change programme Caribbean Planning for Adapting to Climate Change (CPACC) that was implemented in the Caribbean (1997 – 2001).

The second phase of the project brought the same individuals together for a two-day workshop in the Cayman Islands from 2nd – 3rd June 2005. The workshop, entitled 'Preparing for and adapting to climate change in the Caribbean' reviewed: the science of climate change and reasons for concern; areas of vulnerability and ways of assessing vulnerability; adaptation principles applied in other parts of the Caribbean and means of incorporating climate change into wider sustainability planning. Approximately 60 people attended the workshop. The third and final phase of this project is the production of this guidebook.

1 Summary and key references

This chapter has introduced the concept of climate change, what causes climate change and how it can be stopped. It has revealed why climate change is a problem for small islands and why, because of the difficulty in stopping climate change, a commitment to tackling climate change is needed.

Readers should have an initial awareness of the uncertainty associated with climate change, i.e. we know that climate change is happening and will continue to occur, but we are not yet sure in what form. The main threats associated with climate change have been identified, these are:

- More hotter days during the rainy season, or the summer months
- A rising sea level
- A more acidic ocean
- Changes in rainfall; more in the rainy season, less in the dry season
- Changing intensity of tropical cyclones

These changes can become dangerous if we are not prepared. The reader should now be ready to explore the implications of climate change in more detail and to start considering how to go about managing the consequences.

Chapters 2 and 3 will build on the knowledge provided in this chapter and will apply some of the theory to understanding the impacts of climate change in small island states.

2 Understanding climate change risks

Contents

- What can we expect from climate change?
- What determines the type and severity of climate change impacts?
- How to deal with the risks

After working through this chapter you will:

- Understand in more depth the nature of climate change, the expected impacts and associated hazards for small islands
- Understand what determines the severity of these impacts for small islands
- Start to understand what small islands can do to prepare for the impacts of climate change

2.1 What can we expect from climate change?

Climate changes are expected to affect the entire planet in the near term and the future. There will however be some regional variations, with some parts of the world experiencing different impacts. Broadly, climate change is likely to be experienced around the world as either: slow onset changes or sudden changes, such as extreme events. Both manifestations of climate change bring with them a range of hazards.

The Scientific Annex to this guidebook, gives a more comprehensive background to the science of climate change, climate scenarios and issues of uncertainty.

2.1.1 Recent global and regional changes

The most significant and immediate consequences of climate change are:

- Increase in air temperature
- Increase in sea surface temperature
- Increase in sea level
- Changes in rainfall (precipitation)
- More extreme weather conditions

Recent years have been among the warmest since the mid 19th century – the period for which temperature records are available. Some places have warmed more than others. The Northern Hemisphere, the Pacific Ocean and Caribbean Sea have experienced greater warming than the global average.

Box 2.1 provides some examples of current climate changes that have already been observed and experienced around the world. Over the last 100 years, the sea has risen by about 25 centimetres. Much of this rise in sea level is related to the rising air temperature. Therefore we know that because the air has warmed, the sea has also warmed. Simple laws of physics tell us that as water gets hotter, it expands. We can now attribute between 2cm and 7cm of the observed sea-level rise to the warmer air. Melting glaciers and ice caps account for a further 2cm to 5cm of the sea-level rise. Other factors contributing to sea-level rise are less well understood, such as the melting of the huge ice sheets of Greenland and Antarctica.

e.g.

Box 2.1 Examples of current climate changes being experienced around the world

Air and sea surface temperature rise

- Global air surface temperature has increased by about 0.6°C over the last 100 years.
- Globally the 1990's was the warmest decade, and 1998 the warmest year recorded.
- The frequency of hot days has increased.
- Snow cover has decreased in area by 10% since observations began by satellite in the 1960's.
- Arctic sea-ice has thinned by up to 40% in recent decades and has decreased in its extent by up to 15% since the 1950's.
- The growing season has lengthened by up to 4 days in the Northern Hemisphere during the last 40 years.
- Plants and animals (e.g. birds, insects and fish) have shifted pole-ward / to higher altitudes.
- Earlier plant flowering, earlier bird migration, earlier breeding seasons and earlier emergence of insects has been observed in the Northern Hemisphere.
- El Niño events have become more frequent, persistent and intense during the last 20 years compared to the previous 100.

Sea-level rise

- Global average sea level has increased by about 2mm annually over the last 100 years.

Changes in precipitation

- Precipitation (e.g. rainfall, snowfall) has increased by up to 10% in the Northern Hemisphere and decreased in other regions (e.g., North and West Africa, parts of the Mediterranean).
- The frequency and severity of drought has increased in some regions, such as parts of Asia and Africa.

Source: Watson et al. (2001)

We do not expect these changes to stop in the short term and if we fail to cut our greenhouse gas emissions we can expect more intense warming of the planet in the future.

go to The Scientific Annex explains what greenhouse gas emissions are and how they are contributing to climate change.

2.1.2 Future climate change in small islands

The islands in the Pacific, Indian and Atlantic Oceans and the Caribbean Sea are likely to be profoundly affected by climate change. Global assessments have consistently identified small islands as among the most high-risk areas, which are likely to suffer disproportionately from the negative impacts of climate change.

KEY message

Over the next 100 years, small islands are likely to experience a rise in sea surface and air temperatures (between 1.4°C and 5.8°C), rise in sea level (as much as 9mm per year), changes in rainfall patterns, increase in the frequency of extreme events and a possible increase in the intensity of tropical cyclones and changes in their tracks.

Some work has been carried out to identify some of the climate changes that are already being observed and experienced. Two examples from the Caribbean and Pacific are given in Box 2.2.

e.g.

Box 2.2 Examples of climate changes already being experienced in the Caribbean and the Pacific

In the Caribbean:

- The Caribbean Sea has warmed by 1.5°C in the last 100 years.
- Observations have shown a decrease in rainfall in the Caribbean. Over the last few decades there have been prolonged dry spells.

(Source: Clarke, 2004)

In the Pacific:

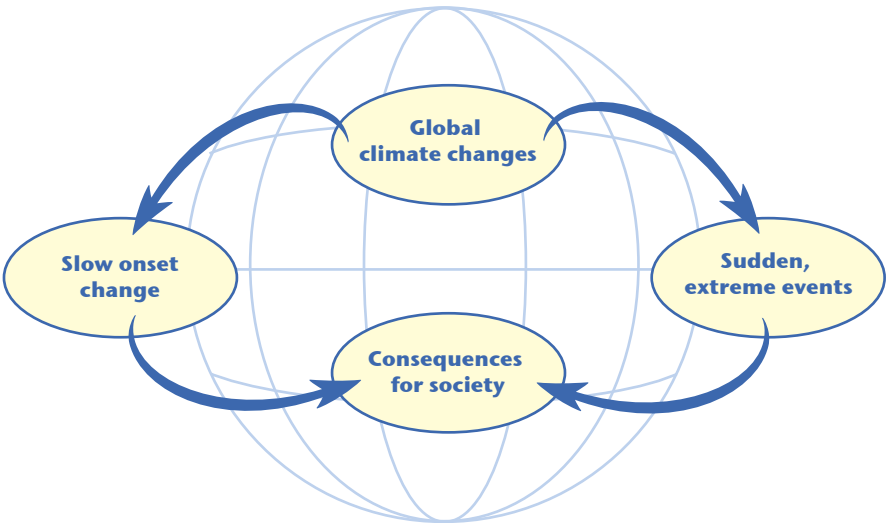
- Increases in surface air temperatures have been greater in the Pacific than global rates of warming. For example, since 1920, temperature has risen by 0.6-0.7°C in Noumea (New Caledonia) and Rarotonga (Cook Islands), which is greater than the mean global increase.
- Across the Pacific region, atoll dwellers speak of having to move their houses away from the ocean because of coastal erosion; of having to change cropping patterns because of saltwater intrusion; of changes in wind, rainfall, and ocean currents.
- Fiji has experienced two droughts, and severe flooding in the past decade.

(Source: World Bank, 2000)

2.1.3 Hazards associated with climate change: slow onset and extreme events

Even though there are a range of potential impacts from climate change, ranging from rising sea levels, to changing rainfall patterns, individuals and countries are likely to experience climate change in two main ways; either as a change in average climate conditions (often referred to as slow onset change), or as an increase in sudden, extreme events. See Figure 2.1.

Figure 2.1 The relationship between climate change, human experience of climate change and the social consequences



Examples of slow onset change:

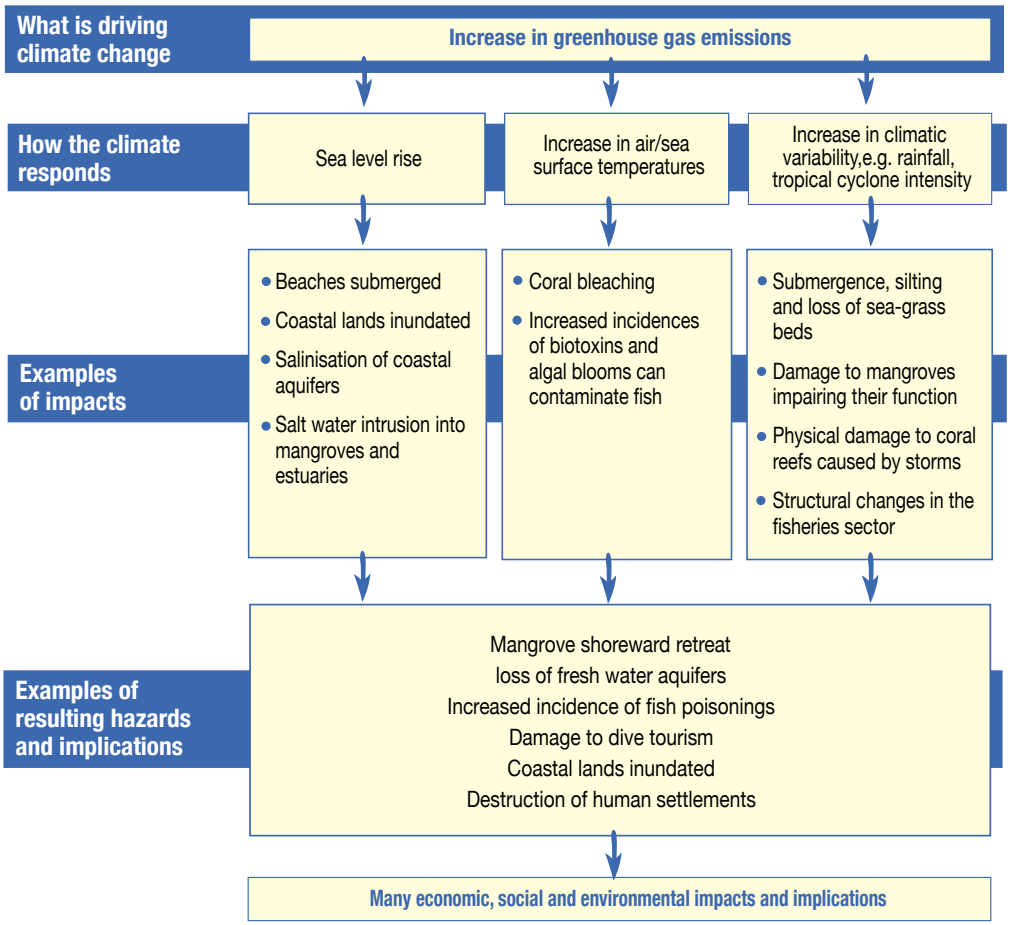
- Sea-level rise
- Increase in air temperature: The average warming in regions where small islands are located is likely to be between 2.0 and 2.8°C by 2050 (compared with 1990 temperatures). By 2080, the increase (above 1990 temperatures) is likely to be between 3.1 and 4.3°C.
- Increase in sea surface temperature
- More rainfall and flooding during wet seasons
- Less rainfall during dry seasons.

Examples of sudden, extreme events:

- The frequency of extreme temperatures (e.g. heatwaves) is likely to increase
- An increase in the intensity of rainfall
- An increase in the intensity of tropical cyclones.

Figure 2.2 gives the reader an idea of how climate changes present physical hazards and have social and economic implications for small islands.

Figure 2.2 The potential impacts of climate change threatening *coastal zones*



(Adapted from: Clarke, 2004)

The chain of events from the increase in greenhouse gas emissions to the coral bleaching shown in Figure 2.2 are described in more detail in the following sections.

2.1.3.1 Slow onset changes

There are various potential hazards associated with slow onset changes.

A rising sea surface temperature is likely to exacerbate existing problems of coral bleaching as corals exist in a narrow range of sea temperatures and they are very sensitive to temperature change. Coral reefs negatively affected by bleaching could also suffer from reduced calcification rates due to higher carbon dioxide (CO_2) absorption into seawater. Mangroves, sea grass beds, other coastal ecosystems and the associated biodiversity are also likely to be adversely affected by rising temperatures and accelerated sea-level rise. For those islands that rely on marine tourism and fisheries the consequences for society are significant. Without healthy reefs the diving industry is likely to suffer and the productivity of local fisheries is likely to be severely affected.

A change in the acidity of the oceans. Carbon dioxide is absorbed by the oceans and can increase the acidity of the water. As atmospheric concentrations of carbon dioxide increase, so does oceanic absorption. This could have a variety of effects. For example, as the acidity changes this could have an impact on coral life and reef fish, potentially threatening their survival. Consequently, the abundance of reef fish, those who earn their livelihoods from reef fisheries and those who rely on the fisheries as a significant food source are likely to be affected.

Sea-level rise. The projected sea-level rise of 2 to 9mm per year will increase rates of coastal erosion and loss of land. For those societies which have developed around the coastal zone of their island (this is the case in almost all small island states) this will lead to loss of infrastructure and property, potential dislocation of people, increased risk from storm surges, reduced resilience of coastal ecosystems and possible saltwater intrusion into freshwater resources. The danger of soil salinisation, coupled with the existing limited area of arable land makes agriculture, both for domestic food production and cash crop exports, highly vulnerable to climate change.

Table 2.1 describes some of the sectors that are likely to be affected by slow onset climate changes.

Table 2.1 Sectors likely to be affected by slow onset climate change hazards

Sector	Climate change	Examples of climate change impacts
Water resources	Changes in precipitation	Water supply problems
	Sea-level rise	Salt water intrusion of freshwater sources
Terrestrial biodiversity	Sea-level rise	Mangrove migration inland
Marine biodiversity	Increases in sea temperature and sea-level rise	Adverse effects on sea grasses
	Rising sea temperature	Coral bleaching
Fisheries	Death of coral reefs and sea grasses	Reduced fish catch
Tourism	Changes in temperature and rainfall patterns	Changing visitor trends
	Sea-level rise	Loss of beaches
	Tropical cyclone intensity	Damage to tourism infrastructure
Human settlements & infrastructure	Sea-level rise	Coastal inundation causing relocation inland
Insurance	All impacts	High payouts for damage to housing and tourism infrastructure

See section 6.2 under the heading 'Information portals on climate change' for links to resources which will help you to learn more about the impacts of climate change.

2.1.3.2 Sudden or extreme events

Sudden or extreme events are likely to be a cause of concern for people on small islands.

The most immediate and obvious hazard associated with climate change is the expected change in rainfall patterns that could lead to periods of very intense rainfall, leading to **flash floods and landslides**.

Changes in rainfall patterns can also lead simultaneously to worsening **drought** conditions in the dry season. Islands with very limited water supplies are already vulnerable to periods of droughts. They are likely to become increasingly vulnerable to the impacts of climate change on water supplies.

The changing intensity of tropical cyclones is a further climate change related risk. Tropical cyclones already have damaging impacts on agriculture, infrastructural development and wider commerce. Tourism, which is an important source of income and foreign exchange for many islands, inevitably faces severe disruption after major cyclones. Human health is also affected by cyclone activity through human exposure to diseases and stress, both during the event and throughout the recovery period which can take years.

The weather phenomenon **El Niño** (also called the El Niño-Southern Oscillation Event, or ENSO) has an influence on variations in the climate. The El Niño phenomenon affects the climate throughout the Pacific region and brings about dramatic changes in weather patterns worldwide. A major El Niño event generally occurs every 3 to 7 years. El Niño has been linked to:

- Increases in temperature in some places which are greater than the global average (e.g. Rarotonga, Cook Islands)
- Some regions becoming wetter (e.g. Northern French Polynesia)
- …drier (e.g. Tonga)
- …warmer and sunnier (e.g. New Caledonia and Fiji)
- …cloudier (e.g. Samoa).
- Increased drought and forest fires (e.g. in Guyana)
- Decrease in the frequency of hurricanes in the Caribbean

The variations expected to be brought about by climate change are likely to be strengthened by El Niño. These include changes in rainfall, more extreme weather conditions and an increase in the magnitude of tropical cyclones. See Box 2.3 for examples of the impacts that El Niño has on climatic conditions in different parts of the world.

e.g.

Box 2.3 Examples of the climatic impacts of El Niño

In general, when El Niño conditions develop in the eastern Pacific, the first visible impacts include an increase in precipitation in this area (including parts of South America) and a decrease in precipitation for western Pacific locations such as Australia, Indonesia, Southeast Asia, and the Philippines. As El Niño continues, other impacts include a significant decrease in tropical storm activity in the Atlantic Ocean and a corresponding drought in the Caribbean and Central America. Tropical storm activity increases in the eastern Pacific.

- In the **Caribbean**, for example, Barbados, Dominican Republic and Jamaica, drought is currently experienced during El Niño episodes. Impacts include: poor sugar harvest; bleaching of coral reefs; shortages of certain food crops; high temperatures; carrot, onion, and beet seed losses and/or plant loss due to heat in the early spring and reductions in irrigated rice, un-irrigated corn and sorghum crops.
- The **Philippines** have, in the past experienced: drought and floods leading to decreased agricultural growth, insect infestation and decrease in un-milled rice yield. Coping strategies have included dam-building, water conservation and recycling efforts, cloud-seeding, and fast-track construction of small water-impounding facilities and reservoirs.

Table 2.2 gives some examples of sectors likely to be affected by sudden or extreme climate change hazards.

Table 2.2 Sectors likely to be affected by sudden or extreme climate change hazards

Sector	Climate change	Examples of climate change impacts
Agriculture and forestry	Changes in rainfall patterns	Drought or flood conditions
Health	Extreme temperatures	Heat stress
	Flooding	Increased incidences of vector- and water-borne diseases
Tourism	Changes in tropical cyclone intensity	Decrease in number of tourists visiting, impact on local economy

go to See the box at the end of this chapter for links to more information about El Niño.

2.2 What determines the type and severity of climate change impacts?

Not all islands will experience the same type of hazards and even those experiencing the same hazards will not experience the same severity of hazard. The severity of a hazard will vary by island depending on the geo-physical, social and economic characteristics of each island. Therefore it is important to consider the probability of a hazard occurring in the region, the likelihood of an island being physically affected, the severity of the impact and the vulnerability of the island.

KEY message

Each island's economic, social and environmental conditions will determine how they experience the impacts of climate change.

2.2.1 What risks do climate changes pose for small islands?

Specific climate hazards will not pose the same risks to every small island. This is because the likelihood of a specific climate hazard affecting an island depends on the location of an island as well as the frequency and severity of the hazard. Each small island has different characteristics which determine how vulnerable it is to the impacts of climate change.

The risks posed to small islands by climate change are dependent on: the magnitude and severity of a given hazard; the likelihood of the hazard happening; the existing economic, social and physical conditions of the island; the ability to cope with the hazard. In short we can say:

Risk = (hazard + vulnerability) x probability

With climate change, there is little that small islands can do to change the magnitude of a hazard (although reducing greenhouse gas emissions would send a signal to the rest of the world to do the same), nor can they change the probability of the hazard occurring. Small islands can invest in vulnerability reduction as this is the main option to reduce the damage caused by environmental hazards.

2.2.2 Vulnerability to climate changes

Vulnerability refers to the ability of a community, group or individual to cope with the impacts of a hazard and to recover. Vulnerability incorporates:

- The degree to which you are **exposed** to the impacts of climate change.
- How much you are **affected**, directly or indirectly, and adversely or beneficially by these climate change impacts.
- Your potential to **cope** with climate change impacts, recover and adjust.

There are common characteristics on many small islands which make them vulnerable to climate change impacts. Some examples of these common characteristics are provided in Box 2.4.

e.g.

Box 2.4 Common characteristics identifying small islands as vulnerable to climate change impacts

- **High exposure to natural hazards:** e.g. tropical cyclones and associated storm surge, droughts, tsunamis, and volcanic eruptions;
- **Limited physical size:** reducing some adaptation options to climate change and sea-level rise (e.g. coastal retreat impossible in some cases where entire islands may be inundated);
- **Relative isolation** (in some cases) and great distance to major markets;
- **Limited natural resources and over exploitation:** many already heavily stressed from unsustainable human activities leading to degradation of natural systems (e.g. pollution and increasing industrial activity; coastal ecosystems which would otherwise act as natural sea defences / storm protection and increasing nutrient fluxes);
- **Thin water lenses and decreasing fresh water availability** (high sensitivity to sea-level change);
- **Import dependence and high sensitivity to external market shocks** over which they exert little or no control (low economic resilience) and the effects of economic globalisation;
- **Generally high population densities** and in some cases, rapid population growth;
- **Intra- and inter-island migration** and rapid changes in social structure;
- **Growing urbanisation and industrial activity** and rapidly developing infrastructure, often in coastal areas, impacting on coastal ecosystems (e.g. degrading natural sea defences);
- **Poorly developed infrastructure** (except for major foreign exchange-earning sectors such as tourism);
- **Limited funds and human resource skills** which severely limit the capacity of small islands to adapt to the impacts of climate change.

Adapted from: McCarthy et al., (2001)

2.2.2.1 Exposure – the severity of climate hazards

The degree to which you are exposed to the impacts of climate change is a key element of vulnerability. Exposure to climate hazards encompasses both the frequency and severity of a hazard.

Many islands are already vulnerable to frequent damage from climate-related events simply because of their geographical locations. In the Caribbean, tropical cyclones

are commonly called hurricanes. They are an important and regular climatic event, the intensity of which may increase with future climate changes. Islands located in the Caribbean region are more likely to be exposed to strengthening hurricanes than islands located in the Southern Atlantic, such as the Falkland Islands, or Pitcairn Island. These latter islands are more likely to be exposed to different kinds of climate change hazards (e.g. changes in storminess affecting island access).

2.2.2.2 Sensitivity to the impacts of climate change

Sensitivity refers to the degree to which an island is affected either adversely or beneficially by climate change. The factors influencing sensitivity to climate change hazards are: culture, tradition, gender, social networks, equity and governance. These can be broadly grouped into social, economic and geo-physical factors, and they determine who is affected, how they are affected, and the degree to which they are affected. Each is discussed below.

Social factors including, population size, density and distribution on islands determine who is affected by hazards. It is often the poor who are the most affected by changing environmental conditions and who are likely to suffer the most from lack of preparedness. For example, those living in low lying flood-prone areas tend to be the poorer in society. Poverty which is often accompanied by sub-standard housing and high rates of disease transmissions increase sensitivity. Strong community development and access to regional support networks reduce sensitivity. Trust in government institutions and the ability of government to implement policy all affect how an island experiences hazards. For example, recent research in Cuba and the Cayman Islands has shown that where there is a good government response to tropical cyclone risk, there is reduced impact.

Economic factors such as small size, high transport costs, import dependence, the remoteness from other markets and the small domestic markets can make many islands vulnerable to external shocks of any kind, and hence sensitive to climate change impacts. The wealth of local economies also affects how communities are able to adapt.

Geo-physical conditions, such as small island size, high residential and infrastructural density in the coastal zone, low lying islands all add to this sensitivity. Changes in rainfall affecting water supplies could have more serious consequences for islands without freshwater aquifers, e.g. low lying islands with no natural freshwater storage and subject to salt water intrusion. It should be remembered that physical conditions also may assist some countries in adapting. Sea level rise may not be such a serious threat to a mountainous, volcanic island as it is to a very low-lying island.

2.2.2.3 An island's ability to cope and recover from climate change hazards

An important element in understanding the severity of a climate change impact comes from the ability of an island to cope with or adapt to the impacts of climate change, in other words, its resilience.

Definition of resilience !

The capacity to cope with climate changes, recover and adjust (without becoming undermined or unable to adapt).

Some of the factors contributing to the sensitivity of an island also affect its ability to cope with, to recover from and adapt. For example, high economic dependence and environmental degradation. Those who have better access to resources – both economic and social – often have a greater capacity to withstand the impacts of hazards than poorer members of society. Social networks are also an important factor in enhancing ability to cope.

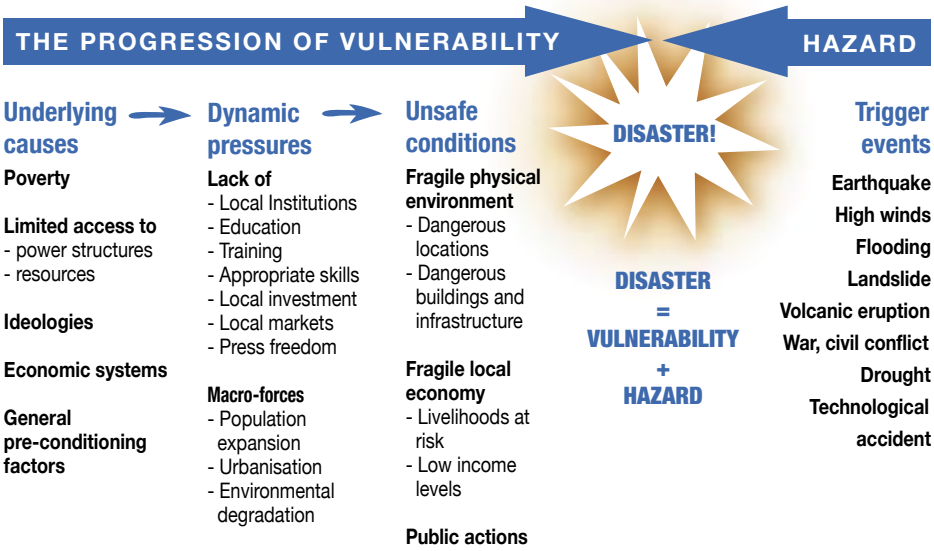
Ability to cope with hazards is reduced by absolute poverty, rapid population growth, rapid or mass urban migration, inequitable patterns of land ownership, lack of education and subsistence agriculture on marginal lands, etc. These factors lead to unsafe site locations for buildings and settlements, unsafe homes, malnutrition, unemployment, underemployment, and illiteracy and other conditions limiting resilience.

2.2.2.4 The causes of disasters

All small islands are starting from the position of being *both* vulnerable and resilient to external shocks. Many small islands are already adept at dealing with inter-annual climate variability or sudden climate shocks. Islands are also adept in some cases at dealing with other types of hazard, for example, the volcanic eruptions in Montserrat that started in the 1990s.

Hazards by themselves do not necessarily lead to disasters; it is the interaction of the hazard with a vulnerable part of society that creates a disaster. Disasters therefore only occur when a hazard affects people who are not prepared – or who are vulnerable. Figure 2.3 illustrates how disasters occur, when factors of vulnerability are combined with some kind of hazard. It depicts how increasing vulnerability enhances the likelihood that a disaster will occur as a result of a hazard event (e.g. climate change impacts such as intense storms, flooding or extreme temperatures). It is called the disaster crunch model as it shows how the collective pressures of economic, social and physical vulnerability when combined with a hazard push communities to breaking point.

Figure 2.3 The Disaster Crunch Model



(Adapted from Blaikie et al., 1994)

Climate change disasters are likely to occur when there is already social and economic pressure building up. To avoid disasters it is important to prepare for the hazards and to reduce economic, social and physical vulnerability of individuals and communities. By taking action in advance to manage a hazard and reduce the level of vulnerability, it is possible to lessen the adverse effects of hazards and to increase the potential to cope with them.

go to Chapter 3 will help you to assess the vulnerability of your island to climate change, and the climate change hazards that you face.

2.2.3 Maladaptive behaviour

Maladaptive behaviour refers to laws or actions by governments or individuals that reduce the ability to cope with and recover from hazards or shocks.

2.2.3.1 By governments

Many small islands have already developed strategies to make themselves more resilient to external shocks. For example, in the Bahamas, Cayman Islands and the Turks and Caicos Islands, well crafted banking laws have allowed the islands to benefit from operating as off-shore financial centres. Banking therefore acts as a secondary economic support to tourism industry and other small industries that operate there. However, there

also exist laws that reduce the ability to cope with shocks. Such laws and activities can be thought of as 'maladaptive'. Examples of such laws can be seen in Table 2.3.

Table 2.3 Examples of policies increasing vulnerability to climate change impacts in the Cayman Islands.

e.g.

Policy area	Policy choice	Impact	Recommended improvements
Land and coastal zoning	Systematic reduction of mangrove buffer zone	Reduced storm protection	Increase mangrove buffer zones inland and along other coastlines. Also consider hurricane evacuation zones in general zoning plans.
Coastal set-back	Relaxing set-back regulations especially for large-scale developments typically underwritten by foreign investment.	Downstream coastal erosion, future coastal erosion problems.	Revise and enforce set-backs; siting of ancillary structures (e.g. seawalls, swimming pools) within setback.
Coastal zone management and planning	Lack of comprehensive coastal zone management and planning	Piece meal management of the coastal zone, contributing to coastal erosion.	Establish an education or awareness campaign focussing on the potential impacts of sea-level rise, increased storm intensity and associated beach erosion.
Water management	Legislation conflicts with sustainable development policies, e.g. use of grey water by hotels for irrigation not permitted under Water Authority Law.	Increased risk of drought	Use grey water instead of desalination or groundwater stores to irrigate golf courses and landscaped areas.

Source: Hurlston (2004)

Several islands already have experience of coping with maladaptive behaviour. For example, in some islands, marine parks have been established to cope with over-use and consequent degradation of marine areas. Additionally, planning regulations have been modified to reflect the changing awareness of the dynamism of the coast and the need to build shore-front properties at a suitable distance from the sea to avoid damage. In Antigua and Barbuda, building code regulations have been enacted and incentives set up through concessionary insurance premiums for those who comply.

Care needs to be taken when planning for climate change not to worsen the ability of a country or government to respond to climate change. Specifically, three concerns need to be addressed when planning for climate change. It is important to ensure that climate change impacts are not:

i) *Underestimated*, so that money is wasted as the action is inadequate, e.g. building sea defences with an expected life of 50 years that are over-topped within 5 years;

ii) *Overestimated*, so that money is wasted as the action is too over zealous, e.g. building sea defences that undermine natural beach processes and that are not necessary during their 50 year life;

iii) *Mis-estimated*, e.g. sea defences are built; when the most critical impacts from climate change manifest themselves as more intense rainfall events, so that inland flooding rather than coastal flooding is the issue.

Despite the potential to make mistakes, this is no reason not to make decisions. Examples of major infrastructural developments that require decisions today can be found in other parts of the world, for example in the UK, the British government is developing a series of Shoreline Management Plans (SMPs), that develop coastal management strategies for the next 50 years. All SMPs assume that the sea level will rise on average at a rate of 5mm per year, and they develop strategies that contain 'headroom' for climate change. In other words the strategies all acknowledge that the impacts of climate change could be different and that the SMP may have to change.

2.2.3.2 By individuals, communities and organisations

There are individuals who deliberately choose to ignore the risks posed by climate change. How to manage this group is difficult, as it can be the wealthiest in society. For example, in parts of the USA and some Caribbean islands there is frustration at those who live on vulnerable parts of the coast and who are affected every year by storms, yet they re-build in the same vulnerable location after each storm passes.

Picture 2.1 Maladaptive behaviour: example of the consequences of building too close to the high water mark following a hurricane

Source: Department of Physical Planning, Anguilla

Through such behaviour, those deliberately choosing to ignore the risks are placing a burden on the insurance system. Each re-build is financed by insurance pay-outs, which affects the insurance premiums for all residents in that location, sometimes including those who protect their properties or those who live in less vulnerable locations, see Box 2.5.

e.g.

Box 2.5 Deliberate over-exposure to hazards in the Cayman Islands.

"This cycle of build and bust has a devastating effect on society because the people whose places are destroyed are wealthy – the insurance pays them off and then they go back and rebuild. It means that homeowners who look after their properties and who build in storm protection measures find that their insurance goes up and up. This is happening here in Cayman now. People who build regular homes are now having to pay a high cost of insurance because of that 'don't care' attitude of wealthy people who want to live by the sea."

Source: Interview with a member of National Hurricane Committee, Cayman Islands, 2002

The issue of deliberate exposure to climate impacts by certain groups is a challenge for government. Creating markets for hazard mitigation, encouraging risk-based insurance premiums and modifying Building Codes are all possible responses.

2.3 How to deal with the risks

The many responses to climate change may be broadly grouped into actions that tackle the causes of climate change (usually referred to as *mitigation*) and those that aim to minimise the consequences (*adaptation*).

Definition of mitigation and adaptation !

Adaptation:	Adjustment in natural or human systems in response to actual or expected climatic changes or their impacts, so as to reduce harm or exploit beneficial opportunities.
Mitigation:	A human intervention to actively reduce the production of greenhouse gas emissions (reducing energy consumption in transport, construction, at home, at work etc.), or to remove the gases from the atmosphere (sequestration).

To manage climate change, both the causes and the consequences of climate change need to be addressed. This means that nations must address both mitigation and adaptation. Mitigation and adaptation have more detailed and distinct meanings among climate change experts.

go to See section 6.2.6 which gives links to information provided by the Intergovernmental Panel on Climate Change. In particular, Watson *et al.* (2001).

2.3.1 Adapt to the changing conditions

For nations such as small islands that are highly vulnerable to climate change, adaptation should be a major part of national climate change response strategies. Adaptation to climate change refers to preparing for, responding to, coping with, recovering from and living with climate induced changes. This can be achieved through two main activities: first building adaptive capacity, and second implementing adaptation actions. It is important to distinguish between the two as they are both important.

Two ways of adapting

Building adaptive capacity:	Improving the ability to cope with or respond to the impacts of climate change. Undertaken by: gathering knowledge and information about climate change; training people; researching; making plans, creating networks and discussion fora.
Implementing adaptation:	Decisions or choices that generate change. Implementation occurs through: laws or policies; organisational change; individual action.

There is not one specific action that builds adaptive capacity or that leads to adaptation actions being implemented. In this guidebook we offer some options and guidance on how you might decide what to do. This includes guidance on building adaptive capacity (how to assess your island's vulnerability, how to assess the climate change hazards threatening your islands and how to design an adaptation strategy) and how to go about implementing adaptation.

It should be remembered that some adaptation actions are taken deliberately, others are taken sub-consciously, some are taken before impacts are felt, and others are taken during or after the impact. Managing national adaptation requires taking these considerations into account. Adaptation can include simple measures taken by an individual, such as putting shutters on windows to reduce damage from tropical cyclone or hurricane-force winds, to larger national initiatives, such as the managed coastal realignment process in the UK, where parts of the coast are no longer being protected.

go to Chapters 4 and 5 give information on developing and implementing an adaptation strategy.

2.3.2 Mitigate: reduce the likelihood of future climate change

To reduce the likelihood of future climate change, there has to be a reduction in the global emission of greenhouse gases. Mitigation activities can be undertaken directly on small islands, and small islands can play an important role in convincing other countries to reduce their emissions.

Historically, small island states have not been responsible for the build up of greenhouse gases in the atmosphere. Nonetheless, while small islands contribute very little to total greenhouse gas emissions (they currently account for less than 1% of greenhouse gas emissions) some islands have very high per capita emissions, for example, the US Virgin Islands is the largest per capita producer of carbon dioxide, each citizen on average produces approximately 99 metric tons of carbon dioxide each year.

Many countries in the world have started to reduce their CO2 emissions, and small islands must be prepared for the changes that are coming, both in terms of climate, and in terms of the behavioural changes of other nations. Some nations may impose a tax on airline travel to reduce greenhouse gas emissions, which could affect tourism.

go to The Scientific Annex gives a background to climate change science.

2.3.3 Learn from past lessons

People who live with environmental risks, including those emanating from climatic and hydrological hazards have to deal with great uncertainty. For example:

- In terms of rainfall: when will the rains come? Will there be sufficient rain to grow a particular crop? Which crops should be selected if there is likely to be a low rain year?
- In terms of cyclone activity: how much of the national budget should be spent on preparedness when there is no probability that a location will be hit? Should individual households spend precious resources on expensive hurricane shutters and roof ties when their children need food and clothing?

Despite the uncertainty associated with weather related hazards, many people are prepared. This comes from the acceptance that the hazards will happen and that you "live with" these hazards. Over centuries, humankind has adapted to a wide variety of hazards, from natural hazards such as heavy rains or strong winds, to the more recent man-made hazards, such as transport accidents, or collapse of infrastructure. All countries and societies have responded through necessity to past hazards and shocks, some more successfully than others. A traditional response to storm risk in the Caribbean is promoted through the oral tradition of storytelling. There is a familiar saying used to

remind householders that the hurricane season runs from June to October and not to let their guard down too early:

"June too soon, July stand by, August come it must,
September remember, October all over."

The need for preparedness and constant attention to the hazard during the hurricane season as noted in the rhyme reflects lessons borne from experience. There are clearly many other lessons that have already been learned by individual country responses to past hazards, as well as from other countries' approaches to dealing with current hazards.

KEY message

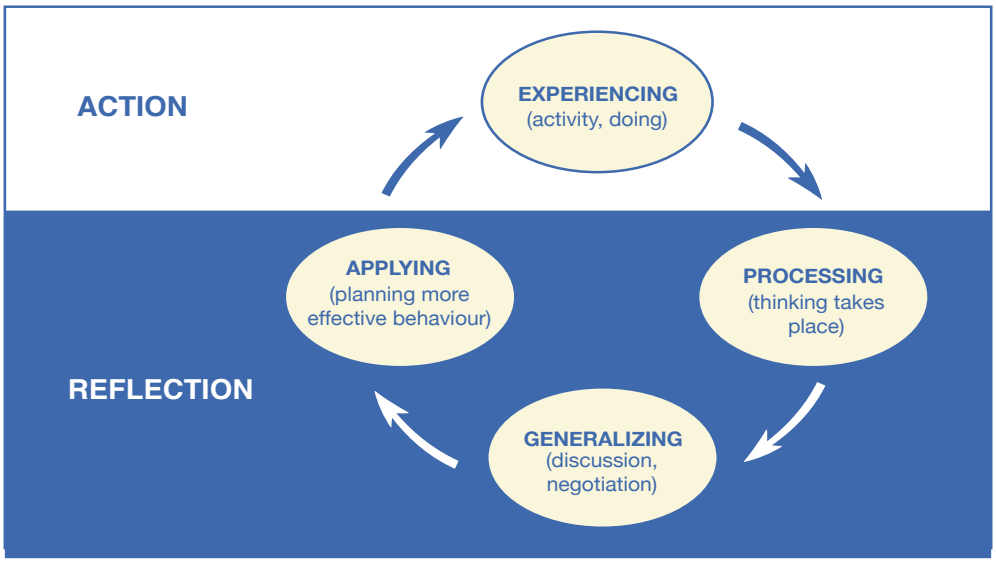
No one is 'starting from scratch' in preparing for climate change. All countries and societies have experienced hazards and shocks, economic, man-made, weather-related, social or otherwise. All have experiences of dealing with these shocks.

Drawing lessons from past experiences requires the consideration of what strategies have worked locally in the past. It is important to remember to:

- Make plans and revise them as more information becomes available
- Learn from mistakes
- Accept that actions taken won't be perfect the first time around.

This learning approach is central to planning for climate change. It is illustrated in Figure 2.4.

Figure 2.4 The learning cycle



(Adapted from: Olsen et al., 1997)

The learning cycle tells us that there are two periods: one of action, the other of reflection, where it may appear that nothing is happening. During the period of reflection information is processed to assess how successful the action was. Was the process as well as the outcome a success? If not, why not? This can also be a period of negotiation and resolving conflicts that may have emerged. This leads to a period of generalising… what could be done better next time, what lessons have been learned? This new understanding can then be applied in new plans for more effective behaviour. At the end of the period of reflection, the new plan can be implemented, then the plans are tested and actions are taken. At the end of the actions, the period of reflection begins again to ensure that there are feedback loops and lessons are being learned. Examples of this learning process can be found in islands which have had to develop evolving response strategies to hurricanes, volcanoes and coastal erosion. The learning cycle is applied to the development of the adaptation strategy described in Chapters 4 and 5.

2 Summary and key references

Every nation is unique with different defining characteristics. Small island states clearly vary by their geography and their environmental, social, political, economic and cultural characters (and 'other' stress factors). These elements affect how vulnerable islands are; their degree of exposure to climate change, their sensitivity and their capacity to adapt to climate change hazards.

This section has introduced an approach to identifying the climate change impacts that may be expected in future. The guidance in this chapter should provide readers with adequate information to enable them to find and understand climate change information in other sources. We advise that readers spend some time using the Intergovernmental Panel on Climate Change website to find answers to specific questions.

The chapter has introduced the reader to a way of thinking through a potential chain of events, beginning with the main characteristics of climate change (increase in temperature, sea-level rise and increase in climate variability) and ending with a consideration of the economic, social and environmental impacts. An understanding of this chain of events and the resulting implications for your island is crucial in preparing for climate change. The following chapters will take you through this process in more detail.

This information will enable you to move on to the next chapter which will help you to assess the likely impacts of climate change on your island and to think about the adaptation planning process.

More information can be found in:

- The scientific annex to this guidebook.
- The information portals on climate change listed in section 6.2. Particularly the Intergovernmental Panel on Climate Change Third Assessment Report (2001), specifically the 'Scientific Basis', and 'Impacts, Adaptation and Vulnerability'.

- World Bank (2000) for a report providing evidence of climate change in Pacific Islands and insights into how these islands have prepared for climate change.
- The Adaptation Policy Framework by the United Nations Development Programme
- World Disaster Report 2002 – reducing risk (International Federation of Red Cross and Red Crescent Societies)
- International Strategy for Disaster Reduction (2004) *Living with Risk: A global review of disaster reduction initiatives.* Geneva: United Nations.
- For more information about El Niño, go to the World Meteorological Organisation, National Oceanic and Atmospheric Administration, and the United States Geological Survey.
- See Olsen *et al.* (1997) for a more detailed account of the learning cycle.

See Chapter 6 for full reference details for these suggested sources of information, web links to them and further sources of information.

3 Assessing vulnerability and structuring an adaptation plan

Contents

- How to assess vulnerability to climate change
- How to assess the physical climate change hazards threatening your island
- Elements of an adaptation strategy
- Taking the first steps

After working through this chapter you will be able to:

- Assess the vulnerability of your island to climate change
- Assess (what) the physical climate change hazards might be on your island
- Think about preparing an adaptation strategy for your island
- Know the main elements of a climate change adaptation strategy.

3.1 How to assess vulnerability to climate change

The things that make an island vulnerable to any change are often the same things that will make an island vulnerable to climate change. It was shown in Chapter 2 that the causes of vulnerability are closely linked to an island's social, economic and geo-physical characteristics. Therefore, any assessment of vulnerability has to take into account the unique social, political, economic and geo-physical conditions in each country.

Assessing vulnerability requires taking a detailed look at the historical, cultural, political, social, economic and environmental factors that have shaped the country and population as it exists today. For example, in Anguilla, there are a range factors that make it vulnerable to climate change related hazards, see Box 3.1.

e.g.

Box 3.1 What makes Anguilla vulnerable?

The following characteristics make Anguilla vulnerable to *natural hazards*:

- Reliance on primary exports
- Wide disparities in economic well-being within society
- Limited development of physical and social infrastructure
- Ad hoc land use planning
- Weakness in governance and public administration

There are further problems that make the island vulnerable to *climate-related hazards*:

- **Small physical size:** limited natural resource base; high competition between land-uses; intensity of land-use; interdependence of human and biophysical environmental systems; spatial concentration of productive assets.
- **Remoteness:** time delays and high costs in accessing imports; geopolitical dependence.
- **Environmental factors:** exposed interiors; large coastal zones.
- **Disaster mitigation capacity:** limited hazard forecasting ability.
- **Demography:** small population, limited human capital; single urban centre; high per capita cost for infrastructure and services due to dis-economies of scale.
- **Economy:** small economy, highly dependent on external finance, small internal market, extremely dependent on natural resources, little or no production capacity.

Adapted from: Pelling and Uitto (2001) in Brooks Hodge (2004)

Vulnerability assessment can be undertaken in a range of different ways, however it requires consideration of:

- The types of hazard facing a group
- The level of exposure to this hazard
- The level of sensitivity to this level of exposure
- The ability to cope

These are discussed below.

3.1.1 Vulnerability assessment

Each island must 'scope' the potential impacts of climate change it will experience and assess which sectors might be vulnerable to specific impacts. This exercise is termed a vulnerability assessment.

Definition of vulnerability assessment !

Vulnerability assessment identifies who and what is exposed and sensitive to change.

In Chapter 2, it was noted that both risks and vulnerability need to be understood before effective planning could be undertaken. Chapter 2 describes the process of assessing risk and this chapter focuses on assessing vulnerability. Therefore it requires an exploration of the three elements of vulnerability, i.e. level of exposure to climate changes, sensitivity to these changes and the ability to cope.

What is the likely level of exposure to climate changes? The answer to this question is intrinsically linked to existing hazards, to current and future climate impacts and social, economic and environmental conditions. Understanding climate impacts is an important first step. Much information exists that can assist the regions to assess the potential hazards they will face. For example, a simple overview of recent developments on Viti Levu, the main island of Fiji where 77% of the population, the major cities, industries and tourism are located, shows the pressures that exist and the stresses that they have caused. Already Viti Levu's coastal areas are naturally exposed to weather events. About 86% of the 750 kilometres of coast are less than 5 metres above sea level. Intensive urban development, growing poverty, deforestation of watersheds, pollution and increased exploitation of coastal resources have exposed large areas of the coast to inundation and erosion. Shorelines have been retreating over the past few decades due to the loss of mangroves. Therefore it is immediately apparent where the vulnerable areas are. We know what the climate change impacts are likely to be and hence we identify very specific areas of vulnerability under future climate changes, see Table 3.1. Of course, the degree of vulnerability in each sector varies according to national circumstances in each country.

Table 3.1 Examples of areas of vulnerability to current pressures and to future climate changes in Viti Levu, Fiji

e.g.

Area of vulnerability	Development and environmental pressures	Current and future problems
Coastal areas	Deforestation of watersheds Exploitation of coastal resources	Coastal erosion Coastal inundation
Water resources	Pollution of water supply Droughts	Limited access to fresh drinking water
Agriculture	Over-reliance on sugar cane due to subsidies	Lack of adequate food crops
Public health	Dengue fever Diarrhoeal disease	Nutrition-related diseases

When thinking about vulnerability to current and future changes it is useful to adopt the WEHAB+ framework. WEHAB+ is simply an acronym to remind us of six important supports for society, these are:

- **W**ater resources
- **E**nergy supply
- **H**ealth
- **A**griculture and food supply
- **B**iodiversity, terrestrial and marine ecosystems (incorporating forestry, fisheries, biodiversity, coral reefs, etc.)
- **+** includes Human settlements and infrastructure (particularly coastal)

Water resources are often critically important in small islands, sustaining human health and welfare, agriculture and biodiversity for example. Some small islands do not have any surface rivers and they rely on a few underground freshwater lenses. Even those islands where there are groundwater resources often experience limited recharge. Assessing how vulnerable water resources are to climate changes, including sea-level rise, is a central part of the assessment process. Four specific areas of concern arise:

- What is the impact of sea-level rise and salt-water intrusion?
- What is the impact of reduced rainfall?
- What is the impact of increased evaporation?
- What are the impacts of changing rainfall patterns and intensity?

Thinking through these changes and who they will affect is a useful starting point for a vulnerability assessment, see Table 3.2.

Table 3.2 Vulnerability assessment of water resources on a small island

Climate change	Exposure	Who or what affected
Sea-level rise and saltwater intrusion	• Salinisation of water lenses • Less fresh water available	• Human consumption and health • Water suppliers • Plant nurseries and parks • Biodiversity, protected areas
Reduced average rainfall	• Less fresh water available • Droughts	• Aquifer recharge rates • Cisterns and reservoirs • Biodiversity
Increased evaporation rates	• Soil erosion	• Farming community; crop yields • Biodiversity
Increased rainfall intensity	• Runoff and soil erosion	• Reduction in crop production • Sedimentation of water bodies • Blocked storm water wells

Adapted from: Hurlston (2004)

Table 3.2 shows that climate change is likely to increase the exposure of small islands to water shortages for various reasons. Specific groups are likely to be sensitive; for example, those who rely on subsistence agricultural production and families who rely on cisterns may have to consider other means of accessing water. In this table we have not considered the ability to cope, although there are a variety of strategies that could be adopted, such as more stringent water resources management, more or larger desalinisation plants and water conservation schemes, and protection of non-contaminated water lenses.

It is also acceptable to develop a qualitative vulnerability assessment. A simple vulnerability assessment of the fisheries sector has been carried out for Montserrat, see Box 3.2. The process of assessment was undertaken as above: first there was consideration of the potential risks, and then there was assessment of the vulnerable systems that can be affected.

e.g.

Box 3.2 A simple vulnerability assessment of fisheries in Montserrat

Fisheries are crucial to the livelihoods of many Montserratians.

Main impacts of climate change:

Higher sea surface temperatures, sea-level rise, and increased storm intensity.

Impacts on fisheries:

- Coral bleaching leading to coral decline and death = loss of fish breeding and harvesting grounds leading to lower fish stocks and catch.
- Inundation of coastal wetlands and erosion of beaches = loss of mangroves, leading to lower fish stocks and contamination from land based pollutants. Loss of protection for beached boats during storms, disruption of beach fishing methods.
- Damage to coral reefs and sea grass beds leads to lost habitat for fish, turtles and conch. This leads to smaller fish catch and threatens fisheries based livelihoods.

Adapted from: Gray (2004)

The vulnerability assessment in Box 3.2 demonstrates an initial assessment. However, it provides enough information to decision makers to enable them to start to factor climate change impacts into their thinking and planning for the fisheries sector.

go to See section 6.2.12 for links to resources which give examples of, and information about assessing vulnerability.

3.1.2 Vulnerability indicators

To prepare for climate change it can be useful to measure how vulnerable different social and ecological systems are to climate change impacts. Monitoring changes in these systems can be achieved through the use of indicators. Indicators do not need to be quantitative, they can be qualitative. The main purpose of indicators is to reveal changing levels of vulnerability.

In general, indicators that reveal the vulnerability of one group to a specific hazard are not transferable to another location or group. For each hazard faced and for each group experiencing the hazard (e.g. an island community) it is always useful to go through the thought process to create new indicators for the context in which they are to be used.

KEY message

It should be remembered that complicated indicators of vulnerability are not necessary to reveal changes in vulnerability to hazards. Simple indicators work just as well.

In Table 3.3 we present a set of indicators that might be useful for a small island facing tropical cyclone risk. These indicators were developed through a brainstorming process by six individuals from different Caribbean islands. This is not an exhaustive list, simply a set of indicators that could be used to show changing levels of vulnerability to tropical cyclones.

Table 3.3 Examples of vulnerability indicators for tropical cyclone risk

Key / threatened systems	Concerns	Indicators
Coastal zone	Vegetation loss	• Vegetation mapping (satellite imagery, aerial photos, ground-truthing, GIS) before and after event
	Beach loss	• Beach profiling before and after event, calculating sand budget / volumes and beach width
Water resources	Contamination of groundwater	• Percentage (%) of septic tanks susceptible to overflow • Location and % of aquifers testing positive for faecal coliform
	Supply/scarcity	• % of population dependent on public supply vs. % of population who have cisterns
Human health	Mortality	• Number (No.) of deaths during past events
	Disease	• No. of cases of dysentery, cholera, dengue contracted after last major event
Tourism sector	Tourism infrastructure damage and economic loss	• No. of rooms and revenue-generating nights lost • % of residents employed in sector, and of total revenue represented by sector or individual properties
Low-income housing	Mortality	• No. of deaths during past events
	Exposure	• No. of hurricanes passing within 100 miles
Agriculture	Crop resilience	• % of crop failure due to winds exceeding 75 mph • Heavy rainfall exceeding monthly average / crop threshold
	Livestock	• Livestock mortality during past events • % of farmers with shelter for livestock
Government functioning	Awareness information supplied by Govt.	• No. of Government documents produced • No. of radio announcements • % of population with access to the media
	Trust in forecasts	• % of forecasts accurate over 10 year period

There are many other sectors and systems that might be threatened by climate change. Appropriate indicators for these other systems have been developed by a number of agencies. For example, the South Pacific Applied Geoscience Commission (SOPAC) has compiled environmental vulnerability profiles for most countries using 50 indicators. Much information about environmental vulnerability is accessible on the SOPAC website. The Tyndall Centre for Climate Change Research has also been conducting a project on indicators of vulnerability.

go to See sections 6.2.9 and 6.2.10. These include links to SOPAC and the Tyndall Centre and section 6.3 for references to Kaly *et al.* (2002) and Adger *et al.* (2004).

3.2 How to assess the physical climate change hazards threatening your island

3.2.1 Use of existing climate data

Over a 15 year period, the Intergovernmental Panel on Climate Change (IPCC) has produced three global assessments of the potential impacts of climate change on the various regions around the world. In addition, various regional projects have sponsored research into the impacts of climate change on their region. Where these do not exist, the global IPCC reports can be useful in explaining the main risks faced.

There are many different ways in which climate change will manifest itself, although there are six main threats associated with climate change that all islands need to consider:

1. Increases in average temperature
2. Increases in sea level
3. Increases in sea surface temperature
4. Changes in rainfall patterns (timing, frequency, intensity)
5. Changes in ocean acidity
6. Changes in tropical cyclone intensity

Information on the projected changes in these variables can be found in a variety of sources. For example, the IPCC Distribution Centre and the UK Climatic Research Unit. This information is particularly useful in the context of the current pressures and hazards faced. For example, a low-lying island that is experiencing rapid mangrove clearance for residential or tourism development needs to take into account: increases in sea level; changes in rainfall; and changes in tropical cyclone intensity.

go to See the Scientific Annex and Chapter 6 (section 6.2) for information about the science of climate change, and access to the sources quoted above.

3.2.2 Development of regional scenarios

For most small islands, local or even regional assessments of the impacts of climate change may not yet exist. Developing these scenarios is useful to ensure that the most detailed information about potential risks is available. There are freely available models that can be accessed to develop regional models of climate change, such as the PRECIS (**P**roviding **R**egional **C**limates for **I**mpact **S**tudies) model developed by the UK Government's Hadley Centre. PRECIS is a regional climate modelling system available to anyone who wishes to generate regional climate information with useful local detail including realistic extreme events. It is designed to run on a PC and can be applied easily to any region of the globe to generate detailed climate-change predictions.

Section 6.2 under the UK Met Office and Hadley Centre provide a link to the PRECIS website where you can download an information sheet and brochure. These give an updated description of PRECIS, examples of its use and cover aspects such as availability, support and requirements.

Scenario generator models are also freely available, such as MAGICC (**M**odel for the **A**ssessment of **G**reenhouse-gas **I**nduced **C**limate **C**hange) and SCENGEN (A Regional Climate **SCEN**ario **GEN**erator). MAGICC and SCENGEN are user-friendly interactive software suites that allow users to investigate future climate change and its uncertainties at both the global and regional levels. In running MAGICC/SCENGEN, the user can intervene in the design of the global or regional climate change scenarios.

Section 6.2.9 under the Climatic Research Group provides a link to a webpage where these models may be downloaded.

These 'off-the-shelf' models are very useful, and the examples recommended above are the best that are currently available. These models should be viewed as an interim measure only. More refined scenarios can be generated by drawing on local weather data. Local meteorological data can be used to reveal local trends in rainfall and average annual temperature as well as seasonal changes that are occurring.

In many cases local weather data will not exist. In fact in many small islands there may not have been much investment to date in meteorology at all. Even if local data are not currently available it is useful to begin collecting local weather data to provide information to decision makers over time on how key indicators have changed.

3.2.3 The consequences of waiting for more detailed information to become available

As explained in the Scientific Annex to this guidebook, climate change is a science that is riddled with uncertainty. However, there is much that we know without any doubt

already. For example, we know today that if the concentration of carbon dioxide in the atmosphere continues to increase then the temperature will increase. It is up to individual decision makers to balance the potential risks with the known uncertainties. For example, we do not know exactly how the changes in the composition of the atmosphere will change weather patterns, seasonality and climate regimes around the planet. We also do not understand biological or ocean systems well enough to know precisely what an increasingly acidic ocean will do to marine life, or what a warmer climate will do to flora and fauna around the world, although we can make general predictions.

go to The Scientific Annex provides more information about the causes of climate change, climate scenarios and issues of uncertainty.

The problem with waiting until these latter uncertainties are resolved is that we may have passed a point of no return in the climate cycle. It is up to individual islands to inform themselves, learn about the risks posed by climate change and weigh up their options.

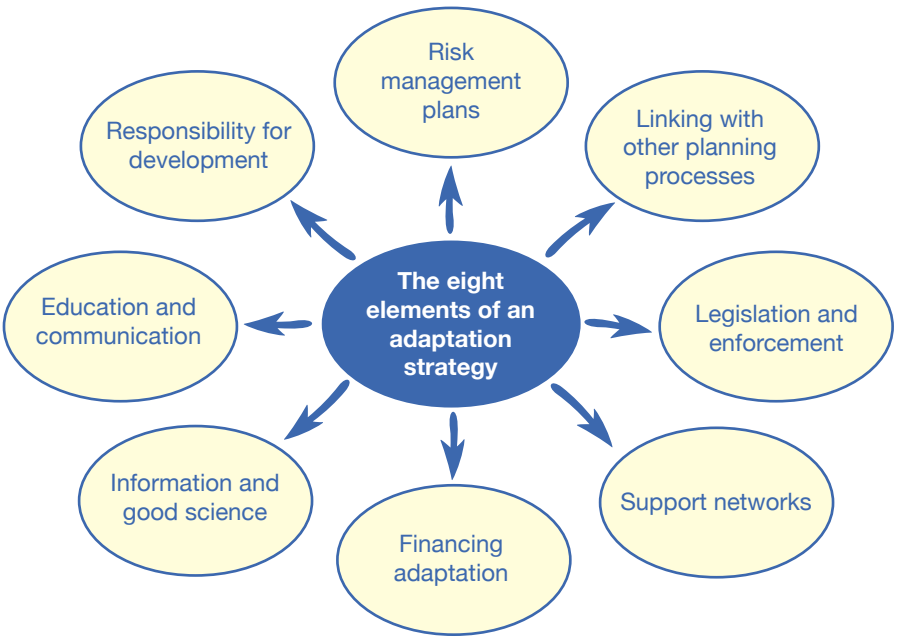
3.3 Elements of an adaptation strategy

Designing and producing a climate change adaptation strategy involves bringing all the elements described in this chapter together to understand what climate change really means for your island. Developing an assessment of the impacts of climate change will help you to begin to build your capacity to adapt.

Any adaptation strategy has to be developed according to the unique conditions that exist in each country. Traditional ways of making decisions, expectations of government, reliance on overseas assistance and other factors will each affect how a strategy is developed. An appropriate strategy for Cuba may not be appropriate for the Turks and Caicos Islands. Nonetheless, there are some useful guiding principles that can be applied to every country. As demonstrated in Figure 3.1, any adaptation strategy must contain 8 elements, which deal with:

1. Responsibility
2. Plans
3. Legislation
4. Links with other planning processes
5. Education
6. Other people
7. Science
8. Money

Figure 3.1 Elements of an adaptation strategy



These 8 elements are all necessary but to varying degrees. In one island, it might be more important to promote the planning aspect to bring all parties on board, in another island where climate change has already been identified as an issue needing attention, a focus on building regional networks and allocating responsibilities might be more appropriate. In other islands, where there is much scepticism there might need to be a greater investment in information and good science.

The following chapters detail a process beginning with the initial thinking about developing a strategy and then the development of plans to manage new forms of risk. Chapter 5 explores the issues relating to laws, education, building networks with other people, the role of science, and paying for adaptation.

3.4 Taking the first steps

The first step in developing a strategy involves getting the right people on board. This section considers who should be included and how to engage them in a process of deliberation.

3.4.1 Who is responsible, who decides, whose opinion counts?

Climate change is not just a problem for government. Climate change will affect every person and living thing on this planet. Governments can take many actions to

help people prepare for climate change however government alone cannot prepare a whole nation for the impacts of climate change. Entire societies, including individuals, communities, clubs, social groups, local government, private businesses and international organisations all need to be actively involved in the preparedness and adaptation process.

There is no 'perfect' road map to developing an adaptation strategy. Each country will be used to developing planning and management strategies in its own way. If a specific approach already works, then we would recommend that this be used.

If however, there have been problems of lack of public support for strategies then the question of who should be included in the strategy-development stage is critical. Public consultation (and ideally engagement) of some form is necessary. This is both to raise the profile of the issue and to identify priorities that need addressing that may have been overlooked by government. Public consultation and engagement can be undertaken in many different ways, such as community group meetings, electronic debates, public fora or opinion polls. It should be stressed that the tried and tested methods used in-country should always be used first.

3.4.2 Making trade-offs between risk, cost and public participation

Balancing the concerns and considering who decides, who pays and who bears the risks associated with climate change is at the heart of any strategy to adapt to climate change. Those who decide are often removed from the risk, those who pay sometimes do not face the risk, and those who bear the risk sometimes do not have their voice heard in the decision making process. There are clear trade-offs that have to be made between minimising the cost of adapting to climate change, minimising the risk of damages occurring, and ensuring that local voices are heard in the decision making process, so that local views and values can be taken into account.

Research undertaken in the Orkney Islands off the coast of Scotland revealed that most residents who are vulnerable to climate change are unwilling to compromise their opportunity to participate in the decision making process for possible risk reductions. In the research it was found that the Orkney Islanders felt that they could interpret the scientific uncertainty as well as the politicians, and they would know best what preparedness activities would be most appropriate. When asked to state how important minimising risk of future disruption, minimising the cost of responding to climate change and ensuring that local voices are heard, community members ranked local participation in decision making as most important, see Table 3.5.

Table 3.5 Risk, cost, 'voice' trade-offs in decision making about climate change in the Orkney Islands, Scotland

e.g.

CRITERION	RANK
Risk of future disruption should be minimised	2
New spending should be minimised	3
The decisions made must reflect local views	1
Most important = 1	

Adapted from: Brown et al. (2005)

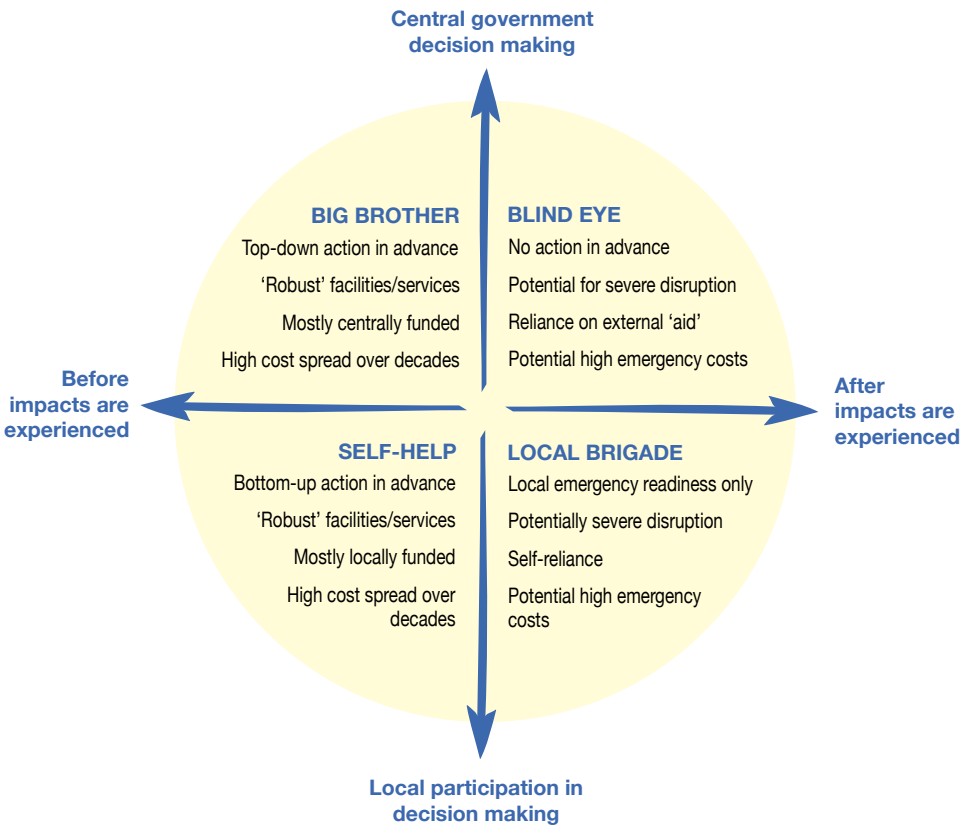
To prepare for climate change, the questions: who decides, who pays, and who bears the risk have to be considered and trade-offs made. Each island needs to make these trade-offs.

Broadly, decisions can be made either centrally by decision makers or locally by people affected by the impacts. Decisions can be taken to prepare for climate change impacts either before or after the impacts are felt. Whoever makes the decision and decides on the timing of implementation of action will have a lot of power to decide who will experience the impacts. Thought therefore needs to be given to two key questions:

- Should climate change adaptation decisions be taken centrally by government, or should communities be given the choice about how they would like to prepare for climate change?
- Should decisions be taken in the anticipation of uncertain events or should decisions be deferred until more concrete information is made on which to base these decisions?

These are not simple trade-offs but value judgements that have to be considered. There is no right answer. Whichever decision is taken, there must be realisation of the potential errors associated with that course of action. Researchers from the Tyndall Centre for Climate Change Research created a visual representation of these trade-offs to assist decision makers consider the consequences of the various management approaches, see Figure 3.2.

Figure 3.2 Trade-offs between scale of decision and timing of decision



Adapted from: Brown et al. (2005)

The question of who pays for adaptation is extremely topical and again there is no 'right' answer. Nonetheless, in low-lying islands, adaptation to climate change needs to be a priority and resources need to be found to support it.

3.4.3 Embarking on a strategy-development process

Climate change affects almost all government actions and impinges on all government activities. Hence a climate change focal point, an individual whose sole responsibility is to research, communicate and organise climate change activities by the government is vital. This person can be based in any department. Unfortunately with any new initiative there is always the potential problem of departmental territorialism.

The focal point can provide many services, and the first objective of the focal point should be to develop a set of goals and objectives. Without a clearly defined mission, the

focal point could just end up replying to information requests 24 hours a day and 7 days a week. The main goals of the climate change focal point could be to:

- Provide a link with regional climate change adaptation programmes and other regional focal points
- Work with other government departments to integrate climate change issues into general planning processes.
- Be a source of knowledge and resources on climate change and climate change adaptation measures
- Assess areas of existing vulnerability
- Manage the public consultation programme to shape the climate change adaptation strategy
- Raise the profile of climate change and climate change adaptation within the government
- Motivate government, private sector and individuals to think about and prepare for climate change and its impacts.
- Work with other government departments to raise their level of understanding about climate change and climate change adaptation

See Box 3.3 for an example of how climate change is being managed by the UK government.

e.g.

Box 3.3 Managing climate change in the UK

The UK Government has focused on:

- monitoring climate trends and funding good science to understand what is happening to the climate
- working with scientists to estimate the costs and benefits of climate change
- education and communication through the UK Climate Impacts Programme (www.ukcip.org.uk)
- creating support for policy makers through the Global Atmospheres Division within the Department of Environment, Food and Rural Affairs
- building support networks through EU and G8 leadership focus on climate change
- making plans and assessing risks of climate change on government functioning

Even though the UK is a larger nation with more resources, there are many lessons that can be learned from this approach.

3 Summary and key references

There are a number of common climate change impacts that might be expected to affect small islands. However, the hazards that these present will be specific to each island. This is because the outcomes of the climate changes that are experienced will also be dependent on social, economic and geo-physical characteristics. These combine to determine the vulnerability of small islands, their sensitivity to the impacts and their capacity to adapt to the changes.

All signatories to the United Nations Framework Convention on Climate Change (UNFCCC) are required to prepare a National Communication comprising three major elements: a national greenhouse gas inventory, abatement analysis, and vulnerability and adaptation assessments. Examples of national communications prepared by other small island states, which include vulnerability assessments, or existing communication for your island may be useful. National communications by small island states can be accessed via the UNFCCC Secretariat.
This chapter has concluded by outlining the main elements of an adaptation strategy upon which Chapters 4 and 5 will build. Before starting to develop an adaptation strategy, identify:

- Critical climate change impacts
- How these impacts will be felt locally (i.e. what the local impacts/hazards are likely to be)
- What are the key vulnerable areas
- Why are these areas vulnerable
- How to address these vulnerabilities (i.e. what are the adaptation options)
- Local conditions that may facilitate adaptation

Key references:

- IPCC Third Assessment Report on Impacts, Adaptation and Vulnerability. Chapters 1 and 17 are particularly relevant. Chapter 17, for example, gives regional projections for future temperature and precipitation change (Atlantic, Caribbean, Pacific, Indian Ocean, and the Mediterranean).
- The Adaptation Policy Framework by the United Nations Development Programme
- For information about reducing risk and managing vulnerability; International Federation of Red Cross and Red Crescent Societies World Disasters reports: Focus on Reducing Risk (2002) and Focus on Community Resilience (2004); Bethke *et al.* (1997) Building Capacities for Risk Reduction; Living with Risk: A global review of disaster reduction initiatives. The United Nations International Strategy for Disaster Reduction (2004); Kaly *et al.*, (2002).
- Sector specific publications highlighting vulnerability and how to build resilience in these sectors include: Global Coral Reef Monitoring Network; the World Health Organisation; IUCN – World Conservation Union; Adaptation of water resources management to climate change (Bergkamp *et al.*, 2003)
- Kaly *et al.* (2002) for information about managing environmental vulnerability in small island developing states.
- National communications to the UNFCCC (which include vulnerability assessments): http://unfccc.int/national_reports/non-annex_i_natcom/items/2979.php and National Adaptation Plans of Action (NAPA's)
- UNFCCC Compendium on methods and tools to evaluate impacts of, vulnerability and adaptation to climate change (http://unfccc.int/adaptation/methodologies_for/vulnerability_and_adaptation/items/2674.php)

Chapter 6 provides reference details and web-links to this information and other useful sources.

4 Developing an adaptation strategy

Contents

- Making plans to prepare for climate change
- Linking climate change with other planning processes
- Making successful adaptation decisions

After working through this chapter you will:

- Understand the different kinds of plans that are useful for adapting to climate change
- Understand that these plans cannot stand alone, they must relate to other planning processes
- Understand some of the moral issues and value judgements that have to be made when preparing for climate change

4.1 Making plans to prepare for climate change

Plans are important: both *visionary plans* that consider what could be done and *implementation plans* that detail who will do what, where and why, when will actions happen and who will pay for the costs. Detailed risk management plans need to be in place, showing who is responsible, when they need to take action, how they should act and to whom they should report.

Detailed risk management plans are often not made because individuals and organisations often do not take risk management seriously. This could be because they:

- Believe hazards are unlikely to affect them, or that the risk is very low.
- Believe that, if a hazard hits, they will be able to 'muddle through'.
- Are busy with other things, so risk management receives low priority.
- Consider risk management an expensive luxury.

Most of these reasons stem from a lack of awareness of the actual risks associated with hazards. As a result of these beliefs risk management is often sidelined. When this happens disasters are more likely to happen. Examples of high costs associated with a lack of planning can be found globally. In recent years there have been several high profile climate-related hazards that were unexpected. Each of these hazards led to deaths and high post-hazard recovery costs.

- *Example 1 (1987)*: high winds, referred to as 'the UK hurricane', caused chaos in the UK when a strong storm affected southern England (see Section 4.2).
- *Example 2 (2003)*: a heat wave in France led to the deaths of many elderly and poor people.
- *Example 3 (2004)*: in the Caribbean, four major hurricanes affected many islands, some islands were clearly better prepared than others.
- *Example 4 (2004)*: in South-East Asia, an earthquake and then a tsunami led to many thousands of deaths.
- *Example 5 (2005)*: Hurricane Katrina affected New Orleans and lack of planning meant that many people suffered unnecessarily.

It has been argued that if better plans were in place, for example, a heatwave plan, an evacuation plan or an early warning tsunami plan, many lives that were lost in these events could have been saved. However, the existence of plans alone does not save lives. It is the effective implementation of these plans that is important. The critical elements in implementing plans are discussed in Chapter 5.

Plans are very important in preparing for climate change. It is important to differentiate between two types of plan. One-off or sudden-onset hazards can be planned for using specific implementation plans which detail what to do, when to do it, who should do it, why they should do it, how they should do it and who will pay. Such plans specify behavioural and institutional actions that individuals should undertake under certain

conditions. Slow-onset hazards and slowly changing conditions require a different type of planning. Here the focus needs to be on a continual assessment of the hazards faced and those most vulnerable to the hazards. These visionary plans describe broad objectives that governments might want to pursue. Both types of plan may be implemented through various means, for example: laws and policies; technical fixes; organisational and behavioural changes; financial mechanisms; public outreach, education and awareness-raising.

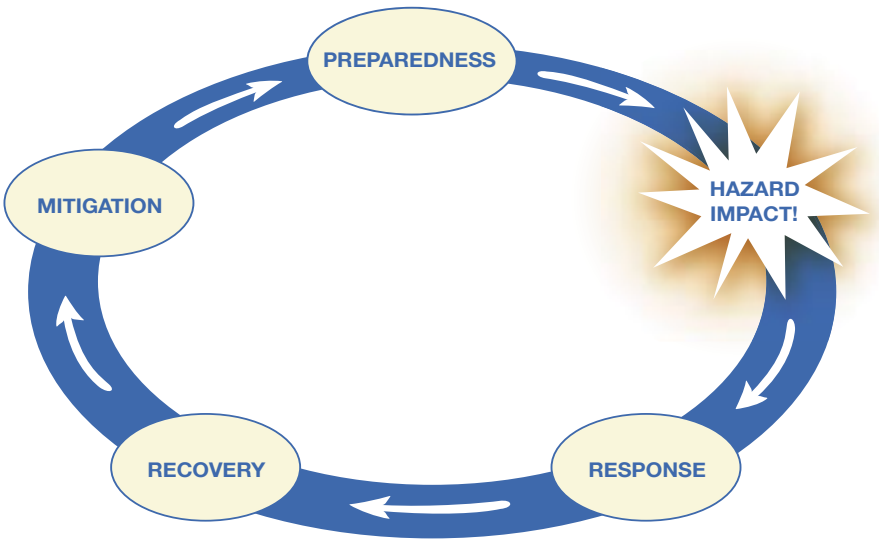
Climate change will bring both sudden or extreme events (such as intense rainfall events, floods or storms and heat waves) and slow-onset hazards from changes in environmental conditions (such as a rising sea level, increased erosion rates or a warming sea). To prepare effectively, each type of change requires a different method of planning.

All plans must include backups and alternative strategies in the event that the first option does not work. Without careful advanced planning and preparation, testing and re-testing of the plans, climate change plans cannot be effective.

4.1.1 Develop implementation plans to prepare for sudden or extreme events

With sudden or extreme events the range of potential impacts are most often known or can be estimated. In these cases hazard mitigation and preparedness will save lives as well as costs of repair and recovery. The disaster risk management approach can be used to develop detailed implementation plans for sudden or extreme events. The disaster risk management approach informs us that for any hazard we must plan, prepare, respond and then recover. See figure 4.1.

Figure 4.1 The Disaster Risk Management Cycle



Plan
Planning is critical before a hazard occurs and it should guide both the preparedness and the recovery processes. Good advanced planning can eliminate or reduce the probability of a disaster, or reduce the effects of unavoidable disasters. Examples of hazard planning include: undertaking vulnerability analyses; active public education; implementing tax incentives and disincentives to change public behaviour towards risk; re-allocating resources; introducing more effective preventive health care. Examples of hazard planning to facilitate recovery include: strengthening building codes and regulations; reconsidering zoning and land-use management; disaster unemployment insurance and risk assessment studies.

Prepare
Preparedness refers to activities taken prior to a disaster, to save lives, minimize disaster damage, and enhance response operations. During this phase, governments, organisations and individuals develop plans and implementation strategies. Examples include: preparedness plans; emergency exercises/training; warning systems; emergency communications systems; evacuation plans and training; mutual aid agreements; and public information/education.

Respond
Response refers to activities during and following a disaster to provide emergency assistance for casualties, reduce the probability of secondary damage, and speed recovery operations. Examples of responses include: public warning systems; notifying of public authorities; mobilizing emergency personnel/equipment; emergency medical assistance; manning emergency operations centres; declaring disasters and evacuating; mobilizing security forces; search and rescue; and emergency suspension of laws.

Recover
Recovery refers to activities following a disaster, which continue until all systems return to normal or better. Examples of recovery include: returning life-support systems to minimum operating standards; damage insurance/loans and grants; temporary housing; long-term medical care; public information; health and safety education; reconstruction; counselling programs; and economic impact studies.

Together, these four elements provide a comprehensive approach to preparing for and responding to sudden hazards. The disaster risk management approach recommends using the learning cycle as described in Chapter 2, see Figure 2.4. This is because it is very difficult for people to prepare for events that are bigger or more severe than has previously been experienced. Hence, preparedness tends to be based on the most recent 'bad' event. By incorporating a learning process into the disaster risk management cycle, it ensures that after every event, successes will be built upon and failures identified and reflection will be given to how to prevent them from happening again. For an example of the adoption and use of the disaster risk management approach in the Cayman Islands, see Box 4.1.

e.g.

Box 4.1 Successful adaptation to tropical storm risk in the Cayman Islands

In the Cayman Islands preparing for tropical storms has largely followed the disaster risk management process, i.e. plan, prepare, respond and then recover. While the disaster risk management approach is generic, it has been successful in the Cayman Islands because it has been adapted to local conditions. Factors that led to the development and adoption of the Cayman Islands disaster risk management strategy are:

- Mental link made between hazard events, vulnerability and impacts
- Important respected individual takes responsibility for the issue
- Respected individual persuades others to engage with the issue
- Small group of concerned individuals formed
- Small group pushed for preparedness action in their areas
- National Hurricane Committee formed

Annual planning process begins: develop preparedness plans (January – April); test plans (May); on standby during hurricane season (June – November); review successes and failures of plans (December – March); revise plans (March – April); test plans (May)…and so on.

The lesson that the Cayman Islands' Government can take forward in its planning for climate change is the process of making plans, revising plans and accepting that plans are not perfect, but constantly require upgrading and improvement.

By accepting that no plan is perfect, each department is then able to revise its plan annually without any fear of criticism or sense of failure.

Climate change can potentially change the frequency or intensity of sudden or extreme events. Therefore, as part of a climate change adaptation strategy relevant disaster risk management plans need to be in place. These plans must detail who is responsible, when they need to take action, how they should act, to whom they should report and who will bear the cost of the action. The plans must include backups and alternative strategies in the event that the first option does not work. Without careful advanced planning and preparation, testing and re-testing of the plans, disaster risk management cannot work.

4.1.2 Develop visionary plans for slow-onset climate hazards

Climate change will lead to slow but continuous changes in sea level, atmospheric and sea surface temperature and rainfall. Such slow-onset and continuous hazards cannot be prepared for in the same way as individual hazards. This is because slow-onset hazards can reach thresholds beyond which they have sudden impacts (such as sea surface temperature and coral bleaching), or because of the accumulation of past changes (for example sea-level rise and low lying islands). Preparing for the slow changes in climatic conditions and the consequent impacts is therefore difficult. Managing these changes requires an acceptance of change and a flexibility to adapt to constantly changing conditions. It also requires a much greater recognition of the importance of weather information in long term or strategic planning. Nonetheless there are tools that can

be used to help prepare, such as scientific monitoring, education and communication, supportive legislation, as well as technical hazard assessment and vulnerability assessment.

go to See section 3.1 on vulnerability assessment, and Chapter 5 on legislation, education, communication and scientific monitoring.

None of these tools are adequate by themselves to help prepare for slow-onset hazards. They can only work successfully if these ideas are integrated into all areas of government planning and policy making. Hence the key activities in planning for slowly changing risks require tackling fundamental causes of vulnerability and 'climate proofing' government plans, policies and strategies in all areas of government business. 'Climate proofing' can be as simple as taking climate change impacts into account when undertaking long term planning. Some of the main ways in which this can be undertaken are described in Chapter 5. Broadly, it is through education and communication, changing legislation, and allocating resources to this activity.

4.1.3 Focus on reducing social and economic vulnerability

Tackling the causes of vulnerability involves building resilience into natural systems and reducing social and economic vulnerability to hazards in general. Hence, a visionary climate change adaptation plan needs to focus on reducing social and economic vulnerability in conjunction with development planning – with an explicit objective of reducing vulnerability to climate change impacts.

Vulnerability reduction is not a new idea, it basically describes the roles of most government departments, such as social services which already care for the poor, the elderly, the disabled, and those living in sub-standard conditions; finance and economic units, which encourage the development and enhancement of livelihoods, helping those living on the margin or in poverty; environmental and public health aim to reduce the factors that compromise people's well-being. All arms of government need to be involved in reducing vulnerability. For example, higher branches of government must support departmental activities through adequate allocation of much needed resources, and have the political will to carry forward policies that are developed through widespread public consultation but rarely implemented, e.g. effective environmental management and resource conservation and rehabilitation. Climate change poses new and additional risks to those who are already vulnerable; remembering to focus on vulnerability reduction is a really important step towards preparing for and adapting to climate change.

Developing risk management plans that address sudden or extreme events as well as visionary plans that 'climate-proof' decisions that the government is making are important. However the other elements in an adaptation strategy need to be explored. Chapter 5 reviews these other elements in detail.

4.1.4 The role of technical fixes

There are a few technical approaches to managing risk. Two important 'fixes' are early warning systems and hazard mapping/monitoring.

Definition of early warning systems !

Early warning systems do exactly what they say they do – they let you know that you are at risk from a hazard and that your risk is changing. They can be complex and expensive electronic surveillance systems such as seismic activity detectors, or simple social systems, such as radio announcements to indicate approaching tropical cyclones.

Early warning systems have been used throughout history, for example, during World War II, air raid sirens were used in the UK to alert the British people to the fact that the German air force were approaching and to expect bombing raids to begin. Other examples of early warning systems are pollen counts given on weather forecasts, and earthquake risk monitoring systems in some parts of the world. Early warning systems are already in place in many islands to alert residents to approaching storms.

Early warning systems are only useful if everyone knows what the system of warning means, what the stages of warning are and what to do when the warnings are given. If the warning is given and no one responds then it is useless. The trouble with early warning systems is that sometimes people fail to heed them. This can happen for many reasons. One is because people lose faith in the system. This can occur when the early warning signal is repeatedly given but the hazard does not occur; this was an issue in the years prior to Hurricane Ivan in the Cayman Islands. See Box 4.2.

e.g.

Box 4.2 Crying wolf – the case of early warning in the Cayman Islands in 2002

In 2002, during hurricane season, there were three calls by the National Hurricane Committee to prepare for a hurricane. The schools were closed and government employees were sent home, hence the private sector had to follow suit (people needed to collect their children from government schools). In all three instances there was no impact by the hurricane – it passed by the islands.

At the end of the hurricane season there was much criticism of the National Hurricane Committee in calling for a government shut down as the private sector estimated the cost of this closure in terms of their profits. The National Hurricane Committee lost some of its credibility in the following year, as people paid less attention to their warnings. This is not a criticism of the National Hurricane Committee, but it draws attention to the problem that early warning systems can be ignored if they turn out to be false alarms and do not always precede a hazard impact.

Early warning systems however have been recommended for a number of climate hazards that have been experienced in recent years including extended periods of heat stress, tsunamis and volcanic eruption. Early warning systems have to be developed in a manner that is suitable for the cultural context. For example, in the past flags were used to communicate the level of threat from a hurricane in the Cayman Islands. However as the population has changed and the immigrant population has increased, there is no longer a general understanding of the meaning of these flags. There is more reliance on radio and television (particularly local channels) and though flags are still flown on all Government and other public buildings. Early warning systems therefore require constant review to ensure that they are understood and that people know what to do when early warnings are given.

Another important technical fix for adapting to climate change is the production of indicators which monitor vulnerability in key sectors and can be used as a signal for when decisions are needed.

go to See section 3.1.2 for specific information about vulnerability indicators for tropical cyclone risk and the sources described in section 6.2.12.

Other technical fixes include monitoring, assessment and mapping of ecosystems and land use. Because of the coastal nature of small islands there should be a focus on coastal hazards, which can generate coastal flooding, beach erosion, destruction of infrastructure among other problems. There are many ways of monitoring and mapping land use practices, three are suggested:

1. Build and expand long-term beach monitoring programs to show changes in coastal conditions
2. Promote increased use of geographical information systems (GIS) and remote-sensing/spatial planning applications to assist in visualising climate impacts
3. Establish a computer network linking major sea-level rise and climate change monitoring institutions

Several of these activities can be funded through global or regional programmes which are establishing monitoring stations. For example: GEOS, the Global Earth Observation System is being established by the World Meteorological Organisation to monitor regional changes in climate; CPACC, the Caribbean Planning for Adapting to Climate Change, has created a set of 18 sea-level monitoring stations in the Caribbean.

Definition of hazard mapping !

The process of establishing where and to what extent particular phenomena are likely to pose a threat to people, property, infrastructure and economic activities. Hazard mapping represents the results of a hazard assessment on a map, showing the frequency/probability of ocurrences of various magnitudes or durations.

4.2 Linking climate change with other planning processes

There is the danger that preparing for climate change can become an isolated activity that occurs in a single department and is not included in other departmental plans. Several activities need to be undertaken to ensure that this does not happen. Weather, climate and physical hazard information needs to be incorporated into the physical planning processes, and any planning needs to be linked to other planning processes.

4.2.1 Integrating weather, climate and hazard information into physical planning processes

By integrating weather and climate information and potential hazards into physical planning processes, it is more likely that infrastructural developments and the physical environment in general will be more robust to future impacts. This type of activity is often referred to as 'climate proofing' national development plans. To achieve this, a formal link must be made between those who understand climate change and the likely impacts (e.g. the Meteorological Office and the Department of Environment) and the planning arms of government. It may be that there is no Meteorological Office in the government; however, establishing a knowledgeable body who can interpret the climate science in the local context is a priority. If a Meteorological Office exists, the next step involves ensuring that the Meteorological Office is incorporated into development planning, either through inclusion on a planning committee, or by requesting that prior to planning approval being given, the Meteorological Office 'climate check' the plans to ensure that there is headroom in the plan for potential climate impacts. This level of inclusion of the Meteorological Office is unusual, however the growing issue of climate change requires that meteorologists need to be involved in formal planning processes.

By formally including climate scientists in planning decisions, those making the decisions are forced to take climate science explicitly into account. As with any visionary planning, it is likely that for many years, the Meteorological Office will be included in processes of decision making in name only until the impacts of climate change start to be seen. Nonetheless, the very process of including representatives from the Meteorological Office will itself start to change the way decision makers think about and incorporate the weather and more importantly the climate into critical decisions.

For small islands, climate change is just one of many serious challenges with which they are confronted. Pressing priorities concerning socioeconomic issues such as, housing, education, and health care all compete for the resources available. Therefore, adaptation to climate change impacts certainly requires integration of appropriate risk reduction strategies with other sectoral policy initiatives in areas such as:

– Sustainable development planning

- Physical planning and development control (including infrastructure and transport planning)
- Natural disaster prevention, response and management
- Fresh water resource management and development
- Strategic environmental and public health management / planning
- Integrated coastal management (coastal and marine resource management and development)
- Agriculture development
- Economic initiatives and incentives
- Fisheries management and development
- Public education and awareness
- Sustainable tourism development

4.2.2 Linking with other planning processes

Identification of climate change threats as they relate to the national priorities of each country is necessary; the adaptation plan and associated proposals for policies and legal or institutional frameworks must be customised to respond to the specific needs of each country. Adaptation options should therefore be regarded in the context of contributing to sustainable development.

Because small island states traditionally experience some of the greatest variations in climatic and oceanic conditions on an annual basis, many of their natural systems are adapted to the stresses that future climate change may bring. Thus, many strategies that small island states might employ to adapt to climate change may be very similar to those that constitute sound environmental management, wise use of resources, and appropriate responses to present-day climate variability. Some of these strategies may well be developed already, or be at some stage of formulation.

People involved in the process of formulating an adaptation plan must, at an early stage, begin scoping:

a) The expected impacts of climate change and the hazards that these pose, the factors influencing how vulnerable an island might be to these impacts and hazards and the key vulnerable sectors

b) Existing policies across sectors, and how these might be relevant (e.g. either by acting to increase or decrease the vulnerability of your island)

Potential climate change adaptation options may overlap with policies currently in place.

Policies must also seek to be carefully integrated because the impacts of climate change do not simply affect one sector at a time. For example, the quantity and quality of available water supplies can affect agricultural production and human health. The importance of policy integration and careful consideration of the vulnerabilities of an island cannot be stressed enough. Wherever possible it is recommended that you try to identify clear linkages between sectors and key issues so that policy making can be clearly informed of the complexity of the challenges which climate change poses for your small island state. For example, a country which is heavily dependent on coastal tourism for foreign exchange, but which is also low-lying, exposed to storm surge and periodic beach erosion, a policy which fails to restrict beach sand mining and the harvesting of coral reef materials, will exacerbate vulnerability to climate change and sea-level rise.

Many states have a sustainable development agenda or a related clause in national development plans. Therefore the synergies between responding to climate change and measures that help achieve sustainable development objectives should be particularly supported. For example, activities that reduce pressures on resources, improve management of environmental risks, and increase the welfare of the poorest members of society can simultaneously advance sustainable development and equity, enhance adaptive capacity, and reduce vulnerability to climate change and other stresses.

go to See the key references listed at the end of this chapter, and section 6.2 which points you to a number of resources which relate to integrated management. For example The World Commission on Protected Areas.

Identification of likely impacts and possible intervention options or adaptation measures is your next step. Impacts by sector may perhaps be prioritised by their vulnerability. For example, because climate change and sea-level rise are inevitable in the future, it is vital that beach and coastal assets in small island states are managed wisely. Integrated coastal management has been identified and proposed as an effective framework for accomplishing this goal.

Box 4.3 presents some examples of potential adaptation options that you may want to bear in mind as you work through the rest of this guidebook.

e.g.

Box 4.3 Potential adaptation options for small islands

Coastal land loss and erosion:

- The application of beach setbacks for construction (e.g. amendment of building standards, development of new legislation and changing land-uses in the coastal zone).
- Vulnerability studies of the coastal zone
- Restore damaged or destroyed coastal ecosystems where technically feasible Construction of coastal engineering structures such as sea walls and breakwaters

Some sustainable development practices which would constitute responding to climate change:

- Water resource management (e.g. water saving devices, water conservation, establishing a management regime)
- The development of hazard maps
- The development of stricter building codes and land use policies.

Other options applying to all sectors might include:

Public education and awareness (e.g. in many sectors, for example, water conservation to increase awareness of climate impacts on water supply and to support adaptive responses)

Adapted from: Moore and Trotz (2001)

4.2.3 Driving climate change adaptation through one important policy

Links to other policy processes can be made by incorporating climate change risk into one aspect of decision making. In many Caribbean and Pacific islands, annual tropical cyclones require advance planning and the preparations occupy much time for most people. In many islands there is already an effective planning process in place. Highlighting the existing vulnerabilities and the expected additional risks under climate change can raise the profile of climate change adaptation. For example, actions could be built into tropical cyclone preparedness based on what is already known about climate change, these suggestions are presented in Box 4.4.

e.g.

Box 4.4 Actions to reduce vulnerability to heightened Category 5 tropical cyclone risk under future climate changes

1. Building codes and standards need to be better enforced:
   a. Especially tropical cyclone preparedness regulations, e.g. everyone must shutter homes; in the coast everyone must build with ground floor floodable
   b. In new developments encourage underground utilities to be used
2. Increase coastal set backs 'x feet' behind line of permanent vegetation or high water mark – which ever is higher
3. Enforce coastal set backs
4. Include the environment in economic appraisals
5. Generate management plans for coastline stabilisation
6. Natural resource conservation especially within the coastal zone e.g. plant mangroves
7. Factor in the increased risk of storms when considering new development projects in Town & Country Planning
8. Department of Environment setting up hazard reduction units
9. Develop incentives for new building-strengthening technology e.g. hurricane-resistant glass and buildings
10. Relocate vulnerable areas prone to seasonal flooding and convert back to natural environment e.g. wetlands, mangrove swamps, etc.
11. Provide better public education and incorporate climate change and storm planning / disaster management into the national curriculum
12. Provide training courses / education for developers to explain the risk of storm damage to them.
13. Change land use policy, e.g. increase the use of buffers

4.2.4 Developing a government climate impacts programme/agency

If resources are available, an alternative to fully integrate climate change into development planning is to build the climate change focal point into an agency. The remit of the agency would not be to make policy or to legislate, but to engage other government departments, businesses and individuals. The UK Climate Impacts Programme (UKCIP) is an excellent example of good practice. This small organisation (with a staff of seven people), funded only for staff salaries, not for research or enforcement, or policy making, has endeavoured over a five year period to help organisations to assess their vulnerability to climate change so that they can adapt effectively. This has been achieved through pursuing seven key objectives:

1) Promote and co-ordinate stakeholder-led assessments on the impacts of, and adaptation to climate change at a regional and national level, with an increased emphasis on exploring adaptation options within studies;

2) Provide stakeholders with common tools, methodologies and datasets to facilitate integration;
3) Develop a framework for integration and synthesis of studies, to progress towards a national integrated assessment of the impacts of climate change;
4) Provide advice and assistance to stakeholders and researchers on how to conduct studies and how to use impacts and adaptation tools and datasets;
5) Disseminate information;
6) Provide a focal point for climate change impacts and adaptation information;
7) Develop appropriate links with related programmes and organisations.

This bottom-up approach has enabled stakeholders to determine their own priorities and to find the information they require. Projects that individual stakeholders wished to pursue required funding that was sought by the stakeholder in conjunction with UKCIP. The result has been a successful production of regional climate change impact studies and adaptation strategies.

go to See examples of regional capacity building projects and initiatives, including links to information about UKCIP in section 6.2.8.

4.3 Making successful adaptation decisions

Adaptations will not necessarily lead to the desired outcome. Examples exist in every country where a government has implemented a policy which has completely unexpected consequences. For example, in 2000 in Europe, increased fuel tax (which should have reduced the demand for petrol and hence have had beneficial effects on greenhouse gas emissions), led to European wide protests and road blockades by car owners, farmers and freight drivers. This led to the governments backing down and reducing fuel tax. The objective, to reduce the demand for fuel remains, however the method of achieving it required a re-think after the fuel protests.

Unexpected outcomes of climate change preparedness actions can affect individuals as well as national governments. For example, the construction of coastal defence structures such as a sea wall by one person can undermine beach processes in the area creating increased erosion for that individual and for others downstream.

Variability and uncertainty lie at the heart of climate change. There will not be a one-off change that individuals can prepare for and then respond to, as one might for a hurricane, tropical storm or flood. Climate change can appear in many forms. For example, a slow-onset drought that lasts for decades or a rising sea level that creeps higher every year. It can also manifest as more intense storms or changed wind direction. Hence adopting a learning-doing-changing approach is critical.

'Learning-doing-changing' refers to the process of learning from hazards. In this regard, planning for failure is critical. With an attitude of 'we will get it right the first time', there is little chance that changes will be made, that modifications will be possible, or that anyone will admit to mistakes. We know that climate change is happening and will continue to occur over the next 20 to 30 years at least. Yet because of the uncertainty surrounding the distribution and type of climate impacts likely to be experienced 5 years hence, mistakes are central to planning for and responding to climate change. Many small island governments do not have unlimited resources and cannot afford many mistakes. Therefore, there should also be a focus on making sure that the best available information is used when deciding on a course of action and that adaptation strategies have been carefully designed to ensure success, as far as is possible.

The example of hurricane preparedness in the Cayman Islands is a useful template for learning from mistakes – see Box 4.5.

e.g.

Box 4.5 Factoring mistakes in hurricane preparedness in the Cayman Islands

Flexible decision making processes: "Coastal vulnerability mapping based on several factors, with the discretion built in for the decision-makers is what is needed in planning for the future."

Inclusion: "The NHC [National Hurricane Committee] has been so successful because it has included all the different sectors and the civil servants. It doesn't matter how good any individual is on their own success comes from working together."

Learning based approach: "The plan that you see today is a lot better than the one we had one year ago, and the one from one year ago is better than the year before. We use our experience every year from actual events to make our plans better."

Preparedness exercises: "These people [NHC] are very serious, they do an annual exercise – it showed last year, with the three hurricanes in a row, these people were doing their things day and night. Things were alright. I think given the circumstances they did an awfully good job."

Quotes taken from interviews with Government officials in 2002

As mistakes become accepted in planning for unknown climatic conditions, testing and re-testing of climate change preparedness plans becomes a part of the process of learning. Learning and incorporating new knowledge into climate change preparedness is vital for both building adaptive capacity and for implementing new adaptation actions.

This needs to be taken into consideration when implementing adaptation actions, as described in Chapter 5.

4 Summary and key references

Before plans are made it is vital to think through the objectives of a climate change strategy and to think through issues of cost and responsibility. Once these are decided, plans need to be developed. Planning is critical. Both visionary plans, that enable groups to re-think their priorities and directions, as well as implementation plans that guide individuals and organizations in what to do in the event of a disaster. This chapter also emphasises the importance of taking an integrated approach to planning for climate change by linking with other planning processes.

More general information about planning to adapt to the impacts of climate change can be found in the IPCC Third Assessment Report, Working Group II (Impacts, Adaptation and Vulnerability), Chapter 2 (Methods and Tools). Other examples of more specific sources include:

- For guidelines on adaptation, see: The Adaptation Policy Framework; Overview of potential adaptation options for the Caribbean (Moore & Trotz, 2001); Caribbean Risk Management Guidelines for Climate Change Adaptation Decision Making. CARICOM (2003) in association with the Adapting to Climate Change in the Caribbean (ACCC) Project; Assessments of Impacts and Adaptations to Climate Change (AIACC) in Multiple Regions and Sectors.
- For guidelines on planning areas or sectors relevant to integration in an adaptation strategy, see: Kok & Coninck (2004); The World Commission on Protected Areas (WCPA) for guidelines which help countries to establish and effectively manage marine protected areas and help the integrated management of coastal and marine areas; National Drought Mitigation Center for advice on understanding your risk, planning for, monitoring and mitigating drought; Westmacott *et al.* (2000) for information about managing bleached and damage coral reefs; Bergkamp *et al.* (2003) for information about the adaptation of water resources management.
- See World Bank (2000) for an insight into how Pacific islands have approached the challenge of preparing for climate change.

See Chapter 6 for details of these and other links to useful information and resources.

5 Implementing a climate change adaptation strategy

Contents

- Who implements adaptation?
- Legislation and enforcement
- Education and communication
- Information and good science
- Financing adaptation
- Support networks
- Continuing the adaptation process

After working through this chapter you will be able to:

- Identify who is responsible for making decisions and taking action
- Re-think the implications of existing legislation for climate change adaptation
- Focus on new areas of legislation for climate change adaptation
- Have an idea of the important components of an education and communication strategy
- Be able to tap into existing sources of funding and know how to raise additional resources
- Acknowledge the importance of support networks and factor these into the adaptation strategy
- Understand that adaptation to climate change is not a static exercise – it is a continuing process

5.1. Who implements adaptation?

Once plans have been developed and visions have been created of how to tackle climate change, there remains the hurdle of how to implement actions. Some actions will require significant funding and will require a change in the way in which things are done: other actions will be small step changes that require some behavioural modifications while other actions will barely be noticed.

Public adaptation will be initiated and implemented by governments, directed at collective needs. Such adaptations may include policy changes including: the development of a new building code; practical adaptation actions such as a national programme to rehabilitate a mangrove forest; or building adaptive capacity, for example by producing regional climate change scenarios. Regional and international adaptation may also be needed, for example to cope with food shortages, organise disaster relief, or deal with climate refugees.

Private adaptation measures are likely to be implemented by individuals, households and private companies. At the local level, individuals or communities that have a history of being exposed to climate-related hazards or who may have the knowledge and means to alter their lifestyles may engage in adaptive behaviour without any prompting. These actions are likely to be prompted by self-interest.

5.2. Legislation and enforcement

There are many policies that small islands can implement to tackle the causes of climate change. These relate to energy conservation and support for and use of carbon-neutral energy alternatives. However, islands also need to actively prepare for the consequences of climate change.

5.2.1. What already exists and what is missing?

Most small islands do not have any policies relating to either energy conservation or alternative energy supplies, often due to monopoly ownership of energy supply. This set up has been advantageous in the past when the monopoly owner guaranteed supply to entire islands. However in many islands monopoly licences have been granted to energy suppliers on the provision that no other energy supplier can operate – this includes domestically produced energy, for example, through solar water heaters. New legislation is needed to consider future energy security. For instance, new energy policies may be needed that encourage energy conservation and that encourage companies and individuals to rely less on energy produced by burning coal and oil, and to rely more on energy generated through renewable means, e.g. solar panels, solar water heaters, or small scale wind turbines. These policies are themselves an adaptation to climate change as they reduce reliance on imported fuels and the price fluctuations that can be experienced.

In terms of managing the consequences of climate change there are many actions that can be undertaken. These relate to: long term land-use and infrastructure planning; streamlining legislation to avoid mal-adaptation; and planning for disasters. Seven policy goals can facilitate the management of climate change risk:

1. Develop and keep up-to-date comprehensive land-use plans
2. Develop and implement integrated coastal management plans/watershed management plans
3. If possible, adopt a "retreat approach" to planning and development in extremely vulnerable areas along the coast
4. Integrate regional disaster mitigation strategies with national/physical planning
5. Maintain, preserve and restore ecological buffers
6. Enhance coastal protection where retreat is not possible

5.2.1.1 Long-term infrastructure and land-use planning

Most island governments have already thought extensively about land use planning given their small size and the need to plan carefully. Hence two areas which have already been addressed by many islands are: building codes and coastal zone management. These areas now need reconsideration to ensure that potential climate changes are factored in.

In a review of planning regulations across the Caribbean it was recognised that managing the Building Code is one of the most effective means of ensuring that new constructions incorporate climate hazards (see table 5.1). Specifically, there are three important actions:

1. Ensure that national building codes factor in climate change;
2. Develop regulations to phase out development in high hazard areas;
3. Strengthen regulations to protect ecological buffers.

Table 5.1 Some examples of Caribbean island Building Codes in 2002

e.g.

Country	Building Code Status	Building Inspection Capacity
Anguilla	• Building Code completed and being used administratively • Building regulations mandating the use of the Code will be incorporated into the new Physical Planning Ordinance	• Being developed • One Inspector employed by the Department of Physical Planning
Antigua and Barbuda	• Completed • Based on OECS model building code • Legislated in 1996 as regulation under the Development Control Ordinance	• Five building inspectors on staff • Training programme to be developed
Barbados	• Draft Code developed in 1993 • Technical provisions being based on standards contained in CUBiC • A Building Authority being established • Appointment of Building Inspectors going ahead	• Recommendations made for engaging an adequate number of building inspectors for monitoring residential construction • Professional engineers and architects on a case-by-case basis will monitor other buildings
Dominica	• Code drafted, based on OECS model building code and submitted for legislative review • Dominica Physical Planning Act being set up to mandate the use of the Building Code	• Development Control Authority has five building inspectors
Jamaica	• National Building Code drafted and distributed for comment in 1984 but not adopted • Revised code in progress • Building by-laws apply in each Parish and in Kingston-St. Andrew	• Each Parish has building inspectors • Staffing in some places will have to be augmented to ensure that building plans can be properly reviewed in accordance with the new Code
Trinidad and Tobago	• Building Code drafted and submitted for comments and enabling legislation submitted for legislative approval • For engineered buildings, British, American and Canadian codes are used as standards	• Special committee mandated to prepare building regulations for legislative review

Adapted from 'Caribbean risk management guidelines for climate change adaptation decision making'. Adapting to Climate Change in the Caribbean Project (2003), Caribbean Community (CARICOM) Secretariat p.66.

In addition, islands need to think carefully about long term infrastructure planning, notably water supply, roads, ports, schools, hurricane shelters and airports. These infrastructural plants are expected to have a life of 20 to 50 years and hence they need to factor in long term shifts in climate.

Coastal zone management has also received much attention in small islands. It is widely recognised that coral reefs, along with sea grass beds and mangroves act as a buffer against storms and coastal erosion. One simple way to prepare for climate change is to reduce the stressors on corals and mangrove areas. This involves managing run-off from land, siltation and eutrophication. In this way coral reef ecosystems can increase the ability of small islands to cope with climate change.

Enhancing the quality of, preserving or re-seeding natural systems may be a climate change adaptation strategy for some areas, where the natural systems are not too degraded, or where human development has not extended to the edge of the coast. See, for example, Picture 5.1, which depicts mangrove replenishment in the British Virgin Islands (BVI).

Picture 5.1 An example of mangrove replenishment for natural sea defence in the British Virgin islands

Picture by the Conservation and Fisheries Department, Ministry of Natural Resources and Labour, Government of the British Virgin Islands.

Building the resilience of natural ecological buffers can be achieved through planning and conservation agencies maintaining or enhancing managed natural systems when investing in new projects (e.g. dykes, beach replenishment, land clearance, coral reef development, planting mangroves, etc.) with the explicit objective of reducing vulnerability to climate change impacts.

Building social resilience, i.e. encouraging communities to develop the same capacity as resilient ecological systems (ability to self-organise, ability to buffer disturbance and capacity for learning and adapting) can help communities which depend on natural resources to better cope with climate changes, see Box 5.1.

e.g.

Box 5.1 Building resilience of natural resources through co-management in St Lucia and Tobago

Current thinking suggests that community-based management or co-management can also enhance ability to prepare for climate change in two ways. Firstly by encouraging collaborative working among resource-users, which it has been proven, is important for coping with extreme events; secondly, by retaining the resilience of the natural resources and ecological systems.

In St Lucia, local reef users, working in collaboration with the St Lucian Government, developed a zoning structure for the marine park, to ensure that all users could continue to enjoy the benefits from the reef without exclusion. In Tobago, reef users established a discussion group to agree to changes that they personally are willing to make to improve the quality of the reef and they identified actions, which if taken by government, they would support.

Collaborative working can enhance the quality of reefs, although it has been shown to work best under the following conditions: (1) smaller groups tend to be more successful than larger groups; (2) the more equitable the distribution of benefits from management of the area among members, the greater the chance of success; and (3) selective benefits and new forms of management may overcome failures of collective action.

Neither land use planners nor coastal zone managers can afford to ignore the climate changes that are expected. It is critically important that these groups can be engaged in the climate change debate and provided with the information they need to factor climate impacts in to their long-term planning horizons.

5.2.1.2 Streamlining legislation to avoid mal-adaptation

One danger in planning for climate change is that government departments will act individually and potentially undertake mal-adaptive actions. For example, out of concern for the elderly, social services may choose to install air conditioning units in care homes for the elderly, while the department of environment may be trying to reduce reliance on fossil fuels.

Climate change can have direct and indirect consequences for many parts of the economy. For example, European countries may implement a carbon tax on international air travel. If this happens then travel to small islands by tourists may change. Tourism policies that do not take this into account may result in damaging impacts on the tourism industry. For more examples of policies that increase or decrease ability to cope with climate change, see Table 5.2.

Table 5.2 Policies that affect ability to cope with climate change

Policy area	Policies that take climate change into account	Policies that ignore climate change risks
Housing	• Building on higher ground • Using natural ventilation to cool buildings • Encouraging the use of small-scale renewable energy, e.g. small wind turbines and solar water heaters	• Building in low-lying or easily flooded areas • Using air-conditioning
Tourism	• Encouraging longer stay visitors • Promoting eco-tourism through investment in preservation of buffering ecosystems	• Encouraging visitors to the island on 'weekend breaks' • Promoting eco-tourism through the exploitation of natural resources
Energy	• Supporting individual use of solar panels • Solar water heaters	• Preventing use of solar panels • Solar water heaters
Transport	• Promoting low-energy forms of transport, e.g. cycling, shared cars, hybrid cars, energy efficient cars	• Encouraging use of large energy-intensive vehicles, e.g. Hummers, SUVs
Food security	• Promoting and supporting local production of agricultural goods	• Increasing reliance on foods imported from overseas
Water supply	• Water conservation	• Water over-use

There are always many pressures on island governments. Hence, in order to encourage growth and development, approval may be given to some developments or activities that actually increase the vulnerability of the islands, for example building in vulnerable areas or allowing energy intensive recreational activities to develop. Governments need to think through the implications of climate change in every decision made. In this way islands are less likely to increase their exposure to the impacts of climate change.

5.2.1.3 Planning for disasters

Legislation can help in planning for disasters. Adopting the disaster risk management cycle into government planning is an important first step.

go to Section 4.1.1 which explains the disaster risk managment cycle

So too is the need to actively save for disasters. All countries are affected by disasters, whether social, economic or environmental and resources need to be available to cope with the aftermath of these events. Legislation to create a Disaster Management Fund is important. This can be funded by a new tax, e.g. a carbon tax levied on all passengers arriving in the country. This tax would be ring-fenced for the disaster management fund. Alternatively the tax could be funded through an additional tourist night tax, which each visitor pays for each night of their stay. However if this fund is created, it is important that clear rules exist for when and how the funds may be accessed to ensure that the funds are not used prematurely for non-emergencies.

Policy change can also assist in planning for disasters. First, by acknowledging that disasters are caused by vulnerability, issues of vulnerability rise to prominence. Whether the vulnerability to hazards is caused by poverty, low quality housing, or being located in a geographically vulnerable area, the underlying vulnerability needs to be addressed. Policies that tackle the causes of the vulnerability, e.g. building codes, education, health care and economic growth have to be included in any comprehensive disaster management plan.

5.2.2 Principles underlying legislation and enforcement

To ensure that any new climate change related legislation is implemented effectively it needs to be perceived to be fair and just; those affected by it need to understand it and to understand why it has been established; and there needs to be some support for it by the wider community. To achieve this, policies and legislation need to be transparent and open and there needs to be active enforcement.

Developing new legislations can be time consuming and frustrating. Stakeholder engagement is now more commonly used to develop legislations, yet the very process of stakeholder engagement can extend the length of time that it takes. Nonetheless, one reason for stakeholder engagement is to gain support for the legislation which is more likely to lead to its effective implementation.

If legislation is supported then it is more likely to be enforceable and enforced. However, resources have to be made available to enable laws and policies to be enforced. Examples from around the world show that the legal establishment of a marine park that includes no funds for enforcement creates a park which is widely ignored. Other examples show that parks that are created without stakeholder dialogue and support are also ignored and practices often carry on as before.

5.2.3 Extension of international laws to small islands

The United Nations Framework Convention on Climate Change (UNFCCC) is the international law that acknowledges the problems associated with climate change and lays out a plan to manage it. The UNFCCC suggests that industrialised countries reduce their greenhouse gas emissions and rich countries help poor countries adapt

to the consequences of climate change. Most countries in the world have signed this convention, including the main current producers of greenhouse gases such as the USA, Japan, Russia and the United Kingdom; the expected future large producers of greenhouse gases: China, Brazil and India; as well as those most likely to suffer the consequences such as Cuba, Barbados and Samoa. By extending the UNFCCC to individual islands they are then required to undertake the obligations of the treaty, i.e. recording their greenhouse gas emissions, as well as benefit from the resources available.

Many small islands are represented in the international negotiations through the Alliance of Small Island States (AOSIS). AOSIS argues that small islands have not contributed to the causes of climate change and yet will be the first to feel the consequences of climate change. As such, AOSIS is demanding assistance from the industrialised nations to adapt to climate change impacts.

There are no international laws or conventions which require countries, governments, businesses or individuals to adapt to climate change or to assist other countries to adapt to climate change. Even in industrialised countries such as the UK which are investing in advancing the science of adaptation, there is no adaptation policy (although during 2005, the UK Department of the Environment, Food and Rural Affairs is in the process of developing an Adaptation Policy Framework). The United Nations has developed an 'Adaptation Policy Framework' although few countries have yet adopted this.

go to Chapter 6, section 6.2.4 and 6.2.7 for links to more information on the UNFCCC and the various initiatives within it. See Section 6.2.8 for information about AOSIS.

5.3 Education and communication

A larger programme to raise the profile of climate change and its impacts is important as part of a strategy to improve public awareness and to educate different groups about their relative vulnerability to impacts. There are many courses, reports and websites that advise on establishing education and communication strategies.

5.3.1 Clear target audience(s)

The first step in any communication strategy is to identify the target audience. Climate change will affect entire nations, therefore an education strategy may need to include everyone, however, there have to be appropriately targeted messages for each group, sector, type of institution, level of organisation and so on. Making sure that the right message reaches the right people can only be achieved by making sure that all of the 'right' people are identified. To start with, an education and communication strategy may want to consider those people included in Table 5.3 below.

Table 5.3 Organisations and institutions to be included in an education and communication strategy

Public sector	• Government Ministries and Departments • Government agencies • Government programmes • Government funded research institutes • Regional government agencies/government offices in the regions • Public-private partnerships (PPP)
Private sector	• Multi-national or overseas companies • Large national corporations • Medium and small national corporations
Not-for-profit sectors	• Voluntary, community and NGO's • Associations and Networks (e.g. trade associations) • Research organisations
Individuals	• By age, gender, occupation, area of residence etc.

5.3.2 A communication strategy

The strategy describes the methods to ensure engagement. This can include advertising campaigns; information dissemination; round table discussions; funding research projects or programmes; school or voluntary participation in research or data collection; or methods that promote individual behavioural change. Other less traditional methods of education and communicating can come through planning; networking or private-public partnerships; by giving responsibility to specific staff to manage climate change issues; or by creating an agency responsible for action, public education and awareness.

In every context there will be a method that works best. In societies which rely more on oral traditions for passing on information, street theatre may be most appropriate. In societies where the written word is heeded more then this type of strategy will be required. In other societies change comes from investing in people and buildings to create a physical entity and a body of knowledge about an issue. Existing mechanisms are often the best starting place for communicating new messages.

Any strategy requires funding, which can be generated in a number of ways. For example, the funding could be jointly raised by government and the private sector for an 'information exchange' whereby an individual or group collected information to help the private sector and government understand climate change impacts and to develop adaptation strategies. This has been the highly successful strategy used in the UK, where the UK Climate Impacts Programme (UKCIP) has managed to reach out to the private sector and many arms of government by working with each group to identify its needs and then to undertake research to answer the key questions that it is asking.

All research that is undertaken can be funded by the party for whom the information is being provided. There are clearly other ways of funding outreach and communication for this type of activity, such as direct government funding, public-private partnerships and research centres.

go to For more information on the history of the UK Climate Impacts Programme and for access to the various tools and methods that they have developed see sections 4.2.4 and 6.2.8.

5.3.3 Clear objectives, key messages and specific activities

No strategy works without a clear objective, clear messages and specific activities that it will undertake to achieve these activities. Bearing in mind the nature of the education and communication programme, it should also be consistent with any sustainable development strategy that exists. If no such strategy exists then any climate change strategy should also deal with issues of citizenship, stewardship of the environment and stakeholder participation.

The objective could be to raise awareness about climate change science, or to work with stakeholders to understand the impacts of climate change on them, or to identify adaptation options with a local community. Any specific objective should be developed in collaboration with a target audience so that it is significant and relevant to them. Whatever the objective, it needs to be clear or the education message can be lost.

Key messages should focus on the issues that are close to the heart of individual stakeholders, these could be waste, transport, land use or employment issues. These are best identified through discussion with individuals in the target audience. Possible key messages for specific groups are described in Table 5.4.

Table 5.4 Possible key messages for specific groups

GROUP	KEY MESSAGE
Tourists	"Help us from where you live. Lobby your government for lower greenhouse gases."
Land developers	"Smart growth means build green and save $$$."
Policy makers	"Policies that are good for current and future generations."

These types of messages can only be delivered through specific activities. For example, successes by any individual, company or government agency should be recognised publicly and promoted. It may also be useful to establish a co-ordinating agency to monitor such a process.

5.4 Information and good science

A key element in developing an adaptation strategy involves understanding the basic facts about climate change and what impacts it will have on a region, i.e. what is climate change, what are the regional impacts and what is the likelihood of change occurring. Unfortunately there are many uncertainties about how climate change will be experienced and there are even more uncertainties about the best way of managing the impacts. The first step is to find out more.

go to The Scientific Annex contains more information on climate scenarios and uncertainty.

5.4.1 Collate information about climate change

Compiling clear and concise information on what is known about climate change (including information on where there are uncertainties associated with the science) is the best way to dispel myths about climate change and to ascertain its true nature. It is the very process of gathering information, of researching and finding answers to questions that will build knowledge.

Start any search with the best source of information about climate change science, impacts, adaptation and mitigation options, as well as areas of uncertainty and climate sceptics' arguments. Today in 2005, the best source currently available is a four volume report entitled 'Climate change 2001, IPCC Third Assessment Report'. This set of reports is re-produced every five years by the Intergovernmental Panel on Climate Change (IPCC) which comprises the worlds leading climate scientists. The next set of reports will be available in 2007.

go to Sources of this report (both hard copy and online) are included in section 6.2.6.

While collating information, it is also useful to try and understand the literature produced by climate sceptics. Many advocacy organisations (both pro- and anti- climate change action) produce information claiming to report the 'truth' about climate change science. Read this information but bear in mind that the most reputable source of information comes from the IPCC (details given above). The information you collate needs to address the myths created by these advocacy groups. In particular, when collating information it is important to be able to explain:

- What causes climate change and the uncertainties
- What does not cause climate change
- The reasons why climate sceptics say climate change is not happening – and the counter arguments

- The reasons why climate sceptics say climate change is happening, but is not very important – and the counter arguments
- The expected consequences of climate change
- How long is it before the impacts are likely to be felt and the limitations to current knowledge
- What weather changes can / cannot be attributed to climate change
- The costs of responding to climate change and the problems associated with estimating costs.

Unless you are working with practising climate scientists (who can guide you to the most up to date information) use the IPCC-produced information to answer your questions about climate change.

5.4.2 Compile information about the impacts of climate change on your region

Having identified what climate change is, it is then necessary to understand why climate change is a threat. Compiling clear and concise information on the potential impacts of climate change on your region may be difficult as there may be no specific information available. This is because most of the information available about climate change has been generated from global climate models. These complex models describe global atmospheric and oceanic conditions and how climate change is likely to affect the planet as a whole.

Understanding the unique impacts of climate change on your own region is important. Even if storminess is expected to change globally, the specific change in intensity or frequency of storms in your region needs to be understood, so that preparatory plans can be made. In the absence of scientific climate change information, information can also be gleaned from non-scientists. Phenology, for example, can be used informally to help understand local changes. Meteorologists and naturalists have used phenology for over 150 years to identify changing patterns.

Whichever source of information is used, it is important to ensure that the information is up to date. As more is understood about the science of climate change, the potential impacts and the range of hazards faced, the information you have collated needs to be updated. Old information may no longer be useful. As scientific knowledge increases so our ability to prepare for potential change increases. Therefore updating knowledge regularly and changing our ideas about climate change plays an important part of the adaptation strategy.

5.4.3 Monitoring and data collection

Once more is known about climate change, local monitoring can be used to show changes that are occurring locally and feed information into wider regional models

that show changes in the region. The outputs can be used as part of an education and communication campaign.

Specific data should be collected to provide an idea of local trends. This should include:

- Air temperature
- Sea surface temperature
- Rainfall
- Sea-level rise
- Biological indicators (e.g. flowering times, nesting, rates of coral bleaching)

Significant advances in monitoring and data collection can be made by investing in a focal point. A focal point has the dedicated task of gathering information and ensuring it is complied and disseminated.

go to See section 4.2 for more information on the role of a national focal point.

There are challenges in establishing long term data collection projects. Data collection is always costly, hence there may need to be a legal priority for data collection, otherwise departmental priorities may change which could lead to this expensive item being dropped from their annual budget.

In small islands where regional data may be of use, regional cooperation to collect data may reduce the costs of individual islands collecting all the data. However, if many islands agree to share data then there need to be universally agreed methods for data collection and universally agreed standards and measures. Otherwise, the data will not be comparable. Similarly there may need to be a central facility for data collation, processing and distribution. If the cost of such a facility is shared among nations this could reduce individual island burdens.

5.4.4 Regional guidelines

While there are no regional laws or policies about adapting to climate change, there have been a few regional programmes, which offer guidelines and information. These include:

- Caribbean Planning for Adaptation to Climate Change (CPACC) project (1998-2001), and its successor projects, the Mainstreaming Adaptation to Climate Change (MACC) project and the Adapting to Climate Change in the Caribbean (ACCC) project;
- Pacific Islands Climate Change Adaptation Programme (PICCAP);
- Capacity Building for the Development of Adaptation Measures in Pacific Island Countries (CBDAMPIC);
- Maghreb project on adapting to climate change (*Projet Maghrebin sur les Changements Climatiques*).

These regional programmes have been important in creating a focal point within countries, whose job is to coordinate climate change initiatives and actions. The regional programmes have also invested in training individuals about climate change and its impact and in establishing a centre of excellence with a regional specialisation in climate change.

go to Chapter 6, section 6.2.8 gives details and links to these programmes and associated resources.

5.5 Financing adaptation

Adaptation to climate change is not free, so 'no regrets' adaptation strategies should be adopted. Such strategies are beneficial whether or not climate change occurs and hence can be justified on economic grounds. These strategies include: better land use planning (not removing natural coastal buffers, e.g. mangroves and sea grass beds); avoiding building in low-lying or regularly flooded areas; providing better housing which is more able to withstand hazards (e.g. storms, coastal flooding, heavy rains or strong winds); strengthening the building code for those buildings already in vulnerable areas; disaster planning and streamlining government policies.

Even though these policies are often perceived to be 'win-win' policies, they are sometimes not implemented. This can be because there are no resources available to implement them, there are other more pressing priorities, or the government does not perceive them to be important. This leads to the question of who pays for adaptations that are not 'win-win' but are vital to save individuals from the worst effects of climate change.

5.5.1 Who pays for adaptation locally?

Adaptation can be undertaken by the government for the benefit of the wider community, by government for specific individuals in the community, by the private sector for wider community benefits, or by the private sector for their own benefits. Similarly, individuals can participate in adaptations that benefit others or only themselves.

Who should pay for the adaptations is a political decision and there are many arguments about who should receive government assistance, for example:

- *The most deserving* – those who already protect their homes from hurricanes or those who have not made themselves deliberately vulnerable to hazards;
- *The most socially vulnerable* – those who cannot afford to look after themselves, e.g. the elderly, the poor and those without homes;
- *The most physically vulnerable* – this includes those who have made themselves

deliberately vulnerable, e.g. those who have built homes in low-lying areas or in areas known to flood;

- *Everyone, equally* – if everyone contributes to government revenues, then all should benefit from its expenditure equally;
- *The most important* – those businesses and individuals who are critical to the running of the country, i.e. key health care workers, police, utilities workers, etc.

Irrespective of who benefits from adaptation, someone has to pay. We offer some guidelines about who should pay using the arguments above. In general whoever benefits from the action should pay, see Table 5.5.

Table 5.5 Benefits from adaptation – who should pay?

Who acts?	Who benefits?	Example of adaptation	Who *should* pay?
Government	Whole country	• Building hurricane shelters • Protecting mangrove buffers • Providing climate change impact information • Creation of a disaster relief fund	Whole country through government
	Individuals	• Building sea walls in front of individual properties	Individuals
Private sector	Individuals	• Provision of insurance • Training courses in disaster management	Individuals (subsidised by government for the poor?)
Individuals	Individuals	• Buying sand bags • Buying fans • Reconstructing homes after disaster • Buying in emergency supplies before a disaster	Individuals (subsidised by government for the poor?)

In general, if there are private benefits, individuals should pay, although the government can assist by providing subsidies to the poor and those least able to prepare. Where there are collective benefits the government should pay. These are not rules; they are suggestions for managing this difficult issue.

5.5.2 What is the role of the regional and international community in paying for adaptation?

In many small islands adaptation should be a priority. Yet where there are limited resources and climate change is not prioritised due to other pressures from, for example, population growth, resource depletion and poverty, adaptation could be sidelined.

Individuals can undertake specific actions, however, without external assistance large scale collective adaptation may not be possible.

Most developed countries are able to fund their own national adaptation (and mitigation) initiatives. Under the United Nations Framework Convention on Climate Change, developed countries have been mandated to assist developing countries; however the assistance is often inadequate when divided amongst many nations. Broadly there are three international financial mechanisms to provide support for adaptation initiatives in developing countries, and therefore these may be of relevance to some small islands. These are:

- The Least Developed Countries (LDCs) Fund – to partly advise the LDCs on strategies and approaches to implement national adaptation programmes of action (NAPAs).
- The Special Climate Change Fund (SCCF) – to provide further financial assistance to developing countries vulnerable to climate change impacts.
- Funding for Pilot Adaptation Measures established under the Global Environment Facility (GEF) to fund the implementation of pilot adaptation projects.

go to Section 6.2.11 describes initiatives associated with the UNFCCC and includes more details about NAPA's, the SCCF and the GEF.

International agreements like the UNFCCC are the main drivers of adaptation at the national and regional levels. This is partly because they provide funding opportunities, but also because of the requirements they place on countries to act, for example to prepare National Communications which involve undertaking vulnerability and adaptation assessments.

5.5.3 Financial tools for adaptation

Changes in policy and legislation are not the only way to change behaviour. Financial mechanisms can also be used, either through incentive payments, subsidies or taxes. The appropriate tax or incentive will depend on the action or capacity that needs to be developed or constrained. It will also depend on the type of government and the public acceptability of the different schemes.

Adaptation can involve the government trying to prevent mal-adaptive action, encouraging a change in behaviour or supporting changes that are already occurring. Mal-adaptive actions can be prevented through simultaneously levying taxes on mal-adaptive behaviour and subsidising adaptive behaviour, e.g. higher import duties on jet skis and reduced import duty on windsurfs, see Table 5.6.

Table 5.6 Examples of financial tools to modify behaviour in different areas

Area	Desired change in the sector	Financial tool to bring about change
Housing	• Use natural ventilation to cool buildings • Discourage building in vulnerable areas • Build to new building code that can cope with climate change hazards	• *Subsidy*: provision of free advice to new home builders on the use of natural ventilation • *Subsidy*: Link property insurance with construction and quality standards • *Subsidy:* Establish a revolving loan fund for home improvement
Tourism	• Encourage longer stay visitors • Promote eco-tourism through investment in preservation of buffering ecosystems • Promote low carbon-intensive activities e.g. sailing, surfing, shore diving, walking, swimming, cultural activities	• *Tax*: on international travel • *Incentive payment:* to tourism ventures that preserve natural ecosystem buffers • *Subsidy:* Government promotion of the island as a 'green' island • *Tax:* on high energy intensive activities, or on fuel for these activities
Energy	• Support individual use of solar panels and solar water heaters	• *Subsidy:* remove barriers for importation and installation of small scale renewable energy generators
Transport	• Work with importers to promote low-energy forms of transport, e.g. cycling, shared cars, hybrid cars, energy efficient cars • Discourage use of large energy-intensive vehicles	• *Subsidy*: reduce import duties on energy efficient cars and low energy transport • *Tax:* increase import duty on energy intensive vehicles
Water supply	• Water conservation	• *Tax*: government charge on all water used
Flood risk management	• Movement away from building in high risk areas	• *Insurance:* high premiums or unavailability of insurance for properties built in high risk areas, determined using flood risk mapping

Clearly there are a variety of market-based incentives that can be used to change behaviour. Each island state will have specific taxes and subsidies that are more or less socially and politically acceptable. The most important rule in developing financial mechanisms to encourage behavioural change is to apply mechanisms that will be most acceptable, and hence most likely to be supported.

5.6 Support networks

5.6.1 Regional co-operation

Regional programmes have been important in creating a focal point within countries. The regional programmes have also invested in training individuals about climate change and in the case of CARICOM countries in the Caribbean, establishing a centre of excellence with a regional specialisation in climate change.

Actions taken alone by individual islands can result in significant adaptive changes; however there are a number of actions which can be more successful if undertaken by a group of islands together. Regional co-operation is particularly useful where:

i. Collective *pressure* is needed to encourage behavioural change in a regional organisation, e.g. regional insurers offering incentives to those who reduce their exposure to hazards
ii. Collective *funds* are required to pay for information, e.g. the production of regional climate change scenarios
iii. Collective *knowledge* is needed to tackle a complex problem that one island cannot manage alone
iv. Collective *assistance* is required, for example post disaster recovery assistance

There are already many networks providing this type of regional support, see Table 5.7 for examples in the Caribbean.

Table 5.7 Regional support networks in the Caribbean

e.g.

Scale	Focus	Association / linkage
Regional	Coastal health	CARICOMP (Caribbean Coastal and Marine Productivity Programme)
	Emergency assistance	Other Caribbean islands will assist in an emergency (informal morally-based links)
	Financial planning	Caribbean Development Bank
	Health management	Caribbean Epidemiology Centre (CAREC) Caribbean Health Research Council
	Water Management	Caribbean Water and Waste Water Association
International	Climate observation	Global Climate Observing System
	Emergency assistance	UK emergency and humanitarian assistance to its Overseas Territories
	Health management	Pan American Health Organisation (PAHO) and World Health Organisation (WHO)

There are a variety of regional support networks that have evolved as a result of funding through the World Bank's Global Environment Facility (GEF) that exist specifically for the purpose of adapting to climate change. The three most notable examples are the networks that were established through GEF funding (see section 5.5.4).

5.6.2 Local networks and collaboration

Local networks can also be exploited to find out information, to provide support and to assist with preparedness and recovery. Networks have proven useful in generating information about hazards, preparing for and then recovering from hazards in other contexts.

The Cayman Islands have shown a high resilience to hurricane impacts and there appears to be a link between this resilience and the participation by Caymanians in local and regional networks. Many people belong to a wide range of networks within the Cayman Islands and outside on which they have drawn on before and after past hurricanes. The local networks are shown in Table 5.8.

Table 5.8 Examples of Cayman Islands' Government participation in local networks for hurricane preparedness

e.g.

Scale	Focus	Network
Local	Health management	Baptist Hospital and Public Health
	Inter-island support	National Hurricane Committee
	Welfare	Cayman Islands' Red Cross links with British Red Cross and others

Not all islands are structured in such a way that strong links exist both within the island and to agencies and bodies outside the island. Yet research on resilient communities has shown the importance of these networks, hence if possible they should be encouraged and developed.

5.7 Continuing the adaptation process

Adaptation to climate change is not a one-off event. It is a long-term investment in people and knowledge and in developing changing policies. The process of taking new knowledge on board can be difficult, costly, and time consuming. Incorporating new information assumes that there is a willingness to change, and that there is space for:

- Making time to learn (building in time for learning/iteration into the process)
- Changing attitudes (moving towards ideas of "living with...")

As described throughout the guidebook so far, this requires consideration of several important questions:

- What are the major current and potential future hazards?
- What are the major impacts/outcomes of these hazards?
- What determines the type and severity of the impacts/outcomes?
- What measures will reduce the impacts and improve the outcomes?
- Can these adaptation measures be undertaken? If not why not?

These questions are best answered by those likely to be affected by the changing climate. However, much research shows that very few individuals, companies or government departments believe they will be affected by climate change. Fewer still have considered the wide range of impacts they may experience.

5 Summary and key references

Gathering information about what climate change is, the causes and consequences, what the climate sceptics say and counter-arguments is a critical first step in the adaptation planning process. You are not alone – all islands are facing similar threats. It is possible to learn from your own experiences to past hazards as well as other countries' experiences.

This chapter has reviewed some of the tools that could be used to start to prepare for climate change. It has outlined how you may use legislation and enforcement, education and communication, gather information and good science, go about financing adaptation, join and build support networks and continue the adaptation process. The chapter has also highlighted many of the problems that can arise in climate change preparedness and how serious mistakes might be avoided. Testing and re-testing plans, and learning from mistakes are central to the success of any preparedness initiatives.

More general information about the practicalities of adapting to the impacts of climate change can be found in:

- The Adaptation Policy Framework (2004)
- UNFCCC Compendium on methods and tools to evaluate impacts of, vulnerability and adaptation to climate change
- Kelleher, G. (1999) Guidelines for Marine Protected Areas. Phillips, A. (ed.): IUCN – The World Conservation Union.
- Caribbean Risk Management Guidelines for Climate Change Adaptation Decision Making (Caricom, 2003)
- See World Bank (2000) for an insight into how Pacific islands have approached the challenge of preparing for climate change.
- Vulnerability and Adaptation Resource Group (VARG)

See Chapter 6 for details of and links to these and other information resources.

6 Further information

Contents

- Glossary of terms
- Further information and links to useful resources (organised by subject area)
- References (alphabetical)

6.1 Glossary of terms

Adaptation – Adjustments in natural or human systems in response to actual or expected climatic changes or their impacts, so as to reduce, harm or exploit beneficial opportunities.

Adaptive capacity – The potential or capability of a system to adjust its characteristics or behaviour to cope better with climate variability and change.

Advocacy organisation / group – An organisation or group that works on behalf of, or supports, a cause or belief. Advocacy is an umbrella term for organised activism related to a particular set of issues.

Building code – Laws that control the construction or re-modelling of homes or other structures. They are regulations which are enforceable under the police powers of the state and locality controlling alterations, construction methods and materials, size and setback requirements, use, and occupancy of all structures. Building codes have specific regulations covering all aspects of construction and are designed to maximize the health and welfare of the residents.

Climate change – Any change in climate over time, whether due to natural variability or because of human activity.*

Climate scenario – Representations of what may possibly happen to the climate in future, based on different assumptions about how the world develops, and on our understanding of how the climate system works.

Climate sceptic – Someone who disagrees with claims or statements about the reality of climate change and/or its attribution largely to human causes.

Climate variability – Variations in the mean state and other statistics (such as standard deviations, the occurrence of extremes, etc.) of the climate on all temporal and spatial scales beyond that of individual weather events. Variability may result from natural internal processes within the climate system (internal variability) or to variations in natural or anthropogenic external forcing (external variability).*

Cryosphere – The frozen part of the Earth's surface. The cryosphere includes the polar ice caps, continental ice sheets, mountain glaciers, sea ice, snow cover, lake and river ice, and permafrost.

El Niño – El Niño is a warm water current that periodically flows along the coast of Ecuador and Peru. This oceanic event is associated with a fluctuation of the inter-tropical surface pressure pattern and circulation in the Indian and Pacific Oceans, called the Southern Oscillation. This coupled atmosphere-ocean phenomenon is collectively known as El Niño-Southern Oscillation. During an El Niño event, the prevailing trade winds weaken and the equatorial counter-current strengthens. This causes warm

surface waters in the Indonesian area to flow eastward to overlie the cold waters of the Peru current. This event has great impact on the wind, sea surface temperature and precipitation patterns in the tropical Pacific. It has climatic effects throughout the Pacific region and in many other parts of the world.

Eutrophication – The process by which lakes and ponds become enriched with dissolved nutrients (e.g. run-off from agriculture and sewage entering water courses). This results in excessive growth of algae and other microscopic plants, depleting oxygen concentrations in the water.

Fossil Fuel – Fossil fuels are concentrated deposits of carbon stored underground or beneath the sea. They are composed of the fossilised remains of plants and animals, which have decayed over millions of years, slowly being converted to fuel which can be extracted from the Earth millions of years later. This stored energy in the form of coal, oil and natural gas can be used as fuel when it is burned.

Geographical Information System – A computer system for capturing, storing, checking, integrating, manipulating, analysing and displaying data related to positions on the Earth's surface. Typically, a GIS is used for handling maps of one kind or another. These might be represented as several different layers where each layer holds data about a particular kind of feature (e.g. roads). Each feature is linked to a position on the graphical image of a map. Layers of data are organised to be studied and to perform statistical analysis (e.g. combining flood risk maps, with area development plans).

Greenhouse gas – A greenhouse gas is a component of the atmosphere that absorbs heat radiated by the earth and subsequently warms the atmosphere, creating what is commonly known as the greenhouse effect. Common greenhouse gases include carbon dioxide, methane and water vapour.

Hazard – A physically defined source of potential harm, or a situation with a potential for causing harm, in terms of human injury; damage to health, property, the environment, and other things of value; or some combination of these.**

Hazard Mapping – The process of establishing where and to what extent particular phenomena are likely to pose a threat to people, property, infrastructure and economic activities. Hazard mapping represents the results of a hazard assessment on a map, showing the frequency/probability of ocurrences of various magnitudes or durations.

Hazard Assessment – Hazard assessment refers to the process of assessing the size, severity, intensity and direction of a hazard. In the absence of sophisticated equipment, this process can be more a thought process than an engineering exercise. The thought process requires a consideration of the possible set of hazards that could affect an area and then a mental exploration of the impacts of those hazards. If resources are available, more technical assessments are possible, such as SLOSH models, which warn of the direction and height of storm surge associated with hurricanes.

Indicator – An item that can be clearly characterized and possibly quantified that represents an abstract concept, such as human well-being.*

Impact – Something that logically or naturally follows from an action or condition related to climate change or climate variability.**

Mal-adaptation – Is a faulty or inadequate adaptation and may include, for example, poorly designed responses to water level changes such as the promotion of development in high-risk locations.

Monitoring – A mechanism or mechanisms to track progress in implementation of an adaptation strategy and its various components in relation to targets.*

Phenology – Refers to the observation of the first flowering and fruiting of plants, the foliation and defoliation of trees, the arrival, nesting, and departure of birds, and such like.

Public-private partnership – Public-private partnership (PPP) is a variation of privatization in which elements of a service previously run solely by the public sector are provided through a partnership between the government and one or more private sector companies. Unlike a full privatization scheme, in which the new venture is expected to function like any other private business, the government continues to participate in some way.

Resilience – Refers to three conditions that enable a social or ecological system to bounce back after a shock. The conditions are: ability to self-organise, ability to buffer disturbance and capacity for learning and adapting.

Risk (climate related) – The result of the interaction of physically defined hazards with the properties of the exposed systems – i.e., their sensitivity or vulnerability. Risk can also be considered as the combination of an event, its likelihood, and its consequences – i.e., risk equals the probability of climate hazard multiplied by a given system's vulnerability.*

Risk management – The systematic application of management policies, procedures, and practices to the tasks of analysing, evaluating, controlling, and communicating about risk issues.*

Risk Management Plan – A Risk Management Plan summarises the proposed risk management approach for a project, programme or policy.

Scenario – See climate scenario.

Sector – A part or division, such as the economy (e.g. the manufacturing sector or the services sector), or the environment (e.g. water resources or forestry).*

Siltation – A build-up of silt (fine particles or earthy matter), suspended in rivers or other bodies of water which is then deposited in channels, reservoirs, estuaries, harbours,

etc. It enters watercourses as a side effect of soil erosion and water run-off (e.g. because of deforestation).

Stakeholders – Those who have interests in a particular decision, either as individuals or as representatives of a group. This includes people who can influence a decision as well as those affected by it. Decision makers are also stakeholders.

Strategy – A broad plan of action that is implemented through policies and measures. Strategies can be comprehensive (i.e. focusing on national, cross sectoral scales) or targeted (i.e. focusing on specific sectors, regions, or measures).*

Subsidy – A subsidy is generally a monetary grant given by government in support of an activity regarded as being in the public interest. Sometimes it may also refer to assistance granted by others, such as individuals or non-government institutions, although this is more usually described as charity.

Sustainable Development – A widely-used and accepted international term that is defined as: "development which meets the needs of the present without compromising the ability of future generations to meet their own needs."

Uncertainty – An expression of the degree to which a value (e.g. the future state of the climate system) is unknown.*

Vulnerability – The degree to which an individual, group or system is susceptible to harm due to exposure to a hazard or stress, and the (in)ability to cope, recover, or fundamentally adapt (become a new system or become extinct).

Vulnerability analysis – This identifies who and what is exposed and sensitive to external impacts. A vulnerability analysis starts by considering the factors that make the people of environment susceptible to harm, i.e. access to natural and financial resources; ability to self-protect; support networks and so on.

Vulnerability assessment – Identifies who and what is exposed and sensitive to change. A vulnerability assessment starts by considering the factors that make people or the environment susceptible to harm, i.e. access to natural and financial resources; ability to self-protect; support networks and so on. It will be helpful to think through some of the 'symptoms' of vulnerability reflected in certain sectors.

* taken from the Adaptation Policy Framework (Burton & Huq et al., 2004)
** taken from CARICOM, 2003
Information about both of these specific sources is provided in section 6.2.4.

6.2 Further information and links to useful resources

This section provides web links to information portals, details of institutions that assist with adaptation planning, regional initiatives, and resources that exist to assist small

islands adapt to climate change. It is organised into the following sections:

- Caribbean experiences of adapting to climate change
- Data collection and natural resource monitoring
- Disaster risk management guidelines
- Guidance on how to adapt (books and other resources)
- Human health impacts
- Information portals on climate change (electronic)
- International law on climate change
- Regional capacity building projects and initiatives
- Research institutes investigating climate change (academic)
- Research institutes investigating climate change (regional)
- Resources/training courses for further learning about climate change
- Vulnerability assessment

6.2.1 Caribbean experiences of adapting to climate change

CPACC (Caribbean Planning for Adapting to Climate Change)
http://www.cpacc.org
The CPACC Project was the first Caribbean wide initiative that sought to monitor resources and put the groundwork in place for technical and institutional adaptation to climate change in the Caribbean. CPACC ended in 2001, but was followed by MACC, ACCC and then CCCCC (all described below).

Mainstreaming Adaptation to Climate Change (MACC)
The MACC project incorporated adaptation strategies identified under CPACC into national and sectoral development plans and continued with the capacity development initiatives started under CPACC.

Adapting to Climate Change in the Caribbean (ACCC) Project
The ACCC project had nine components, which built upon CPACC's experiences in order to consolidate, extend and make sustainable climate change responses. Information about this project is available via the CCCCC website: http://www.caribbeanclimate.org

Caribbean Community Climate Change Centre (CCCCC)
http://www.caribbeanclimate.org
CCCCC is an implementing body for regional climate projects. The website provides links to sources for information on regional and international negotiations and response efforts in the small islands. More information is available via the CCCCC website (www.caribbeanclimate.org), or for further information, contact:
Mainstreaming Adaptation to Climate Change (MACC) Project
University of Belize, R.L.C. Building
City of Belmopan, Belize
Tel: 011 501 822 1094/1104

Fax: 011 501 822 1365
Email: dtennyson@caribbeanclimate.org

6.2.2 Data collection and natural resource monitoring

Global Coral Reef Monitoring Network (GCRMN)
The Global Coral Reef Monitoring Network (GCRMN) works to improve management and conservation of coral reefs by providing manuals, equipment, databases, training, problem solving, and helps with finding funds for reef monitoring – all coordinated in a global network. http://www.gcrmn.org/

Global Coral Reef Monitoring Network and the International Coral Reef Initiative (2004) *Status of Coral Reefs of the World: 2004*. Wilkinson, C. (ed.) Townsville, Queensland: Australian Institute of Marine Science. http://www.gcrmn.org/Status2004.asp
The report documents how human activities continue to be the primary cause of the global coral reef crisis. The report details many initiatives such as by conserving the biodiversity, the economic value and beauty of coral reefs.

IUCN – The World Conservation Union
http://www.iucn.org/
IUCN builds bridges between governments and NGOs, science and society, local action and global policy. Its mission is "to influence, encourage and assist societies throughout the world to conserve the integrity and diversity of nature and to ensure that any use of natural resources is equitable and ecologically sustainable." This link offers access to some interesting publications concerning climate change adaptation and ecosystems, water management, forests, nature, etc.: http://www.iucn.org/themes/fcp/experience_lessons/climate_iucn_initiative.htm
Some particularly relevant publications are:
http://www.iucn.org/themes/marine/pdf/coralen.pdf
(Westmacott, S., Teleki, K., Wells, S., and West, J. (2000) *Management of Bleached and Severely Damaged Coral Reefs*. Gland, Switzerland and Cambridge, UK: IUCN – The World Conservation Union.)
This report is intended to contribute to effective and immediate management action to aid reef protection and regeneration, and to enhanced research to develop the necessary tools and measures for long-term success.
http://www.waterandnature.org/change/index.html
(Bergkamp, B., Orlando, B., and Burton, I. (2003) *Change: Adaptation of water resources management to climate change*. Gland, Switzerland and Cambridge, UK: IUCN – The World Conservation Union.)
This report will help water professionals to identify actions that can be taken to adapt to the changes in the world's water regimes expected to occur over the coming decades.

World Commission on Protected Areas (WCPA) (Part of IUCN)
http://www.iucn.org/themes/wcpa/

The aim of the WCPA is to promote the establishment and effective management of a world-wide representative network of terrestrial and marine protected areas, as an integral contribution to the IUCN mission.
http://www.iucn.org/themes/wcpa/pubs/pdfs/mpa_guidelines.pdf
(Kelleher, G. (1999) Guidelines for Marine Protected Areas. Phillips, A. (ed.): IUCN – The World Conservation Union.)
The aim of these guidelines is to help countries establish systems of Marine Protected Areas (MPAs), as a key component of integrated management of their coastal and marine areas and as part of sustainable development. The guidelines would be useful to natural resource managers at all levels, whether working on conservation of nature or sustainable use of marine resources. They therefore contain material of help to policy-makers, planners and field managers.

6.2.3 Disaster risk management guidelines

Building capacities for risk reduction. Written by Bethke, L., J. Good, et al. (1997) in the Disaster Management Training Programme. United Nations Department of Humanitarian Affairs.
See http://www.undmtp.org/english/riskreduction/riskreduction.pdf
This text is one of a series of training modules prepared for the UN Disaster Management Training Programme (DMTP). It takes the view that the first and best line of defence against disasters is the local community's knowledge and awareness of disaster reduction activities. It describes a process of local capacity building for the purpose of risk reduction.

European Environment Agency
http://www.eea.eu.int
Late lessons from early warnings: the precautionary principle 1896-2000. See references for full details.
This report is about the gathering of information on the hazards of human economic activities and its use in taking action to better protect both the environment and the health of the species and ecosystems that are dependent on it, and then living with the consequences. It is based on case studies by experts in the fields of environmental, occupational and consumer hazards. Each identifies the dates of early warnings, to analyse how this information was used, or not used, in reducing hazards, and to describe the resulting costs, benefits and lessons for the future.
Copies can be obtained from:
The European Environment Agency,
Kongens Nytorv 6
DK-1050 Copenhagen K
Denmark
Tel: (45) 33367100
Fax: (45) 33367199
Email: eea@eea.au.int

International Federation of Red Cross and Red Crescent Societies
The International Federation's programmes are grouped into four main core areas: promoting humanitarian principles and values; disaster response; disaster preparedness; and health and care in the community. http://www.ifrc.org
The federation provides a number of useful publications, including:
World Disasters Reports:
Focus on Recovery (2001) http://www.ifrc.org/publicat/wdr2001/
Focus on Reducing Risk (2002) http://www.ifrc.org/publicat/wdr2002/
Focus on Community Resilience (2004) http://www.ifrc.org/publicat/wdr2004/

For example, the 2004 report argues that a developmental approach to creating disaster resilience is needed, which puts communities in charge of defining their needs and crafting the right solutions. Chapters of the report (and previous ones) are available online via the link above. Previous reports have slightly different areas of focus. For example, the 2002 report focuses on reducing risk.
To order hard copies, contact:
Kumarian Press Inc
1294 Blue Hills Ave
Bloomfield CT 06002, USA
Tel: (1)(860) 243 2098 Fax: (1)(860) 243 2867
E-mail: kpbooks@aol.com Web: http://www.kpbooks.com
OR: Eurospan
3 Henrietta Street
Covent Garden
London WC2E 8LU, UK
Tel: (44)(20) 7240 0856 Fax: (44)(20) 7379 0609
E-mail: orders@edspubs.co.uk Web: http://www.eurospan.co.uk

Living with Risk: A global review of disaster reduction initiatives (2004)
Produced by the International Strategy for Disaster Reduction and the United Nations, Geneva.
See http://www.unisdr.org/eng/about_isdr/bd-lwr-2004-eng.htm
This report is intended for interested people and practitioners in disaster risk management and sustainable development. It seeks to provide guidance, policy orientation and inspiration as well as a body of reference to further study the subject. Rather than focusing on specific experiences of disaster preparedness, response or recovery, it aims at providing a comprehensive compilation of initiatives and reference information on disaster risk reduction.

National Drought Mitigation Center
http://www.drought.unl.edu/index.htm (ndmc@drought.unl.edu)
The National Drought Mitigation Center helps people and institutions develop and implement measures to reduce societal vulnerability to drought. Based at the University

of Nebraska-Lincoln, USA, it stresses preparation and risk management rather than crisis management. It offers advice on what drought is, planning for drought, monitoring drought, understanding your risk and mitigating drought.

United Nations International Strategy for Disaster Reduction (UN/ISDR)
http://www.unisdr.org/isdrindex.htm
The ISDR aims at building disaster resilient communities by promoting increased awareness of the importance of disaster reduction as an integral component of sustainable development, with the goal of reducing human, social, economic and environmental losses due to natural hazards and related technological and environmental disasters. The website contains a section on disaster reduction and climate change: http://www.unisdr.org/eng/risk-reduction/climate-change/rd-cch-infolink3-04-eng.htm

6.2.4 Guidance on how to adapt

Adaptation Policy Framework (APF)
Burton, I., S. Huq, et al. (2004). Adaptation Policy Framework. New York, United Nations Development Programme. http://www.undp.org/cc/apf.htm
The APF is a book that aims to assist countries to develop national strategies for adaptation. It provides guidance on designing and implementing projects that reduce vulnerability to climate change, by both reducing potential negative impacts and enhancing any beneficial consequences of a changing climate. It seeks to integrate national policy making efforts in a "bottom-up" direction, emphasising five major principles: adaptation policy and measures are assessed in a developmental context; adaptation to short-term climate variability and extreme events are explicitly included as a step toward reducing vulnerability to long-term change; adaptation occurs at different levels in society, including the local level; the adaptation strategy and the process by which it is implemented are equally important; and building adaptive capacity to cope with current climate is one way of preparing society to better cope with future climate.

Caribbean Risk Management Guidelines for Climate Change Adaptation Decision Making
This book produced by CARICOM (the Caribbean Community Secretariat) in 2003, was developed with the Adapting to Climate Change in the Caribbean (ACCC) Project. The guidelines were developed to serve as a user-friendly risk management framework to assist the process of decision-making concerning the selection and eventual implementation of adaptation options. The specific objective of the document is to describe and illustrate the steps of the Caribbean risk management decision-making process for adaptation to climate variability and climate change.

Cities, Seas, and Storms: Managing Change in Pacific Island Economies. Volume IV: Adapting to Climate Change (2000).
Written by the World Bank, the Papua New Guinea and Pacific Islands Country Unit. Published in Washington, D.C. November 30, 2000.

This readable report provides detailed evidence of climate change in Pacific Islands, and provides insights into how different islands have approached the challenge of preparing for climate change. See:
http://siteresources.worldbank.org/INTPACIFICISLANDS/Resources/4-VolumeIV+Full.pdf
The full report (containing 4 volumes) also explores the influences of growing Pacific towns and the ocean on Pacific economies. The report argues that to manage all three influences there needs to be an inclusive institutional framework and for stronger partnerships between Pacific Island governments, traditional organizations and the broader civil society. The report was produced in partnership with national, regional, and international experts. Link to contents page and full report:
http://web.worldbank.org/WBSITE/EXTERNAL/COUNTRIES/EASTASIAPACIFICEXT/PACIFICISLANDSEXTN/0,,contentMDK:20218394~pagePK:141137~piPK:217854~theSitePK:441883,00.html

Compendium on methods and tools to evaluate impacts of, vulnerability and adaptation to climate change. Produced by the UNFCCC. The compendium provides users with key information about available frameworks and tools, special features of each framework or tool, and information about how to obtain documentation, training, or publications supporting each tool. It has been designed to be used as a reference document to identify available frameworks and tools for assessing vulnerability and adaptation. It offers both overall frameworks (e.g. stakeholder approaches, decision tools) and sector specific tools (e.g. agriculture sector tools, water sector tools). http://unfccc.int/adaptation/methodologies_for/vulnerability_and_adaptation/items/2674.php

National Adaptation Plans of Action (NAPAs)
NAPAs have been established to address the urgent and immediate national needs of Least Developed Countries (LDC's) for adapting to the adverse impacts of climate change and for preparation of National Communications to the UNFCCC. NAPAs provide a process for LDCs to identify priority activities to respond to climate change. The NAPA takes into account existing coping strategies at the grassroots level, and builds upon that to identify priority activities. Prominence is given to community-level input as an important source of information, recognising that grassroots communities are the main stakeholders.
www.undp.org/cc/napa.htm
http://unfccc.int/national_reports/napa/items/2719.php;

Beyond Climate: Options for broadening climate policy (2004).
Edited by Kok, M., and Coninck, H.D. Funded by the Netherlands Research Programme on Climate Change: Scientific Assessment and Policy Analysis.
This publication may be of interest in planning for adaptation. It shows the relevance and possibilities of mainstreaming climate in other policy areas such as poverty

reduction, land-use & agriculture, security of energy supply, trade & finance and air quality & health. It addresses how a so-called 'non-climate policy track' could be made part of national and international efforts to mitigate climate change and adapt to climate impacts that are occurring.
See http://arch.rivm.nl/ieweb/ieweb/Reports/rep500019001.pdf

Towards managing environmental vulnerability in small island developing states (SIDS) (2002).
Written by Kaly, U., Pratt, C., and Howorth, R.
This paper was produced on behalf of the South Pacific Applied Geoscience Commission (SOPAC), see:
http://www.un.org/special-rep/ohrlls/sid/sid2004/SOPAC-concept%20paper.pdf

Vulnerability and Adaptation Resource Group (VARG)
http://www.climatevarg.org/
An informal network of institutions: The mission of VARG is to facilitate the integration of climate change adaptation in the development process through the sharing, assessment, synthesis, and dissemination of existing knowledge and experience. The target audience is developing countries, the UNFCCC process, civil society, and development agencies. The website provides links to a number of documents on climate change provided by different institutions, and useful links to information about:

- Climate variability, extremes and change: scientific background on vulnerability and adaptation
- The political context of climate change
- Development, poverty and climate change
- Adaptation projects and initiatives

6.2.5 Human health impacts

World Health Organisation
The World Health Organisation is the United Nations special agency for health. They have information relating health to climate change:
http://www.who.int/topics/climate/en/
http://www.who.int/globalchange/climate/en/
Via these pages, you will be able to get access to much information and a number of publications concerning the impacts of climate change on health and information about adaptation.

Go to: http://www.who.int/globalchange/publications/en/

- Climate Change and Human Health: Risks and Responses (2003), written by McMichael, A. et al. http://www.who.int/globalchange/publications/cchhsummary/en/
- Methods of assessing human health vulnerability and public health adaptation to climate change (2003). Written by Kovats, R.S. et al. http://www.euro.who.int/globalchange/Publications/20031125_1

- Climate change and Human Health: Impact and adaptation (2000). Kovats, R.S. et al. http://whqlibdoc.who.int/hq/2000/WHO_SDE_OEH_00.4.pdf

6.2.6 Information portals on climate change (electronic)

Asia-Pacific network
http://www.ap-net.org/index.html
A knowledge based resource for the Asia-Pacific region on climate change issues. It provides: a platform for policy dialogues and consultation with the region; access to the latest information and data on climate change issues and developments focusing on the Asia-Pacific; support for capacity building for developing countries in the region. The following link will take you to the Adaptation documents library. This is where you can find all sorts of different publications concerning adaptation to climate change in the region:
http://www.ap-net.org/database/library/09.html

Intergovernmental Panel on Climate Change (IPCC)
http://www.ipcc.ch/
The role of the IPCC is to assess on a comprehensive, objective, open and transparent basis the scientific, technical and socio-economic information relevant to understanding the scientific basis of risk of human-induced climate change, its potential impacts and options for adaptation and mitigation. The most recent Third Assessment Report is available online: http://www.grida.no/climate/ipcc_tar/. This report comes in four parts:

- The Scientific basis (Working Group 1): http://www.grida.no/climate/ipcc_tar/wg1/index.htm
- Impacts, Adaptation and Vulnerability (Working Group II): http://www.grida.no/climate/ipcc_tar/wg2/index.htm
- Mitigation (Working Group III): http://www.grida.no/climate/ipcc_tar/wg3/index.htm
- Synthesis Report: http://www.grida.no/climate/ipcc_tar/vol4/english/index.htm

Of particular relevance to the objectives of this guidebook is the 'Impacts, Adaptation and Vulnerability' volume, which contains a chapter about Small Island States (chapter 17). A hard copy summary of the four volume report for 2001 can be obtained free of charge from:
The IPCC Secretariat, c/o World Meteorological Organization,
7 bis Avenue de la Paix, C.P. 2300,
CH – 1211 Geneva 2, Switzerland
The IPCC can be contacted via telephone: +41-22-730-8208; fax: +41-22-730-8025; or email: IPCC-Sec@wmo.int. Full copies can be purchased from Cambridge University Press, 110 Midland Avenue, Port Chester, NY 10573-4930, USA (Telephone: +1 914-937-9600, Fax: +1 914-937-4712, Web site: http://www.cup.org)

The IPCC also runs a Data Distribution Centre (http://ipcc-ddc.cru.uea.ac.uk/) which offers access to baseline and scenario data. It also provides technical guidelines on the

selection and use of different types of data and scenarios in research and assessment. The DDC is designed primarily for climate change researchers, but materials contained on the site may also be of interest to educators, governmental and non-governmental organisations, and the general public.

National Oceanic and Atmospheric Administration
Website includes storm watches and warnings, weather information, tropical cyclone forecasts and advisories for all over the world.
National Hurricane Center: http://www.nhc.noaa.gov/ (Includes information on hurricane preparedness and forecasts)
Information about El Niño: http://www.elnino.noaa.gov/

The New Scientist
www.newscientist.com/channel/earth/climate-change/
The website of the New Scientist magazine includes recent climate change news, background information, web-links to informative resources and answers to frequently asked questions on climate change.

The Royal Society
http://www.royalsoc.ac.uk/page.asp?id=2986
The Royal Society provides a guide to facts and fictions about climate change. This website examines twelve misleading arguments put forward by the opponents of urgent action on climate change and highlights the scientific evidence that exposes their flaws.

UK Met Office and Hadley Centre
The Met Office is a leading provider of environmental and weather-related services including sources of information about climate change. The Hadley Centre for Climate Prediction and Research is part of the met office, providing a focus on climate change science. http://www.metoffice.com/index.html and http://www.metoffice.com/research/hadleycentre/index.html
For information about the Hadley Centre's PRECIS model outlined in Chapter 3, go to: http://www.metoffice.com/research/hadleycentre/models/PRECIS.html

United Nations Environment Programme (UNEP) for small islands
http://islands.unep.ch/
This resource provides access to a number of resources concerning islands, primarily from within the United Nations system that are otherwise rather scattered and difficult to obtain. It includes basic UN documents or extracts from documents relevant to islands, educational materials concerning islands, and a directory listing some 2,000 islands and giving their basic geographic, environmental and socio-economic characteristics.

United Nations Development Programme (UNDP)
UNDP is the UN's global development network, an organization advocating for change and connecting countries to knowledge, experience and resources to help people build

a better life. They have a lot of information relating to climate change, available via the following link:
http://www.undp.org/gef/undp-gef_focal_areas_of_action/sub_climate_change.html

United States Geological Survey
Has a useful page providing information on El Niño and how it exacerbates climate hazards, floods, landslides and coastal hazards: http://walrus.wr.usgs.gov/elnino/

World Meteorological Association (WMO)
This website provides much background information about the climate system. In the specific case of weather-related natural disasters, WMO's programmes provide the vital information for the advance warnings that save many lives and reduce damage to property and the environment. http://www.wmo.ch/index-en.html
Information about El Nino: http://www.wmo.ch/nino/ninoi.html

6.2.7 International law on climate change

United Nations Framework Convention on Climate Change (UNFCCC)
The UNFCCC is a global treaty that commits signatories to take collective responsibility for climate change and to take action to address the problem. It calls for the "stabilization of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system". It was signed at the 1992 Earth Summit in Rio de Janeiro. http://unfccc.int
There are several sections pertaining to adaptation, see:
http://unfccc.int/adaptation/items/2973.php

6.2.8 Regional capacity building projects and initiatives

Alliance of Small Island States (AOSIS)
A coalition of small island and low-lying coastal countries that share similar development challenges and concerns about the environment: especially their vulnerability to the adverse effects of global climate change.
http://www.sidsnet.org/aosis/index.html

Capacity Building for the Development of Adaptation Measures in Pacific Island Countries (CBDAMPIC)
This project is being executed by the South Pacific Regional Environment Programme (SPREP) for the Canadian International Development Assistance in the Cook Islands, Fiji, Samoa and Vanatu. See the CBDAMPIC annual report (2003)
http://www.sprep.org.ws/climate/documents/First_Six_Monthly_Report-CBDAMP.pdf

Government of Canada
The Canadian Government has produced a report entitled 'Climate Change Impacts and Adaptation: A Canadian Perspective'. The report is a good example of a national overview of key climate change concerns within several major sectors and considerations

for adaptation. It is available at:
http://adaptation.nrcan.gc.ca/perspective_e.asp

Maghreb project (*Projet Maghrebin sur les Changements Climatiques*)
This collaborative regional project (covering the Maghreb region, i.e. Algeira, Morocco, Tunisia) explores policy responses to climate change vulnerability with a view to guiding the region toward reduced impacts and greater adaptive capacity. Project information is available via this website (in French):
http://www.ccmaghreb.com/Projet_RAB_cc/mainfrab.htm

A report is also available:
'*Vulnerability of the Maghreb Region to Climate Change, and Needs for Adaptation (Algeria, Morocco, Tunisia)*':
http://www.ccmaghreb.com/main/papierv&ABill.pdf

PICCAP (Pacific Islands Climate Change Assistance Programme)
PICCAP is a US$3.2 million, 10 Pacific Island country programme enabling activity on climate change. PICCAP commenced operation in July 1997. The primary aim of PICCAP is to build, enhance, and strengthen national capacities in Pacific Island countries to undertake studies and to report to the United Nations Framework Convention on Climate Change (UNFCCC). Through PICCAP, participating countries have completed, Greenhouse Gas Inventories, Mitigation Analysis, Vulnerability and Adaptation Assessment, and National Communications. National Implementation Strategies have also commenced.
Information is available at:
http://www.gefweb.org/Outreach/outreach-PUblications/Project_factsheet/Asia_Pacific-paci-3-cc-undp-eng.pdf

UK Climate Impacts Programme (UKCIP)
http://www.ukcip.org.uk/
UKCIP was set up in 1997. It provides guidance to UK climate change stakeholders on how to prepare for and respond to climate change. There are many resources available on the web site to help individuals and companies adapt, these include an 'adaptation wizard; climate change scenarios and regional impact and vulnerability assessments. UKCIP shares this information with organisations in the commercial and public sectors to help them prepare for the impacts of climate change.

6.2.9 Research institutes investigating climate change (academic)

Climatic Research Unit
The Climatic Research Unit is based in the School of Environmental Sciences at the University of East Anglia, Norwich, UK. It is widely recognised as one of the world's leading institutions concerned with the study of climate change. It provides a good source of much climate data, information about climate change and links to information sources based around the world. The Unit also provides information about and access to

the climate models MAGICC and SCENGEN as outlined in Chapter 3.
http://www.cru.uea.ac.uk/cru/projects/magicc/

RIVM
The National Institute for Public Health and the Environment (RIVM) is a recognised leading centre of expertise in the fields of health, nutrition and environmental protection. RIVM works mainly for the Dutch government but shares knowledge with governments and supranational bodies around the world. The results of RIVM's research, monitoring, modelling and risk assessment are used to underpin policy on public health, food, safety and the environment.
http://www.rivm.nl/en/

Tyndall Centre for Climate Change Research
http://www.tyndall.ac.uk
The Tyndall Centre is a national UK centre which brings together scientists, economists, engineers and social scientists, who together are working to plan for climate change. The Tyndall Centre has a research programme focussed on adaptation to climate change:
http://www.tyndall.ac.uk/research/theme3/theme3.shtml

6.2.10 Research institutes investigating climate change (regional)

SOPAC
SOPAC is the South Pacific Applied Geoscience Commission. It is an inter-governmental, regional organisation dedicated to providing services to promote sustainable development in the countries it serves. For general information about SOPAC:
http://www.sopac.org/tiki/tiki-index.php

South Pacific Regional Environment Programme (SPREP)
SPREP is a regional organisation established by the governments and administrations of the Pacific region to look after its environment. It has grown from a small programme attached to the South Pacific Commission (SPC) in the 1980s into the Pacific region's major intergovernmental organisation charged with protecting and managing the environment and natural resources. SPREP's climate change portal can be found at:
http://www.sprep.org.ws/climate_change/index.asp

6.2.11 Resources/training courses for further learning about climate change

Assessments of Impacts and Adaptations to Climate Change (AIACC) in Multiple Regions and Sectors
A global initiative developed in collaboration with the UNEP/WMO Intergovernmental Panel on Climate Change (IPCC) and funded by the Global Environment Facility to advance scientific understanding of climate change vulnerabilities and adaptation options in developing countries. AIACC aims to enhance the scientific capacity of

developing countries to assess climate change vulnerabilities and adaptations, and generate and communicate information useful for adaptation planning and action.
http://www.aiaccproject.org/aiacc.html

The Global Environment Facility
The Global Environment Facility (GEF) helps developing countries fund projects and programs that protect the global environment. GEF grants support projects related to biodiversity, climate change, international waters, land degradation, the ozone layer, and persistent organic pollutants.
http://www.gefweb.org/index.html

The Special Climate Change Fund (SCCF)
The SCCF under the UNFCCC will finance projects relating to adaptation; technology transfer and capacity building; energy, transport, industry, agriculture, forestry and waste management; and economic diversification.
http://unfccc.int/cooperation_and_support/funding/special_climate_change_fund/items/2602.php

6.2.12 Vulnerability assessment

SOPAC indicators of environmental vulnerability
Information about SOPAC's work on vulnerability can be found via this link:
http://www.sopac.org/tiki/tiki-index.php?page=Environmental%20Vulnerability

Tyndall indicators of vulnerability to climate change
This project created indicators of vulnerability to climate change and adaptive capacity. A technical report can be found at:
http://www.tyndall.ac.uk/research/theme3/final_reports/it1_11.pdf

UNFCCC National communications
All signatories to the UN Framework Convention on Climate Change (UNFCCC) are required to prepare a National Communication comprising three major elements: a national greenhouse gas inventory, abatement analysis, and vulnerability and adaptation assessments: http://www.undp.org/cc/index2.htm.
Examples of national communications prepared by other small island states, or existing communications may be useful in compiling a vulnerability assessment. They can be accessed via the UNFCCC:
http://unfccc.int/national_reports/non-annex_i_natcom/items/2979.php

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S Scientific Annex

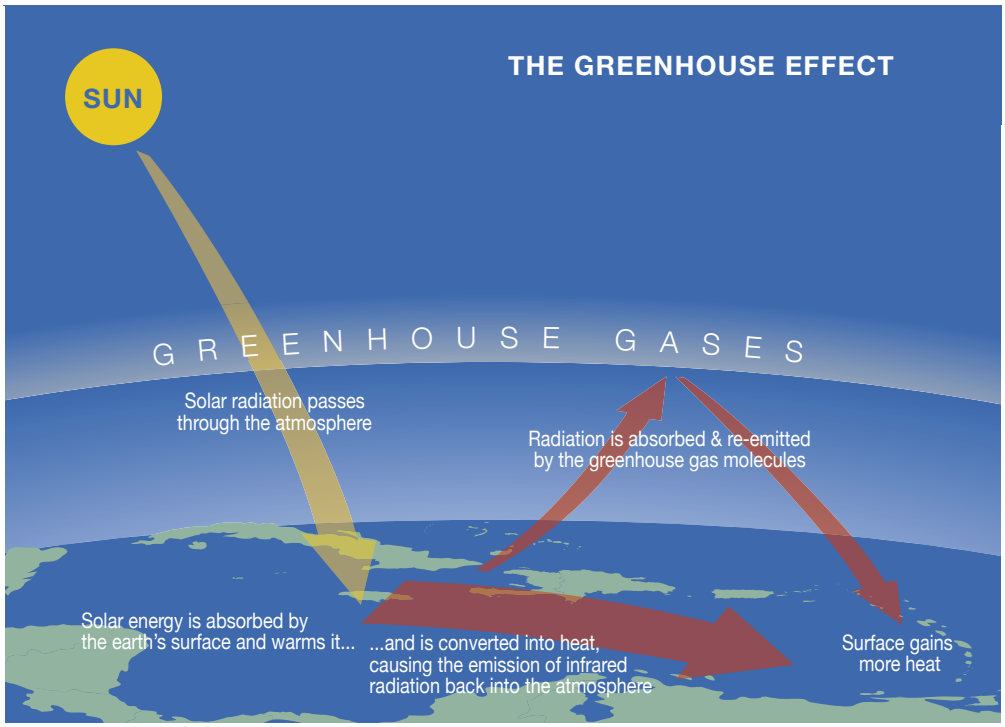
Contents

- What is causing climate change?
- Climate scenarios and uncertainty

1. What is causing climate change?

The Earth has always been surrounded by gases which form our atmosphere, notably: water vapour, carbon dioxide, nitrous oxide and methane. These gases are produced naturally; they keep the planet warm and make it suitable for human habitation by trapping energy from the sun (see Figure A1). Because of the way in which the gases warm our world, they are referred to as greenhouse gases. Without the presence of greenhouse gases in the atmosphere we would not be able to survive on this planet. This is because heat would escape back to space and the Earth's average surface air temperature would be much colder (about 30°C colder).

Figure A1 – The greenhouse effect



(adapted from: http://www.grida.no/climate/vital/03.htm)

Greenhouse gases are accumulating in the Earth's atmosphere as a result of humans burning fossil fuels, clearing land and cutting down forests. We rely on fossils fuels – coal, oil and gas – to power a vast range of activities, including transport, manufacturing and the cooling and heating of buildings. The recent rise in greenhouse gases started around the middle of the 1800's, which coincides with the European industrial revolution and an exponential growth in the burning of fossil fuels.

Definition of fossil fuels

Fossil fuels are concentrated deposits of carbon stored underground or beneath the sea. They are composed of the fossilised remains of plants and animals, which have decayed over millions of years. This stored energy in the form of coal, oil and natural gas can be used as fuel when it is burned. Burning fossil fuels is the major way in which humans add greenhouse gases to the atmosphere.

Climate change is the term used to refer to the consequences of the recent accumulation of greenhouse gases in the Earth's atmosphere. Climate science tells us that as the burning of fossil fuels continues, more greenhouse gases are being produced. The concentrations of these gases in the atmosphere are increasing, causing additional warming of planet Earth, as more of the sun's energy is trapped within the atmosphere. As planet Earth warms, the climate is changing; the extra warming has knock-on effects, including changes in global precipitation patterns and sea level rise.

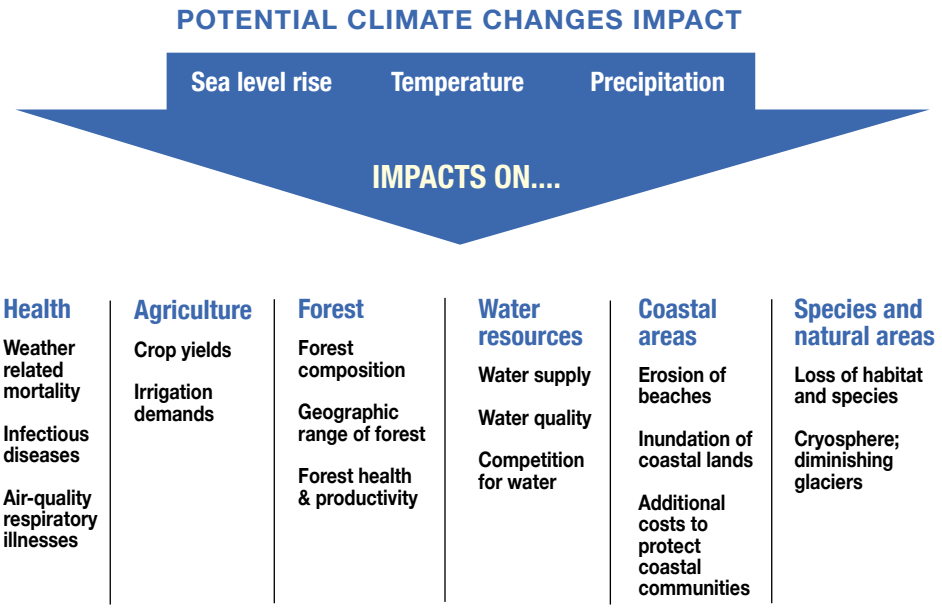
KEY message

Since 2001, the world's leading body of climate scientists, the Intergovernmental Panel on Climate Change, has agreed that the majority of the climate changes currently being experienced can probably be attributed to the human production of greenhouse gases.

The long-term climatic changes that are resulting from changes in the composition of greenhouse gases in the atmosphere are projected to continue in the future. Even if humans were to reduce emissions of greenhouse gases, climate change would still happen. This is because there is a long lag-time between the emission of gases and the realisation of climate changes. For example, if emissions were held constant from today, greenhouse gas concentrations would rise for another 10-20 years, global temperature would rise for another 50-100 years, and sea-level would rise for another 500-1000 years.

The impacts of changes in the climate system will have effects on people globally, especially those in poor communities, located in low-lying areas and those who are already vulnerable to economic, social and environmental shocks. Figure A2 demonstrates the kinds of impacts that might result from changes in temperature, sea level rise and precipitation (e.g. rainfall).

Figure A2 The impacts that might result from climatic changes – temperature, sea-level rise and precipitation



(adapted from: http://www.grida.no/climate/vital/20.htm)

While the majority of the world's leading scientists believe that climate change is happening and it is a problem, not everyone agrees. One reputable scientist argues that there is not yet enough information to be able to make a definitive judgement about the causes of climate change, yet he does not dispute that there are climatic changes occurring. Others suggest that the changes that are being experienced are cyclical and attributable to other natural causes, such as sun spot activity or incorrect data. Some economists argue that we do not need to worry about climate change now as we will be able to develop technology in the future that completely protects us from the worst impacts of climate change.

2. Climate scenarios and uncertainty

There is a clear consensus that climate change is occurring. The Intergovernmental Panel on Climate Change concludes that mankind has influenced the Earth's warming over the last 50 years. Climate science has a long pedigree and much of what we know today has 150 years of science to support it, see Box A1.

e.g.

Box A1 The history of climate change science

Since **1859** we have known that different gases have different global warming potentials. This means that we know that if the composition of the atmosphere changes, the world temperature will change.

Since **1896** we have known that if the concentration of carbon dioxide in the atmosphere increases we can expect the planet to warm. In 1896 it was estimated that if carbon dioxide doubled in concentration from its level then of 280 parts per million, then the atmosphere would warm by 4.0°C and 5.7°C. Scientists have been trying to determine the precise warming effect of a doubling of carbon dioxide in the atmosphere since that time.

Since **1938** we have known that the global mean temperature has been rising since the 1860s. The warming has accelerated substantially since the 1970s.

Since **1960** we have known that the carbon dioxide concentration in the atmosphere has been rising; at this time the carbon dioxide concentration was estimated to be 330 parts per million.

We know today that if the concentration of carbon dioxide in the atmosphere continues to increase then the temperature will increase. The current carbon dioxide concentration in the atmosphere is 380 parts per million and global average temperature has risen by 0.7°C over the past 120 years. Models now suggest that a doubling of carbon dioxide in the atmosphere (to 560 parts per million) will lead to a temperature increase of between 2°C and 11°C.

However, scientists are still unsure about how large the effects of climate change will be, or when the worst impacts will occur. To help people prepare for climate change, scientists have created climate scenarios.

Definition of climate scenarios !

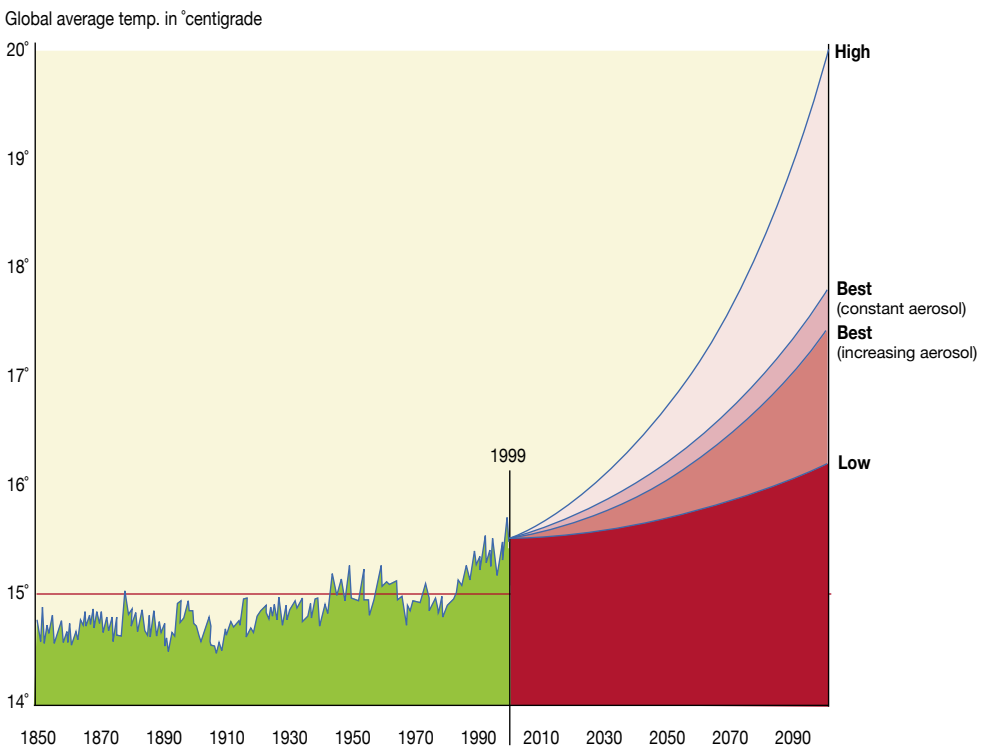
Climate scenarios are representations of what may possibly happen to the climate in future, based on different assumptions about how the world develops, and on our understanding of how the climate system works.

Building climate scenarios is a complicated science. State of the art models are used by scientists to estimate the future responses of the climate system to rising levels of greenhouse gases in the atmosphere. Climate modelling is a fast moving subject and new advances are regularly being made. However, climate models are not 100% accurate. Different models give different results because of different assumptions being made. It is also difficult for climate models to describe future climates over very small areas, e.g. for small islands.

From these complex models, we expect that the average temperature around the Earth will rise in future by between 1.4°C and 5.8°C by 2100 relative to 1990. This means

that the atmosphere could be 1.4°C to 5.8°C hotter in 2100 than it was in 1990. The potential range of temperature change over this time period is depicted in Figure A3. The sea level is expected to rise by between 9 and 88 cm over the same time scale.

Figure A3 Projected ranges of increase in global temperature



(adapted from: http://www.grida.no/climate/vital/23.htm; http://www.grida.no/climate/vital/24.htm)

We do not know if the temperature and sea level will rise by the higher or lower amount because we do not know the volume of greenhouse gases we, and future generations, will produce. How we live affects how much gas is produced, which in turn affects the climate. It is very difficult for climate scientists to predict what people will do!

KEY message

Whichever future climate change scenario occurs, there will be a hotter atmosphere and the sea level will rise. The climate of the twenty-first century will *not* be like that of the twentieth century.

Even the highest projections of temperature and sea level rise may not sound like much: 5.8°C and 88cm. However, these levels of warming and sea level rise will have severe consequences for the planet. The impacts will not be evenly distributed; some regions of the world may become hotter, but others could become cooler, drier, or wetter or a combination of all of these at different times of year.

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SURVIVING

CLIMATE CHANGE

IN SMALL ISLANDS

A GUIDEBOOK

This guidebook provides information about the risks associated with climate change, as well as providing ideas, tools and techniques for those who need to start taking action today to prepare. It is primarily aimed at government officers who would like to learn more about climate change, its impacts and how to start preparing.

Specifically, it has been written to facilitate incorporation of climate change into planning and development activities on small islands. The general approach described is also useful for other geographic locations, enabling any reader to apply the recommendations and develop their own climate change adaptation plans.

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