Climate Change in the UK Overseas Territories

An Overview of the Science, Policy and You

JOINT NATURE CONSERVATION COMMITTEE

United Kingdom OTEP Overseas Territories Environment Programme

Commonwealth Foundation

Climate Change in the UK Overseas Territories

An Overview of the Science, Policy and You

Nicole Brown

Climate Change
Adaptation,
Mitigation and
Ecosystem Services
in the UK Overseas
Territories

JOINT NATURE CONSERVATION COMMITTEE

Acknowledgements:
This booklet is produced by the Joint Nature Conservation Committee with funding from the Overseas Territories Environment Programme (OTEP). It is published with assistance from the Commonwealth Foundation. Thank you to everyone who contributed in different ways toward the publication.

Lead author: Nicole A. Brown
CANARI team: Sarah McIntosh, Leslie Walling, Owen Day, Leigh Morton, Alex McCaffery

Editorial/Steering Committee:
Tara Pelembe (JNCC)
Diana Mortimer (JNCC)
Deborah Procter (JNCC)
Karen Dickenson (JNCC)
Gina Ebanks-Petrie (Director, Department of Environment Cayman Islands)
Jack Ward (Director, Department of Conservation Services, Bermuda)
Susanna Musick (Director, Department of Conservation, Ascension Island)
Elaine Kendall (Defra)
Rowena Harding (Commonwealth Foundation)
Jean-Phillipe Palasi (IUCN)
Sarah Sanders (RSPB)

Contributors:
Timothy Austin (Cayman Islands Government), Tom Boden (CDIAC), Rob Bowman (Foreign and Commonwealth Office), Dr Barbara Carby (Cayman Islands Government), Darren Christie (Government of South Georgia and the Sandwich Islands), Rhon A. Connor (Government of Anguilla), Athena Dinar (British Antarctic Survey), Corinda Essex (St. Helena Government), Steven Freeman (AM-Sciences), James Glass (Tristan da Cunha Government), Lisa Greene (Bermuda Aquarium, Museum and Zoo), Mike Halpert (NOAA), Karim V. D. Hodge (Government of Anguilla), Kevin Hughes (British Antarctic Survey), Andy Holbrook (Cayman Islands Government), Lisa-Ann Hurlston (Cayman Islands Government), Gordon Liddle (University of Dundee), Jeremy Madeiros (Bermuda Department of Conservation Services), Farah Mukhida (Anguilla National Trust), Grant Munro (Falklands Conservation), Helen Otley (Falkland Islands Government), Louise Quarrell (Impetus Consulting), Professor Charles Sheppard (University of Warwick), Vince Thompson (St. Helena National Trust), Melinda Tignor (IPCC).

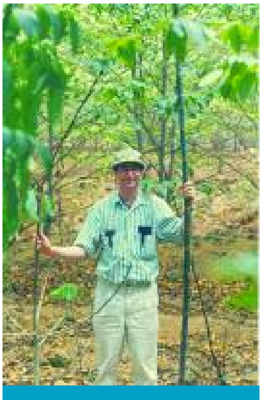
Cover Photographs:
Rockhopper penguins – Falklands Conservation
Storm in Cayman Islands – Department of Environment, Cayman Islands
Fisherman's pirogue – Steve Freeman, AM-Sciences
Reef – Charles Sheppard
Cayman Islands beach – Department of Environment, Cayman Islands Government

Funding:
Funded by Overseas Territories Environment Programme.

Citation:
This document should be cited as Brown, N. 2008. *Climate change in the UK Overseas Territories: An Overview of the Science, Policy and You*. Peterborough,UK: Joint Nature Conservation Committee

ISBN-13:978 1 86107 609 0

Foreword



Dr Peter Bridgewater

Climate change is without doubt the most pressing of the world's environmental issues, if only because other serious issues such as biodiversity loss, shortage of fresh water and increasingly problematic food security are all linked with, or a consequence of climate change. Large land areas may have sufficient buffering space to be able to manage the fallout from climate change, but islands often do not, having finite and limited resources. Ecosystem services, including the ability for ecosystems to help mitigate against and adapt to climate change, are present everywhere, however, and islands often have well adapted ecosystems in this way. Understanding these, and then conserving and managing them well, must be an imperative for the future.

Climate change is seen as critical to the long term health of ecosystems – yet it is also critical to the health of people, simply by virtue of ecosystem changes. We can no longer assume that we are not connected with nature; our future on the planet is inextricably entwined with that of nature. Thus this means that for the overseas territories of the UK, as with small islands generally, there are very special threats for very special systems.

We know that climate change is not easily forecastable, and that existing models are not necessarily in synchrony. But we also know for certain that we have to face up to increasing uncertainty. And managing for uncertainty is the most challenging issues for the territories. This booklet attempts to explain climate change in an 'easy-to-read' way for decision makers and the wider community in the United Kingdom Overseas Territories (UKOTs), so that they can get a good grasp of the basic key concepts. It also attempts to outline what the present and future impacts of climate change will be specifically for the

UKOTs, and outlines options for adaptation and mitigation. Among other materials, there are many recipes for sustainability in the guide.

The biodiversity of the UKOTs is important at a global scale, largely because of the restricted species, their genetic diversity and the attendant variation in land and seascapes of the territories. And as islands they all sit in the world's oceans – ocean biodiversity, whether from coastal systems like mangroves and coral reefs, to deep water ecosystems, are all known key spots for vulnerability to climate change.

Climate change also interacts with other environmental pressures, including increasing habitat fragmentation, pollution from fertilizers and invasive species. This combination may well result in novel species assemblages, some of which will be unstable, but others of which will offer huge potential for management of landscape elements. Looking out for these opportunities are new challenges for natural resource managers of our overseas territories, and will not be easy choices to make.

And while conservation is critical, let us not forget the role rehabilitation and restoration can play – regenerating forgotten forests, managing coastal systems back to health and productivity must be part of our future solutions. Yet looking for opportunities to enhance and improve ecosystem resilience in the face of climate change are what UKOTs can and must do to ensure their survivability and prosperity. This guide is a small contribution to making that happen; to minimise risk and maximise benefit for people and nature on the UKOTs.

Dr Peter Bridgewater
Chair, Joint Nature Conservation Committee

Contents

Abbreviations and Acronyms

ACC	Antarctic Circulation Current
BIOT	British Indian Ocean Territory
CFCs	Chlorofluorocarbons
DFID	Department for International Development (UK)
ECLAC	Economic Commission for Latin America and the Caribbean
ENSO	El Niño – Southern Oscillation
GDP	Gross Domestic Product
IPCC	Intergovernmental Panel on Climate Change
LDCs	Least Developed Countries
MACC	Mainstreaming Adaptation to Climate Change
NAPA	National Adaptation Plans of Action
PRECIS	Providing Regional Climates for Impact Studies
SBAs	Sovereign Base Areas
UKOT	United Kingdom Overseas Territory
UNFCCC	United Nations Framework Convention on Climate Change

Glossary

Adaptation	In the context of climate change, adaptation is the adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities.
Anthropogenic	Caused by humans or human activities; usually used in reference to environmental degradation.
Biome	A regional ecosystem characterised by distinct types of vegetation, animals and microbes that have developed under specific soil and climatic conditions.
Biodiversity	The variety of plant and animal life found in an ecosystem (see below) and the variation in their genetic makeup. Biodiversity is a measure of the health of an ecosystem, with healthy ecosystems having greater variety and variation in plant and animal life than unhealthy ones.
Carbon dioxide saturation point	The point at which oceans are no longer able to effectively absorb carbon dioxide and act as a counterbalance to greenhouse gas emissions.
Carbon sink	A reservoir that can absorb or "sequester" carbon dioxide from the atmosphere. Forests are the most common form of sink, as well as soils, peat, permafrost, ocean water and carbonate deposits in the deep ocean.
Climate	The average, or typical, weather conditions of a given area observed over a long period of time, usually 30 years or more.
Climate change	Any significant, long-term modification in the climate of a zone or region.
Climate zone	An area with a prevailing climate that distinguishes it from other areas by parameters such as temperature, rainfall and even plant species.
Coral bleaching	Loss of colour of corals due to loss of the symbiotic algae that provide their nutrients and colouration. Bleaching occurs in response to physiological shock as a result of abrupt changes in temperature, salinity, and turbidity.
Critically endangered species	A plant or animal is critically endangered when it is considered to be facing an extremely high risk of extinction in the wild.
Ecosystem	A community of living (plants and animals) and non-living things (climate, landscape) which interact together and affect each other.

Glossary cont'd

El Niño/El Niño – Southern Oscillation
A climatic pattern that results from the interaction between the ocean and the atmosphere in the Pacific and the follow-on effect on global climate. It is caused when the trade winds that blow from east to west along the equator in the Pacific decrease in intensity (this is the Southern Oscillation) and bring about warming of the ocean temperature. The consequences are felt in the Pacific as well as globally.

Endangered species
A plant or animal is endangered when it is considered to be facing a very high risk of extinction in the wild.

Endemic/endemism
Found only in a certain strictly limited geographical region, i.e. restricted to a specified region or locality. This can apply to a disease or to an animal or plant species.

Extinct (in the wild)
A plant or animal considered extinct in the wild when it is known only to survive in cultivation, in captivity or as a naturalised population (or populations) well outside the range in which it previously occurred.

Fossil fuels
A fuel produced by the remains of living organisms that built up underground over geological periods. They mainly consist of carbon and hydrogen and are therefore also known as hydrocarbons. They are found in different states: liquid (for example, oil), solid (for example, coal, peat) and gaseous (for example, natural gas).

Greenhouse effect
The warming effect of the Earth's atmosphere. Light energy from the sun that passes through the Earth's atmosphere is absorbed by the Earth's surface and re-radiated into the atmosphere as heat energy. The heat energy is then trapped by the atmosphere, creating a situation similar to that which occurs in a greenhouse. Greenhouse gases (see below) allow incoming solar radiation to pass through the Earth's atmosphere, but prevent most of the outgoing infrared radiation from the surface and lower atmosphere from escaping into outer space. This process occurs naturally and has kept the Earth's temperature about 15°C warmer than it would otherwise be. Current life on Earth could not be sustained without the natural greenhouse effect.

Greenhouse gases
The atmospheric gases that absorb and emit radiation at specific wavelengths within the spectrum of infrared radiation emitted by the Earth's surface, the atmosphere and clouds. Water vapour (H_2O), carbon dioxide (CO_2), nitrous oxide (N_2O), methane (CH_4), and ozone (O_3) are the primary greenhouse gases in the Earth's atmosphere.

Habitat
The location and environmental conditions in which a particular organism (plant, animal, fungus or bacterium) normally lives.

Ice age
A period of long-term reduction in the temperature of the Earth's surface and atmosphere, resulting in an expansion of continental ice sheets, polar ice sheets and alpine glaciers.

Ice core
Cylinders of ice obtained by drilling into a glacier. Since the different layers of ice are formed over time through build-up of snow, ice cores provide information on climate from different periods (up to almost one million years) that can be used for research.

Glossary cont'd

Intergovernmental Panel on Climate Change	Established in 1988 by the World Meteorological Organization and the UN Environment Programme, the IPCC surveys world-wide scientific and technical literature and publishes assessment reports that are widely recognized as the most credible existing sources of information on climate change. The IPCC also works on methodologies and responds to specific requests from the subsidiary bodies of the United Nations Framework Convention on Climate Change (UNFCCC – see below) The IPCC is independent of the Convention.
Invasive species	Plants and animals that are introduced to an area from another and successfully establish themselves and then overcome, otherwise intact, pre-existing native ecosystems.
Kyoto Protocol	An international agreement that is linked to the United Nations Framework Convention on Climate Change (UNFCCC). Its major feature is that it sets binding targets for 37 industrialized countries and the European community for reducing greenhouse gas (GHG) emissions. These amount to an average of five per cent against 1990 levels over the five-year period 2008-2012.
Mitigation	Interventions to reduce the sources or enhance the sinks of greenhouse gases.
Native species	All plants and animals that naturally occur, either presently or historically, in an ecosystem.
Photosynthesis	The process a plant uses to combine sunlight, water, and carbon dioxide to produce oxygen and energy (sugar).
(Carbon) Sequestration	The removal and storage of carbon from the atmosphere in carbon sinks (such as oceans, forests or soils) through physical or biological processes, such as photosynthesis.
United Nations Framework Convention on Climate Change	The Convention on Climate Change sets an overall framework for intergovernmental efforts to tackle the global challenge posed by climate change. It recognises that the climate system is a shared resource whose stability can be affected by industrial and other emissions of carbon dioxide and other greenhouse gases. The Convention enjoys near universal membership, having been ratified by 192 countries.
Vulnerable species	A plant or animal is vulnerable when it is considered to be facing a high risk of extinction in the wild.
Weather	Short-term atmospheric conditions. Weather is measured by temperature, humidity, wind speed, atmospheric pressure, cloudiness and precipitation.

Sources: Green Facts Glossary http://www.greenfacts.org; IPCC Glossary of Climate Change Terms http://www.unfccc.int; IUCN http://www.iucn.org; La Cité des Sciences et de l'industrie http://www.cite-sciences.fr; CANA www.cana.net.au/kyoto/template.php

Executive Summary

What do droughts in the Mediterranean, more intense hurricanes in the Caribbean, warmer seas in the South Atlantic, and disappearing coastlines in the Pacific have in common? They are all results of the phenomenon known as climate change. Climate change, or global warming as it is sometimes called, refers to the steady climb in the Earth's temperature caused by increased levels of carbon dioxide and other gases in the atmosphere. It is a pressing issue for the entire global community and it is one that the 14 United Kingdom Overseas Territories (UKOTs) cannot afford to ignore.

The global trend in the Earth's average temperature is undoubtedly upwards:

- Global average surface temperature increased by about 0.6°C during the 20th century.
- Sea levels increased between 10 cm and 20 cm and the temperature and acidity of oceans changed.
- The 1990s were the hottest decade on record and 1998 the hottest year on record since temperature recording began some 150 years ago.

Climate change is happening at a much faster rate than originally expected. The Intergovernmental Panel on Climate Change (IPCC), an assessment team of hundreds of scientists worldwide who have been studying and tracking the climate system and reaching consensus on their findings and observations since 1988, has warned that average global surface temperatures could increase between 1.4°C and 5.8°C by the end of this century. This projection is significantly larger than the panel's 1996 prediction at the time of its second assessment report, which suggested temperatures could increase between 1°C and 3.5°C by 2100.

As a result of this warming, the IPCC has projected that the global mean sea level could rise between 9 cm and 88 cm between 1990 and 2100. This could mean flooding, loss of land in low-lying areas, contamination of groundwater with saltwater, and the destruction of wetlands and coastal ecosystems. Warming also brings changes in precipitation patterns. Water-scarce areas, like the Mediterranean, are likely to suffer from further decreases in rainfall. Some areas, like the Caribbean and the Pacific, will experience an increase in the intensity of tropical cyclones.

Another impact associated with the warming climate is change in the distribution, range and abundance of plants and animals. Changed climatic conditions will either allow them to thrive outside their usual range or make their usual range inhospitable. Melting glaciers, also known as glacial retreat, in the South Georgia and South Sandwich Islands, could increase the habitat of invasive mice and reindeer, which would put the Antarctic's only songbird, the endemic South Georgia pipit (*Anthus antarcticus*), at risk.

Climate change is also likely to affect human health, not only through increases in heat stress and air pollution, but also through declining water quality and the spread of infectious diseases as vectors change range or modify their life cycles. In both the Caribbean and the Pacific, there is concern about increases in the frequency and severity of dengue fever outbreaks as warmer temperatures reduce the incubation period of the dengue virus and speed up the larval stage of the mosquitoes.

Climate change poses a challenge for all aspects of human and social development in the UKOTs. It is one of the most complex issues of our time and the relationship between man and the environment is at the heart of this issue. As with all environmental issues, impacts and consequences come together in a large interconnected web.

Another level of complexity stems from the uncertainty that surrounds climate change. There is consensus that change is taking place, but there is less agreement on what portion of the change is due to natural climate variability and what portion is a consequence of human activity. Although the science is still evolving and many of the projections are hindered by large uncertainties, there is growing evidence that climate change could cause sudden and dangerous changes. This evidence ought not to be ignored by UKOTs.

Part of the core concern about climate change is the human potential to alter the climate through activities that are a result of our way of life and how we treat the natural environment. However, the fact that we contribute to the problem means we can also do something about it. The European Union, including the United Kingdom, has set a target to ensure that global temperatures do not rise by more than 2°C above pre-industrial levels. Addressing climate change requires a global agreement for reducing greenhouse gas emissions as well as local commitment to action.

Although UKOTs are negligible producers of greenhouse gases in global terms, they are very vulnerable to the effects of increased concentrations of these gases in the atmosphere. This stems, in part, from inherent economic, ecological and social vulnerabilities associated with the small size of their land mass, populations and economies. In addition, several of the ecosystems found in the territories, such as mangroves and coral reefs in the Caribbean and Pacific, sea ice biomes in the Antarctic, and Mediterranean-type ecosystems, are among those that the IPCC has identified as “most vulnerable” and “virtually certain to experience the most severe ecological impacts” of climate change. With the exception of the British Antarctic Territory and Gibraltar, the UKOTs are small islands, and small islands are expected to experience some of the most severe impacts of increasing temperatures.

Climate change is also increasing pressure on the rich biodiversity resources of the UKOTs. It is affecting habitats and ecosystems and could lead to a decline in the populations of some species. For example, coastal erosion, some of which is linked to climate change, is causing the loss of turtle nesting sites in the Caribbean territories. This loss of plants and animals has more than just ecological consequences for the UKOTs. There are economic consequences that need to be considered. Several of the territories, particularly those in the Caribbean and the South Atlantic, depend to varying degrees on tourism. The environment plays a large role in the viability of this industry. Fisheries and agriculture are similarly very dependent on the environment. This means ecological changes, such as declines in populations of some plants and animals, can negatively affect these industries.

Because UKOTs and small islands are more vulnerable, it is particularly important that their citizens understand the hazards and risks associated with climate change and the actions they can take to make a difference.

Ascension has a unique biodiversity largely stemming from the island's remote location in the South Atlantic. *Credit: Chris Gilbert/BAS*

Although climate change and its impacts may seem daunting, there are things UKOTs can do about them in their local context. Taking action now to prepare for climate change impacts will be less costly and more effective than remedial measures in the future. Addressing climate change now is an opportunity for the territories to build resilience in the face of their inherent vulnerabilities, improve natural resource management and physical planning processes, as well as adapt to changing climate conditions.

Understanding both the need and the opportunities for adaptation to climate change is fast becoming an essential requirement of both governments and the private sector of vulnerable countries. Good climate policy includes ensuring structures and systems are better able to withstand change (adaptation) and taking measures to reduce the human impact on the climate system (mitigation).

UKOTs make a small contribution to warming and have little control over global mitigation, but they can play their part in the global reduction of greenhouse gas emissions in the following ways:

- enhancing energy efficiency;
- diversifying their energy sources and increasing reliance on non-fossil fuel sources of energy; and
- providing for the development and uptake of climate friendly technologies.

Contributing to the global reduction of greenhouse gas emissions is certainly a good thing for any member of the international community to do, but the benefits of such actions are also immediate to UKOTs in the form of reduced fossil fuel dependency, decreased dependency on imports and lower fossil fuel import bills.

There is a very strong case for UKOTs to bring adaptation into the mainstream of national policymaking, planning and development. Adaptation is the only way to deal with the inescapable impacts of climate change. The reality of global warming means that development cannot be sustainable unless it factors in climate impacts and natural hazards and finds ways of reducing risks and minimising vulnerability. Several of the UKOTs are prone to natural disaster as part of their normal climate conditions. Effectively managing inherent risk is important in adapting to climate change.

Mainstreaming climate change issues into the national policy and planning process does not require a dramatic departure from all that has gone before and there are even many low- or no-cost actions that can be taken. For example, mainstreaming adaptation can be done in an incremental way, by building on, and adjusting, existing policies, programmes, and structures. What is required is a commitment to dealing efficiently and comprehensively with current climate, environmental, social and economic needs and vulnerabilities in an integrated or holistic manner. By addressing the development challenges that have led to the accumulation of hazard and human vulnerability, decision makers and planners will reduce the negative effects of extreme climatic events and natural disasters. This will significantly limit the immediate losses while reducing the future costs of recovery from climate events. For policy and decision makers, adaptation to climate change is a win-win proposition.

Addressing climate change in UKOTs is everyone's business, not just a matter for policy and decision-makers to deal with. Individuals, households, and the public and private sector can do their part to reduce their own vulnerability to the effects of climate as well as to reduce greenhouse gas emissions by making life style choices.

It is hard to predict with complete accuracy the full extent of how climate change will affect the UKOTs, but what is certain is that there is a lot at stake for them. Adopting a wait and see attitude towards climate will serve no one's interests in the long term. Climate change is a big issue with big impacts and potentially serious consequences. Adaptation and mitigation do not come cheap and without effort, but the cost of doing nothing will surely be higher.

1 Why Climate Change Matters for UK Overseas Territories

1.1 A pressing and complex issue

Compelling evidence

The scientific evidence is indisputable. The world's climate changed during the 20th century. Global average surface temperature increased by about 0.6°C; snow cover and ice extent decreased; the temperature and acidity of oceans changed and sea levels around the world increased between 10cm and 20 cm. Seasonal patterns, including rainfall, have also changed the world over. The 1990s were the hottest decade and 1998 the warmest year on record, since temperature recording began some 150 years ago. And, while it is true that there have been natural and cyclical variations in the Earth's climate in the past, it is also true that the current rate of change is faster than anything the planet has experienced before.

> ***"... there have been natural and cyclical variations in the Earth's climate in the past, [but] the current rate of change is faster than anything the planet has experienced before."***

What's more, there is evidence that the pace of change has been accelerated by human activities, or **anthropogenic** causes, such as the burning **fossil fuels** for energy and the cutting down of forests for agriculture. Such activities have helped increase the concentration, and alter the balance, of the **greenhouse gases** that are responsible for keeping the Earth warm. The net effect has been warmer surface and sea temperatures. These have in turn affected nature and society in a number of different ways.

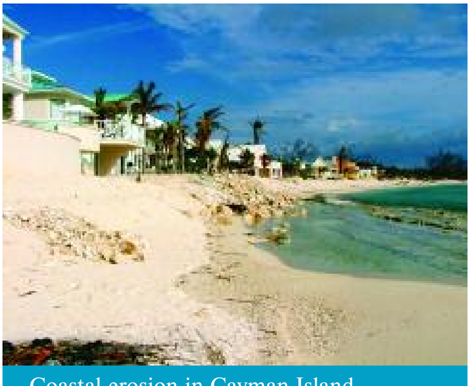
The complexities of climate change

Climate change is one of the most complex issues of our time. The relationship between man and the environment is at the heart of this big issue, and, as with all environmental issues, impacts and consequences come together in a large interconnected web.

One small change, like an increase in sea surface temperature by a few degrees, can spark a chain of reactions. Warmer waters affect coral reef health and the availability of fish species. In countries that are highly dependent on fisheries, a downturn in this sector has a negative impact on individual families as well as the national economy.

Even though many of the impacts of climate change are environmental, for example, sea level rise, flooding, changing seasonal patterns, it also has far-reaching implications for economies, social development, physical planning, and even human security. The all-encompassing nature of climate change means it could affect every aspect of human well-being, from jobs and livelihoods, to health, food security, leisure and recreation. Responding to climate change therefore needs action on several different fronts. We need to dramatically reduce and cap greenhouse gas emissions while also putting in place measures to prepare for and respond to current and future climate-induced changes. Without some stabilisation of greenhouse gases within a timeframe and at a level that allows ecosystems to adapt naturally to change, the consequences for man and nature are expected to be dire. With this in mind, the United Kingdom and the European Union have set a target to ensure that global temperatures do not rise by more than 2°C above pre-industrial levels.

Another complexity of climate change stems from the uncertainty that surrounds it. Although there is consensus that change is taking place, there is less agreement on what proportion of the change is natural climate variability and what proportion is human-induced. This makes it difficult for individual countries to decide what resources to allocate to reducing human impact on the climate system (**mitigation**) and what to spend



Coastal erosion in Cayman Island
Credit: Department of the Environment, Cayman Island Government

> ***"Addressing climate change requires a global agreement for reducing greenhouse gas emissions as well as local commitment to action."***

on strengthening their structures to withstand change (**adaptation**).

Uncertainty about the patterns of change and the scale of the impacts further complicates matters. Although the evidence of past change points to certain possibilities, there is still an element of the unknown. Countries therefore find themselves faced with the prospect of planning for a very uncertain future. Not only are there many unknowns about the full extent of future impacts, current impacts are not well understood in many countries, including some United Kingdom Overseas Territories (UKOTs) where there has been little monitoring to date.

Addressing climate change requires a global agreement for reducing greenhouse gas emissions as well as local commitment to action. Part of the difficulty in forging a global agreement is that although everyone is affected, not all have contributed equally to the problem; some of the places that have contributed least, such as small islands, will be affected the most. There are also high costs associated with reducing emissions and finding alternatives to fossil fuels, which are a large source of greenhouse gases.

There is still some debate about how the challenge of climate change should be financed. Funding adaptation requires many tens of billions of dollars each year (Oxfam, 2007). Financing for the most urgent and immediate adaptation priorities of the least-developed countries (LDCs) alone is likely to cost \$1–2bn. But by 2007, the industrialised countries had only

Box 1. About the Intergovernmental Panel on Climate Change (IPCC)

The Intergovernmental Panel on Climate Change (IPCC) is an intergovernmental scientific body that was set up in 1988 by the World Meteorological Organisation and the United Nations Environment Programme. It assesses and summarises scientific, technical, and socio-economic information and research that relates to human induced climate change, including options for mitigation and adaptation. It aims to provide decision makers and others interested in climate change with an objective source of information about climate change.

Its review work is done by hundreds of scientists worldwide who collaborate through three working groups and the Task Force on National Green House Gas Inventories.

- Working Group 1 deals with "The Physical Science Basis of Climate Change";
- Working Group 2 deals with "Climate Change Impact, Adaptation and Vulnerability"; and
- Working Group 3 deals with "Mitigation of Climate Change".

The main objective of the Task Force is to develop and refine a methodology for the calculation and reporting of national greenhouse gas emissions and removals.

The conclusions of the working groups are presented in comprehensive Assessment Reports. To date, four Assessment Reports have been completed in 1990, 1995 and 2001 and 2007 respectively.

Source: IPCC (www.ipcc.ch)

pledged $182m to international funds for developing-country adaptation (Oxfam, 2007). An equitable approach to funding adaptation would suggest the countries that have contributed most to greenhouse gas emissions should bear the brunt of covering the cost of adapting to and countering climate change. However, even as international debates continue about how to fund adaptation, the urgency of climate change is such that all countries, regardless of income level, have to take responsibility for reinforcing their communities, systems and natural and physical infrastructure.

Climate change is experienced differently throughout the world

The change in climatic conditions has meant different things for people across the planet. For the UKOTs in the Caribbean, it has meant an increase in the intensity of tropical cyclones. The low-lying Chagos Islands in the British Indian Ocean Territory (BIOT) are facing the prospect of losing some of their already small land area because of rising sea levels. In the Mediterranean region, the threat of drought has increased.

Change is expected to continue

Based on the evidence of change to date, scientists have modelled future impacts and risks of climate change factoring in various emissions scenarios based on different sets of assumptions. It is not possible to predict what will happen with 100 per cent accuracy, but adverse effects are projected. The Intergovernmental Panel on Climate Change (IPCC) (Box 1) has warned that average global surface temperatures could increase between 1.4°C and 5.8°C by the end of this century. It has also projected that the global mean sea level could rise between 9 cm and 88 cm

> "...the UKOTs are very vulnerable to the effects of climate change."

between 1990 and 2100. Were these changes to occur over millennia, their impact would be less severe as plant and animal species, including man, would gradually adapt to new conditions. However, the current and projected rate of change is so fast that there is little capacity for natural adaptation.

1.2 UK Overseas Territories have much to lose

Though disparate, as a group the UKOTs are very vulnerable to the effects of climate change. Several of the ecosystems found in the UKOTs, such as mangroves and coral reefs in the Caribbean and Pacific, sea ice biomes in the Antarctic, and Mediterranean-type ecosystems are among those that the IPCC has identified as "most vulnerable" and "virtually certain to experience the most severe ecological impacts" of climate change (Parry *et al*., 2007) In addition, the UKOTs (with the exception of the British Antarctic Territory and Gibraltar) are small islands, and small islands are expected to experience some of the most severe impacts of increasing temperatures (Mimura *et al*., 2007).

Inherent vulnerabilities combined with climate change increase risk to natural hazards

Most of the UKOTs face inherent economic, ecological and social vulnerabilities associated with the small size of their land mass, populations and economies. The economies of UKOTs are not highly diversified and they depend on a narrow range of goods and/or services. UKOTs are too small to realise gains from economies of scale, are highly dependent on exports, have high communication and transportation costs and are vulnerable to natural hazards. Changing climate patterns and extreme weather add another dimension of vulnerability.

Low-lying coastal areas in UKOTs are vulnerable to the threat of rising sea levels.
Credit: Charles Sheppard

Threats to biodiversity and the economy

Climate change is also increasing pressure on the rich biodiversity resources of the UKOTs. It is affecting habitats and ecosystems and could lead to a decline in the populations of some species. For example, there are fewer available turtle nesting sites in the Caribbean territories as a result of coastal erosion, some of which is linked to climate change.

Loss of plants and animals has more than just ecological consequences for the UKOTs. There are economic consequences that need to be considered. Several territories, particularly those in the Caribbean and the South Atlantic, depend to varying degrees on tourism. The environment plays a large role in the viability of this industry. Fisheries and agriculture are similarly very dependent

> *"Addressing climate change is an opportunity for the territories to build resilience in the face of the inherent vulnerabilities associated with their size and natural features..."*

on the environment. Therefore, ecological changes, such as declines in populations of some plants and animals, can negatively affect these industries.

1.3 The time to act is now

UKOTs ought to assume that future climate impacts will be more severe than anything experienced to date. The scope of the problem, the challenge of reaching global consensus, the uncertainty of future projections becoming reality, the question about how much change is due to natural variability and how much is human-induced, and the very practical issue of cost should not be barriers to taking decisive action now. No matter what the scenario for the future of greenhouse gas emissions, change is already underway. The big question is, can countries and citizens afford to do nothing in the face of inexorable changes in climate patterns? It is only with hindsight that we will have conclusive evidence, but by then it could be too late. People and the environment will already be confronted with the consequences of changed conditions. Taking action now to cap greenhouse gas emissions and prepare for climate change impacts will be less costly and more effective than remedial measures in the future.

View from St. Helena
Credit: Vince Thompson, St. Helena National Trust.

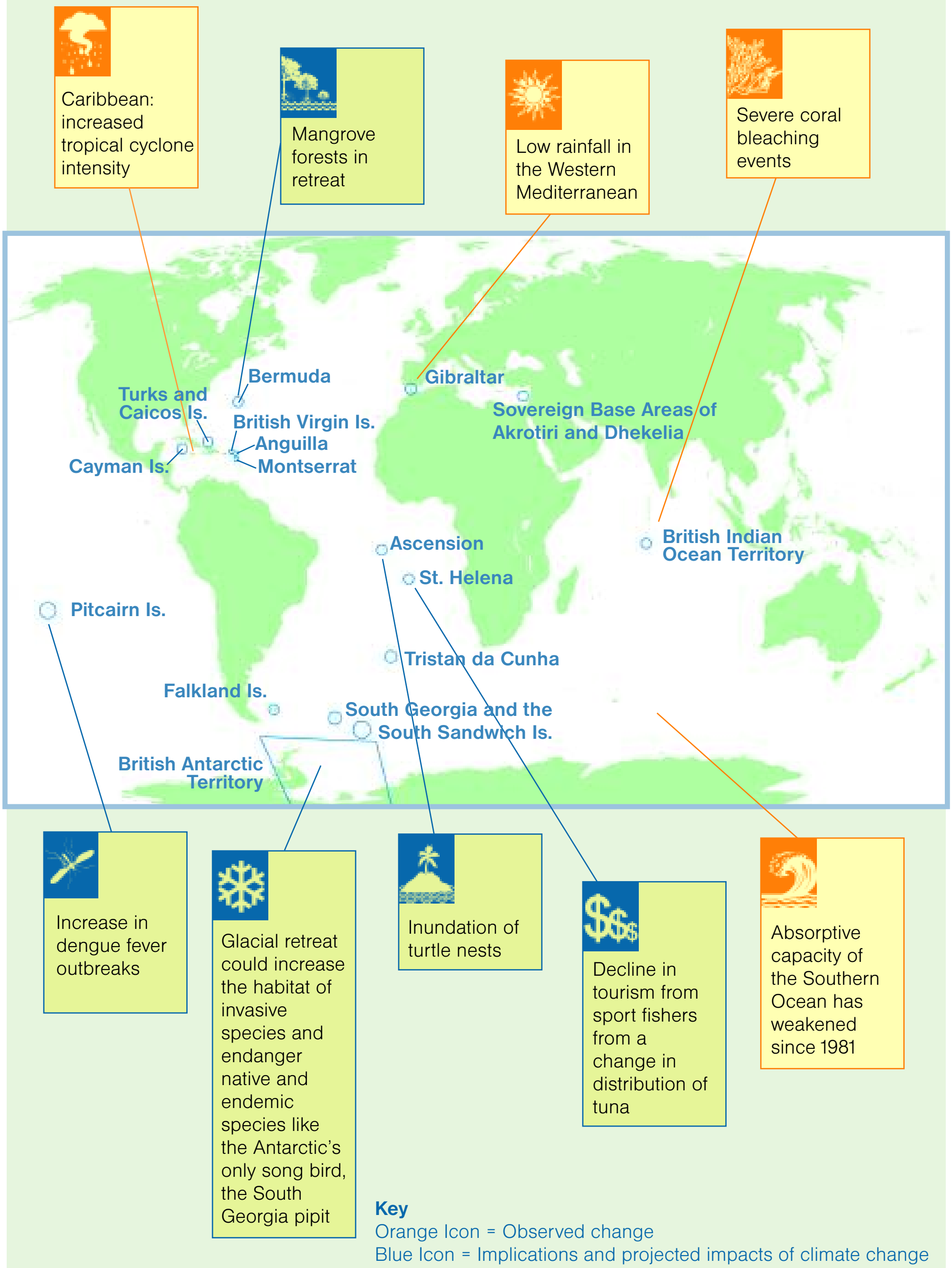
An opportunity for UK Overseas Territories

Although climate change and its impacts may seem daunting, there are things UKOTs can do about them in their local context. Addressing climate change is an opportunity for the territories to build resilience in the face of the inherent vulnerabilities associated with their size and natural features, in addition to adapting to changing climate conditions. It is also an opportunity for these countries to take measures to stem future impacts as part of a strategy of moving towards what former UN Secretary-General Kofi Annan has referred to as "safer, sounder models of development" (Annan, 2006). UKOTs have the potential to be models of climate change adaptation and mitigation for the rest of the world.

A 'win – win' proposition

Adaptation can be a 'win-win' situation for UKOTs. Targeted actions designed to address current issues such as the need for effective biodiversity conservation and the reduction of vulnerability to climatic events (for example, droughts, storms, floods) are the first steps in the climate change adaptation process. This approach is based on the premise that if a country or community is not fully able to cope with current climatic conditions, it cannot expect to effectively adapt to future changes in climate. Any commitment or investment in current needs therefore eliminates the question of whether to invest in current needs or climate change adaptation.

Figure 1. Selected global warming changes and impacts in UK Overseas Territories[1]



[1] These are just a few examples. Each country and region is likely to experience multiple changes and impacts.

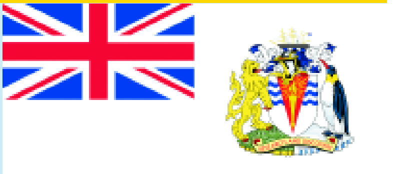
Box 2. The UK Overseas Territories in Brief

The 14 United Kingdom's Overseas Territories are a diverse grouping. They range from the tiny Pacific island of Pitcairn with 47 inhabitants and a fragile subsistence economy based on fishing, horticulture, and the sale of handicrafts, to Bermuda just north of the Caribbean, which has a population of more than 62,000 and is one of the world's major financial centres. They also include the Sovereign Base Areas on Cyprus, which are military bases.

The Overseas Territories are: Anguilla; British Antarctic Territory; Bermuda; British Indian Ocean Territory; British Virgin Islands; Cayman Islands; Falkland Islands; Gibraltar; Montserrat; St. Helena and Dependencies (Ascension Island and Tristan da Cunha); Turks and Caicos Islands; Pitcairn Island; South Georgia and South Sandwich Islands; and the Sovereign Base Areas on Cyprus.

Antarctic and sub-Antarctic

The British Antarctic Territory (BAT)



The British Antarctic Territory

Location: The sector of the Antarctic below latitude 60°S, between longitudes 20°W and 80°W.

Size: Total area of 1,709,400 km^2.

Climate: The coldest, driest and windiest continent in the world. The average annual temperature at the South Pole is -49°C.

Topography: Only 1.4% of the BAT's surface is ice-free. The remainder is covered by a permanent ice sheet of up to three km thick.

Biodiversity: On land, although vegetation is sparse, there are many types of lichen, moss and algae. In the surrounding seas, vast amounts of krill provide the basis for rich marine life. This includes whales, seals and very large numbers of birds especially petrels and penguins, inhabiting the islands and coastal areas of the Peninsula.[1]

Main economic activities: There is no economic activity in the BAT; however, tourism is growing. The United Kingdom Antarctic Heritage Trust (UKAHT) has a team at Port Lockroy each season. This historic site usually attracts about 6,000 visitors a year.

Other information: There is no indigenous population in the Territory. The United Kingdom's presence is through the British Antarctic Survey (BAS), which maintains two permanently manned scientific stations (at Halley and Rothera) and three summer-only stations (at Fossil Bluff on Alexander Island, Sky Blue at the base of the Antarctic Peninsula and Signy in the South Orkney Islands).

South Georgia

Location: An isolated sub-Antarctic island about 1,390 km south east of the Falkland Islands and about 2,150 km east of Tierra del Fuego. In addition to the main island there are smaller islands, islets and rocks.

[1] UK Overseas Territories Conservation Forum. n.d. *Promoting Biodiversity Conservation in the UK's Overseas Territories.* United Kingdom: UKOTCF.

Size: 3,755 sq km

Climate: Surrounded by cold waters originating from the Antarctic, South Georgia has a harsher climate than expected for its latitude.

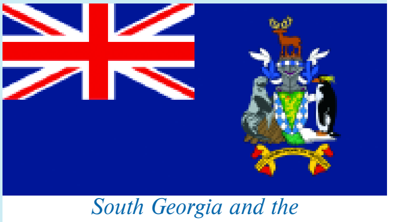
Topography: Very mountainous, the island is formed of two mountain ranges. The main mountain range, the Allardyce Range, has its highest point at Mount Paget (2,934 m). More than 50% of the island is covered by permanent ice with many large glaciers reaching the sea at the head of fjords.

Biodiversity: Despite a very limited number of flowering plants, there is great diversity in the mosses and lichens; many are found nowhere else in the world. Several seal species breed on the island and whales are frequently seen offshore. There are estimated to be more than 30 million birds on South Georgia. It is an important nesting site for the largest seabird in the world, the wandering albatross (*Diomeda exulans*).[2]

Main economic activities: Fisheries. There is a developing tourism industry.

Other information: South Georgia has no permanent population.

The South Sandwich Islands



South Georgia and the South Sandwich Islands

Size: A chain of 11 volcanic islands ranging in length from 1-28 km. The total land area of the Islands is 310 sq km.

Location: The Islands lie 470 km south east of South Georgia and 1,130 km from the Antarctic Continent.

Climate: The climate is wholly Antarctic.

Topography: The islands form a volcanic arc. The larger islands are covered in ice year round; some of the smaller islands are ice-free in summer.

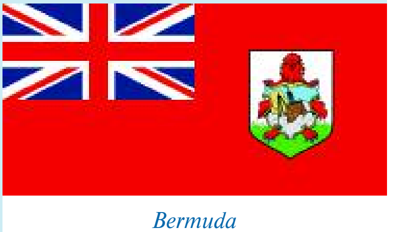
Biodiversity: 16 seabirds and several seal species breed on the islands. A variety of bryophytes, lichens and hepatica grow but only one species of vascular plant is recorded.

Main economic activities: Fisheries.

Other information: Uninhabited. Some of the volcanoes are still active.

Bermuda and the Caribbean

Bermuda



Bermuda

Size: There are 138 islands and islets, however, the eight main islands form a chain about 30 km long, interconnected by bridges and causeways.

Location: The islands and islets of Bermuda lie along the southern rim of the summit of a submarine volcanic mountain in the Western

[2] UK Overseas Territories Conservation Forum, n.d. *Promoting Biodiversity Conservation in the UK's Overseas Territories.* United Kingdom: UKOTCF.

Atlantic, lying 912 km east of the coast of North Carolina

Climate: The warming effect of the Gulf Stream makes Bermuda the most northerly group of coral islands in the world.

Topography: The limestone islands sit on the largest of three volcanic seamounts formed about 110 million years ago.

Biodiversity: About 250 of more than 8,000 plant and animal species known from Bermuda are unique. Many of these are found in the extensive network of submerged caves and, like the Bermuda petrel (*Pterodroma cahow*), locally known as the cahow are endangered or, in the case of the Bermuda skink (*Eumeces longirostris*), critically endangered.[3]

Main economic activities: The major industries are insurance, re-insurance, international finance, tourism, and light manufacturing.

Other information: Population - 64,000 (2007 estimate).

Anguilla

Anguilla

Size: An archipelago of 22 islands, the main island is 26 km long and a maximum of 5 km wide, comprising a total of 90 sq km.

Location: The island is the most northerly of the Leeward Islands in the Eastern Caribbean.

Climate: A tropical, but relatively dry climate, temperatures moderated by northeast trade winds.

Topography: A low and flat coralline island formed from limestone and marls developed on old limestone rocks. The coastline has sandy beaches in the south and rocky cliffs in the north. Offshore there are extensive coral reefs including the 17 km long coral reef along the south east coast.

Biodiversity: The unique ecosystems of Anguilla and its offshore cays are home 21 species of reptile. These include the endemic black lizard (*Ameiva corvina*) on Sombrero Island, the harmless Anguillan racer snake (*Alsophis rijersmai*) and the Lesser Antillean iguana (*Iguana delicatissima*). About 139 bird species and more than 550 plant species have been recorded, with the Anguilla bush (*Rondeletia anguillensis)* classified as an endemic.[4]

Main economic activities: The major industries are tourism, construction, government service, banks and insurance.

Other information: Population - 13,600 (2005 estimate).

The British Virgin Islands (BVI)

Size: The BVI comprise more than 60 islands, islets and cays (some little more than rocks). A total land area of only 153 sq km scattered over some 3,458 sq km of sea.

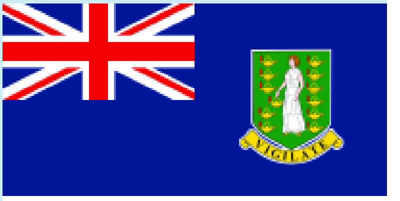
Location: Adjacent to the US Virgin Islands (USVI) and 96 km east of Puerto Rico

[3] UK Overseas Territories Conservation Forum, n.d. *Promoting Biodiversity Conservation in the UK's Overseas Territories*. United Kingdom: UKOTCF.

[4] *Ibid*.

Climate: A tropical climate moderated by trade winds.

Topography: Most of the islands are hilly with steep slopes, having been formed from formerly submerged volcanoes. Many of the islands have lush vegetation, sandy beaches, and coral reefs.



British Virgin Islands

Biodiversity: The islands support a number of endemic and threatened species of international importance, such as the critically endangered endemic Anegada rock iguana (*Cyclura pinguis*). The BVI also possess a number of globally significant plant species, some of which occur only on Anegada, such as pokemeboy (*Acacia anegadensis*) and wirewist (*Metastelma anegadense*).

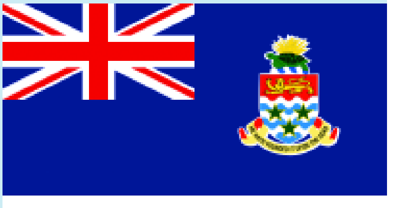
Main economic activities: The major industries are tourism and international financial services.

Other information: Population - 27,000 (2005 estimate).

Cayman Islands

Size: The three islands have a total land area of 259 sq km. Grand Cayman is approximately 35 km long with an average width of 6 km. Cayman Brac is about 19 km long with an average width of one and a quarter miles. Little Cayman, a low-lying island, is approximately 16 km long with an average width of little more than 1.6 km.

Location: 268 km north-west of Jamaica in the Caribbean Sea and 240 km south of Cuba. Grand Cayman, which is much larger than the others are, lies 128 km to the west of Cayman Brac and Little Cayman, which are separated from each other by a channel 8 km wide.



Cayman Islands

Climate: Tropical climate.

Topography: A huge central limestone outcrop called The Bluff rises along the length of the island up to 140 feet. About half of Grand Cayman's area is wetland. Offshore reefs and a mangrove fringe surround most of the islands' coasts.

Biodiversity: Some 17 plant species, seven reptiles and 30 land snails are among those listed as unique to Cayman, along with many unique subspecies of forest birds and spectacular coral reefs.[5]

Main economic activities: The major industries are tourism and offshore finance.

Other information: Some 94% of the population lives on Grand Cayman, with around 1,822 people residing on Cayman Brac and 115 on Little Cayman. Population - 53,252 (2006 estimate).

Montserrat

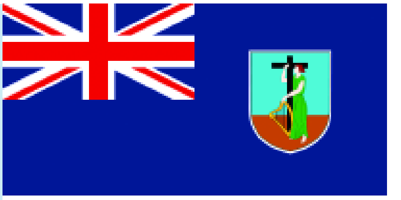
Size: The island is 18 km long and 11 km wide, with a total area of 101 sq km.

Location: One of the Leeward Islands in the Eastern Caribbean, lying 43 km southwest of Antigua and 64 km northwest of Guadeloupe.

[5] UK Overseas Territories Conservation Forum, n.d. *Promoting Biodiversity Conservation in the UK's Overseas Territories*. United Kingdom: UKOTCF.

Climate: Tropical climate.

Topography: Entirely volcanic and very mountainous. The coastline is rugged and offers no all-weather harbour, although there are several anchorages in the lee of the island sheltered from the prevailing trade winds. In 1995, the Soufriere Hills volcano in the south of the island became active for the first time in 350 years. The volcano has remained active since then with pyroclastic flows, a collapse of the dome in 2003 and renewed dome growth. Since April 2007, growth of the current volcanic dome has slowed and the latest scientific advice is that the volcano is in a state of 'pause', but with the danger of a large hot dome remaining.



Montserrat

Biodiversity: Despite its small size, Montserrat supports at least 795 native plant species, 12 restricted range species of birds and 1,241 invertebrates, which include 718 beetles. Endemic to Montserrat are the Montserrat oriole (*Icteris oberis*) and the galliwasp (*Diploglossus montisserrati*), a lizard. The endangered and edible 'mountain chicken' (*Leptodactylus fallax*), a frog, is found only on Montserrat and Dominica. Several other species are restricted to Montserrat and some nearby islands.[6]

Main economic activities: The limited economic activity on the island includes mining and quarrying, construction, financial and professional services and tourism

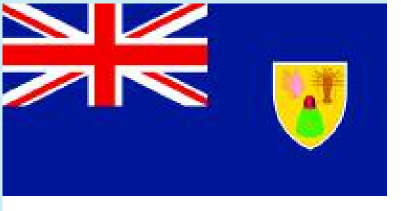
Other information: Population - 4,655 (2006 estimate).

The Turks and Caicos Islands (TCI)

Size: The TCI comprise some 40 islands and cays split into two groups by a deep-water channel. The total land area is 430 sq km.

Location: South-east of the of the Bahamas chain and 44 km north of Haiti and the Dominican Republic, and 920 km south-east of Miami.

Climate: The climate is warm throughout the year but tempered by constant trade winds.



Turks and Caicos Islands

Topography: Limited rainfall plus poor soil and a limestone base restrict the possibilities for agricultural development. The islands are rocky, semi-barren and covered with cacti and thorny acacia trees. There are 200 miles of white beaches.

Biodiversity: More than 30 protected areas have been designated to conserve the delicate ecosystems and wildlife habitats of the creeks, sand flats, lagoons, and marshy wetlands. The islands provide a home for at least 14 unique plants, reptiles, and an unknown number of invertebrates, as well as the vulnerable reddish egret (*Egretta rufescens*) and West Indian whistling duck (*Dendrocygna arborea*).

Main economic activities: The major industries are tourism, property development, real estate, international finance and fishing.

[6] Young, R.P. (ed). 2008. *A biodiversity assessment of the Centre Hills, Montserrat.* Durrell Conservation Monograph No.1, Durrell Wildlife Conservation Trust, Jersey, Channel Islands

Other information: Population - 32,000 (2006 census estimate). Only six of the islands are permanently inhabited.

Indian Ocean

British Indian Ocean Territory (BIOT)

British Indian Ocean Territory

Size: An archipelago of five atolls containing 55 islands covers some 54,400 sq km of ocean. The islands have a land area of only 46 sq km and 698km of coastline. Diego Garcia, the largest and most southerly island, is 27 sq km.

Location: The Territory is in the centre of the Indian Ocean. The southernmost point of the Laccadive-Maldive-Chagos ridge, between 5-7 °S, lies about 1,770 km east of Mahe, the main island of the Seychelles.

Climate: The climate is tropical oceanic type and moderated by trade winds.

Topography: The terrain is flat and low and most areas do not exceed two metres in elevation.

Biodiversity: With a huge network of coral reefs the Territory supports 1.5% of the total global area of reefs (JNCC, 1999). The islands also provide nesting sites for the green (*Chelonia mydas*) and hawksbill (*Eretmochelys imbricata*) turtles, and very large numbers of seabirds.

Main economic activities: There is no civilian air service. There are no economic, industrial or agricultural activities on the islands. UK and US military personnel and civilian contract employees, mostly recruited from Mauritius and the Philippines, carry out construction projects and other services in support of the US defence facility in Diego Garcia. These numbered approximately 4,000 persons (2004 estimate).

Other information: The isolation of the BIOT and the low level of human impact, make it ideal for the study of tropical marine ecology, undistorted by pollution.

Mediterranean

Gibraltar

Gibraltar

Size: Total area of 6.5 sq km.

Location: Bordering the Strait of Gibraltar on the southern coast of Spain. The Strait of Gibraltar links the Mediterranean Sea and the North Atlantic Ocean.

Topography: Formed of Jurassic limestone, the island has a sheer cliff on the eastern side, slopes more gently to the west and consists largely of scrub and patches of woodland, with a rocky shoreline.

Biodiversity: Species confined to Gibraltar include sea-slugs, snails and plants. Within Europe, Barbary macaques (*Macaca sylvanus*) are unique to Gibraltar.

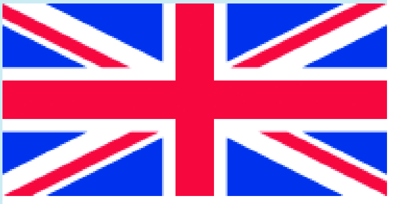
Main economic activities: Gibraltar has a thriving, if narrowly based, economy dominated by three main sectors – financial services, shipping and tourism (including retail for visitors). The tourism industry has grown rapidly over the past 15 years and Gibraltar now receives in excess of 7.8 million visitors per annum, who spend more than GBP170 million.

Other information: Population - 28,779 (Abstract of Statistics 2005).

The **Sovereign Base Areas (SBAs) of Akrotiri and Dhekelia**

[usually referred to as Western Sovereign Base Area (WSBA) and Eastern Sovereign Base Area (ESBA)]

Size: The SBAs cover 3% of the land area of Cyprus, a total of 255 sq km miles (47.5 at Akrotiri and 50.5 at Dhekelia).



Akrotiri and Dhekelia use the Union Flag

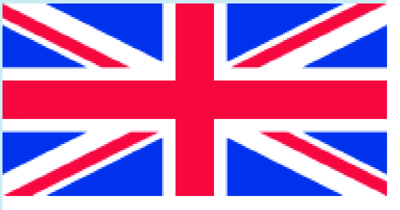
Location: Situated at two locations within Cyprus.

Biodiversity: Akrotiri salt lake provides a wintering area for up to 30,000 greater flamingos (*Phoenicopterus roseus*) and is an important staging area for cranes, migrant waders (*Charodrii*) and birds of prey, in particular. Rare endemic orchids and various reptiles and amphibians are also found within the bases, as well as many migrant songbirds.

Main economic activities: The SBAs are primarily required as military bases and not ordinary dependent territories.

South Atlantic

Ascension[7]



Ascension uses the Union Flag

Size: 97 sq km

Location: Ascension lies at latitude 7°7'S and longitude 14°22'W, 1,296 km to the north west of the nearest land – the island of St. Helena. The nearest continental land Liberia 1,504 km to the north north-east.

Climate: The climate of Ascension is dry, tropical and oceanic with little seasonal change. Temperatures vary from 31°C to 27°C. moderated by the South East Trade winds. Rainfall is variable but showers fall throughout the year.

Topography: The island is a rocky peak of volcanic origin with 44 distinct craters. The lower slopes and western side are made up of volcanic ash with little vegetation. Green Mountain, which rises to a height of 859 m at the centre of the island, is lush and green.

Biodiversity: Much of Ascension's global conservation importance comes from the island's remoteness. It has 11 species of breeding seabird, one of which, the Ascension Island frigate bird (*Fregata Aquila*) is endemic. There are six endemic species of terrestrial plants, nine endemic marine fish and two endemic shellfish. The

[7] Ashmole, P and M. Ashmole. 2000. St. Helena and Ascension Island: A Natural History. Anthony Nelson. Oswestry.

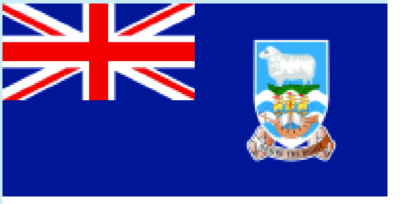
island also has one of the most important breeding green turtle (*Chelonia mydas*) populations in the world.

Main economic activities: Ascension has a USAF and RAF military base and hosts a number of communication companies.

Other information: Civilians contracted from St. Helena, the UK and USA number approximately 1,000.

The Falkland Islands[8]

Size: The Falkland Islands have a total land area of just over 120,000 ha which forms an archipelago of two main islands, East and West Falklands and about 780 smaller islands and islets.



The Falkland Islands

Location: Situated in the south-west region of the South Atlantic Ocean approximately 600km east of the mainland of South America, between latitudes 51°S and 53°S, and longitudes 57°W and 62°W.

Climate: The Falkland Islands have a cool temperate oceanic climate, dominated by westerly winds and low annual rainfall (450-600 mm/year).

Topography: The Islands are generally rugged and hilly – the highest points are Mount Usborne (705 m) on East Falkland and Mount Adam (700 m) on West Falkland.

Biodiversity: The Falklands have a wealth of biodiversity. Of the 363 vascular flora species, 171 species are native and 13 endemic. There are 13 recorded terrestrial endemic invertebrates. The Falkland Islands support globally significant numbers of a number of bird species as well as two endemic species and 14 sub-species. These include vast colonies of seabirds. More than 70% of the world population of black-browed albatrosses (*Diomedea melanophris*) is found here. The inshore and offshore environment of the Falkland Islands support a variety of whale, dolphin, seal and sea lion species, including at least eleven species of cetaceans listed as of global conservation concern on the IUCN red list.

Main economic activities: Agriculture, fishing and tourism.

Other information: Population - approximately 2,900.

St. Helena[9]

Size: 17 km long and 10 km wide at its largest point, with a land area of 122 sq km

Location: Approximately 1,920 km from the south-west coast of Africa and 2,900 km east of South America.

Climate: St. Helena has a sub-tropical but oceanic climate, tempered by the South-East Trade winds. Temperature ranges from 14°C to 27°C .

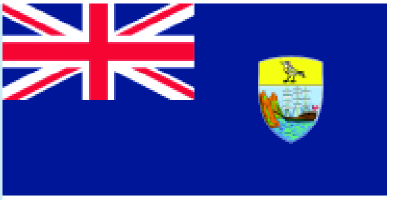
Topography: A volcanic island with a high central ridge. The highest point, Diana's Peak, rises to 823 m above sea level.

---

[8] Otley H, G. Munro, A. Clausen, and B. Ingham. 2008. Falkland Islands State of the Environment Report 2008. Falkland Islands Government and Falkland Islands Conservation, Stanley.

[9] Ashmole, P and M. Ashmole. 2000. St. Helena and Ascension Island: A Natural History. Anthony Nelson. Oswestry

Biodiversity: St. Helena's isolated position in the South Atlantic has given rise to an unusual and remarkable land and marine flora and fauna. The native flora consist of about 40 species, 49 of which are endemic (10 genera). The precise number of endemic invertebrates is uncertain, however of about 1,110 land invertebrates, some 400 are unique to St. Helena. At least six unique land birds once occurred on St. Helena, only one, the wire bird (*Charadrius sanctaehelenae*), survives today. There are 10 endemic, inshore fish species and 16 more are found only here and at Ascension. At least five species of marine mammals are known to occur in the waters around St. Helena.



St Helena

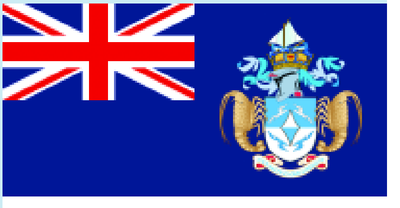
Main economic activities: The main industries are fisheries, tourism and agriculture.

Other information: Population - 4,000. St. Helena is currently accessible only by sea, but there are plans to build an airport in the near future.

Tristan da Cunha[10]

Size: An area of 178 sq km. The Tristan da Cunha group comprises six islands, including Tristan da Cunha and the neighbouring islands of Nightingale, Inaccessible and Gough.

Location: Tristan da Cunha is the most remote inhabited island in the world lying 2,778 km west of Cape Town and 3,947 km from South America.



Tristan da Cunha

Climate: The climate is cool temperate oceanic but varies between islands. Mean annual temperatures vary similarly and range from 14.5°C to 11.3°C.

Topography: The islands are volcanic, the central peak in Tristan rises to 2,060 m above sea level.

Biodiversity: At least 212 plant taxa have been recorded, including 35 ferns and 58 native flowering plants. Seals are the only native breeding mammals. The islands support unique indigenous land-birds, including the Gough bunting (*Rowettia goughensis*) and the rare Inaccessible rail (*Atlantisia rogersi*), the smallest flightless bird in the world. Millions of seabirds, such as the Atlantic yellow-nosed albatross (*Thalassarche chlororhynchos*) and great shearwater (*Puffinis gravis*), breed - as do fur seals and elephant seals. Fourteen of Tristan's bird species are of global concern including the critically endangered Tristan albatross (*Diomedea dabbenena*).

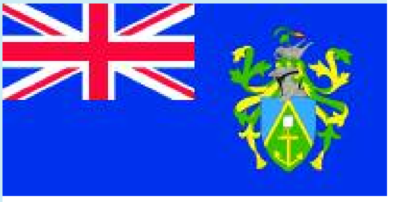
Main economic activities: The island relies on income from fishing and stamp and coin sales.

Other information: Tristan is a dependency of St. Helena. The Settlement of Edinburgh of the Seven Seas in the Northwest is its only inhabited area. Gough and Inaccessible islands are a World Heritage Site. Population – 275.

[10] Sanders, S.M. (ed.). 2006. *Important Bird Areas in the United Kingdom Overseas Territories.* Sandy, UK:RSPB

South Pacific

Pitcairn Island[11]



Pitcairn Island

Size: The Pitcairn Island group is comprised of four small islands. The total land area of the Pitcairn Islands is 4,516 ha. The largest island is Henderson 3,720 ha, while Pitcairn Island is 660 ha.

Location: Situated in the South Pacific Ocean, Pitcairn is roughly 1,570 km West of Easter Island; 5,350 km east north-east of its administrative headquarters in Auckland, New Zealand.

Climate: The temperature ranges from 13°C to 28°C with a mean annual rainfall of approximately 1,716 mm, with considerable annual variation.

Topography: Pitcairn is volcanic; Henderson, Oeno, and Ducie are coral atolls.

Biodiversity: Henderson and Pitcairn support richer floras with a high number of endemic and endangered species. There are nine species of birds of global concern. In addition, more than 90% cent of the world's population of Murphy's petrels (*Pterodroma ultima*) nest on Ducie, and Henderson is probably the principal breeding site for the endangered Henderson petrel (*Pterodroma atrata*).

Main economic activities: The economy of Pitcairn is largely based on subsistence fishing, horticulture, and the sale of handicrafts and postage stamps. The Pitcairn Government is trying to boost revenue through the sale of .pn domain names, honey production and increasing tourist arrivals.

Other information: Population – 47. Henderson is a World Heritage Site.

[11] Smyth, N. And Waldron, S. (in prep) *Pitcairn Islands Environment Management Plan.* Prepared for the UK Foreign and Commonwealth Office by BEC Consultants and Pitcairn Islands and Sanders, S.M.(ed.). 2006. *Important Bird Areas in the United Kingdom Overseas Territories*. Sandy, UK:RSPB

Chapter summary

Climate change is one of the most pressing and complex issues of our time. It is one that UKOTs cannot afford to ignore. Although the territories contribute very little to the underlying causes of climate change, they are particularly vulnerable to its effects. The UKOTs have much to lose: many of them are small islands with a high level of inherent vulnerability to natural and other hazards. The effects of climate change increase this vulnerability.

Even if greenhouse gas emissions were to stop today, the effects would still be felt because of the damage that has already been done to the global climate system. Notwithstanding the uncertainties about climate change and to what extent these changes may occur, there is a strong case for UKOTs to take swift and decisive action to prepare for, and respond to, its effects on nature and society. Adapting to climate change is an opportunity for UKOTs to build resilience and move towards more sustainable forms of development.

2 Unpacking Climate Change

2.1 What is climate?

Understanding climate is a useful starting point for understanding climate change.

Climate vs. weather

The words 'climate' and 'weather' are sometimes used interchangeably, but they are in fact different, though related, phenomena. Weather refers to short-term, atmospheric conditions, climate to long-term ones. Weather is measured by temperature, humidity, wind speed, atmospheric pressure, cloudiness, and precipitation. Climate is the average, or typical, weather conditions of a given area observed over a long period of time, usually 30 years or more.

Climate zones, are distinguished from each other by their prevailing temperature and precipitation, which have a natural range and variability within zones.

Climate variations can occur from year to year, one decade to another, one century to another, or any longer time scale. Weather conditions may change quickly, for example, it may be sunny and dry one day and rainy and cool the next. Climate, on the other hand, is slower to change, but the implications of change are far reaching.

Within each climate zone, the people, plants and animals are adapted to the range of conditions found there. The plants and animals that are native to the tropical climate of the Turks and Caicos Islands thrive there, but would find the Antarctic climate of the British Antarctic Territory hostile and vice versa. However, when change occurs within a climate zone, human and ecological systems are challenged by conditions that are on the edge of, or outside, the normal range. Over time, this can put stress on systems or modify them.

People and climate

Human and biological systems are so interlinked that a change in one area of either system has knock-on effects on others. Human activity is greatly influenced by climate. "Climate shapes ecosystems and species, determines the types of engineering structures we build (from houses to bridges), and affects our culture, our moods, our leisure pursuits" (Hulme, 2006).

2.2 What influences climate?

Several geographic factors influence climate, including latitude and altitude, continentality, distance from the ocean, mountain barriers, solar radiation, ocean currents, volcanic activity, and prevailing winds. It is also influenced by changes in the Earth's orbit around the sun and the energy the planet receives from the sun. All of these geographic factors are fairly constant, however, where there are changes, these take place over the long term.

The interaction between the ocean and the atmosphere (ocean-atmosphere dynamics), has an impact on climate as well. One such phenomenon that has a major influence on climate in the UKOTs is the **El Niño - Southern Oscillation** (ENSO) or El Niño, as the phenomenon is commonly known.

El Niño/La Niña and the Southern Oscillation

El Niño and La Niña are experienced world-wide (Figure 2). El Niño is the result of the interaction between the ocean and the atmosphere in the Pacific and the resulting effect on global climate. It is caused when

> **Box 3.** Global cooling in 2007 – 2008?
>
> The cooling of the oceans experienced in late 2007 through 2008 is due to a La Niña event. Because of La Niña, 2008 has been forecast to be cooler than the previous seven years. But scientists have been quick to point out that this cooling is due to the strength of the La Niña event, and not because global warming or climate change has gone away. The mean temperature is still expected to be above that of 2000.

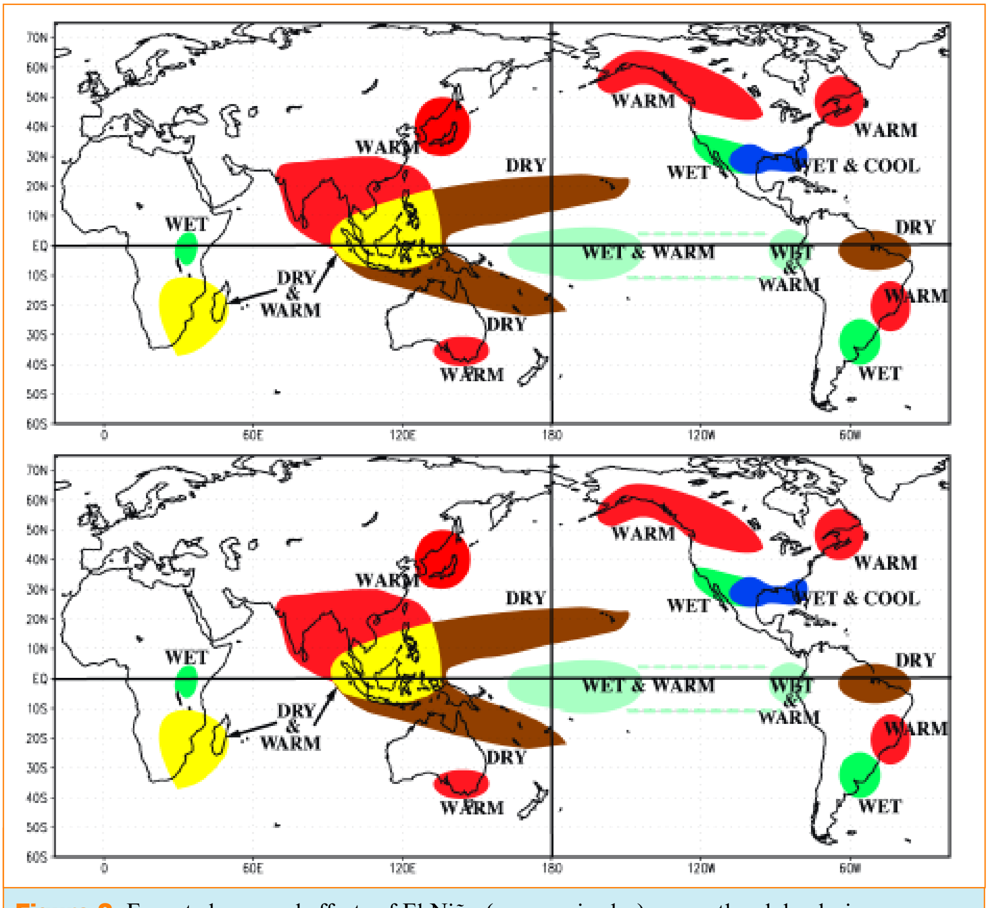


Figure 2. Expected seasonal effects of El Niño (warm episodes) across the globe during December–February (top) and expected seasonal effects of La Niña (cold episodes) during the same time period (bottom). *Source: Climate Prediction Center, NOAA*

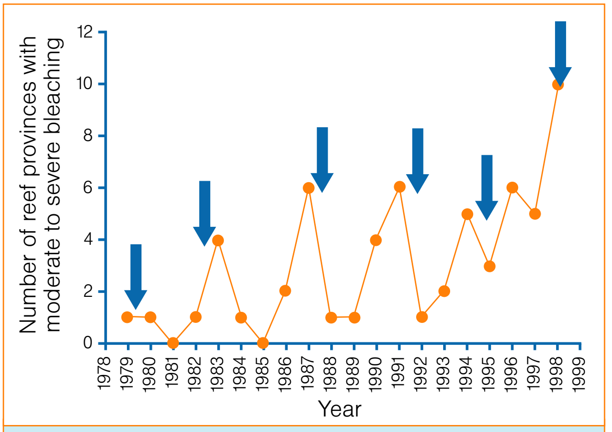


Figure 3. Number of reef provinces bleaching since 1978. Arrows indicate strong El Nino years. While some of the trend can be explained by observer bias, this factor does not completely explain the increasing trend with time.
Source: Hoegh-Guldberg 1999

the trade winds that blow from east to west along the equator in the Pacific decrease in intensity (this is the Southern Oscillation) and bring about an increase in the ocean temperature. This in turn affects where storms occur along the equator and triggers ripple effects worldwide.

Under normal conditions, the westward blowing winds push the ocean's water towards western Pacific. In the deeper eastern Pacific, cold water is pulled from the ocean's depths to replace the water that is blown west. The normal ocean temperature balance is therefore warm water (30°C) in the west and cold water (22°C) in the east.

El Niño events occur about every two to eight years and are considered a normal phenomenon. In an El Niño event, the trade winds weaken and less water is pushed westwards. Cold water in the eastern Pacific is not pulled up, making the water in that part of the ocean warmer than usual. The warmer water contributes to the weakening of the winds in a self-perpetuating or positive feedback cycle.

El Niño events generally cause droughts in several regions, including the Caribbean, the western Pacific, Southeast Asia and Southern Africa. They are also associated with coral bleaching, a phenomenon brought about by high water temperatures that cause corals to lose the symbiotic algae that boost their metabolism, respiration, waste excretion and growth rate. Very severe coral bleaching occurred in the tropical Indian Ocean in 1998, the hottest year on record to date and the year of the strongest El Niño recorded. That year, ocean temperatures were between 3°C and 5°C above normal (World Wildlife Fund and McGinley, 2007).

El Niño events are generally followed by a period of opposite conditions called La Niña. In La Niña conditions, the water in the eastern Pacific is cooler and the winds that blow from east to west are stronger than normal. In most locations, the phenomenon is associated with increased rainfall. Preliminary findings suggest that climate change will cause El Niño events to increase in frequency. When the El Niño events are superimposed on the upward climate change-induced temperature trends, phenomena such as coral bleaching will become more frequent There appears to be a correlation between strong El Nino events and severe coral bleaching. (Figure 3). It has been suggested that bleaching may become an annual event by 2020 (Hoegh-Guldberg, 1999).

2.3 The science behind global climate change

What is climate change?

Climate change is any significant modification in the climate of a zone or region over time. There are natural processes of climate change that have been taking place since the Earth began evolving more than four billion years ago. These natural processes include such things as changes in the Earth's orbit, changes in sun intensity, and volcanic eruptions (which alter atmospheric gases). **Ice ages** are one example of climate change brought about by natural causes. Scientists believe the period of global cooling between the 1400s and 1700s known as "The Little Ice Age" was the result of weakening of the sun's intensity.

The present-day global concern about climate change, however, is not about natural processes. It is rather about the unprecedented and accelerated increase in the Earth's temperature over the past 60 to 100 years, which has its roots in human activity that continues to grow (Solomon *et al*., 2007). Scientific evidence notwithstanding, how much of the observed change is due to human influence has generated a lot of debate; what is not in doubt is that the current rate of climate change is unusual and is linked to how humans use the planet.

The greenhouse effect

The change that is now taking place in the global climate has its roots in the intensification of a natural phenomenon, the greenhouse effect. The atmosphere is made up of water vapour, dust particles and gases. The main gases are nitrogen (78 per cent) and oxygen (21 per cent). Argon, and small amounts of other gases, such as carbon dioxide and trace amounts of hydrogen, methane, ozone, carbon monoxide, helium, neon, krypton and xenon account for the remaining 1 per cent (Figure 4).

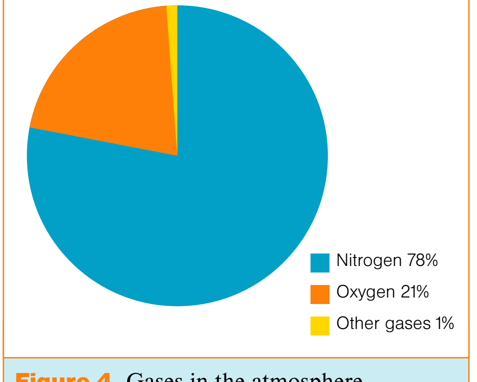


Figure 4. Gases in the atmosphere

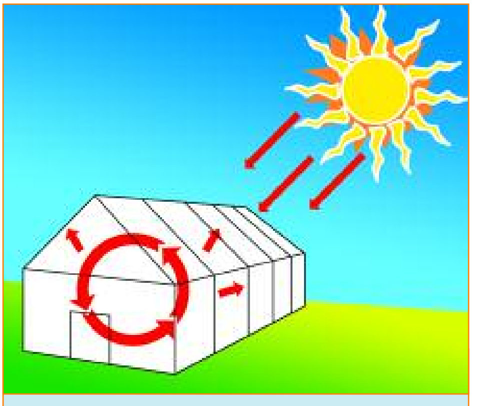


Figure 5. The heat-trapping ability of a greenhouse is influenced by a number of factors, including the transparency of the greenhouse cover, and colour and type of surfaces of the greenhouse.

Some of the gases in this 1 per cent play an important role in regulating the Earth's temperature, however, by helping to balance the energy that is received from the sun and reflected back into space by the Earth. These gases include carbon dioxide, methane, and nitrous oxide and together with water vapour, are commonly known as greenhouse gases. They help warm the atmosphere by trapping some of the energy reflected off the Earth and preventing it from escaping.

The principle is much like the heat-trapping glass panels of a greenhouse (Figure 5), hence the name greenhouse gases. The glass panels of a greenhouse allow radiation from the sun to get in, but prevent the heat that is generated by the ground, plants and objects inside from escaping easily. The result is a build-up of heat inside.

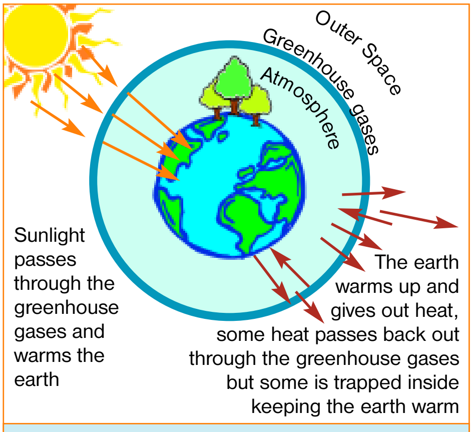


Figure 6. Greenhouse effect
Source: Impetus Consulting Ltd.

The greenhouse effect works much the same way. Energy from the sun, or solar radiation, passes through the atmosphere and warms the Earth's surface. Some of the radiation is reflected back out into space at the level of the atmosphere. Some reaches the Earth, is absorbed by the ground and released as heat. Some of this heat passes back through the atmosphere into outer space and some is retained by the gases in the atmosphere and warms the Earth (Figure 6).

This natural warming is what makes the Earth habitable for the plants, animals and humans that have evolved there; without it, the Earth's average temperature would be an inhospitable -18°C instead of the present 14°C.

The enhanced greenhouse effect

When this natural warming process is exaggerated or enhanced, there is cause for concern. An increase in the concentration of greenhouse gases in the atmosphere results in more heat being retained and an overall warming of the Earth's temperature. Although they make up a small percentage of atmospheric gases, changes in the concentration of greenhouse gases have a huge effect on the balance of natural processes.

The human factor

The core concern about climate change is human potential to alter the climate through activities that are a result of our way of life and how we treat the natural environment. There have been significant

Box 4. Human activity and greenhouse gases

The principal greenhouse gases that enter the atmosphere because of human activities are:

Carbon Dioxide (CO_2): Carbon dioxide enters the atmosphere through the burning of fossil fuels (oil, natural gas, and coal), solid waste, trees and wood products, and also as a result of other chemical reactions (e.g., manufacture of cement). Carbon dioxide is also removed from the atmosphere (or "sequestered") when it is absorbed by plants as part of the biological carbon cycle.

Methane (CH_4): Methane is emitted during the production and transport of coal, natural gas, and oil. Methane emissions also result from livestock and other agricultural practices and by the decay of organic waste in municipal solid waste landfills.

Nitrous Oxide (N_2O): Nitrous oxide is emitted during agricultural and industrial activities, as well as during combustion of fossil fuels and solid waste.

Fluorinated Gases: Hydrofluorocarbons, perfluorocarbons, and sulfur hexafluoride are synthetic, powerful greenhouse gases that are emitted from a variety of industrial processes. Fluorinated gases are sometimes used as substitutes for ozone-depleting substances (i.e., CFCs, HCFCs, and halons). These gases are typically emitted in smaller quantities, but because they are potent greenhouse gases, they are sometimes referred to as High Global Warming Potential gases ("High GWP gases").

Source: US Environmental Protection Agency (www.epa.gov/climatechange/emissions/index.html)

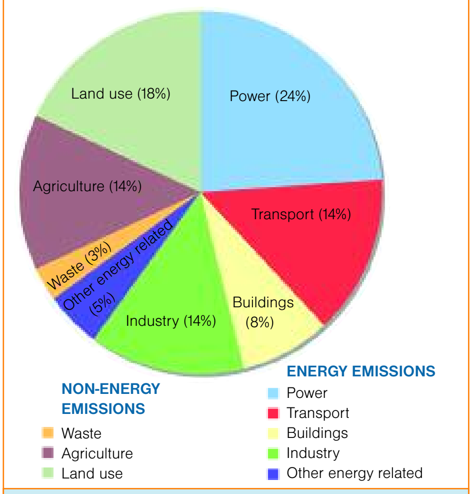


Figure 7. Greenhouse-gas emissions in 2000, by source. *Source: Prepared by Stern Review, from data drawn from World Resources Institute Climate Analysis Indicators Tool (CAIT) on-line database version 3.0.*

technological advances over the past 60 to 100 years that have offered humankind countless benefits and conveniences. These increases in human activity, however, have also led to an additional release of greenhouse gases that have placed stress on natural processes.

Some of the gases, such as carbon dioxide, water vapour, methane, nitrous oxide, and ozone are the result of both natural and human processes. Others, notably fluorinated gases, are generated solely by human activities. The sources of these gas emissions include burning fossil fuels to power our way of life, industrial processes, urbanisation and land use, agriculture and deforestation (Figure 7 and Box 4). Since the beginning of the industrial revolution, concentrations of carbon dioxide in the atmosphere have increased nearly 30 per cent (Figure 7), methane concentrations have more than doubled, and nitrous oxide concentrations have risen by about 15 per cent.

Carbon dioxide and the increase in warming

Carbon dioxide is the single largest contributor to the enhanced greenhouse effect. Increases in carbon dioxide emissions account for approximately 70 per cent of the enhanced greenhouse effect. Using **ice cores** from the Antarctic, scientists estimate that the concentration of carbon dioxide in the atmosphere in the pre-industrial era had a value of approximately 280 parts per million (ppm). Measurements in 2005 put it at 379 ppm. The 2005 figures also tell a story of alarming growth. The 2005 carbon dioxide levels exceeded the natural range of atmospheric carbon dioxide over the last 650,000 years (180 to 300 ppm). In addition, even though there has been year to year variability (at an average of 1.9 ppm), the annual growth rate of carbon dioxide concentrations in the atmosphere was larger during the 10 years between 1995 and 2005 than it had been since the beginning of continuous direct atmospheric measurements between 1960 and 2005 (average: 1.4 ppm per year) (IPCC, 2007).

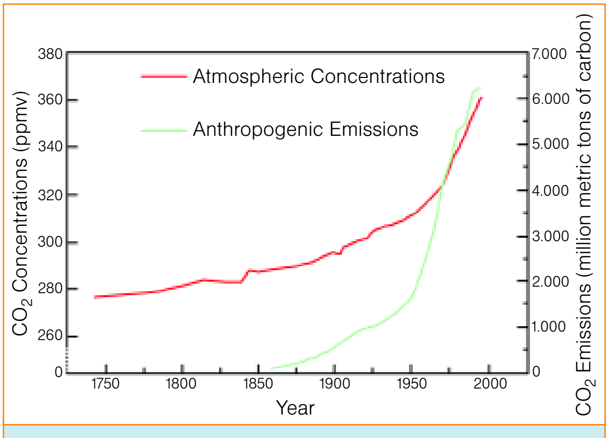


Figure 8. Trends in Atmospheric Concentrations and Anthropogenic Emissions of Carbon Dioxide
Source: Oak Ridge National Laboratory.

The carbon dioxide imbalance

It is true that natural sources of carbon dioxide - plant respiration and decomposition of organic matter - generate more than 10 times the amount of carbon dioxide produced by human activities such as driving motor vehicles, heating homes and powering factories. However, in the past, natural processes that remove or **sequester** carbon dioxide from the atmosphere, namely **photosynthesis** and the carbon reservoir function of the oceans, balanced out these releases.

We now have a situation where not only are additional sources producing and emitting carbon dioxide in significant quantities, but the natural sinks that remove carbon dioxide are also being compromised. Trees and forests are being cut down for a variety of reasons, including agriculture and human settlements. At the same time, oceans, including the North and South Atlantic oceans, are reaching their **carbon dioxide saturation point** because their absorptive capacity is failing to keep pace with the increase in carbon dioxide emissions. A 10-year study by the University of East Anglia found that the North Atlantic halved its absorption of carbon dioxide between the mid-90s and 2005 (Schuster and Watson, 2007). Scientists previously thought the **carbon sink** function of the oceans would help offset the increase in anthropogenic carbon dioxide emissions. However, this appears not to be the case. Even though a decrease in the ability of the oceans to absorb carbon dioxide was anticipated by scientists and even factored into some climate models, it seems to be happening 40 years earlier than expected.

Ocean acidification

Scientists are now observing trends of ocean acidification, a decrease in the pH due to increased absorption of atmospheric carbon dioxide. Surface ocean pH is already 0.1 units lower than pre-industrial values and, in one emissions scenario, by the end of the century it could be lowered by an additional 0.14–0.35 units. Research is suggesting that if the acidification trend continues, marine organisms such as coral, plankton and shellfish, might not be able to make their skeletons and this could have ramifications for coastal and marine environments.

Under normal conditions, carbonate ion levels are high in the ocean, but when the water becomes more acidic, they decrease. When this happens, structures that are made of calcium carbonate are at risk of dissolution. In the case of corals, this could cause slower or more fragile growth and lead to a decrease in coral cover and a smaller reef framework (Kleypas *et al*., 2006; Orr *et al*., 2005; The Royal Society, 2005). The Caribbean is one of the regions where reefs are expected to suffer the effects of ocean acidification (Hoegh-Guldberg, *et al*., 2007).

Coral reefs play an important role in protecting the shoreline from wave erosion. They generate coral sand, provide nurseries and habitats for fish and other marine species and provide opportunities for recreation activities, particularly diving and snorkelling. Compromised coral reefs weaken coastal defences and can have a negative effect on fisheries, beach quality and tourism.

2.4 How do we know that climate change is occurring?

The mass media have made much of the fate of polar bears in the Arctic due to losses of summer sea ice. Although melting sea ice and glaciers and drowning bears are some of the widely known early warning signs of change, they are not the

Box 5. Slow onset versus sudden extreme events

Although 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.

Slow onset changes include:

- Sea-level rise
- Increase in air temperature: The average warming in regions where small islands are located is likely to be between 2.0°C and 2.8°C by 2050 (compared with 1990 temperatures). By 2080, the increase (above 1990 temperatures) is likely to be between 3.1°C 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., heat waves) is likely to increase
- An increase in the intensity of rainfall
- An increase in the intensity of tropical cyclones.

Source: Tompkins et al., 2005

only things that tell us something is awry with the global climate.

Changes in climate cues

In some northern latitudes, growing seasons are longer because spring now arrives earlier and bird nesting and animal migration patterns have changed. Some species of insects, like butterflies, dragonflies and beetles, are surviving at higher latitudes than before. Some species more commonly associated with warmer climates, like loggerhead turtles, are increasingly being spotted in the United Kingdom.

Changes in weather patterns

These changes in climate cues are linked to changes in weather patterns, particularly changes in temperature and precipitation. Single abnormalities in weather are not the things that tell us that climate change is occurring. On their own, an unseasonably cool December in Bermuda or a wetter than usual summer in the Chagos Islands could be random events, but evidence of climate change comes from observed patterns over time. The IPCC and other climate researchers have been building a body of observational data that show medium to long-term trends, and this information points to four things.

First, changes in the atmosphere have had an effect on temperature, precipitation, storms and sea level. Second, warming has noticeably influenced many physical and biological systems (Parry *et al.*, 2007, Solomon, *et al.*, 2007). Third, climate change impacts fall into two main categories: slow onset impacts (changes in average climate conditions) and extreme events (increased intensity in rainfall and tropical storms) (see Box 5). Finally, climate change is not experienced in the same way by all countries and regions.

Observed trends

Some of the IPCC conclusions about observed trends are below.

Temperature: Eleven of the 12 warmest years since 1850 (when instrumental record keeping began) occurred between 1995 and 2006. The linear warming trend over the last 50 years, an average of 0.13°C per decade (with a range between 0.10°C and 0.16°C), is nearly double that of the previous 100 years. The total temperature increase from 1850–1899 to 2001–2005 is

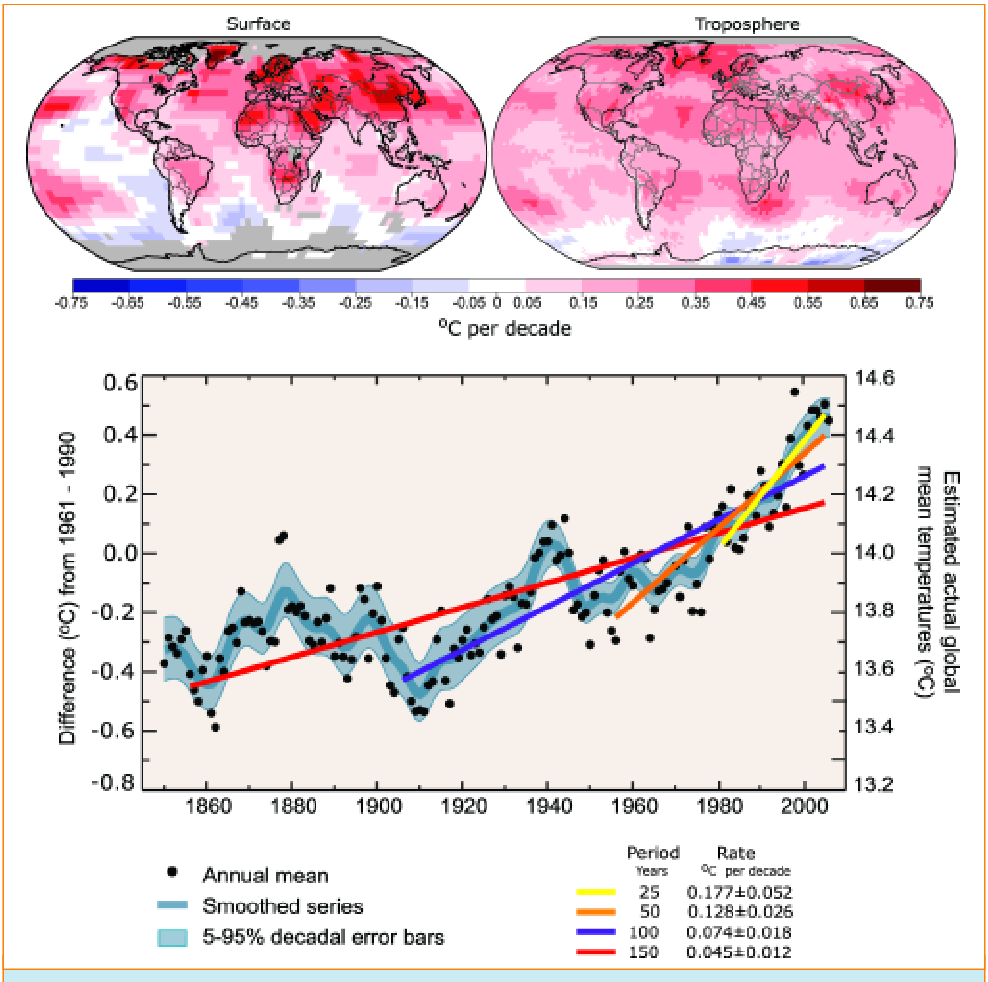


Figure 9. (Top) Patterns of linear global temperature trends over the period 1979 to 2005 estimated at the surface (left), and for the troposphere from satellite records (right). Grey indicates areas with incomplete data.

(Bottom) Annual global mean temperatures (black dots) with linear fits to the data. The left hand axis shows temperature anomalies relative to the 1961 to 1990 average and the right hand axis shows estimated actual temperatures, both in °C. Linear trends are shown for the last 25 (yellow), 50 (orange), 100 (purple) and 150 years (red). The smooth blue curve shows decadal variations, with the decadal 90% error range shown as a pale blue band about that line. The total temperature increase from the period 1850 to 1899 to the period 2001 to 2005 is 0.76°C ± 0.19°C.

(Source: IPCC, 2007a, FAQ 3.1, Figure 1).

an average of 0.76°C, with a range between 0.57°C and 0.95°C (IPCC, 2007). (Figure 9)

In their Fourth Assessment Report, the IPCC concluded it is very likely that over the past 50 years cold days, cold nights and frosts have become less frequent over most land areas, and hot days and hot nights have become more frequent. It also suggests heat waves may have become more frequent over most land area and there are possibly more heavy precipitation events over most areas (IPCC, 2007).

Precipitation: Between 1900 and 2005, there was an increase in precipitation in some parts of the world and a decline in others. There were significant increases in eastern parts of North and South America, northern Europe and northern and central Asia but decreases in the Sahel, the Mediterranean, southern Africa and parts of southern Asia. More areas seem to be affected by drought globally since the 1970s (IPCC, 2007). In the future, Arctic and Equatorial regions may become wetter, and subtropical regions drier. However, projections of precipitation changes for temperate regions are less consistent.

Storms: Since 1970, there has been more intense tropical storm activity, marked by a 75 per cent increase in the number of category 4 and 5 hurricanes. The largest increases were in the North Pacific, Indian and Southwest Pacific Oceans, but the number of hurricanes in the North Atlantic has also been above normal in nine of the past 11 years, including the record breaking 2005 season (IPCC, 2007). One of the natural factors that helps decrease storm intensity is cold ocean waters, but as average ocean temperatures increase (see below), a natural retardant is becoming an accelerant.

Hurricane Ivan in the Cayman Islands. The number and intensity of storms has increased in recent years *Credit: Department of Environment, Cayman Islands Government*

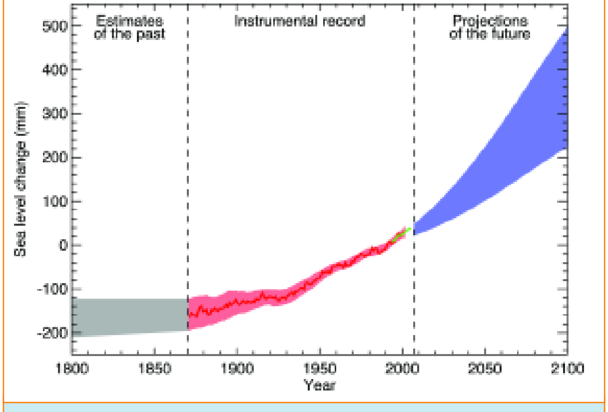


Figure 10. Time series of global mean sea level (deviation from the 1980-1999 mean) in the past and as projected for the future. For the period before 1870, global measurements of sea level are not available. The grey shading shows the uncertainty in the estimated long-term rate of sea level change. The red line is a reconstruction of global mean sea level from tide gauges and the red shading denotes the range of variations from a smooth curve. The green line shows global mean sea level observed from satellite altimetry. The blue shading represents the range of model projections of the Special Report on Emissions Scenarios (project A1B) for the 21st century, relative to the 1980 to 1999 mean, and has been calculated independently from the observations. Beyond 2100, the projections are increasingly dependent on the emissions scenario. Over many centuries or millennia, sea level could rise by several metres.
(Source: IPCC, 2007b, p.111).

Sea level and temperature: Global average sea level has risen at an average rate of 1.8 mm per year since 1961, with a marked acceleration in the rate of increase to an average of 3.1 mm per year since 1993 (Figure 10). It is too soon, however, to know if the latter is a short-term variability or a long-term trend. Sea level rise is the consequence of two processes associated with warming: inflows of water from melting glaciers, ice caps and the polar sheets and thermal expansion of seawater, that is, an increase in the volume of seawater in response to a temperature change.

More than 80 per cent of the heat added to the climate system is being absorbed by oceans and this is affecting not just the surface water, but water at greater depths as well. Observations since 1961 show the average temperature of water at depths of up to 3,000 m has increased (IPCC, 2007).

In their latest report, the IPCC projected that global sea level rise in the 21st century would be at a greater rate than the period from 1961 to 2003.

Snow and ice extent: Satellite data since 1978 show that annual average Arctic sea ice extent has shrunk by an average of 3.7 percent per decade, with larger decreases in summer of 7.4 per cent per decade. Mountain glaciers and snow cover on average have declined in both hemispheres.

Chapter summary

Climate change is any significant modification over time in the climate of a zone or region. This change can be natural or it can have its roots in human activity. Natural processes of change have been taking place since the Earth began evolving, but the present day global concern is about the unprecedented rate of change over the past 60 to 100 years that is caused by human activity.

The change that is now taking place is the result of the intensification of a natural and necessary process, the greenhouse effect. Increased emissions of greenhouse gases are leading to an increase in the Earth's average surface and sea temperatures.

Changes in the atmosphere are having an effect on temperature, precipitation, storm activity and sea level. The linear warming trend over the last 50 years is nearly double that for the last hundred years. Some parts of the world have been experiencing an increase in precipitation while others have had a significant decline. Global average sea level has risen at an average of 1.8 mm per year since 1961 because of melting glaciers, ice caps and sea ice. Satellite data since 1978 show that annual average see ice extent has shrunk by an average of 3.7 per cent per decade.

All of these consequences of warming in turn influence physical and biological systems; this has serious implications for man and society.

3 Climate Change in UK Overseas Territories: Present and Future Impacts

Climate scientists use data and information about past and present conditions to model scenarios that provide projections on plausible future changes (Box 6). Each scenario or set of scenarios is based on assumptions about how present conditions might change. Changes in population, energy use and technology are some of the things that scientists factor in. This information is used to make predictions.

Getting the right data together to provide evidence of change is a big challenge. Using what we have now has given us enough to understand the general principles of what has happened and to predict how things will change. In some places the data are very clear, and are linked to what is happening locally. In other places, the basic data have not been collected and so predictions about what will change and why have to be based on the best available evidence and on basic scientific principles.

Challenge of making projections for UKOTs

Making climate projections for UKOTs and consequently predicting future impacts is not that straightforward, even with the caveat that making predictions about climate-induced changes globally is an uncertain science. First, data are simply not available. The spatial scales, or grids, of most models of the global climate system are too large to provide information about small countries like the UKOTs.

The Caribbean is trying to address this issue through joint collaboration between regional institutions and the Met Office Hadley Centre in the United Kingdom, under the Providing Regional Climates for Impacts Studies (PRECIS) project.

Predicting impacts is further complicated by the fact that climate change is not the only process that is affecting the natural and physical environments in UKOTs. Other phenomena and processes influence, and are influenced by, climate change impacts. Vulnerability to climate change can be exacerbated by the presence of other stresses or forcing factors, whether natural, such as ENSO or a volcanic eruption, or man-made, such as pollution or land use patterns.

Not only is there a lot of uncertainty surrounding the future impacts of climate change on UKOTs, the full extent of current impacts is unknown. This is in part because there has been little climate change-specific monitoring to date.

> ***"...what's at stake for most [UK] territories is a way of life and many of the natural and cultural features that are so much a part of their identity."***

Box 6. Three temperature increase scenarios

It is a foregone conclusion that the Earth's temperature will continue to rise for some time to come. What is not known is the extent of the change that will take place. Climate scientists have modeled different scenarios of mean temperature changes with a view to predicting what some of the likely impacts of temperature changes would be.

Global mean temperature changes of up to ***1.5°C*** would exacerbate current key vulnerabilities and cause others, such as negative health effects caused by heat waves, floods an droughts, as well as malnutrition and infectious diseases, millions more people exposed to increased water stress, increased damage from storms and floods, increased coral bleaching.

Global mean temperature changes of ***1.5°C to 3.5°C*** would result in an increasing number of key impacts at all scales, such as many million more people at risk from coastal flooding, widespread loss of biodiversity, and commitment to widespread melting of the Greenland and West Antarctic ice sheets with associated sea level rise.

Global mean temperature changes ***greater than 3.5°C*** would exceed the capacity of all systems - physical, biological and social, in particular of human societies - to adapt to this extent of warming, especially since it can be even more pronounced regionally. As examples, about 30% loss of global coastal wetlands and widespread mortality of corals.

Source: German Federal Ministry for the Environment, Nature Conservation and Nuclear Safety et al.*, 2007*

Need for action in the UKOTs

Based on the data and information that are available (some of which is summarised below), climate change is already affecting UKOTs. The IPCC projects that, even in the best possible scenario, the effects of climate change will worsen before the situation improves. UKOTs have no control over the storm surges that affect their shores, nor can they regulate the increasing ocean temperatures that affect their coral reefs or fish and marine animals in their waters, but what they can do is plan for these threats and put in place systems and infrastructure to reduce risk and build resilience.

UKOTs cannot afford to adopt a wait and see attitude. The economies of the territories are too small and they are too dependent on sensitive ecosystems. If they are completely unprepared, the external shocks of some climate change impacts could be devastating. In the most extreme circumstances, some UKOTs could lose land because of rising sea levels. Even without the most extreme scenario becoming reality, what's at stake for most territories is a way of life and many of the natural and cultural features that are so much a part of their identity.

Vulnerability to climate change can be intensified by the presence of other stresses

Climate change is not the only threat that UKOTs face. Each territory has its particular mix of stresses on the natural and physical environments. Some of these pressures are a result of changes people have made to the landscape and oceans. Some are a consequence of pollution, the introduction of **invasive alien species**, and the over harvesting of plants, fish and animals. Some have their roots in natural phenomena. Nevertheless, whatever the source, together with climate change, they increase risk and reduce resilience to natural hazards in a mutually reinforcing

Climate change increases the habitat of invasive species. In some of the South Atlantic and sub-Antarctic islands invasive reindeer are putting endemic species at risk. *Credit: Falklands Conservation*

cycle. These pre-existing stresses make it difficult for systems to naturally withstand all the effects of climate-induced change. Climate change presents additional challenges for systems already under strain.

3.1 Overall impacts of climate change in UKOTs

The full extent of climate change impacts on UKOTs is uncertain because it is difficult to project future climate scenarios with accuracy. However, based on trends to date, UKOTs can anticipate being affected by climate change ecologically, economically and socially.

Livelihoods and food security: UKOTs rely more heavily on fragile natural resources than many other societies. They also rely on a limited set of coastal and marine resource systems. Most economies, and consequently community and individual livelihood strategies, are not very diversified and there is little potential for diversification (Sear *et al*., 2001, Mimura *et al*., 2007). Some of the key sectors that provide opportunities for livelihoods in UKOTs – tourism, fisheries and agriculture – will be affected by climate change.

Tourism in the Caribbean UKOTs and Bermuda would be particularly affected by climate change because of their reliance on coastal and marine resources. Because of the linkages between tourism and other sectors, such as agriculture, handicraft industries, entertainment and small businesses, a downturn in the tourism industry would have serious knock-on effects in those UKOTs where tourism is a major economic activity. The entire economies of places like the Cayman Islands and Anguilla, where tourism contributes 45 per cent and 28.7 per cent of GDP respectively, would certainly feel the effects of any decline in the industry.

Other forms of tourism are also likely to be sensitive to climate change impacts on coastal and marine habitats. Those territories that sell a nature tourism product that is built around their birds and marine animals, such as South Georgia and the South Sandwich Islands, could also experience a down turn in arrivals if loss of habitat and food supplies leads to a decline in the species that visitors go to see.

In addition, the increasing cost of travel and changes in destination choices may reduce the number of tourists visiting UKOTs (Sear *et al*., 2001).

Commercial and subsistence fishing are important in a number of UKOTs, including Anguilla, the Falkland Islands, St. Helena, the South Georgia and South Sandwich Islands, the Turks and Caicos Islands and Tristan da Cunha. Fisheries account for 85 per cent of GDP in South Georgia and the South Sandwich Islands. With most of the world's fisheries under stress from over fishing and habitat destruction from pollution, climate change only adds another layer of pressure. Water temperature influences the migration, growth, recruitment and mortality of fish. As habitats become less favourable, species migrate in search of conditions that are more suitable. In some instances species risk becoming locally extinct.

A Cayman Islands' beach, before and after erosion.
Credit: Department of Environment, Cayman Islands Government

Changing growing seasons, drought and water shortages are placing a strain on food production in some territories. Those territories that are prone to tropical cyclones risk devastation of local agriculture after intense storms. Scientists do not yet know the full effect that global warming will have on agriculture. What they do know is that temperature, carbon dioxide concentration and ozone levels all affect crop yields.

Health: The IPCC projects that climate change will increase the burden of disease globally (Parry *et al.*, 2007). The health risks associated with extreme weather in UKOTs will increase. It is also likely that the incidence of water and vector borne diseases will increase as water availability is affected and higher temperatures change the geographic distribution of vectors and shorten incubation periods.

Water resources: Though it is difficult to predict exactly what rainfall patterns will be in future, precipitation changes are likely to influence water supplies. The wet and dry cycles associated with ENSO events can seriously affect water supplies in countries that are heavily dependent on rain water. Ground water supplies, in small islands in particular, face possible threats from contamination by salt water. Drought-prone regions that already experience water shortages, like the Mediterranean, are likely to see more acute scarcity.

Economic and financial impacts: The small and narrow economic bases of the UKOTs make them very vulnerable to external shocks. All of the physical impacts of climate change in the coastal zone have associated economic costs. Some are direct, as in the case of damage to infrastructure (see below), human settlements, crops etc. Others are indirect, such as foregone earnings from major sectors like tourism and loss of the services of critical ecosystems. Extreme weather events, such as hurricanes or tropical storms, can be particularly costly. For example, Hurricane Ivan in 2004 cost the Cayman Islands USD3,432 million or 138 per cent of GDP (Zapata Martí, 2005). There are also considerable costs associated with addressing climate change proactively by reducing risk and building resilience.

> ***"The goods and services that coastal and marine ecosystems provide UKOTs are critical to the well-being of their people and economies"***

Infrastructure: Most UKOTs have a high concentration of critical infrastructure (ports, airports, houses and businesses) in the coastal zone. Flooding and physical damage may lead to closure of roads, airports and bridges. The resulting disruption is also likely to affect communications as well as other key dependent sectors and services, including tourism, agriculture, health care delivery and market supplies (Mimura *et al.*, 2007).

Coastal and marine resources: Oceans and seas are important ecosystems in all the UKOTs. The goods and services that coastal and marine ecosystems provide UKOTs are critical to the well-being of their people and economies.

Coral reefs and sea grass beds are important nurseries for fisheries, for example, and beaches are breeding grounds for several marine species, such as turtles in the Caribbean and Pacific and seals in the Antarctic and sub-Antarctic. Coral reefs are an extremely diverse ecosystem. Globally, they cover a mere 0.2 per cent of ocean floor, but they are home to 25 per cent of its species (Roberts, 2003 cited in Grimsditch *et al.*, 2006), they are also part of the tourism product that many of the Caribbean UKOTs market. They generate the fine white sand that is part of the appeal of tropical beaches and their abundant marine life and structural formations attract snorkellers and divers.

Mangroves and other wetlands are an important part of the natural defences of several UKOTs and play a role in water quality management and erosion control. They are also wildlife habitats and breeding grounds for some marine species.

Healthy coral reefs support much biodiversity in our oceans, but they are vulnerable to impacts of climate change.
Credit: BdaReef. TMurdoch 2005

Climate change and sea level rise contribute to coastal erosion, landward intrusion of seawater, flooding (including higher storm surge flooding), damage to coral reefs from bleaching and disease, destruction of mangroves and sea grass

Box 7. Possible intensification of the El Niño Southern Oscillation

The natural pattern of El Niño/ La Niña events appears to be changing. The evidence is not yet conclusive, but it seems that since the 1970s the events are becoming stronger and more frequent, with little return to normal conditions in between. Climate scientists are beginning to look at the relationship between this phenomenon and global warming to ascertain if and to what extent human-induced climate change may be playing a role in this. Intensification of ENSO would have climate and economic implications globally, including for UKOTs.

Some commercially valuable fish species will not survive increased sea temperatures, threatening fisherfolk livelihoods.
Credit: Steve Freeman

beds, higher seas surface temperatures and reduced sea ice cover.

Biodiversity: The **biodiversity** resources of UKOTs make a significant contribution to global biodiversity (Joint Nature Conservation Committee, 2006). These mainly small and often isolated locations have a high degree of endemism. This means many of the plants and animals found on them occur nowhere else in the world. Of globally threatened species identified in the 2007 IUCN Red List, 61 **critically endangered species** are found in the UKOTs[12], compared to five in metropolitan UK. Fifty-eight **endangered species** occur in the territories (10 in metropolitan UK) along with 168 **vulnerable species** (23 in the metropolitan UK) (IUCN, 2007).

The biodiversity of UKOTs is under threat. There are more than 200 endemic plant species, 20 known endemic bird species, and 500 endemic invertebrates in the UKOTs. There are also, however, 39 recorded extinctions in the UK Overseas Territories and two species are extinct in the wild. The latest extinction in the Overseas Territories, namely that of the St. Helena olive (*Nesiota elliptica*), occurred in 2003 when the last tree in cultivation died (JNCC, 2006).

In addition to the number of globally threatened species, the UKOTs also hold regionally or globally important concentrations of species. For example, Ascension Island supports the second largest green turtle rookery in the Atlantic; Gough Island (Tristan da Cunha) has been described as the world's most important seabird island; and the reefs of the Chagos Archipelago (British Indian Ocean Territory) are considered to be some of the most pristine and best protected in the Indian Ocean (and account for some 1.3 per cent of the world resource). The importance to nature conservation of parts of the Territories is

Box 8. What the terminology means

A plant or animal is **critically endangered** when it is considered to be facing an extremely high risk of extinction in the wild. Extinct in the wild means a plant or animal is known only to survive in cultivation, in captivity or as a naturalised population (or populations) well outside the past range.

A plant or animal is **endangered** when it is considered to be facing a very high risk of extinction in the wild.

A plant or animal is **vulnerable** when it is considered to be facing a high risk of extinction in the wild.

Source: IUCN (http://www.iucn.org)

[12] These figures include all of Cyprus and Antarctic as the IUCN figures for Cyprus SBA and BAT are not broken down to this level.

Box 9. Why is biodiversity important to us?

The term **biodiversity** or biological diversity refers to the variety of plant and animal life on Earth. It includes the different ecosystems and habitats, the range of species found in them and the variation in their genetic makeup.

All of these come together in the natural environment and support human existence by providing direct and indirect benefits. These include ecosystem goods and services like food, water, timber, genetic material for medicines and cosmetics, as well as regulation of climate, flooding, water quality. Biodiversity also supports ecological processes that maintain the environment, including pollination and soil formation. The benefits of biodiversity also include social benefits such as recreation, aesthetic enjoyment, spiritual fulfillment, tourism, education and research. Biodiversity is also important in its own right; natural heritage is every bit as precious as cultural heritage.

Preserving biodiversity is important for maintaining known benefits, goods and services, as well as safeguarding potential benefits. As species are lost, so too is the potential they may offer for new fibres, fuels, medicines, and crops, among other things.

recognised through the designation as World Heritage Sites of Gough Island and Inaccessible Islands (Tristan) and Henderson Island (Pitcairn) for their insular natural heritage interests (JNCC, 2006).

One of the impacts associated with climate change is species expansion, that is, the migration of plants and animals to new ranges for all or part of their life cycle because of changed climatic conditions that allow them to thrive outside their usual range. In the absence of natural predators or competitors, they sometimes change the balance of species in the new location. Conversely, they create room for other species to become established. Changes, over time, could lead to a considerable decline in the populations of some plants and animals, or even their local or global extinction. Besides prompting changes in species range and abundance, climate change affects species composition, or the variety of species found in an area.

Climate change is not the only threat to ecosystems and habitats, but the effects of climate change on them reinforce just how important it is to conserve biodiversity resources to minimise the loss of species. Although biodiversity is threatened by climate change, proper management of biodiversity resources can reduce the impacts of climate change. Some of the ways in which this can be done include:

- protecting and enhancing ecosystem services;
- managing habitats for endangered species;
- creating refuges and buffer zones; and
- establishing networks of terrestrial, freshwater and marine protected areas that take into account projected changes in climate (Secretariat of the Convention on Biological Diversity, 2007).

3.2 Regional trends and national impacts

3.2.1 Antarctic and sub-Antarctic

There are two UKOTs in this region: the British Antarctic Territory and South Georgia and the South Sandwich Islands.

Sea ice cover has shrunk in the seas to the west of the Antarctic Peninsula but increased elsewhere in the Antarctic.
Credit: Pete Bucktrout/BAS

Observed change

Data and information from the British Antarctic Survey (2007) highlight the following trends:

- Temperature trends vary across Antarctica. The west coast of the Antarctic Peninsula is one of the most rapidly warming areas of the planet. Since the 1940s when records for the area began, the temperature there has increased by almost 3°C, or 10 times the mean rate of global warming. Warming has been slower on the eastern side of the peninsula, with the greatest temperature increases occurring in summer and autumn. The temperature of the high plateau of East Antarctica, which includes the area around the South Pole, appears not to have changed much.
- There has been considerable warming in the Southern Ocean and the waters of the Antarctic Circumpolar Current (ACC) are warming more rapidly than the global ocean. Since 1955, upper ocean temperatures to the west of the peninsula have increased by more than 1°C since 1955.
- In keeping with global trends, the troposphere (or lowest layer of the atmosphere), above the Antarctic has warmed and the stratosphere (the next layer up) has cooled. However, in the lower levels of the troposphere, at heights of 5 km above the Antarctic, the 30-year warming trend is more than three times the average rate of warming for the Earth as a whole.
- There has been an overall increase in sea ice extent, but this is distributed unevenly: sea ice cover has shrunk in the seas to the west of the Antarctic Peninsula but increased elsewhere in the Antarctic.

Projections

- IPCC projections for loss of summer sea ice range from a slight increase to near-complete loss.
- Warming of the atmosphere and ocean around Antarctica could lead to loss of mass from the Antarctic ice sheets, and this could make a significant contribution to sea level rise.
- As the climatic barriers that protect polar species from competition are lowered, the part of the Antarctic may see the encroachment of alien species.

The decline in sea ice in sections of the Antarctic is leading to a decline in the Adélie Penguin population.
Credit: Chris Gilbert/BAS

Table 1. Country impacts – Sub-Antarctic	
Country	**Impacts**
South Georgia and South Sandwich Islands	An increase in sea temperature could lead to a movement or loss of the fish stocks that support fisheries and many of the seabirds and marine animals found in South Georgia, such as albatross, prions, petrels, penguins and seals. Sea level rise could threaten beaches where fur seals and elephant seals breed and the tussac grass communities where the endemic South Georgia pipit (*Anthus antarcticus*) lives and breeds. Glaciers currently play an important role in containing rats, mice and reindeer. At present rats occupy 65 per cent of the coastline; mice are restricted to one area, and reindeer to two. Glacial retreat would increase the habitat of these invasive species, which would endanger the pipit and lead to loss of habitat for certain burrowing petrel species.

Source: D. Christie, Environment Officer, Government of South Georgia and the South Sandwich Islands

Implications and possible future impacts

- The Southern Ocean's carbon absorptive capacity has been weakened since 1981; changes in ocean temperatures currents and sea ice could further affect its capacity to absorb carbon dioxide.
- Most environmental change has taken place in the Antarctic peninsula where climate change has been largest. Since the 1970s, the population of krill, the tiny shrimp-like creatures that are major part of the diet of many Antarctic species, including whales, penguins and seals, has been in decline and this is believed to be linked to warming waters. With the decline of krill, an important link in the Antarctic food chain is being broken.
- The Adélie penguin (*Pygoscelis adeliae*), which is well adapted to sea ice conditions, is in decline and is being replaced by open water species, such as the Chinstrap penguin (*Pygoscelis antarctica*) (Fraser *et al*., 1992 cited in BAS, 2007).

3.2.2 Bermuda

Observed change

- There has been an increase in the frequency and magnitude of coral disease and bleaching events over the last three decades.
- Data from the Bermuda Atlantic Time-series Study station show carbon dioxide levels at the ocean surface of the Sargasso Sea southeast of the Bermuda Triangle are rising at about the same rate as atmospheric carbon dioxide. The change is even greater at deeper levels: in the waters between 250 and 450 m deep, carbon dioxide levels are rising at nearly twice the rate of the surface waters (Glick, 2004).

Implications and possible future impacts

- Bermuda's mangrove forests are threatened by salt water inundation due to rising sea levels. Climate change is contributing to the death of mangroves at the Hungry Bay Mangrove Swamp, a

The Cahow (*Pterodroma cahow*) is an endangered species endemic to Bermuda.
Credit: Andy Dobson

designated wetland of international importance under the Ramsar Convention. This mangrove forest is considered to be "in retreat."

- Turtle nesting sites are subject to erosion from tropical storms and hurricanes that affect the island.
- Bermuda's coral system is distinctive for being the most northerly of its kind in the world and is among the more geographically isolated reefs. The fate of this reef system is linked to those of the Caribbean, which seed them. The decline in Caribbean coral (see section 3.2.3) will likely affect coral dispersal and gene flow to Bermuda, increasing the geographically isolation of the system there. Limited genetic variation within isolated populations in marginal environments, like the North Atlantic, could lead to a weakening of the coral's capacity to respond to or recover from environmental disturbances. Local coral deaths, whether caused by pollution, dredging, disease outbreaks, hurricane damage or thermally induced bleaching, will have lasting effects (Jones, 2004).

3.2.3 The Caribbean

There are five UKOTs in this region: Anguilla, the British Virgin Islands, the Cayman Islands, Montserrat and the Turks and Caicos Islands.

Observed change

According to the PRECIS project (2005), research by institutions in Cuba and Jamaica show the following regional trends:

- The mean temperatures of individual Caribbean territories show an upward trend over the last 30 years.
- At the end of the 1970s, significant warming in the lower part of the atmosphere was detected in the region. The warming supports the idea that changes are occurring in background climate conditions. It is also consistent with significant variations in circulation patterns that have been detected over the North-Pacific sector of North America for the same period.
- The upward trend in the mean temperatures seems to be largely driven by changes in the minimum temperatures.
- The diurnal temperature range is decreasing, consistent with global trends. From the 1950s to the present, a 2°C change has been detected for the region.
- The number of very warm days in the region is increasing, but the number of very cold nights is decreasing (1950s to present).
- The frequency of droughts has increased significantly since 1960.

A 2001 study of recent global changes in precipitation found that conditions in the Eastern Caribbean (which includes Anguilla, the British Virgin Island and Montserrat) have been slightly drier, while those of the northern Caribbean (which includes the Cayman Islands and the Turks and Caicos Islands) have been wetter (New *et al.*, 2001 cited in Sear *et al.*, 2001).

Projections

As with islands in the Pacific and Indian Oceans, rates of warming in the Caribbean are expected to be lower than the global average (IPCC, 2007). According to the Mainstreaming Adaptation to Climate Change (MACC) Project in the Caribbean, temperature increases are expected to be between 2.0°C and 2.8°C for the 2050s and 3.1°C to 4.3°C for the 2080s. Marginal increases in rainfall are expected, and rainfall patterns could change, but it is not yet known how. MACC reports that sea level is expected to rise by about 38 cm between 1990 and 2080. Hurricane intensity is likely to increase and higher temperatures could lead to a greater incidence of vector borne diseases, such as dengue and malaria (Chen *et al*., 2006).

Implications and possible future impacts

Economy: More than half the population in the Caribbean live within 1.5 km of the coastal zone. Damage to the coastal zone translates into damage to a considerable proportion of the infrastructure, human settlements and industry of these countries. There are the direct costs of repairing damage caused by storms and other weather events, as well as the indirect costs of loss of productivity and income forgone from badly affected industries and sectors.

The galliwasp *Diploglossus montisserrati*, is a critically endangered species, endemic to Montserrat. *Credit: C. McCauley, Centre Hills Project*

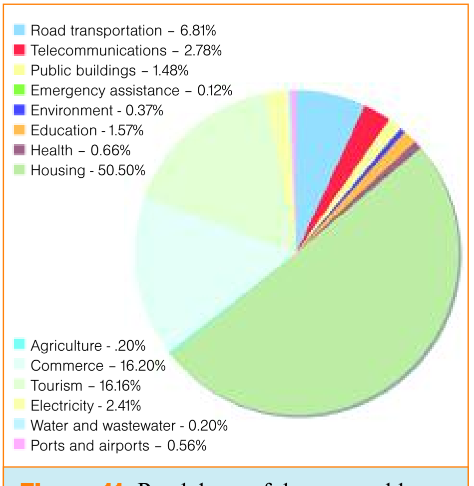


Figure 11. Breakdown of damage and losses in the Cayman Islands, Hurricane Ivan 2004
Source: Zapata Martí, 2005

A study by the United Nations Economic Commission on Latin America and the Caribbean (ECLAC) of the economic impact of the 2004 hurricane season in six Caribbean countries, including the Cayman Islands, found that 76 per cent of the total impact was made up of actual physical damage to assets (houses, businesses, roads and bridges, utilities, schools, hospitals and clinics, etc.) (Zapata Martí, 2005). Most of the damage affected the social sectors (47.5 per cent). Damage and losses to infrastructure and utilities such as electricity, water and sanitation, and transport accounted for 15.6 per cent, and the direct environmental impact was calculated at 1.3 per cent since most of natural resources were expected to recuperate (Zapata Martí, 2005:42). Figure 11 shows the breakdown of damage and losses in the Cayman Islands from Hurricane Ivan. Housing suffered the greatest proportion of damage, followed by commerce and tourism.

There are the longer-term costs of declining production in key sectors – agriculture and fisheries and potentially tourism, as well as the cost of loss of ecosystem services.

Table 2. Country impacts – Caribbean	
Country	**Impacts**
Anguilla	Depletion of fish stocks. Beach erosion, compounded by development in the coastal zone. A longer dry season and decreased availability of water could affect agriculture. Sea level rise will increase the risk of salt-water contamination of rivers and salt-water intrusion of ground water, which will jeopardise agricultural production in and around coastal communities. Increased hurricane and storm intensity could disrupt sanitation and sewerage disposal systems as well as cause damage to coastal communities and infrastructure.
British Virgin Islands	Coral bleaching. Low-lying Anegada is vulnerable to the effects of sea level rise and to storm surges and wave action during hurricanes.
Cayman Islands	Coral bleaching. Beach erosion and destruction of turtle nesting sites. As low-lying islands, the Cayman Islands are vulnerable to the effects of seal level rise and to storm surges and wave action during hurricanes.
Montserrat	Changes in coastal vegetation. Coral bleaching.
Turks and Caicos Islands	Sea level rise will increase the risk of salination of rivers and salt-water intrusion of ground water, which will jeopardise agricultural production in and around coastal communities.

Higher temperatures and variability in water supplies in the Caribbean could translate into increased transmission of dengue fever. Drier conditions associated with El Niño events, which seem to be getting more frequent, often give rise to the need for water storage, which provides breeding habitats for the *Aedes aegypti* mosquito that transmits dengue. Breeding habitats also increase after heavy rains, such as tropical cyclones. Warmer temperatures hasten the larval stage of mosquitoes, causing them to be smaller and to need to feed more frequently. Higher temperatures also reduce the incubation period for the parasite that causes dengue. At 30°C, dengue type 2 has an incubation period of 12 days, but only seven days at 32°C - 35°C. The projected 2°C increased in temperature by 2080 could lead to a three-fold increase in the rate of transmission of dengue fever in the Caribbean (Chen *et al*., 2006).

Caribbean coral reefs are threatened by over fishing, disease, pollution and run-off


Mangrove in the British Virgin Islands
Credit: BVI National Trust

from agriculture, industry and human settlements in the coastal zone. The intensity of hurricanes is also placing stress on corals. The region's reefs have experienced a massive decline from approximately 50 per cent coral cover to less than 10 per cent (Jones, 2004). Reefs are likely to be affected by a higher incidence of bleaching and die-out due to higher water temperatures. Additionally, changes in ocean chemistry that are the result of higher levels of carbon dioxide in the atmosphere are contributing to the weakening of coral skeletons (Jones, 2004).

Across the region, mangroves are threatened by development in the coastal zone and conversion to other uses. Mangroves are an important element of the coastal defence system. They provide protection against cyclones, storm surges, and tides. They are also nurseries and habitats for many marine species and play a role in filtering run-off from the land. Mangroves are sensitive to the threat of sea level rise, particularly from increased salination of the ecosystem. This sensitivity is heightened by the pressures they are already facing.

Over time, higher sea levels are likely to change the size and distribution of coastal wetlands and increase the risk of flooding (Wall, 1998 and Nicholas *et al*., 1999 cited in Sear *et al*., 2001).

Climate change is expected to have long-term impacts on biodiversity in the Caribbean, particularly in marine and coastal ecosystems. Climate change is not the only threat to the region's biodiversity, but it intensifies the effects of other threats and vulnerabilities.

A 0.5 m increase in sea level is expected to result in the loss of just over one third of marine turtle nesting sites in the Caribbean (Fish *et al*., 2005, cited in Mimura *et al*., 2007). This is not the only potential threat to turtles. Sea level rise, increases in water temperature, storminess and rainfall could also damage reefs and sea grass beds, the foraging habitats of sea turtles. Temperature also plays a role in determining turtle sex: eggs incubated in warmer waters produce females and those nurtured in cooler temperatures produce males. According to the Marine Conservation Society in the UK, natural sex ratios and reproduction could be affected if marine turtles do not change their nesting seasons (Marine Conservation Society, 2008).

Commercially valuable fish species such as tuna (*Thunnus albacares*), and parrotfish (*Scaridae*), would not survive a 1°C rise in Caribbean Sea temperature and would migrate further north as formerly cold waters become milder. Loss of the parrotfish would affect coral reef health as well as fisheries. This favourite on Caribbean tables plays an important role in keeping corals free of algae. Without it, unchecked algae could smother the reefs and cause them to die (Moxam, 2008).

3.2.4 British Indian Ocean Territory

The British Indian Ocean Territory has one of the largest and most isolated coral reef and island systems. Because it is largely uninhabited, it is one of the few remaining tropical areas that could be used as a reference location for observing the impacts

Corals killed by sea warming in BIOT
Credit: Charles Sheppard

Same coral species in good health
Credit: Charles Sheppard

of climate change without the presence of human-induced environmental stresses, such as pollution and land-use in the coastal zone.

Observed change

- Rising sea temperatures have contributed to the death of coral reefs. There have been several coral bleaching episodes following the major bleaching event in 1998, which destroyed some 80 per cent of live coral cover to a depth of 30 m after sea surface temperatures rose to almost 30°C in the Chagos Archipelago. Bleaching events have taken place as recently as 2004.
- Some of the islands are experiencing coastal erosion caused by sea level rise and possibly the loss of sand production following the mass mortality of coral reefs. Some areas have been more badly affected than others.
- Sea level rise in Diego Garcia has averaged 0.54 cm per year since 1986, but appears to be accelerating (Sheppard and Spalding, 2003).

Implications and possible future impacts

- Loss of reefs is leading to loss of some fish and other marine species. The biodiversity of reefs and their biological integrity is being compromised.
- Erosion is already causing, and will continue to cause, damage to the shoreline and to buildings and structures along the coast.
- As the sea level rises, the reef flats (the shallow, flattest part of the reef that is often uncovered at low tide) at the mean low tide level will become less effective in offering the shoreline protection from waves.

3.2.5 Mediterranean

There are two UKOTs in this region: Gibraltar and the Sovereign Base Areas of Akrotiri and Dhekelia in Cyprus.

Observed change

- El Niño events have been associated with low rainfall in the western and central Mediterranean.
- Some of the larger river deltas in the region have been affected by sea level rise.
- There have been variations in sea surface temperatures over the last 120 years, but no clear trend has emerged. However, deep-water records for the western Mediterranean point to continuous warming from 1959 (Bethoux *et al*., 1997 cited in Karas, 2000).
- Land records show a warming trend for the western and central part of the region and a slight cooling in the eastern part of the basin.

- Warmer and drier conditions are partially responsible for reduced forest productivity and increased forest fires in the Mediterranean Basin.

Projections

- The long-term prospect is for continued warming as the influence of greenhouse gases increases over time. A 2005 study by WWF found that a global temperature increase of 2°C is likely to lead to a corresponding warming of 1°C to 3°C in the Mediterranean. Temperatures are likely to be higher inland than along the coast and the largest increase will take place during the summer (Giannakopolous *et al*., 2005).
- Precipitation trends are uncertain, but some models suggest an increase of up to 10 per cent in winter precipitation and a decrease of 5 to 15 per cent in summer precipitation by the latter half of the 21st century (Karas, 2000).
- As climate changes in the region, the frequency of extreme weather - heat waves and droughts - will increase. Droughts are likely to be longer.

Implications and possible future impacts

- As early as 1990, the United Nations Environment Programme (UNEP) warned that the Mediterranean would be one of the first regions to feel the impact of climate change on water resources. Water is already scarce in some parts of the region and a decrease in precipitation could make existing problems even worse. Water quality could also be affected. Higher temperatures and evaporation would cause an increase in salinity of lakes and reservoirs. Sea level rise would increase saltwater intrusion into aquifers and estuaries (Karas, 2000).
- The areas that are prone to desertification are likely to increase, as will the severity of desertification in existing dry lands (Karas, 2000).
- There may be a reduction in production and crop yields in the southern part of the Mediterranean basin. Desertification, increased fire risk, spread of pests and diseases in the region, and changes in global markets could affect agriculture to varying degrees (Karas, 2000).
- Warmer temperatures in northern Europe could encourage people there to take domestic holidays, rather than travel to the Mediterranean (Giannakopolous *et al*., 2005). This would adversely affect the economy of the Mediterranean.

Variations in precipitation due to climate change are likely to accelerate erosion on the eastern side of St. Helena. The Great Wood (shown here) was originally populated by gumwood trees endemic to St Helena. The whole forest has been destroyed as timber was used for firewood and the bark for tanning leather. Domesticated animals roamed free grazing on new growth. Low rainfall and the south-easterly winds are now instrumental in changing the exposed woodland soil to parched low-grade sand/clay with low levels of nutrient. Heavy rains can increase the erosion rate; drought retains the conditions for further wind based erosion.
Credit: Vince Thompson, St Helena National Trust

Table 3. Country impacts – South Atlantic

Country	Impacts
Ascension Island	Increase in sea temperature. Sea level rise will adversely affect nesting beaches and could cause a drop in sea turtle nesting success due to nest inundation. Changes in regional seasonal rainfall patterns could advance the spread of invasive plant species and increase erosion.
St. Helena	Fish stocks and the fishing industry are at the highest risk from climate change. Changes in air and sea temperatures could influence weather patterns and cause disruption to established wind and rainfall patterns, leading to floods, drought, and/or soil erosion. Research points to a strong warming trend in air temperature (2°C over 60 years) and a slight decrease in rainfall. Over time, the latter could have implications for local water supplies. Altitudinal shifts in vegetation zones. Currently identifiable ecological imbalances could become even more marked.
Falkland Islands	Cooler, less saline water may affect distribution and abundance of the main inshore fauna and flora. There is need for more research and data gathering on the effects of climate change in the Falklands. To date, little is known about the effects of climate change on plant communities or about what it means for whale and dolphin communities.
Tristan da Cunha[13]	There has been little monitoring of climate-linked changes on Tristan da Cunha and Gough Island, so the full extent of impacts is unknown. However, anecdotal evidence and observation of certain trends point to the several likely changes. Increased invasiveness of introduced species due to warmer temperatures. Species introduced from South Africa, especially invertebrates and plants, that at one time would not survive, may establish themselves. Warmer temperatures could lead to an increase in the mouse population increasing the threat to species like the Tristan albatross (*Diomedea dabbenena*), which is already considered 'critically endangered'. There may be a potential risk to the five seamounts in the islands' exclusive economic zone. Coastal areas are likely to be affected if there is a rise in seawater, as it could encroach on the native habitat forcing species that breed in the coastal zone, such as the northern rockhopper penguin (*Eudyptes chrysocome moseleyi*) and

Country	Impacts
Tristan da Cunha (cont.)	sub-Antarctic fur seal (*Arctocephalus tropicalis*), to move further inland. Although there has been no evidence of a change in rainfall at Gough Island over the last 40 years, anecdotal evidence suggests a seasonal change: instead of four seasons, winter appears to go straight into summer and the summers seem drier and winters wetter. Some of the natural ponds/bogs are becoming smaller (either drying up or being taken over by *Scirpus* and *Sphagnum* bog grass). Fishing industry could be negatively affected by warming temperature. This could have implications for some of the marine predators.The islands are the only breeding site in the middle of the South Atlantic for several species; other breeding areas are 2,000 km away. Increased storm severity puts the sole harbour, which is the only means of access to the outside world, at risk.

[13]Source: J. Glass, Department Head, Agriculture and Natural Resources Department, Tristan da Cunha

- Fire risk could increase, especially in inland locations. The Iberian Peninsula is one of the places where the period of extreme fire risk would increase.
- Wetlands and other ecosystems are at risk of damage or loss as climate change compounds the other pressures these natural resources face. Drier conditions and sea level rise would affect wetlands.

3.2.6 South Atlantic

The territories in this region are St. Helena and its dependencies (Ascension Island and Tristan da Cunha) and the Falkland Islands.

Implications and possible future impacts

Changes in sea temperature can adversely affect native fish populations and potentially lead to mass strandings during the spawning season.

Highly migratory fish species, such as tuna and marlin (*Istiophoridae*), are also highly sought-after sport fishing species. A change in the distribution or abundance of these fish could lead to a reduction in sport fishers and a related loss to the tourism sector of the economy.

Cliff nesting seabirds such as black (*Anous minutus*) and brown (*Anous stolidus*) noddies will be challenged with a higher risk of nest failure from sea level rise.

Albatross Chick
Credit: Falkland Islands Conservation

3.2.7 South Pacific

There is one UKOT in this region: The Pitcairn Islands.

Observed change

- Annual and seasonal ocean surface and air temperature increased by 0.6°C to 1°C since 1910 in much of the Pacific.
- There has been a significant decrease in the annual number of cool days and cool nights, particularly after El Niño events, for the period 1961 to 2003.
- Sea level rise has varied across the region, ranging from 1.5 mm to more than 3 mm per year.
- There has been an increase in tropical storm intensity. Climate scientists have observed a correlation between ENSO and the tracks, density and occurence of cyclones (Walsh, 2004 cited in Mimura *et al.*, 2007).

Projections

The IPCC suggests that the climate in the Pacific could be in a permanent El Niño state with global temperature increases.

A World Bank study of the potential impacts of climate change scenarios in the Pacific (World Bank, 2000) projects the following by 2100:

- Sea level may rise 0.5 m ("best-guess" scenario) to 1 m ("worst-guess" scenario).
- Air temperature could increase between 1.6°C and 3.4°C.
- Rainfall could increase or decrease (most models predict an increase) by 20 per cent, leading to more intense floods or droughts.
- Cyclones may become more intense, with wind speeds increasing by as much as 20 per cent; intensity could increase by 5 to 10 per cent by 2050 (Walsh, 2004 cited in Mimura *et al.*, 2007).

Implications and possible future impacts

Changes in rainfall will also affect agricultural production. Loss of coastal land would reduce the available space for cultivation in some countries. In low-lying ones, salt-water intrusion would also affect production of copra, breadfruit and panadanus. A decline in the cultivation of some traditional crops, such as yams and taro, would also affect the subsistence economy of the Pacific islands (World Bank, 2000).

The tuna fisheries in the western and central Pacific could collapse.

Diarrhoeal and vector borne diseases are expected to increase with warmer temperatures in the Pacific. As in the Caribbean, the frequency, severity and distribution of dengue fever could increase, as warmer temperatures reduce the incubation period of the dengue virus and speed up the larval stage of the mosquitoes.

Climate change could also increase the incidence of ciguatera poisoning. Habitat disturbance, including from extreme weather, and warmer waters cause the algal blooms that produce the ciguatoxins, which are ingested by fish. In Kiribati, which has one of the highest rates of ciguatera poisoning, for example, by 2050 the incidence of poisoning is expected to go up from 35 to 70 people to 160 to 430 per thousand (World Bank, 2000).

Variations in rainfall will affect water supplies in some Pacific islands. Ground water supplies in low-lying islands could be affected by salt-water intrusion.

Coral reefs are also likely to be affected by bleaching events, which could lead to death of the corals and a decline in fisheries and a long-term reduction in coastal protection. Mangroves are likely to be affected by sea level rise and flooding and inundation will affect the costal zone in some islands.

Chapter summary

The information that is available about the impacts of climate change on UKOTs is variable. To date, there has been little climate change-specific monitoring in most territories. Making projections about future impacts is complicated by the fact that most global climate change models are not at a high enough resolution to provide information about the small UKOTs. Climate change is not the only process that is affecting the natural and physical environment on UKOTs. Other natural and man-made processes and phenomena influence, and are influenced by, climate change impacts. Notwithstanding the uncertainty that exists, adopting a 'wait and see' attitude is not something the territories can afford to do. Scientific evidence points to things getting worse before they improve, even if green house gas emissions were halted now.

Climate change causes an increase in temperatures, changes in precipitation, and a rise in sea levels. This has an impact on national and local economies, livelihoods and food security as some of the economic sectors that several of the territories depend on – tourism, agriculture and fisheries – are affected by variations in temperature. Moreover, there are high economic and social costs associated with recovery from damage caused by extreme weather.

Climate change also has implications for human health and water resources. The risk of mosquito and other vector borne diseases is likely to increase in some areas. Precipitation changes will likely affect water supplies, particularly in drought prone areas, and the ground water in some territories is at risk of salt-water contamination.

Coastal and marine resources and biodiversity are also at risk. Climate change and sea level rise contribute to coastal erosion, landward intrusion of seawater, flooding, damage to coral reefs from bleaching and disease and destruction of coastal and marine ecosystems, such as mangroves and sea grass beds. The rich biodiversity resources of UKOTs are threatened by the migration of plants and ranges for all or part of their life cycle because of changed climatic conditions that allow them to thrive outside their usual range. Over time, this could lead to a decline of native plants or animals and an overall reduction in the variety of plants and animals found in a given area.

UKOTs have no control over the storm surges that affect their shores, nor can they regulate the increasing ocean temperatures that affect their coral reefs or fish and marine animals in their waters, but what they can do is plan for these threats and put in place systems and infrastructure to reduce risk and build resilience.

4 What can the UK Overseas Territories do about climate change?

Climate change is not a future possibility. It is part of the current reality for UKOTs and the entire global community. UKOTs are negligible producers of greenhouse gases, but are extremely vulnerable to the effects of their increased concentration in the atmosphere and many of them have economies that are very dependent on climate-sensitive natural resources. It is because of this vulnerability that the territories cannot afford to ignore climate change or put off taking decisive action to reduce its impacts and increase their resilience.

“Even if all human-induced greenhouse gas emissions were to stop today, UKOTs and other countries would continue to feel the impacts of climate change for decades to come.”

Even if all human-induced greenhouse gas emissions were to stop today, UKOTs and other countries would continue to feel the impacts of climate change for decades to come. The time that it takes for greenhouse gases to breakdown in the atmosphere varies greatly. The atmospheric lifetime for methane is 12 years, some chlorofluorocarbons (CFCs) can persist for more than 500 years. However, that is not the full story. All greenhouse gases continue contributing to global warming for years after they have broken down in the atmosphere. This is why it is so important for the global community to reduce greenhouse gas emissions.

Adaptation and mitigation

In addition to producing less greenhouse gas emissions and removing them from the atmosphere, effectively addressing climate-induced change requires a mix of approaches and strategies to prepare for and respond to its various impacts on both society and nature.

Adaptation is about being ready for climate change and responding to it by minimising the risks it presents to people's lives and livelihoods. It includes building capacity and putting measures in place to cope with and recover from impacts, as well as to live with climate-induced changes and take advantage of any benefits they might offer. Adaptation can be done at different levels – national, community or even individual. The benefits of adaptation are immediate (short- to medium-term) and often localised.

Mitigation is a means of stemming climate change impacts. However, just as the effects of climate change felt today are the result of actions in the past, the benefits of mitigation will not be felt immediately. The benefits are global and will be realised in

> ***Good climate policy aims to both adapt and mitigate.***

the future, even though the costs are immediate and local. Robust, early mitigation will reduce the cost of adaptation over the long term (Stern, 2007). Mitigation refers to using policies and other interventions to reduce greenhouse gas emissions and improve the functioning of carbon and greenhouse gas sinks. While adaptation deals with 'weathering' current and future impacts in the best possible way, the idea behind mitigation is to go from present levels of climate change impacts to reduced levels in the future. The international mechanism for doing this is the United Nations Framework Convention on Climate Change (UNFCCC). This treaty and its instruments aim to reduce greenhouse gas emissions, using 1990 as a baseline year, in order to combat climate change (see Box 10).

"Both...and", not "either...or"

Good climate policy aims to both adapt and mitigate. Adaptation is crucial because even the most rigorous mitigation measures taken today will not stave off the negative effect of the warming already in process. Unmitigated climate change at the current rate will challenge the capacity of man and nature to adapt.

Given the small contribution that UKOTs make to greenhouse gas emissions and the great extent to which they are affected by global warming, the thrust towards adaptation will be greater in UKOTs than the adoption of mitigative strategies. Even so, there is scope for them to promote and adopt mitigation options that contribute to the global effort, while advancing their national development agendas.

Box 10. The international response to climate change

The ***United Nations Framework Convention on Climate Change (UNFCCC)*** (UNFCCC) was adopted in 1992 to provide a context for taking measures to stabilise the concentrations of greenhouse gases in the atmosphere at a level that would minimise the human contribution to climate change. Its first mechanism was to set a voluntary target for developed countries to reduce greenhouse gas emissions to 1990 levels by 2000. The UNFCC is a non-binding international treaty, but includes provisions for obligatory procedures or protocols that commit signatories to action.

The first such agreement, the ***Kyoto Protocol***, was adopted in 1997. It is linked to the convention but stands on its own as a legally binding commitment to reduce greenhouse gases by 2012 as a percentage of 1990 levels. Developed country signatories have prescribed targets, while developing countries are encouraged to introduce emission abatement measures.

Negotiations have begun on the agreement that will succeed the Kyoto Protocol. A plan of action for reaching a new agreement once the Kyoto Protocol expires, popularly known as the ***Bali Roadmap***, has been developed. It sets out a process for negotiations that must be completed by 2009 and which will result in a new set of emissions targets. It also provides a framework for talks about adaptation, facilitating the transfer of clean technologies to developing countries and reducing emissions from deforestation.

Source: United Nations Framework Convention on Climate Change (www.unfccc.int)

4.1 Mainstreaming adaptation

The concept of adapting to climate variations is nothing new. People have always found ways of responding to climate variations using their resources and traditional knowledge gained from experiences. However, the current pace of change suggests it is not enough for people to rely on experience to navigate the future.

Adaptation is the only way to deal with the inescapable impacts of climate change (Stern, 2007). If UKOTs hope to sustain those economic activities and livelihood strategies that are climate-dependent (for example, tourism) or heavily climate-influenced (for example, fisheries and agriculture), they have to make adaptation a major part of their national development strategies. The natural disasters that affect many UKOTs as part of their 'normal' climate conditions are becoming more intense and the territories have to look at how these have been, and will continue to be, influenced by climate change. All countries already have some measures in place to deal with natural hazards; adaptation to climate change simply needs to scale up what already exists and strategically identify the gaps and weak points that need to be addressed.

An opportunity for UKOTs

Adapting to climate change is an opportunity for UKOTs to improve natural resource management and physical planning processes. Even if climate change were taken out of the equation, adaptive measures would make the territories better able to deal with the natural hazards that are part of their normal climate variability, as well as the growing human-induced stresses on the environment.

There are many things that UKOTs can do to adapt to climate change. Adaptive

> ***"Adapting to climate change is an opportunity for UKOTs to improve natural resource management and physical planning processes."***

responses can be technological (for example, improving coastal defences), managerial (for example, introducing crop rotation) or policy-based (for example, strengthening planning regulations). They can also be behavioural. At the individual level, this could be something as simple as preparing one's home adequately for a hurricane or using less water in the garden.

Building adaptation into national development agendas

More and more countries are beginning to develop adaptation strategies or plans of action. The UNFCCC makes provisions for its least developed country signatories to prepare National Adaptation Plans of Action (NAPAs) that set out the priority areas in which they need urgent and immediate adaptive measures. Even outside of the NAPA framework, countries are developing adaptation strategies in the face of the growing realisation that action to address climate change is needed now. The Caribbean UKOTs, for example, are working with the Caribbean Community Climate Change Centre (CCCCC) to develop and implement adaptation strategies under the *Mainstreaming Adaptation to Climate Change in the UK Overseas Territories* project, funded by the UK Department for International Development. Some multilateral agencies, like the Asian Development Bank, have begun to integrate climate concerns into their grant and loan procedures.

Simply having a national plan or strategy is not enough; it is how countries use them that is important. There is a strong case for bringing adaptation into the mainstream of national policymaking, planning and development. The effects of climate change cut across all economic and social sectors; at the same time, development decisions and activities in these areas can affect a country's vulnerability to climate change and its impacts.

Overarching national development strategies, such as national sustainable development plans, are a strategic entry point for mainstreaming adaptation. Mainstreaming adaptation means integrating climate concerns into water management, land-use planning, human settlements, natural resource management and conservation, as well as policymaking and practice in all economic (agriculture, fisheries, tourism, forestry, finance etc.) and social (health, education etc.) sectors. It also means ensuring there are budgetary allocations and the necessary funding to cover the cost of doing this.

The reality of global warming means that development cannot be sustainable unless it factors in climate impacts and natural hazards. Adaptation plans or strategies similarly need to take into account all aspects of a country's context

Box 11. Increasing Resilience to Hurricane Risk in the Cayman Islands

The jolt from two Category 5 hurricanes* and a Category 4 one over the thirteen-year period between 1988 and 2002 prompted the government and citizens of the Cayman Islands to strengthen the territory's hurricane preparedness. There have been important regulatory changes to the building code and development planning. There have also been significant institutional changes. The Natural Resources Unit was upgraded to a Department of the Environment in 1988 and integrated into the development planning process and a National Hurricane Committee created. The latter has become an influential local advocate that engages the public, NGOs, the private sector, and religious groups in its efforts to mainstream the concept of hurricane preparedness. Sector response plans have also been developed: the health sector, for example, now has clear guidelines of what to do in a hurricane and who will do it.

This level of knowledge and awareness has translated into support among citizens and civil servants for improving resilience to climate change risk. One study found support for initiatives such as:

- putting measures in place to deal with sea level rise;
- modifying the construction of roads and buildings to increase their ability to withstand everyday weather;
- creating a Disaster Fund for relief in extreme weather situations;
- increasing the minimum elevation for development on reclaimed land to prevent future flooding; and
- developing a national energy policy.

Some of these have already been championed in the government's main policy planning document, Vision 2008.

Source: Tompkins and Hurlston, 2005.

**On the Saffir-Simpson Scale of 1 to 5 for measuring hurricane intensity, a category 1 hurricane has winds of 119 – 153 km/hr and a storm surge of 1.2 – 1.5 m above normal. A category 5 hurricane has winds above 245 km/hr and a storm surge greater than 5.4 m above normal* and capacity rather than rely on a project-by-project approach to tackling problems.

Mainstreaming climate change into the national policy and planning process does not require a dramatic departure from all that has gone before and there are even many low- or no-cost actions that can be taken. Mainstreaming adaptation can be done in an incremental way, building on and adjusting existing policies, programmes, and structures.

Linking adaptation to managing disaster risk

Many of the UKOTs are prone to natural disasters as part of their normal climate conditions. Natural disasters can have a negative effect on a national economy and they can devastate households and communities. Reducing vulnerability to hazards in the short term goes a long way towards reducing long-term risk to climate change (CDERA, 2003). Over time, the introduction of policies and other national responses for managing natural disaster risk can provide a way to introduce measures for preparing for specific climate impacts, as has been the case in the Cayman Islands (Box 11).

Addressing vulnerability as a key to building resilience

The information from climate modelling scenarios is important, but should not be the only thing that countries use to plan for future vulnerability. Existing social and economic vulnerabilities and community and household coping mechanisms influence a country's ability to withstand climate impacts and natural hazards.

Effective adaptation needs to make vulnerable people, communities and locations better able to withstand and recover from major shocks. This means dealing with the underlying causes of their vulnerability, such as low incomes, poor housing stock, lack of education, poor health and nutrition, limited or no assets, inadequate infrastructure and public services, poor governance structures and institutional arrangements for management. Addressing these issues is what sustainable development is all about (UNEP Finance Initiative, 2006).

Strategic climate change adaptation measures that reduce vulnerability in the right way can dramatically reduce risk (Figure 12).

Climate change increases hazard or the potential for harm. With no measures to reduce vulnerability (adaptation), the level of risk, or likelihood of harm, is high, but where appropriate measures are taken to reduce vulnerability, the level of risk decreases dramatically.

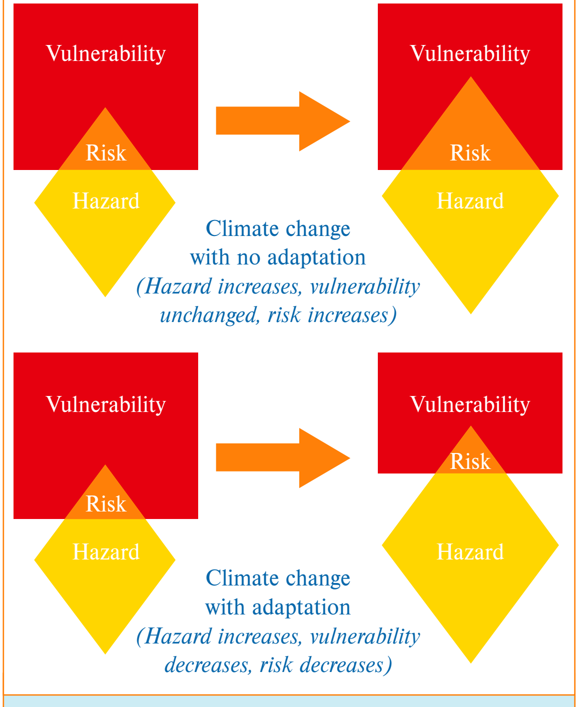


Figure 12. Hazard, vulnerability and risk

Strengthening adaptation through biodiversity conservation and natural resource management

Natural resources and biodiversity can be managed and conserved in ways that help reduce the impacts of climate change. The resilience of ecosystems can be enhanced and the risk of damage to human and natural ecosystems reduced through the adoption of biodiversity-based adaptive and mitigative strategies (Secretariat of the Convention on Biodiversity, 2007).

Resources put into the management and conservation of ecosystems such as coral reefs, forests, mangroves and other wetlands are well used. Not only do the interventions help ensure that these ecosystems can carry out their ecological functions and services, they also help them to reduce the impacts of climate change by bolstering coastal and shoreline defences in the case of mangroves and coral reefs or increasing available carbon sinks, in the case of forests. Mangroves, for example, can absorb 70 to 90 per cent of a normal wave (IUCN, 2005).

A compelling illustration of the protective role of mangroves comes from Sri Lanka's experience of the 2004 Asian tsunami. A survey by IUCN found that coastal areas with dense mangrove forests experienced less damage and fewer losses in the tsunami than those with mangroves that had been degraded or lost through conversion to other land use. Perhaps the most sobering illustration comes from two villages in the lagoon of southern Sri Lanka - Kapuhenwala and Wanduruppa. Only two people died in Kapuhenwala, which has two 200 hectares of dense mangrove and scrub forest around it. In contrast, there were 5,000 to 6,000 tsunami related fatalities in the Wanduruppa district where the mangrove forests are degraded (IUCN, 2005).

Conserving and promoting the planting of endemic and native species of trees and plants also build the resilience of ecosystems to the impacts of climate change. Endemic and native species are better suited to local climatic conditions than introduced or invasive species, and are better able to withstand extreme weather events that are exaggerations of the norm (Box 12).

Box 12. Greater Resistance of Bermuda Endemic and Native Plant Species to Increased Hurricane Frequency than Introduced Invasive Species

The oceanic island of Bermuda has experienced a greatly increased frequency of major impacts by hurricanes in recent years, with seven storms giving hurricane-force or greater winds during the last 20 years, compared to only one for the previous 25 years.

Woodland areas and trees planted for landscaping use on Bermuda are overwhelmingly dominated by introduced tree and plant species, a number of which have become aggressively invasive and now comprise an estimated 95 per cent to 98 per cent of the island's vegetative biomass. The most dominant of these invasive introduced species are the Australian casuarina (*Casuarina equisetifolia*), Brazil pepper (*Schinus terebinthifolia*), Indian laurel (*Ficus retusa*) and allspice (*Pimenta dioica*).

During the increased hurricane activity of recent years, these introduced invasive species suffered considerable damage, with from 50 per cent to 75 per cent of mature trees being

Box 12 continued overleaf

Box 12 cont'd

uprooted or snapped off, causing considerable damage to utilities and buildings on the island. Surviving introduced vegetation also suffered complete defoliation and considerable dieback from wind and salt spray blown over the islands during the hurricanes.

By contrast, tree and plant species endemic or native to Bermuda are mainly found as isolated specimens or small stands on coastal cliffs, rocky areas or offshore islands. The most noteworthy of these plant species are the Bermuda cedar (*Juniperus bermudiana*), Bermuda olivewood (*Cassine laneanum*), Bermuda palmetto palm (*Sabal bermudana*) and yellow-wood (*Zanthoxylum flavum*).

A number of Nature Reserve and Park areas have had invasive vegetation removed and endemic vegetation planted as part of a native reforestation program. The most noteworthy of these are the Nonsuch Island Nature Reserve and Walsingham Trust reserve, where reforestation efforts have been underway for over forty years. In both areas, an immature closed-canopy forest has developed, with a high diversity of understory plant species. These restored endemic/native woodland areas have shown significant resistance to both hurricane-force winds and salt damage. On Nonsuch Island, less than 2 per cent of the mature trees in the restored native forest were uprooted or damaged, despite the extremely exposed aspect of the island. Salt damage to foliage was also much less than that with introduced trees on more sheltered areas on the main island of Bermuda, and new foliage was re-sprouting within two weeks on native trees.

The increased resistance stems from adaptations common to most of Bermuda's endemic and native tree species, including a shorter, dense growth form, salt-resistant foliage and robust root systems which can penetrate deep into cracks in the limestone rock which underlies Bermuda's generally thin soils. These adaptations have given the endemic tree species an advantage over the introduced tree species in extreme hurricane conditions, and have led to the increased propagation and use of endemic species in replanting and landscaping uses on Bermuda. Much of the seed and seedlings used for this purpose are now obtained as surplus from the regenerating native forest on Nonsuch Island.

Source: Jeremy Madeiros, Conservation Officer (Terrestrial), Department of Conservation Services, Bermuda

Meeting multiple objectives through effective adaptation

When investments in climate change adaptation, biodiversity and sustainable development, and disaster management intersect, there is a 'win-win-win' situation (Figure 13). The triple dividend of this investment payback translates into 'safer, sounder models of development' and improved resilience to natural disasters and climate impacts. Each dollar spent goes towards climate impacts, disaster

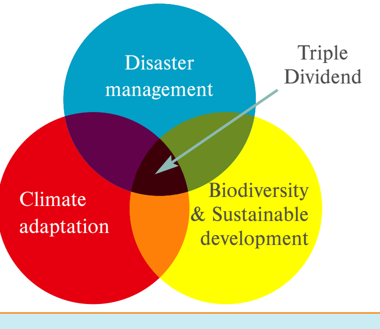


Figure 13. *The* Triple dividend
Source:UNEP Finance Initiative, 2006

recovery and economic growth (UNEP Finance Initiative, 2006).

A stitch in time...

Building adaptive capacity is not without costs for UKOTs, but failing to do so is a potentially more costly alternative in the medium- to long-term.

A growing body of evidence shows that the cost of managing risk to natural hazards is less expensive than repairing damage after the fact. Early investments pay off. The incremental costs of 'climate proofing' structural investments at the outset is often much smaller than repairing damage, as comparative figures from the Caribbean show in Table 6. Reconstruction costs can be as much as 40 per cent of the original investment, which is generally much more than it would have cost to take preventative measures at the start (Bettencourt *et al*., 2006).

4.2 Mitigation

Although UKOTs make a miniscule contribution to warming and have little control over global mitigation, they can play their part in the global reduction of greenhouse gas emissions by enhancing energy efficiency, diversifying their energy sources and increasing reliance on non fossil fuel sources of energy, and providing for the development and uptake of climate friendly technologies. Climate change affects us all, therefore we all have a vested interested in doing whatever we can to reduce emissions, however small the contribution in global terms. Collectively, small efforts add up to a make a difference.

Table 4. Comparing prevention and reconstruction in the Caribbean (in USD)

Infrastructure	Deepwater Port (Dominica)	Norman Manley Law School (Jamaica)	Troumasse Bridge (St. Lucia)	Grand Palazzo Hotel (St. Thomas)
Original project cost	*5,700,000*	*685,000*	*185,000*	*28,000,000*
Reconstruction costs after disaster	*2,310,000*	*28,800*	*32,000*	*5,308,000*
Reconstruction as a % of original construction cost	*40.7%*	*4.2%*	*17.4%*	*19.0%*
Risk management of natural hazards costs as a % of original construction costs	*11.5%*	*1.9%*	*10.8%*	*0.1%*
Risk management of natural hazard costs as a % of reconstruction costs	*28.0%*	*45.0%*	*62.4%*	*0.5%*

Source:: USAID-OAS, 1998 cited in Bettencourt et al. 2006

Some territories have taken steps towards improving fuel efficiency and diversifying their sources of energy. In Bermuda, for example, the power company, BELCO, has taken steps to diversify its energy sources in order to become less dependent on fossil fuels. A government-operated incinerator is diverting waste from landfills and turning rubbish into energy sufficient to power 2,500 homes (Government of Bermuda, 2007). Three wind turbines on St. Helena contribute up to 240Kw to the total demand for electricity. According to the Public Works and Services Department, this accounts for approximately 20 per cent of the supply during peak load and 45 per cent off-peak. The saving in diesel fuel is approximately GBP150,000 a year. A proposed hydro-electric power plant on South Georgia island would reduce carbon emissions there. Plans are also in progress to erect two additional wind turbines on Ascension by 2011, which would bring to nine the total number of wind turbines in use there. Actions such as these not only reduce greenhouse gas emissions, they have the added benefit of reducing fossil fuel dependency, decreasing dependency on imports and lowering a country's oil bill.

Towards a sustainable energy agenda for UKOTs

In order for mitigative actions to be truly meaningful for UKOTs, they have to be compatible with the territories' sustainable development goals, supporting, for example, efforts towards sustainable energy through efficiency, conservation, and diversification.

Areas which UKOTs could consider as priority for mitigation through energy efficiency include:

- development and application of renewable energy technologies, especially solar and wind;
- improved efficiency in energy-use by all users (public sector, private sector, households); and
- strengthened institutional capacity for energy management (Challenger, 2002).

4.3 Policy responses and options

Everyone has a role to play in addressing climate change and everyone can make a difference.

Governments have an important role to play in setting a national agenda and providing a framework for action by individuals, communities, the public and the private sector and putting incentives, institutions and instruments in place to support adaptation and mitigation as well as ensuring that the right information is available to all.

4.3.1 Incentives

Encourage and reward early action

It is important to have incentives in place that encourage appropriate early action, rather than promote remedial action. Some countries have set up disaster recovery funds, for example, and while this is essential, it is also important to have funds in place that support preventative action at all levels.

The right incentives can also support physical planning regulations, encourage the uptake of technologies as part of an energy agenda, and encourage businesses and individuals to take action to reduce damage or losses from weather events.

4.3.2 Institutions

Having the right institutions in place to promote and facilitate adaptation is important. The appropriate institutional arrangements will vary from territory to territory, but there are certain important conditions and characteristics:

a. There should be an institution that drives the process with a clear mandate to coordinate, implement and support appropriate climate change adaptation.

b. This institution should be a part of key decision making processes across sectors and mainstreamed into national economic planning with a role to play in the elaboration of national development plans, budget, sectoral plans, policies, regulations, codes of practice and programmes and projects (Bettencourt *et al*., 2006). When adaptation is mainstreamed or fully integrated into national planning processes and instruments, efforts (and money spent) are more effective than stand-alone ventures.

c. Effective adaptation needs a mix of 'top down' and 'bottom up' contributions, which makes it important to have in place mechanisms that make participation by citizens and their organisations, the private sector, and actors across the public sector possible. These could include provisions for participatory planning that bring all stakeholders (government, civil society and private sector) to agree on priorities and their roles in implementation. They could also include inter-sectoral coordination mechanisms, such as Inter-ministerial committees, as well as participatory budgetary processes (Bettencourt *et al*., 2006).

4.3.3 Instruments

There are several instruments that can be used to support climate adaptation and mitigation. As in the case of institutional arrangements, each country needs to apply the mix of instruments best suited to its capacity, vulnerabilities and needs. The list below is by no means exhaustive.

Policy

- ☐ Integration of disaster management and climate adaptation into national decision making and policy processes (see Table 5).
- ☐ Adjusted building codes to withstand stronger hurricanes and cyclones.
- ☐ Land use policy for development in the coastal zone.
- ☐ Land development control plans.
- ☐ Energy policy to diversify energy sources and decrease reliance on fossil fuels.
- ☐ Hazard disclosure laws for real estate purchases.
- ☐ Economic diversification.
- ☐ Agricultural diversification.
- ☐ Coastal zone settlement policy/relocation of vulnerable communities.

Technology

- ☐ Introduction of early warning systems for hurricanes, floods and droughts and improved weather forecasting.
- ☐ Introduction of water-saving devices.
- ☐ Expanding the network of hydro-meteorological, oceanographic and marine instruments to monitor climate change.
- ☐ Improvements to man-made coastal and sea defences (sea walls, groins, etc).

Economic and fiscal incentives

- ☐ Tax breaks for adoption of clean technologies.
- ☐ Reduced import duties on alternative energy technology.

Information for decision making

- ☐ Regional climate modelling.
- ☐ Flood plain, storm surge, erosion or hazard mapping.
- ☐ Social vulnerability mapping.

Table 5. Policies that affect the 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 short stays/weekend breaks. Promoting eco-tourism through the exploitation of natural resources
Energy	Supporting individual use of solar panels and solar water heaters	Preventing use of solar panels or solar water heaters
Transport	Promoting low-energy forms of transport, e.g., cycling, shared cars, hybrid cars, energy efficient cars Developing public transportation	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
Infrastructure	Ensuring roads have runoff/drainage systems	Roads that do not have runoff/drainage systems

Source: Tompkins et al, 2005

- ☐ Resource inventories.
- ☐ Economic valuations of the impacts of climate change scenarios on economic sectors (tourism, fisheries, agriculture).
- ☐ Capturing traditional knowledge from communities and key natural resource user groups, such as farmers and fishers.
- ☐ Weather hazard audit for infrastructure.

Monitoring and management

- ☐ Watershed management.
- ☐ Integration of climate change consideration into day-to-day management of all sectors.
- ☐ Water quality monitoring of fresh, saline and hyper-saline waters to track the vulnerability to sea level rise.
- ☐ Integrated coastal zone management.

- ☐ Monitoring systems for sea level rise and local wave climate.
- ☐ Shore line monitoring.
- ☐ Beach nourishment.
- ☐ Reduction of external stresses on coastal and marine ecosystems, including coral reefs, sea grass beds, salt marshes, and wetlands.
- ☐ Post-disaster preparedness plans.

Building capacity

- ☐ Improvements to data management systems.
- ☐ Increasing local research and scientific capacity.
- ☐ Building linkages between local research initiatives and communities.

> ***"Widespread public awareness and education are necessary to any effort to get support for climate policy and adaptation."***

4.3.4 Information

It is also important for decision makers, whatever the sector, to have adequate and appropriate information, not only about risks and vulnerability, but also about options for taking action.

It is not just decision makers who need to understand climate risks; the public at large and the private sector do too. One of the implications of this is the need for early warning systems to include a strong communications component.

Widespread public awareness and education are necessary to any effort to get support for climate policy and adaptation. Not only do all groups need to understand potential risk and vulnerability, they also need to appreciate the benefits of adaptation and early action, particularly as they relate to their individual circumstances.

4.4 How individuals can make a difference

Addressing climate change may seem like a daunting task, and it may appear to be the responsibility of governments because of all the policy level actions required. Governments do indeed have a lead role to play in setting the agenda for climate change adaptation and mitigation in their national context and putting things in place to ensure that the necessary steps are taken. However, ordinary citizens in UKOTs can also make a difference. In many cases, all that is needed are small changes in lifestyle and habits.

4.4.1 Reducing personal vulnerability

Individuals, households and businesses can take proactive measures to reduce their personal vulnerability to natural hazards. It is important, for example, to avoid building homes and businesses in hazard-prone areas, such as flood plains or certain sections of the coastal zone.

In cyclone-prone regions, reducing vulnerability includes such things as ensuring hurricane-readiness of homes and buildings by the following:

- ☐ Have a plan in place to secure property, including a system for protecting windows and glass doors. This could be permanent storm shutters or having on hand 5/8" marine plywood cut to fit and ready for installation.
- ☐ Install straps or additional clips to securely fasten roofs to buildings' frame structure.
- ☐ Regularly prune trees and shrubs around buildings.
- ☐ Keep up with routine maintenance and keep rain gutters and downspouts clear of debris.
- ☐ Identify where and how boats will be secured.

Anguilla harbour is vulnerable to sea level rise. *Credit: Anguilla National Trust*

In regions prone to drought or periods of water shortage:

- ☐ Plant drought tolerant plants in gardens and practice water conservation techniques such as the use of mulch to reduce evaporation.
- ☐ Reduce domestic water consumption, for example, through the installation of water-saving devices.
- ☐ Create a soak away system and introduce gray water recycling and rainwater harvesting.

4.4.2 Reducing energy use

Several simple steps can be taken to reduce transport and residential energy consumption.

Transport

- ☐ Drive less and drive more slowly. Cars pollute more when they travel over 90 km/hr.
- ☐ Do not idle car engines for longer than 10 seconds; idling for longer periods uses more fuel than shutting off and restarting the car.
- ☐ Car-pool or use public transport.
- ☐ Purchase energy efficient vehicles when replacing existing models.

Household

- ☐ Power down by turning off appliances when not in use.
- ☐ Improve heating and cooling energy efficiency. Reduce home heating in temperate climates and cool less in tropical climates. Use double glazed windows to improve insulation in temperate climates and construct buildings in the tropics to take advantage of air flows.
- ☐ Use energy-efficient appliances. New refrigerators, for example, use 40 per cent less energy than models made just 10 years ago.
- ☐ Replace incandescent light bulbs with efficiency rated fluorescent ones. Energy efficient light bulbs use 75 per cent less energy and last 10 times longer than conventional ones.

4.4.3 Practicing good environmental habits

Look after the environment and it will look after you. The damage to the environment caused by human activity makes UKOTs more vulnerable to the negative effects of climate change. Good environmental habits like disposing of garbage and waste properly and not cutting down trees also contribute to climate change adaptation and mitigation.

- ☐ Keep rivers and watercourses free of garbage, debris and effluent to help maintain the health of wetlands and reefs so that they can perform their ecological coastal defence functions.
- ☐ Maintain and protect mangroves. Keeping mangrove forests intact allows them to maintain their living barrier function. Converting mangroves for human use like construction of roads, homes or businesses, dumping garbage in mangroves, or cutting them down for fuel wood or agricultural stakes are all activities that compromise the health of mangrove forests. Their ability to support marine and bird life is affected and they are less able to

play their filtering role that reduces the amount of land-based run-off and debris that enters the seas. They are also less effective in protecting the coastal zone from storm surges and wave action.

- Maintain and protect coral reefs. Pollution from activities on land – improper waste disposal and run-off from farming and industry – affects the health of coral reefs, as do activities in the sea. In addition to reducing the land-based sources of reef stress, it is important to ensure that commercial (fishing) and recreational (scuba diving, snorkelling and swimming) activities do not contribute to damaging reefs.
- Avoid unsustainable farming practices. The misuse and over-use of pesticides and fertilizers, over-cultivation on marginal lands, and inappropriate farming techniques on hillsides all contribute to soil erosion and soil loss. Some of this soil ends up in inland water bodies (rivers, lakes, ponds); some makes its way to the marine environment. Pollution of water sources reduces the amount of fresh water that is available for domestic and commercial use. In drought-prone areas, this could lead to competition over a scarce resource.

Beach clean-up in Anguilla.
Credit: Anguilla National Trust

4.4.4 Improving business practices

Understanding both the need and the opportunities for adaptation to climate change is fast becoming an essential requirement of both governments and the private sector of vulnerable countries and makes good business sense. No matter how big or how small, businesses can also do their bit to tackle climate change.

- Manage risk. As extreme weather events and intense natural hazards increasingly become a part of life in some UKOTs, businesses of all sizes will have to look carefully at their exposure to risk and take proactive measures to reduce it. This could mean taking steps to secure equipment, vital records, and buildings during cyclones or taking measures to ensure consistency of adequate water supplies during periods of shortage. Reducing risk also means adhering to building codes, complying with environmental regulations and legislation and not taking short cuts. Much can be done at the design stage to minimise risk, from choices about building materials to where to site buildings and even architectural features.
- Increase energy efficiency and use renewable energy sources. Businesses in UKOTs are not likely to face a cap on their emissions any time soon, but the savings that come from increased energy efficiency and from replacing fossil fuels with alternative sources of energy will make a difference to their bottom line in the medium to long-term. Increasing energy efficiency can be as

simple as replacing light bulbs, powering down equipment that can be turned off when not in use or making modifications to production line processes. The cost of investing in alternative sources of energy, such as solar or wind technologies, may initially be high but will translate into savings in the medium to long-term.

- ☐ Use clean technology and sustainable product sources. As with shifting to alternative energy, the initial outlay for newer, cleaner technologies can be high, but they too generally translate into savings in the medium to long-term.

4.4.5 Advocating for implementation of national adaptation plans and sustainable development policies

Citizens play an important role. UKOT citizens and citizen organisations can call for national climate change adaptation plans to be developed and implemented. They can promote the implementation of sustainable development policies. Examples of such policies include the designation and proper management of protected areas, the implementation of coastal zone plans and compliance with development planning regulations.

Chapter summary

Choosing not to address climate change and its impacts would be a false economy for UKOTs. Although it is hard to say what the full impact of climate change on the territories will be, it is already apparent that they will be adversely affected.

Addressing climate is, however, an opportunity for UKOTs to scale up existing measures for dealing with natural hazards and to improve natural resource management and physical planning processes. The inherent vulnerability that comes from their small size makes them even more sensitive to climate change impacts. It is, therefore, very important for UKOTs to take measures to shore up their structures to withstand climate change (adaptation).

Even if they did not have to contend with climate change, adaptive measures would make UKOTs better able to deal with the natural hazards that are part of the normal climate variability, as well as the growing human-induced stresses on the environment. Although they are not major producers of greenhouse gases, UKOTs can play a role in helping to reduce the human impact on the climate system (mitigation).

Addressing climate change is everybody's business. Governments have an important role to play in setting the national agenda and putting in place the policies, programmes and structures that make it possible for others to play their part in adaptation and mitigation. It is important to have incentives in place that encourage early appropriate action rather than promote remedial responses.

No contribution to the national effort to address climate change is too small. Businesses, households and even individuals can take steps to make their property more resilient to extreme weather, reduce their energy use and play their part in maintaining a healthy environment.

5 The Way Forward

The global trend in average surface temperature is upwards and the pace at which it is moving is fast. While there are still uncertainties surrounding future projections and possible impacts, the evidence points to unprecedented change, with potentially dire consequences. Because of their inherent vulnerabilities, there is a lot at stake for UKOTs .

There is no quick fix to the climate change problem and no single policy will set us on the right path. No single country or group of countries acting alone can solve the problem. This global issue requires an agreement between nations of all sizes and at all stages of development. It requires a commitment to joint and individual action by governments, the private sector, communities, civil society, households and individuals. It requires social, economic, environmental, and cultural policies and actions. It requires vision and creativity.

Coral reef monitoring in the British Virgin Islands (BVI).
Credit: BVI National Trust

5.1 What does this mean for UKOTs?

- ***Action.*** No country has the luxury of waiting to see how the climate change challenge will play out, least of all the UKOTs, where many ecosystems are among those that have already been identified as most vulnerable to climate change and have begun to experience adverse effects of an unstable climate.

- ***Management and protection of ecosystems.*** Looking after biodiversity and critical ecosystems helps ensure that they carry out their ecological functions and services as well as increase resistance to climate change.

- ***Climate-proofing national policies and development.*** Climate change has to become a long-term strategic issue for UKOTs that is factored into decision and policymaking in all spheres, from water resource management to physical planning to agriculture and industrial development. This includes taking a multi-sector and integrated approach to decision making that brings in the views and perspectives of a range of interest groups or stakeholders in society.

- ***Reducing greenhouse gas emissions.*** Capping carbon dioxide emissions is essential if we are to avoid global climate chaos. Even though they are small contributors to the global problem, UKOTs can take steps to reduce their impact on the climate system by reducing fossil fuel dependency and increasing energy efficiency.
- ***Sharing good practice and lessons learned.*** UKOTs can learn much from each other by sharing good practice and lessons from experience.

UKOTs can tackle climate change effectively

UKOTs have it in their power to adapt to climate change and to reduce their own impact on the global ecosystem. The chapters in this book explain what climate change is, why it matters, present and future impacts, and suggest what UKOTs can do about climate change. By establishing strategies and implementing policies to adapt to and mitigate against climate change the UKOTs will be providing a firm foundation for their own future well-being.

Wind farm in St. Helena.
Credit: St. Helena National Trust

References

Annan, K. 2006, November 9. "Climate Change is Not Just an Environmental Issue" *The Independent*. Retrieved 18 February 2008 from http://www.independent.co.uk

Ashmole, P. and M.J. Ashmole, M. J. 2000. *St Helena and Ascension Island: A Natural History*. Anthony Nelson. Oswestry

Bettencourt, S., R. Croad, P. Freeman, J. Hay, R. Jones. P. King, P. Lal, A. Reaves, G. Miller, I. Pswarayi-Riddilough, A. Simpson, N. Teuatabo, U. Trotz, and M. Van Aalst. 2006. *Not If, But When? Adapting to Natural Hazards in the Pacific Islands Region*. A Policy Note. The World Bank. East Asia and Pacific Islands Country Management Unit.

British Antarctic Survey. 2007. *Climate Change – Our View*. (Web page) Retrieved 13 March 2008 from http://www.antarctica.ac.uk/bas_research/our_views/climate_change.php

CDERA. 2003. Seminar Report. *Adaptation to Climate Change and Managing Disaster Risk in the Caribbean and South East Asia*. Barbados, July 24 – 25, 2003. CDERA, Asian Disaster Preparedness Centre, Inter-American Development Bank

Challenger, B. 2002. Conference Paper. *Climate Change Mitigation in Caribbean Micro-States: the Antigua Barbuda Experience*. IPCC Outreach Workshop on Mitigation Working Group III. 23-24 September 2002, Havana, Cuba. National Team on Climate Change, Cuba and the Centre for World Economy Studies with co-sponsorship of the IPCC and the UNDP Office in Havana.

La Cité des Sciences et de l'industrie, n.d. Earth's Atmosphere Glossary (Web page). Retrieved on 20 April 2008 from http://www.cite-sciences.fr

Chen, A., D. D. Chadee, and S. C. Rawlins (eds.). 2006. *Climate Change Impacts on Dengue: The Caribbean Experience*. Climate Studies Group, Mona, University of the West Indies, Jamaica, International START Secretariat, Washington, D.C.

German Federal Ministry for the Environment, Nature Conservation and Nuclear Safety, Deutsche IPCC Koordinierungsstelle, and German Federal Ministry of Education and Research. 2007. Fourth Assessment Report (AR4) of the IPCC (2007) on Climate Change. Synthesis Report. Key Messages. Retrieved 24 March 2008 from http://www.bmu.de/files/pdfs/allgemein/application/pdf/synthesebericht_4sachstandsbericht_en.pdf

Giannakopolous, C., M. Bindi, M. Morindo, P. LeSager, and T. Tin. 2005. *Changes in Impacts in the Mediterranean Resulting from a 2° Global Temperature Rise*. WWF.

Glick, D. 2004. *Signs from Earth: The Big Thaw* National Geographic Online. Republished from the pages of National Geographic Magazine. September 2004. Retrieved from http://science.nationalgeographic.com/science/environment/global-warming/big-thaw.html

Green Facts. 2008. *Glossary* (Web page). Retrieved 20 April 2008 from http://www.greenfacts.org.

Green, K. 2007. *A Plain English Guide to the Science of Climate Change*. Retrieved 13 March 2008 from http://www.reason.org/ps237.html

Grimsditch, G. D. and R.V Salm. 2006. *Coral Reef Resilience and Resistance to Bleaching*. IUCN, Gland, Switzerland.

Government of Bermuda. 2007. *Statement on Global Warming and Small Island States*. The Cabinet Office. Department of Communication and Information. Retrieved 13 March 2008 from http://www.gov.bm.

Hansen, J., L. Nazarenko, R. Ruedy, M. Sato, J. Willis, A. Del Genio, D. Koch, *et al*. 2005. *Earth's Energy Imbalance: Confirmation and Implications*. Science 3 June 2005: Vol. 308. no. 5727, pp. 1431 – 1435.

Hoegh-Guldberg, O. 1999. *Climate Change, Coral Bleaching and the Future of the World's Coral Reefs*. Marine and Freshwater Research. (50):839-866.

Hoegh-Guldberg, O., P.J. Mumby, A,J. Hooten, R.S. Steneck, P. Greenfield, E. Gomez, C.D. Harvell, P.F. Sale, A.J. Edwards, K. Caldeira, N. Knowlton, C.M. Eakin, R. Iglesias-Prieto, N. Muthiga, R.H. Bradbury, A. Dubi and M.E. Hatziolos. 2007. *Coral reefs under rapid climate change and ocean acidification*. Science 318, pp. 1737–1742.

Hulme, M. 2006. *Climate Change: A Statement of Science*. Tyndall Centre for Climate Change Research and School of Environmental Science, University of East Anglia.

IPCC. 2001. *The IPCC Third Assessment Report. Working Group 1: Summary for Policy Makers* Retrieved 13 March 2008 from http://www.ipcc.ch/pdf/climate-changes-2001/synthesis-spm/synthesis-spm-en.pdf

IPCC. 2007a. *Climate Change 2007: The Physical Science Basis*. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change [Solomon, S., D. Qin, M. Manning, Z. Chen, M. Marquis, K.B. Averyt, M.Tignor and H.L. Miller (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.

IPCC. 2007b. Summary for Policymakers. In: *Climate Change 2007: The Physical Science Basis*. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change [Solomon, S., D. Qin, M. Manning, Z. Chen, M. Marquis, K.B. Avery, M. Tignor and H.L. Miller (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.

IPCC. 2008. *Glossary of Climate Change Acronyms* (Web Page). Retrieved 20 April 2008 from http://unfccc.int/essential_background/glossary/items/3666.php.

IUCN. 2008. (Web page). Retrieved on 20 April 2008 from http://www.iucn.org.

IUCN. 2007. 2007 *IUCN Red List of Threatened Species*. Retrieved 4 June 2007 from http://www.iucnredlist.org.

IUCN. 2005. *Mangrove Forests Saved Lives in 2004 Tsunami Disaster*. 19 December 2005. IUCN News Release.

Impetus Consulting Ltd. 2007. *Climate Change Explained*. Retrieved 13 March 2008 from http://www.businessclimatechampions.org/climate-change-explained.php.

Joint Nature Conservation Committee. 2006. *UK Overseas Territories and Crown Dependencies: A Review of JNCC's Current and Future Involvement*. Paper prepared by Vin Fleming JNCC 06 D07

Jones, R. 2004. *The Coral Reef Crisis: Protecting Bermuda's Marine Ecosystems in Bermuda*. Biological Station for Research Annual Report 2004. Retrieved 13 March 2008 from http://www.bios.edu/pubs/ar04/ar04jones/ar04jones.html

Karas, J. 2000. *Climate Change and the Mediterranean Region*. Greenpeace. UK.

Kleypas, J.A., R.A. Feely, V.J. Fabry, C. Langdon, C.L. Sabine, and L.L. Robbins. 2006. Workshop Report. *Impacts of Ocean Acidification on Coral Reefs and Other Marine Calcifiers: A Guide for*

Future Research. 18–20 April 2005, St. Petersburg, FL, sponsored by NSF, NOAA, and the U.S. Geological Survey.

Mainstreaming Adaptation to Climate Change (MACC) Project. 2005. *A Handbook for Concepts and Issues in Climate Change: Global and Regional Perspectives*. A Handbook for Caribbean Journalists.

Marine Conservation Society, 2008, *Turtle Facts - The Marine Turtles* (Web page). Retrieved 24 April 2008 from http://www.mcsuk.org/marineworld/turtles/the+marine+turtles

McCarthy, J., O. Canziani, N. Leary, D. Dokken and K. White (editors). 2001. *Climate Change 2001: Impacts, Adaptation, and Vulnerability*. Contribution of Working Group II to the Third Assessment Report of the Intergovernmental Panel on Climate Change. Published for the Intergovernmental Panel on Climate Change. Cambridge, UK: Cambridge University Press

Mimura, N., L. Nurse, R.F. McLean, J. Agard, L. Briguglio, P. Lefale, R. Payet and G. Sem. 2007. Small islands. *Climate Change 2007: Impacts, Adaptation and Vulnerability*. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change, M.L. Parry, O.F. Canziani, J.P. Palutikof, P.J. van der Linden and C.E. Hanson, Eds., Cambridge, UK: Cambridge University Press, 687-716.

Moxam, E. 2008. "Fish exodus looms - Climate change could drive away species from Jamaica" *Gleaner Online*, Monday, 10 March 2008. Retrieved from http://www.jamaica-gleaner.com/gleaner/20080310/lead/lead1.html

Orr, J., V. J. Fabry, O. Aumont, L. Bopp, S. C. Doney, .R. A. Feely, A. Gnanadesikan, N. Gruber, A. Ishida *et al*. 2005. *Anthropogenic ocean acidification over the twenty-first century and its impact on calcifying organisms*. Nature. Vol. 437. pp. 681-686 doi:10.1038

Otley H., G. Munro, A Clausen and B. Ingham. 2008. *Falkland Islands State of the Environment Report 2008*. Falkland Islands Government and Falkland Islands Conservation, Stanley.

Oxfam. 2007. *Adapting to climate change. What's needed in poor countries, and who should pay*. Oxfam Briefing Paper 104. Oxfam. Oxford, UK.

Parry, M.L., O.F. Canziani, J.P. Palutikof and Co-authors. 2007. Technical Summary. *Climate Change 2007: Impacts, Adaptation and Vulnerability*. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change, M.L. Parry, O.F. Canziani, J.P. Palutikof, P.J. van der Linden and C.E. Hanson, Eds., Cambridge University Press, Cambridge, UK, 23-78.

Procter, D., and L.V. Fleming, eds. 1999. *Biodiversity: the UK Overseas Territories*. Joint Nature Conservation Committee. Peterborough, UK.

The Royal Society. 2005. *Ocean acidification due to increasing atmospheric carbon dioxide*. Policy document 12/05. The Royal Society. UK.

Sanders, S.M. (ed.). 2006. *Important Bird Areas in the United Kingdom Overseas Territories*. RSPB. Sandy, UK.

Sear, C., M. Hulme, N. Adger and K. Brown. 2001. *The Impacts of Global Climate Change on the UK Overseas Territories*. Technical Report and Stakeholder Survey. Natural Resources Institute and Tyndall Centre for Climate Change Research. UK.

Secretariat of the Convention on Biological Diversity. 2007. *Climate Change and Biodiversity*. CDB and UNEP. http://www.cbd.int/doc/bioday/2007/ibd-2007-booklet-01-en.pdf

Schuster, U., and Watson A. J. 2007. *A variable and decreasing sink for atmospheric CO_2 in the North Atlantic*. Journal of Geophysical Research, 112, C11006, doi:10.1029/2006JC003941.

Sheppard, C. and M. Spalding. 2003. *Chagos Conservation Management Plan*. Prepared for British Indian Ocean Territory Administration, Foreign and Commonwealth Office, London.

Stern, N. 2007. *The Economics of Climate Change: The Stern Review*. Cambridge University Press. UK.

Smyth, N. and S.Waldron. (in prep) *Pitcairn Islands Environment Management Plan*. Prepared for the UK Foreign and Commonwealth Office by BEC Consultants.

Solomon, S., D. Qin, M. Manning, R.B. Alley, T. Berntsen, N.L. Bindoff, Z. Chen, A. Chidthaisong, J.M. Gregory, G.C. Hegerl, M. Heimann, B. Hewitson, B.J. Hoskins, F. Joos, J. Jouzel, V. Kattsov, U. Lohmann, T. Matsuno, M. Molina, N. Nicholls, J. Overpeck, G. Raga, V. Ramaswamy, J. Ren, M. Rusticucci, R. Somerville, T.F. Stocker, P. Whetton, R.A. Wood and D. Wratt, 2007: Technical Summary. In: *Climate Change 2007: The Physical Science Basis*. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change [Solomon, S., D. Qin, M. Manning, Z. Chen, M. Marquis, K.B. Averyt, M. Tignor and H.L. Miller (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY,USA.

Tearfund. 2006. *Overcoming the Barriers: Mainstreaming Climate Change Adaptation in Developing Countries*. Tearfund Climate Change Briefing Paper 1. Climate Change and Disasters Group Institute of Development Studies and Tearfund. UK.

Tompkins, E. and L. Hurlston. 2005. *Natural Hazards and Climate Change: What Knowledge is Transferable?* Tyndall Centre Working Paper 69. UK.

Tomkins, E., S. A. Nicholson-Cole, L. Hurlston, E. Boyd, G. Brooks Hodge, J.Clarke, G. Gray, N. Trotz, and L.Varlack. 2005. *Surviving Climate Change in Small Islands: A Guidebook*. Tyndall Centre for Climate Change Research.UK

UK Overseas Territories Conservation Forum. n.d. *Promoting Biodiversity Conservation in the UK's Overseas Territories*. UKOTCF. UK.

UNEP Finance Initiative. 2006. *Adaptation and Vulnerability to Climate Change: The Role of the Finance Sector*. CEO Briefing. A document of the UNEP FI Climate change Working Group. UNEPFI. Geneva.

United Nations Framework Convention on Climate Change. 2008 (Web page). Retrieved 20 March 2008 from www.unfccc.int

US Environmental Protection Agency. 2008. Greenhouse Gas Emmissions (Web page). Retrieved 24 March 2008 from http://www.epa.gov/climatechange/emissions/index.html

World Bank. 2000. *Cities, Seas and Storms: Managing Change in Pacific Island Economies*. Volume I. Summary Report. Papua New Guinea and Pacific Island Country Unit: The World Bank.

World Wildlife Fund (Content Partner); McGinley, M. (Topic Editor). 2007. "Maldives-Lakshadweep-Chagos Archipelago tropical moist forests." in: *Encyclopedia of Earth*. Eds. Cutler J. Cleveland. Environmental Information Coalition, National Council for Science and the Environment. Washington, D.C.Published in the Encyclopedia of Earth. August 31, 2007; Retrieved 11 March 2008 from http://www.eoearth.org/article/Maldives-Lakshadweep-Chagos_Archipelago_tropical_moist_forests>

Young, R.P. (ed). 2008. *A biodiversity assessment of the Centre Hills, Montserrat*. Durrell Conservation Monograph No.1, Durrell Wildlife Conservation Trust. Jersey, Channel Islands

Zapata Martí, R. 2005. *The 2004 hurricanes in the Caribbean and the Tsunami in the Indian Ocean: Lessons and policy challenges for development and disaster reduction* CEPAL - SERIE Estudios y Perspectivas Nº 35. Sede Subregional de la CEPAL en México. United Nations CEPAL/ECLAC. México, DF.

What do droughts in the Mediterranean, more intense hurricanes in the Caribbean, warmer seas in the South Atlantic, and disappearing coastlines in the Pacific have in common? They are all results of the phenomenon known as climate change. Climate change, or global warming as it is sometimes called, refers to the steady climb in the Earth's temperature caused by increased levels of carbon dioxide and other gases in the atmosphere. It is a pressing issue for the entire global community and it is one that the 14 United Kingdom Overseas Territories (UKOTs) cannot afford to ignore.

This book provides an overview of what is happening globally in terms of climate change and how this will affect the UKOTs. It stresses the need for urgent action by all of us and provides practical suggestions for, and examples of, mitigation and adaptation strategies.

This document forms part of series on climate change in the UK Overseas Territories, prepared by the Caribbean Natural Resources Institute for the Joint Nature Conservation Committee. It has been funded by the Overseas Territories Environment Programme (OTEP) with assistance from the Commonwealth Foundation. Thanks are due to the many persons in the UKOTs who provided inputs and advice. Documents in the series:

Climate Change in the UK Overseas Territories : An Overview of the Science, Policy and You - A look at climate science and policy and how global warming affects UK Overseas Territories.
Climate Change in the UK Overseas Territories : A Brief Overview of the Science, Policy and You - Executive summary of the document above.

Climate Change: An Overview for Politicians and Senior Decision Makers - Key issues for policy and decision makers to take into account in climate-proofing national policies and programmes.

Climate Change: A Practical Guide for Your Organisation - How businesses can reduce their carbon footprint.

Climate change in the UK Overseas Territories (DVDs): Part 1: Impacts and Part 2: Adaptation and mitigation

Climate Change: A Practical Guide for You – Simple things individuals can do to reduce their climate impact.

Guidance for Biodiversity Conservation and Management in a Changing Climate in the UK Overseas Territories – Practical guidance for the practitioners who must plan and manage biodiversity in the face of climate change.

JOINT NATURE CONSERVATION COMMITTEE

Copies available on the internet at **http://www.jncc.gov.uk/page-4362**

Paper copies can be requested from:
Joint Nature Conservation Committee (JNCC)
Monkstone House, City Road
Peterborough PE1 1JY
United Kingdom
Tel: +44 (0) 1733 562626; Fax: +44 (0) 1733 555948
Email: communications@jncc.gov.uk

ISBN-13:978 1 86107 609 0