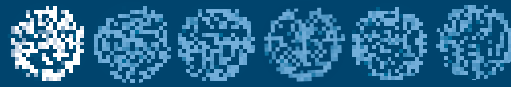


CLIMATE CHANGE





1.0 WHAT IS CLIMATE CHANGE?

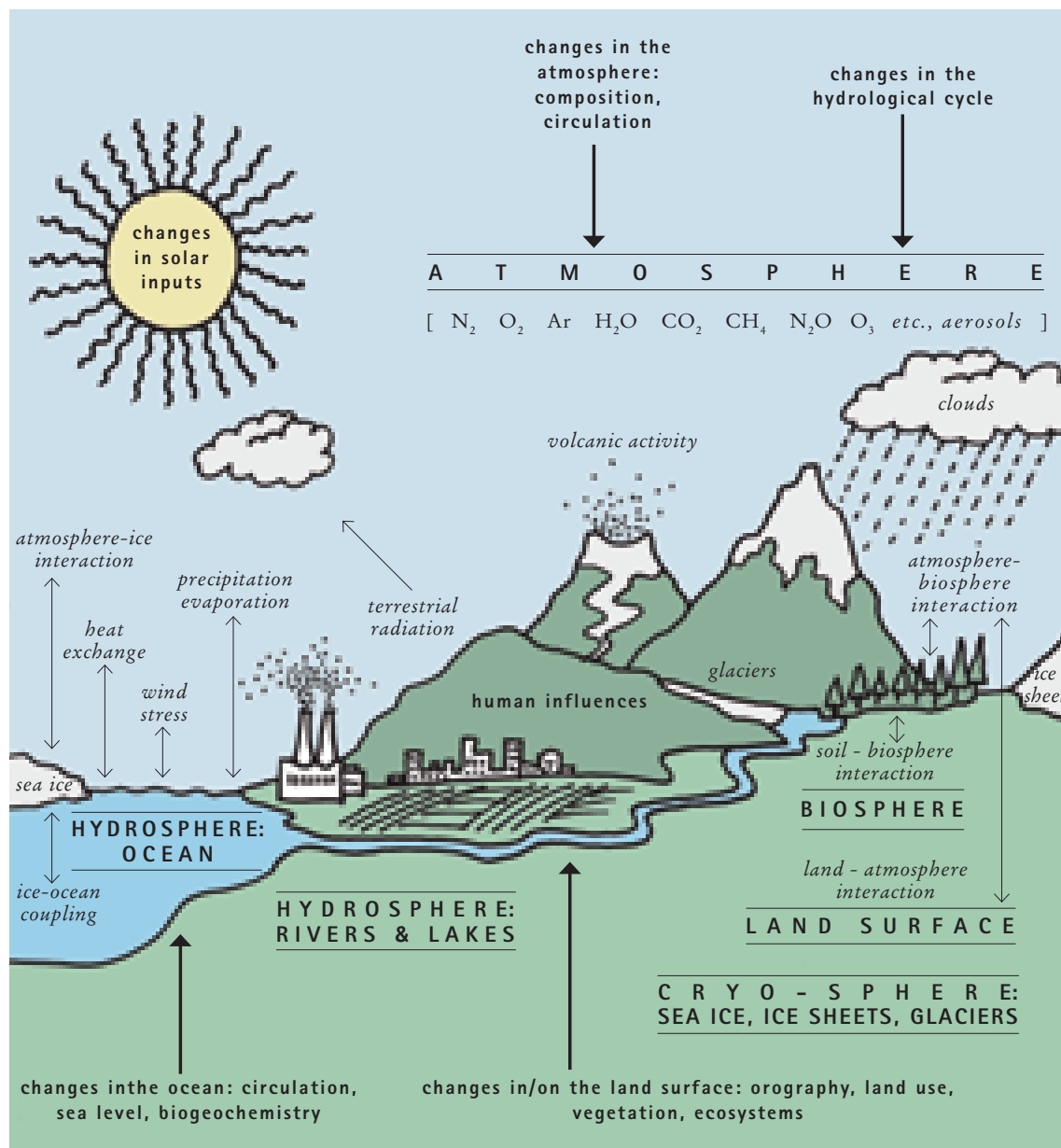
The Earth has gone through many natural cycles of warming and cooling during its long history and has always been subject to climate variability that brings about droughts, flooding and extreme weather patterns. Now, scientists have confirmed that the Earth's atmosphere and oceans are warming gradually as a result of human activity. This warming will exacerbate climate variability and, ultimately, will adversely impact food and water security around the planet. Central to global warming is the “*greenhouse effect*” – a process in which greenhouse gases in the Earth's atmosphere trap some of the Sun's energy and warm the planet. While the greenhouse effect plays a crucial role in warming the Earth to support life¹, over the past 100 to 200 years the concentrations of human-made (anthropogenic) greenhouse gases in the Earth's atmosphere have increased significantly as a result of industrial activity, deforestation and the burning of fossil fuels such as coal and oil (Figure 1.1 & 1.2).

Scientists are concerned that climate change is happening so quickly that most natural ecosystems are in serious danger of collapsing – they simply can't adapt quickly enough to the changing environmental conditions. Climate change has serious implications for all nations but many developing nations are especially vulnerable because they are highly dependent on natural ecosystems for their livelihoods and as sources of food, water and shelter. Many developing countries are also located in regions around the globe that will be most strongly impacted by climate change. Furthermore, they tend to lack the resources to implement adaptation measures or to build resilience by, for example, diversifying food production systems and livelihoods.

(See [TOOLS 6-18](#) for more about climate change and its causes.)

1 Without the natural greenhouse gas effect, the Earth's mean temperature would be a very chilly -18°C.

Figure 1.1: Schematic view of the components of the global climate system (**bold upper case**), their processes and interactions (**thin arrows**) and some aspects that may change (**bold arrows**).



Source: IPCC Third Assessment Report, 2001.

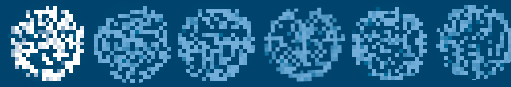
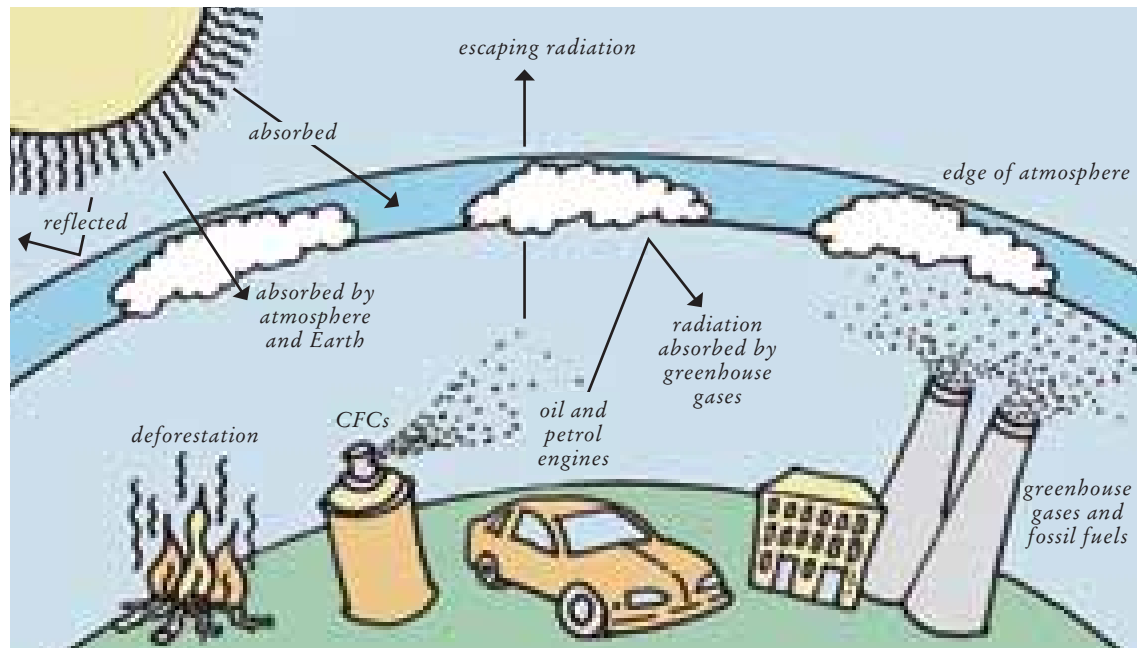


Figure 1.2: Schematic diagram of key climate change mechanisms.



1.1 WHAT IS THE GREENHOUSE EFFECT?

- ~ Incoming solar radiation from the Sun hits the Earth's atmosphere.
- ~ About 30 percent of this incoming radiation is reflected back into space by clouds, ice, snow and other bright surfaces.
- ~ The remaining energy passes through a "blanket" of gases that surrounds the Earth.
- ~ As the Sun's energy reaches the Earth's surface, much of it is absorbed by the planet's land, water and biosphere.
- ~ Most of this energy is eventually radiated back into space as long-wave radiation, but some of it becomes trapped in our atmosphere by greenhouse gases, including water vapor, carbon dioxide and methane.
- ~ This phenomenon is known as the "greenhouse effect" which is essential to life on Earth as we know it. Without it, the Earth would be a very chilly minus 18°C.

- ~ Unfortunately, human activity (e.g. the burning of fossil fuels and forest clearing) is releasing large volumes of human-made or “anthropogenic” greenhouse gases into the atmosphere. This is enhancing the greenhouse effect and causing the Earth’s climate and oceans to warm, slowly but surely.
- ~ Many people confuse the greenhouse effect with the “ozone hole”. These are two entirely different processes and only one leads to global warming – the greenhouse effect!

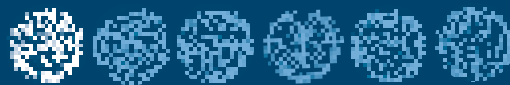
1.2 WHAT WILL BE THE IMPACTS OF CLIMATE CHANGE IN THE PACIFIC?

While there is still some uncertainty surrounding the exact nature and timelines of climate change in the Pacific region, the world’s leading scientists agree that PICTs are highly vulnerable to the impacts of climate change. These changes, already impacting some Pacific nations, include: *rising ocean levels; ocean warming and acidification; changing precipitation patterns; changing cloud cover; altered ocean and atmosphere circulation patterns; increased intensity and possibly frequency of extreme weather events including tropical cyclones, floods and droughts*. Table 1.1 indicates widely accepted projections for some key climate change parameters in the Pacific region over the next 60 to 90 years.

Table 1.1: **Climate change projections for Pacific region**

Surface air temperature increases of 1.0 to 4.17°C in the northern Pacific by 2070-2099
Surface air temperature increases of 0.99 to 3.11°C in the southern Pacific by 2070-2099
Sea surface temperature increases by 1.0 to 3.0°C by 2070-2099
Ocean waters acidify by 0.14 to 0.35 units by 2099
Sea-level rise of 0.18 to 0.59m by 2099
Rainfall decreases or increases from -2.7% to +25.8% in the northern Pacific by 2070-2099
Rainfall decreases or increases from -14% to +14.6% in the southern Pacific by 2070-2099
Possible increases in the intensity of extreme weather events including droughts, floods and tropical cyclones which may exhibit higher increased peak wind speeds and rainfall

Source: IPCC Fourth Assessment Report, 2007 (See [TOOLS 8 & 9](#))



1.3 HOW WILL CLIMATE CHANGE IMPACT FOOD SECURITY IN THE PACIFIC?

Many of the physical impacts of climate change are closely interrelated and will negatively impact food security in PICTs. These impacts may include: *salinization (salt accumulation) of soils and water resources from salt spray and rising ocean levels; soil erosion; spread of plant diseases, pests and invasive species; increased frequency of forest fires due to drought; land and marine ecosystem degradation by intensified tropical storms; and, of course, the inundation (flooding) of low-lying arable land by the sea and swollen rivers.* These impacts are likely to result in many changes to PICT ecosystems and will ultimately change the way in which Pacific Island peoples hunt, gather and grow their food.

In light of these changes, it is imperative that Pacific Islands are adequately prepared for climate change. Ensuring that people have continuous access to nutritious food in times of change is not a simple task. It will require a carefully planned and managed approach to protect existing natural resources and to improve the sustainability of current agricultural, forestry and fishing practices. (See [TOOLS 1-5 to find out how climate change is likely to impact the region's food security.](#))

1.4 HOW DO WE STOP CLIMATE CHANGE?

While Pacific Island countries are responsible for very little (0.03 percent) of the CO₂ and other greenhouse gases entering the Earth's atmosphere, our everyday energy use and the way we manage our environment is still contributing to the build-up of CO₂. For example, every time we cut down a tree for firewood, drive a car, watch TV or cook a meal, we are either directly or indirectly releasing CO₂ into our atmosphere. "*Mitigating climate change*" is all about trying to minimize the amount of greenhouse gases we release into the atmosphere. Alternatively, we also can mitigate climate change by capturing and storing greenhouse gases through activities such as planting trees or by promoting the buildup of organic matter (humus) in soils.

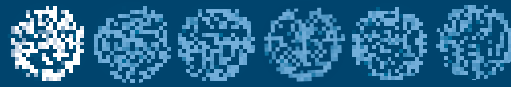
In Pacific Island countries, the main way we can help mitigate climate change is to reduce our use of fossil fuels, such as diesel and petrol, and ensure that we sustainably manage our forests². These actions will not only help global efforts to halt climate change but will also serve to protect our natural environment, and may even save a family money that would have otherwise been spent on fuel and/or electricity. Using sustainable agricultural practices and constructing energy-efficient buildings are other ways we can reduce greenhouse gas emission rates in the Pacific. When PICTs take such steps to cut greenhouse gas emissions, we send a strong message to industrialized countries that they too need to reduce their own greenhouse gas emissions. Basically if we can demonstrate that we can cut our greenhouse gas emissions, it puts pressure on industrialized nations and other developing countries to cut their own emissions too!

Here are some simple steps that you and your family can take to help reduce greenhouse gas emissions and hopefully save some money at the same time.

1.4.1 Checklist of simple mitigation steps

- ~ **Natural lighting:** Whenever practical, use natural lighting from windows and doors to light your house... it is totally free!
- ~ **Energy efficient light bulbs:** Replace incandescent light bulbs (old-style round bulbs) with efficient, low-wattage compact fluorescent lights (CFLs). While CFLs may cost more to buy, they can last much longer and use far less power... saving you money in the long run.
- ~ **Cooling your home:** Windows and doors can provide natural ventilation when it's hot. This will reduce the need for air-conditioning units and fans. Air-conditioners are the most energy-hungry of home appliances, so avoid using them whenever you can. If you have to use one, set the thermostat as high as possible (warmer) and keep the windows and doors closed.

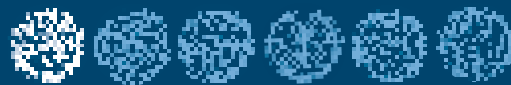
2 Trees mitigate climate change by absorbing CO₂ as they grow. So by planting more trees and protecting existing forests, Pacific Island countries can help fight climate change.



- ~ **Be paint wise:** Use reflective light-coloured paints on both the inside and outside of your homes and buildings to reduce lighting and cooling requirements on the inside.
- ~ **Insulating your home:** Installing insulation in your roof cavity and shading windows can also help keep houses cool in summer and warm in winter. It can also reduce the need to run electric fans, air-conditioning units and heaters, thus saving you money and helping mitigate climate change.
- ~ **Switching off:** Ensure that you switch off lights and appliances at the wall when you are not using them, as many appliances such as TVs and DVD players still use electricity even when they are in standby mode.
- ~ **Clothes drying:** Hang your clothes out to dry rather than relying on energy-hungry clothes dryers.
- ~ **Solar power:** More and more people heat water and generate electricity by using natural and abundant solar energy. The Sun's energy can provide an excellent way to obtain cheap electricity and hot water for your household or business.
- ~ **Leaking taps:** Be sure to fix leaking taps and pipes. These don't just waste precious water resources but electricity too that is used pump and purify water.
- ~ **Appliance settings:** Use energy efficient settings on electrical appliances such as washing machines, and be sure to increase thermostat settings on air-conditioning units to save on energy.
- ~ **Consumer power:** When buying a car or household appliance, look for the most energy-efficient option available to reduce carbon emissions and running costs. Some appliances have "star" ratings, so look for the appliance with the highest star rating.

- ~ **Transport:** Using public transport, sharing lifts, leaving the car at home and biking or walking are all ways in which we can reduce carbon emissions and save money! Biking and walking are also great ways of staying healthy and keeping in shape!
- ~ **Recharge your batteries:** Rechargeable batteries are a cheaper option in the long run for your household and are much better for the planet. Switching to rechargeable batteries for radios, torches and toys will save on carbon emissions and money, and also reduce the toxic waste going into Pacific Island landfills.
- ~ **Recycling:** Find out what materials can be recycled in your country (e.g. plastic bottles, cans and cardboard), and start storing and recycling these materials now. You may be able to recycle more than you think!
- ~ **Packaging:** When buying food and other products, try to buy locally produced products and certainly avoid highly packaged products that don't have reusable or recyclable packaging.
- ~ **Plastics:** Remember that most plastics are not readily biodegradable (they don't break down easily when buried in landfills) so try to avoid using plastic bags and Styrofoam cups and containers whenever possible to help reduce greenhouse gas emissions.
- ~ **Other steps:** Many of the tools and resources outlined in this "food security toolkit" will provide further examples of how you and your family can help mitigate climate change. Activities from growing your own organic vegetables to conserving forest trees all can help improve our access to nutritious, tasty and affordable food while at the same time help to protect our environmental resources and reduce carbon emissions.

(See TOOLS 6, 7, 11 & 14 to find out more about climate change mitigation.)



1.5 WHAT IS THE REST OF THE WORLD DOING?

Over the past few decades, growing understanding and concern about the pending environmental and socio-economic impacts of climate change have prompted international action on climate change and the search for effective adaptation and mitigation measures. In 1988, the *Intergovernmental Panel on Climate Change* (IPCC) was established to evaluate the risk of climate change caused by human activity. The IPCC does not carry out its own research, nor does it monitor climate change or related phenomena itself, but rather it analyses research and published literature to produce special reports on topics relevant to the implementation of the *United Nations Framework Convention on Climate Change* (UNFCCC). These reports are widely cited by the international community and provide information on issues ranging from climate change projections to community-based adaptation measures. (See [TOOLS 8 & 9.](#))

The UNFCCC was established by the United Nations General Assembly in 1992. It is an international environmental treaty that broadly aims to stabilize concentrations of greenhouse gasses in the Earth's atmosphere to prevent dangerous climate change. In an attempt to introduce a mechanism to encourage industrialized countries to cut their greenhouse gas emission rates and meet the objectives of the UNFCCC, the signatories to the treaty established the *Kyoto Protocol*. The Kyoto Protocol, which came into effect in February 2005, established emission reduction targets for 37 developed countries (known as Annex 1 countries) and committed them to cutting collective greenhouse gas emissions by about 5 percent from the 1990 level.

One of the shortcomings of the Kyoto protocol is that it fails to place any binding emission reduction targets on developing countries such as China, India and Brazil who have become major greenhouse gas emitters. In fact, China has now surpassed the USA as the world's major emitter of greenhouse gases and notably neither of these countries has agreed to recommended, or in the case of the USA, binding

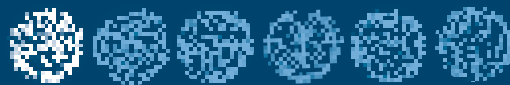
greenhouse gas emission cuts outlined in the Kyoto Protocol. On the other side of the coin, there is no arguing that developed nations, through their present and historic emissions, have set climate change in motion and must lead global efforts to cut greenhouse gas emission rates substantially.

In late 2009, parties to the UNFCCC met in Copenhagen, Denmark, to try to agree upon a *post-Kyoto Protocol*. Because the meeting failed to reach any legally binding emissions targets for either developing or industrialized nations, hope turned to the 2010 UNFCCC Conference of Parties (COP16) meeting in Cancún, Mexico. Post-Cancún, there is little doubt that substantive funding will come on stream within the next few years to support mitigation and adaptation initiatives around the world, and particularly those within developing countries. (See [TOOLS 1-21 to find out more about global efforts to combat climate change.](#))

1.6 WHAT IS CLIMATE CHANGE ADAPTATION?

As the world battles to reach consensus and take action on reducing greenhouse gas emissions, scientists widely acknowledge that historic (and ongoing) greenhouse gas emissions have locked the Earth into some degree of warming over the next century or more. In other words, a certain amount of climate change will happen regardless of what actions are taken today to reduce emissions. Some PICTs are already thought to be feeling the initial impacts of climate change, which are predicted to intensify with time.

To avoid the most damaging impacts of climate change, PICTs must ensure they implement a variety of climate change adaptation measures. These measures include actions designed to reduce the vulnerability of natural and human systems to actual or expected climate change impacts. Most adaptation steps being implemented now within the Pacific region are responding to current climate trends, climate variability and broader environmental degradation. An example of this type of “reactive



adaptation” would be the installation of seawalls to curb intensifying shoreline erosion in some low-lying coastal villages. There are also examples of “anticipatory adaptation” being implemented in the region. This type of adaptation focuses on “anticipating” and reducing the impacts of future climate change. For example, the work being undertaken in the Cook Islands to “build back better” following the devastating impacts of Cyclone Pat in February 2010 is based on the recognition that coastal communities are highly vulnerable to storm surges and cyclones – phenomenon that may intensify as a result of climate change.

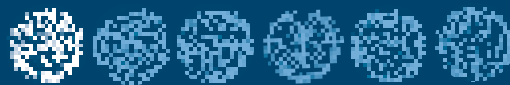
The ability of any country to adapt to and cope with climate change depends on numerous factors, such as the country’s sociopolitical will and access to monetary resources, technical knowhow, skilled trades-people and effective managers. Developing nations, and particularly the poor within developing nations, tend to be the most reliant on natural ecosystems for their livelihoods, and typically have fewer monetary and other resources at hand.

Accordingly, they are most vulnerable to climate change and other socio-economic stresses such as population growth, urbanization, resource degradation and fluctuating commodity prices. Policies that lessen pressures on natural resources, improve management of environmental risks, and increase the welfare of the poorest members of society can advance sustainable development and equity, enhance adaptive capacity and ultimately reduce vulnerability to climate change and other stresses.

While this toolkit focuses on food security as a means of building resilience to climate change, there are numerous other types of adaptation measures that can be taken to reduce the impacts of climate change. The following list includes examples of key adaptation measures.

1.6.1 Examples of climate change adaptation measures by sector

- ~ **Infrastructure development:** Relocating existing buildings and constructing seawalls, surge barriers and windbreaks are examples of common adaptation measures.
- ~ **Energy:** Strengthening energy generation and distribution infrastructure, improving energy efficiency practices and diversifying sources of energy are a few of the adaptation measures available to the energy sector.
- ~ **Food security:** Ensuring that Pacific Island peoples have ready access to safe, nutritious and culturally appropriate food is of critical importance to the continued development and stability of the Pacific region. This is predicted to become increasingly challenging as climate change takes hold. Adjusting planting dates; relocating crops; promoting the use of drought/salt tolerant crop varieties and low-input organic agriculture; improving food processing and distribution networks; conserving coral reefs and coastal ecosystems; and increasing the volume of intraregional trade are just a few of the many measures that can be used to improve food security and build resilience to climate change within the Pacific region.
- ~ **Human health:** Improving the monitoring and control of climate-sensitive diseases and heat-related illness, and improving water and sanitation will be vital adaptation measures for PICTs.
- ~ **Tourism:** The tourism industry is the economic backbone of many Pacific Island nations and is likely to be adversely impacted by climate change. Diversification of tourist activities and reduced reliance on coastal infrastructure and resources will help build resilience to climate change within this industry.
- ~ **Transport:** Relocation and realignment of existing roads, rail and airport infrastructure, and the use of improved design standards and construction techniques will be required to address issues such as increased rainfall, wind speeds and sea levels.



- ~ **Water security:** Climate change is predicted to change rainfall patterns substantively in the Pacific region. While some countries may become more drought prone, others may receive more intense rainfall events. These changes are likely to lead to an overall reduction in crop yields and, when combined with sea-level rise, are likely to reduce potable water supplies in many PICTs. Efforts to protect rainfall catchments and existing water resources; expand water harvesting; and improve water storage, irrigation and conservation practices will become increasingly important adaptation measures for all PICTs. (See TOOLS 11-21 to find out more about climate change adaptation measures.)

1.7 HOW IS THE REGION COMBATING CLIMATE CHANGE?

Pacific Island leaders have been at the forefront of climate change developments over the past few decades and have been instrumental in highlighting the vulnerability of Pacific Island nations to the broader global community. In recent years, Pacific leaders developed several communiqués including the “Niue Declaration on Climate Change” and also guided Council of Region Organisations in the Pacific (CROP) agencies to develop the “2005 Pacific Islands Framework for Action on Climate Change” and its associated implementation plan that was finalized in 2008 (See TOOLS 20 & 21).

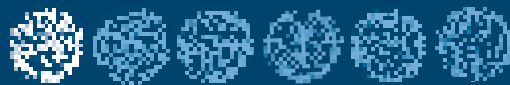
The establishment of the GEF Least Developed Country Fund in November 2002 saw funds allocated to the Pacific region’s Least Developed Countries (Kiribati, Samoa, Solomon Islands, Tuvalu and Vanuatu) to aid them in their preparation of National Adaptation Programmes of Action (NAPAs). Within the NAPA process, each of these countries has identified priority climate change adaptation projects that are eligible for GEF funding. Other developing PICTs within the region are now calling for similar support to be made available to non-LDCs, so that they too have the resources required to map out vulnerabilities, and plan and implement country-specific measures to combat climate change.

Although the UNFCCC has agreed in principal to broaden the NAPA process to include non-LDCs, the decision has not yet been formalized by the UNFCCC's Conference of Parties. This has not deterred PICTs and development partners from commencing a wide range of climate-change related initiatives throughout the region. Gap analysis work carried out by the United Nations System in 2009 indicates that PICT Governments, bilateral and multilateral donors, civil society organizations (CSOs) and international financial institutions are involved in more than 270 initiatives in the Pacific region that either directly or indirectly address climate change mitigation or adaptation. Major stakeholders in the region include: PICT governments; CROP agencies³; the Governments of Australia, Canada, Italy, Germany, Japan, New Zealand and Sweden; various CSOs and NGOs; the Asian Development Bank and the World Bank; the European Union; the Global Environment Facility (GEF); and the many UN System agencies.

Many of the climate change adaptation initiatives being carried out in the Pacific region have a food security component to them (Table 1.2). The major players in this field are FAO and the SPC, and to a lesser extent, the EU, GTZ, IFAD, SOPAC, UNDP and AusAID (see footnote 4). Much of the work being carried out by FAO and SPC is relatively small-scale project-based work designed to improve agricultural production, sustainable livelihoods and ultimately food security. FAO has been particularly active through its TeleFood Project and Regional Programme for Food Security (RPFS), and has also carried out considerable preparatory work towards its new Food Security and Sustainable Livelihoods Programme (FSSLP).

Another major initiative that includes a food security focus is the Pacific Adaptation to Climate Change Project (PACC) that is being managed by the Secretariat for the Pacific Regional Environment Programme (SPREP). This regional project involves

3 CROP agencies include the: Forum Fisheries Agency (FFA), Pacific Islands Forum Secretariat (PIFS), Secretariat of the Pacific Community (SPC), South Pacific Applied Geoscience Commission (SOPAC), South Pacific Tourism Organisation (SPTO), University of the South Pacific (USP), Secretariat of the Pacific Regional Environment Programme (SPREP), Pacific Islands Development Programme, Fiji School of Medicine (FSM), and the South Pacific Board for Educational Assessment. Other donor organizations include European Union (EU), German Technical Cooperation (GTZ), International Fund for Agriculture and Development (IFAD), United Nations Develop Programme (UNDP) and Australian Agency for International Development (AusAID).

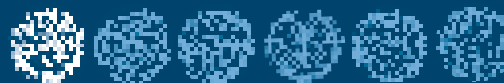


13 Pacific Island countries and is one of the few projects to access the Special Climate Change Fund of the GEF globally. The objective of the US\$13.1 million PACC is to enhance the resilience of a number of key development sectors – such as food production and food security, water resources management, coastal zone and infrastructure – in PICTs to the adverse effects of climate change (Table 1.2).

Table 1.2: A small selection of ongoing and recently completed food security initiatives in the Pacific

TITLE	SELECTED REGIONAL FOOD SECURITY INITIATIVES	LEADS & STATUS	SCOPE
AGRICULTURE AND FOOD SECURITY	AusAID has numerous agricultural and crop development activities throughout the Pacific region that have clear spin-offs for food security in the region. Several examples specifying a food security focus are included below.		regional
AUSAID-“AGRICULTURAL RESEARCH AND DEVELOPMENT SUPPORT FACILITY (ARDSF)”	AusAID is providing funds (2006 to 2011) to the Government of PNG through the Agricultural Research and Development Support Facility (ARDSF). ARDSF is strengthening the capacity of PNG’s primary agricultural research and commodity institutions to deliver improved services to their rural stakeholders, as well as to provide additional resources through a competitive grant scheme to support the testing and promotion of innovations that will have a positive impact on the livelihood of smallholder farmers. Improved services will increase opportunities for small-holder farmers to improve productivity and market competitiveness and strengthen farmer incomes and food security.	AusAID 2011	PNG
AUSAID-ACIAR	AusAID provides US\$2 million annually to the Australian Centre for International Agricultural Research (ACIAR) to facilitate research partnerships into key agricultural research areas in PNG such as reducing pest impacts and the management of fruit fly and potato late blight. Since 1998, AusAID has contributed US\$18.6 million to this programme that is aimed at increasing farmers’ incomes and strengthening food security.	AusAID Ongoing	PNG
REHABILITATION OF THE FIJI AGRICULTURE SECTOR DAMAGED DURING CYCLONE GENE	Funds provided to the Government of Fiji for the rehabilitation of its agriculture which was damaged during Tropical Cyclone Gene in January 2008. Australian funds contributed to crop rehabilitation – mainly through the provision of planting materials – in 12 of Fiji’s 14 provinces, where around 51 000 farmers were affected.	AusAID 2008	Fiji

TITLE	SELECTED REGIONAL FOOD SECURITY INITIATIVES	LEADS & STATUS	SCOPE
COUNTRY ASSESSMENTS ON THE IMPACT OF CLIMATE CHANGE ON AGRICULTURE AND FOOD SECURITY IN THE PACIFIC	Field studies to determine the potential impact of climate change on agriculture and food security in selected Pacific Island countries. Studies, carried out by independent FAO consultant on RMI, Vanuatu and Cook Islands, have been completed.	FAO Ongoing	Regional
DEVELOPMENT PARTNERS MAPPING EXERCISE	Regional study undertaken to map development partners and their activities in the area of Food Security and Sustainable Livelihoods in the Pacific Island Countries.	FAO 2008	Regional
SUPPORT TO THE REGIONAL FOOD SECURITY PROJECT IN THE PACIFIC ISLAND COUNTRIES	Italian-funded Regional Programme for Food Security (RPFS) in the Pacific Island Countries contributes to the stabilization of food security, both at national and household levels in the developing country members of the Pacific Islands Forum. The programme has two main components: (1) enhancing food production and security through investing in specific production-related (supply side) activities, and (2) strengthening agricultural trade and policy. There are 26 national projects in the 14 Forum island countries.	FAO/Italy 2003- ongoing	Regional
TELEFOOD PROJECTS	Grassroots-level projects to assist poor families in improving their means of production, enabling them to produce more food, and to generate cash income which will allow them better access to food. Includes assistance in the area of crop production, small animal & fish production; and value adding. Activities in Cook Islands, Fiji, Federated States of Micronesia, Kiribati, Marshall Islands, Nauru, Niue, Palau, Samoa, Solomon Islands, Tonga, Tuvalu, Vanuatu	FAO 2003- ongoing	Regional
FOOD SECURITY AND SUSTAINABLE LIVELIHOODS PROGRAMME (FSSLP)	The FSSLP has three main components: (1) enhancing food production and income generation at national level, (2) trade facilitation and harmonization, and (3) investment in infrastructure. It addresses agricultural productive supply constraints such as access to inputs, extension services, improved agricultural information availability and dissemination and improved market infrastructure. IFAD fielded a mission to participate in the design of the FAO FSSLP.	FAO/IFAD Pipeline	Regional
CENTRES OF EXCELLENCE FOR RESEARCH AND DEVELOPMENT OF ATOLL AGRICULTURE	This project, implemented by the SPC Land Resource Division supports documentation and promotion of traditional food production, preparation and preservation, was designed to undertake action research and extension activities to address issues such as poor soil, irrigation and limited resource base of coral atolls.	IFAD/GTZ/ SPC 2008-2010	Subregional (based in Kiribati & RMI)



TITLE	SELECTED REGIONAL FOOD SECURITY INITIATIVES	LEADS & STATUS	SCOPE
SPC CLIMATE READY CROPS - ADAPTATION TO CLIMATE CHANGE	Establishment of a "climate ready" collection consisting of crops and varieties with specific traits such as drought and salt tolerance as well as those crops and varieties known to tolerate other marginal growing conditions.	SPC Pipeline	Regional
PACIFIC ADAPTATION TO CLIMATE CHANGE PROJECT (PACC)	This regional project involves 13 Pacific Island countries and is one of the few global projects to access the Special Climate Change Fund of the GEF. The objective of the US\$13 million PACC is to enhance the resilience of a number of key development sectors (food production and food security, water resources management, coastal zone, infrastructure etc.) in the Pacific Islands to the adverse effects of climate change. Various projects are planned for Solomon Islands, PNG, Palau and Fiji that will focus on water and food security (irrigation, drainage, and coastal food production systems).	SPREP/ UNDP Ongoing	Regional
INTEGRATED CLIMATE CHANGE ADAPTATION PROJECT FOR SAMOA	The project implements the remaining and most urgent adaptation priorities in Samoa's National Adaptation Programme of Action (NAPA), namely climate early warning systems, climate agriculture and food security, and climate-sensitive diseases. The objective is to increase the resilience and adaptive capacity of coastal communities in Samoa to the adverse impacts of climate change on agricultural production and public health through improved early warning systems. It also address the PACC SPREP Project and FAO.	UNDP 2008-2012	Samoa

1.8 THE IMPACTS OF CLIMATE CHANGE ON PACIFIC FOOD SYSTEMS

While there is still significant uncertainty surrounding the exact nature, magnitude and timelines of climate change in the Pacific region, there is no doubt that PICTs are highly vulnerable to the present and pending impacts of climate change and climate variability. The agriculture sectors in PICTs are particularly vulnerable given their heavy reliance on a wide range of natural ecosystem services such as soil fertility, insect pollination and the maintenance of soil moisture levels through rainfall, to name but a few. These ecosystem services are highly interrelated and strongly dictated by prevailing climatic regimes. Therefore, long-term changes to rainfall, temperature, and soil and air-moisture regimes will impact agricultural yields and the distribution and types of crops that can be grown in PICTs.

Although there is some evidence to suggest that higher carbon dioxide levels in the atmosphere may actually encourage the growth of some crop species, it is widely accepted that the overall impact of climate change on crop production in the Pacific will be negative.

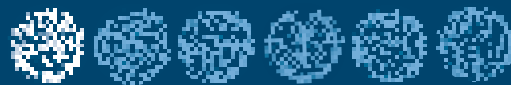
These overall crop production losses are anticipated due to a combination of factors which are summarised in Table 1.3.

Table 1.3: Summarised impacts of climate change on soil resources and crop production

Possible intensified cyclone and storm activity	→	Soil erosion and nutrient depletion, crop and infrastructural damage
Rising sea levels and increased salt spray	→	Seawater inundation of land and soil salinization
Rapidly changing environmental parameters and ecosystems	→	Proliferation of new and existing invasive pests and diseases
Changing rainfall patterns	→	Increased incidence of drought and/or flooding

In the case of tropical root crops, as with some other agricultural crops, many species are already considered to be growing in conditions close to their maximum heat tolerance, which means even a small amount of warming combined with rainfall changes may result in substantive decreases in crop yields. The impact of climate change on production levels will not be uniform across the Pacific region. Rather, it will vary from country to country on account of PICT’s different geophysical attributes (*e.g. geographical location; height above sea level; and extent and fertility of existing soil and land resources*) and of course various socio-economic factors (*e.g. human and financial capacity to plan and prepare for climate change*).

Accordingly, larger and resource-rich islands such as Papua New Guinea and Viti Levu in Fiji, may expect comparatively smaller impacts to their crop production than atoll countries, such as Kiribati, which are low-lying, have very limited soil and



water resources, and also face the grim reality of losing large tracts of agricultural land to sea-level rise and soil salinization. In saying this, it is important to note that while climate change may have lower impacts on crop production on some of the larger Pacific Islands, these same islands host larger populations and, ultimately, the severity of climate change impacts are likely to lie in the way that individual countries “climate-proof” (i.e. plan and prepare) their agricultural sectors for the future. (See [TOOLS 1-5.](#))

1.8.1 Changing water regimes

Rainfall is one of the most important crop production parameters. Unfortunately future rainfall projections for the Pacific region are fraught with uncertainty and even the direction of the rainfall change at the sub-regional level is poorly understood (Table 1.1).

The difficulty scientists face in predicting future rainfall pattern changes in the Pacific region is due to the complex interaction between the various marine and atmospheric systems that dictate weather and climate. The primary drivers of rainfall in the Pacific region include the warming of the atmosphere and oceanic waters, the Inter-Tropical Convergence Zone (ITCZ), the South Pacific Convergence Zone (SPCZ), and the El Niño Southern Oscillation (ENSO). However, numerous other wind and water currents drive seasonal rainfall and weather patterns over the vast Pacific Ocean.

Such a high level of uncertainty of how rainfall patterns will change in the Pacific region is very concerning given that many PICTs are heavily reliant on rain-fed agricultural production and rainfall as a source of drinking water and recharge for aquifers. The stark reality is that even minor changes in rainfall volumes and patterns will have potentially dire consequences for crop production, and food and water security for many PICTs within the Pacific region.

1.8.2 Storms and cyclones

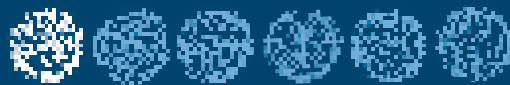
In the Pacific region, there is some evidence to suggest that storm and tropical cyclone activity will intensify as the atmosphere and Pacific Ocean continue to warm. The ENSO, which strongly dictates the development and distribution of cyclones within the Pacific region, will be affected by warming air and ocean temperatures, which essentially “fuel” the development of cyclones.

In a warmer Pacific region, some PICTs in the central and eastern Pacific may become impacted more frequently by higher intensity storms and tropical cyclones if El Niño-like spatial patterns begin to dominate as some researchers predict. Given that many Pacific Islands lie no more than a few metres above sea level, the combined impact of tropical cyclones, storm surges and sea-level rise are of extreme concern, particularly for low-lying atoll nations such as Kiribati, RMI and Tuvalu.

Powerful winds, intense rainfall, and storm surges from tropical cyclones and severe storms have the ability to devastate crops; down trees, fences and farm buildings; and to inundate, erode and leach low-lying agriculture soils in coastal areas and stream catchments. The damage wrought by cyclones (Rene, Tomas, Ului) that hit Fiji, Tonga, Samoa and neighbouring countries in early 2010 are testament to the ferocity of these extreme weather events and the damage they can unleash on crops and infrastructure. (See [TOOLS 8-10](#))

1.8.3 Drought and fire

On the other end of the rainfall spectrum from cyclones is drought and, unfortunately, the frequency and intensity of droughts may also increase in some PICTs as the atmosphere and oceans continue to warm. As with cyclones, droughts can have a devastating effect on crop production. The ravage of drought, felt in many PICTs in the past few decades, is possibly best exemplified by the



El Niño-induced drought that struck Fiji in 1998. This drought decimated about 40 percent of the country's sugar cane crops and directly impacted the livelihoods of an estimated 28 000 households.

In addition to the direct impacts of drought on crop production, drought also substantially increases the risk of fire that has the potential to destroy crops, forests and agricultural infrastructure, such as farm buildings, machinery, fences and shelter belts. Accordingly, many of the impacts of fire on agricultural production can be catastrophic and financially crippling to farmers.

1.8.4 Crop inundation and soil salinization

In many PICTs, large areas of arable land tends to be concentrated on low-lying coastal plains or within the lower reaches of river and stream catchments. These lands are typically vulnerable to flooding, storm surges and longer term sea level rise and are certainly likely to be further compromised by the impacts of climate change as they take hold in the region.

While low-lying atoll nations such as Kiribati, RMI and Tuvalu will be most vulnerable to rising sea levels, every PICT will be seriously impacted by rising ocean levels. Many larger islands, such as Tongatapu in Tonga, can expect to see large tracts of low-lying arable land lost to the rising Pacific Ocean over the next 100 years.

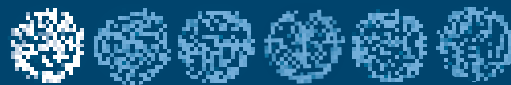
1.8.5 Invasive species, pests and diseases

The establishment of new and/or existing pests and diseases represents some of the most serious, but poorly understood, risks to agricultural production in PICTs. Pacific Islands are particularly vulnerable to invasive species because of their isolation and relatively recent human occupation. Pacific island species have not evolved to cope with the impacts of predators, herbivores, insect pests, highly competitive

weeds and diseases brought in from continental areas and neighbouring islands. Examples of invasive species present in the region include types of: *vertebrate animals* (e.g. rats, goats, cats, mongooses and myna birds etc.), *invertebrate pests* (e.g. snails, slugs, nematodes, mosquitoes, beetles and other insects), *weeds* (e.g. trees, vines, shrubs and grasses) and *other soil, plant and animal pathogens* (e.g. fungi, bacteria, and viruses). These invasive species can affect agriculture, aquaculture, fisheries and forestry sectors and are responsible for the extinction of more island native species than any other cause.

The complex interactions that govern the population dynamics and proliferation of invasive species, pests and diseases make it extremely difficult for scientists to predict how they may impact food production systems under the various climate change scenarios. Scientists are confident, however, that as the Pacific climate becomes warmer and rainfall patterns change, many crops will become stressed and more susceptible to pest and disease outbreaks. In a warmer climate, other currently benign pest and diseases may also rise to the fore as delicate ecological balances are disturbed and ecological ranges change.

While not believed to be attributable to climate change per se, the taro leaf blight (*Phytophthora colocasiae* Racib), a fungal plant disease that devastated Samoa in the early 1990s, provides a graphic example of the devastating impacts that disease can have on crop yields. Within a year of the blight's establishment in 1993, Samoan taro exports fell to less than 2 percent of pre-blight levels and more than 15 years later the taro export industry in Samoa has yet to fully recover. A similar outbreak of TLB seriously undermined food security in the Solomon Islands after World War II and resulted in a permanent shift in some parts of the country away from taro to sweet potato and cassava production. Just how TLB and other diseases and crop pathogens (e.g. taro beetle, taro soft rot, and taro viruses) will impact the region's taro industry remains a matter of much conjecture, but it will be clearly linked with climate change and long-term food security within the region. (See TOOLS 47 & 48 for further information on combating invasive species.)



1.8.6 Ecosystem services

The unique ecosystems in the Pacific region provide many “ecosystem services” from which humans benefit. Ecosystem services are essentially sets of natural assets (e.g. soil, plants and animals, air and water) that have been transformed into things that we value. For example, insects such as bees interact and pollinate flowering plants which, in turn, bear fruit and seeds that provide food for animals and viable seeds to renew the cycle. The complex process of pollination is directly linked with insect life-cycles and plant flowering patterns, which are both strongly dependent on climate and seasonal weather variations.

Other examples of ecosystem services include:

- ~ insect pest control
- ~ maintenance and provision of genetic resources
- ~ maintenance and regeneration of habitat
- ~ provision of shade and shelter
- ~ prevention of soil erosion
- ~ maintenance of soil fertility and waste recycling
- ~ regulation of river flows, groundwater levels, and water filtration.

Ecosystem services are little understood, extremely difficult to model but integrally important to the sustainability of root crop production in the Pacific. Climate change threatens to disturb the natural balance of Pacific ecosystems that will, in turn, impact the natural services they provide. To mitigate the impacts of climate change, the role of ecosystem services will need to be closely considered and must be the focus of targeted research.

(See Module 3 for more information on the role of ecosystem services in food security.)