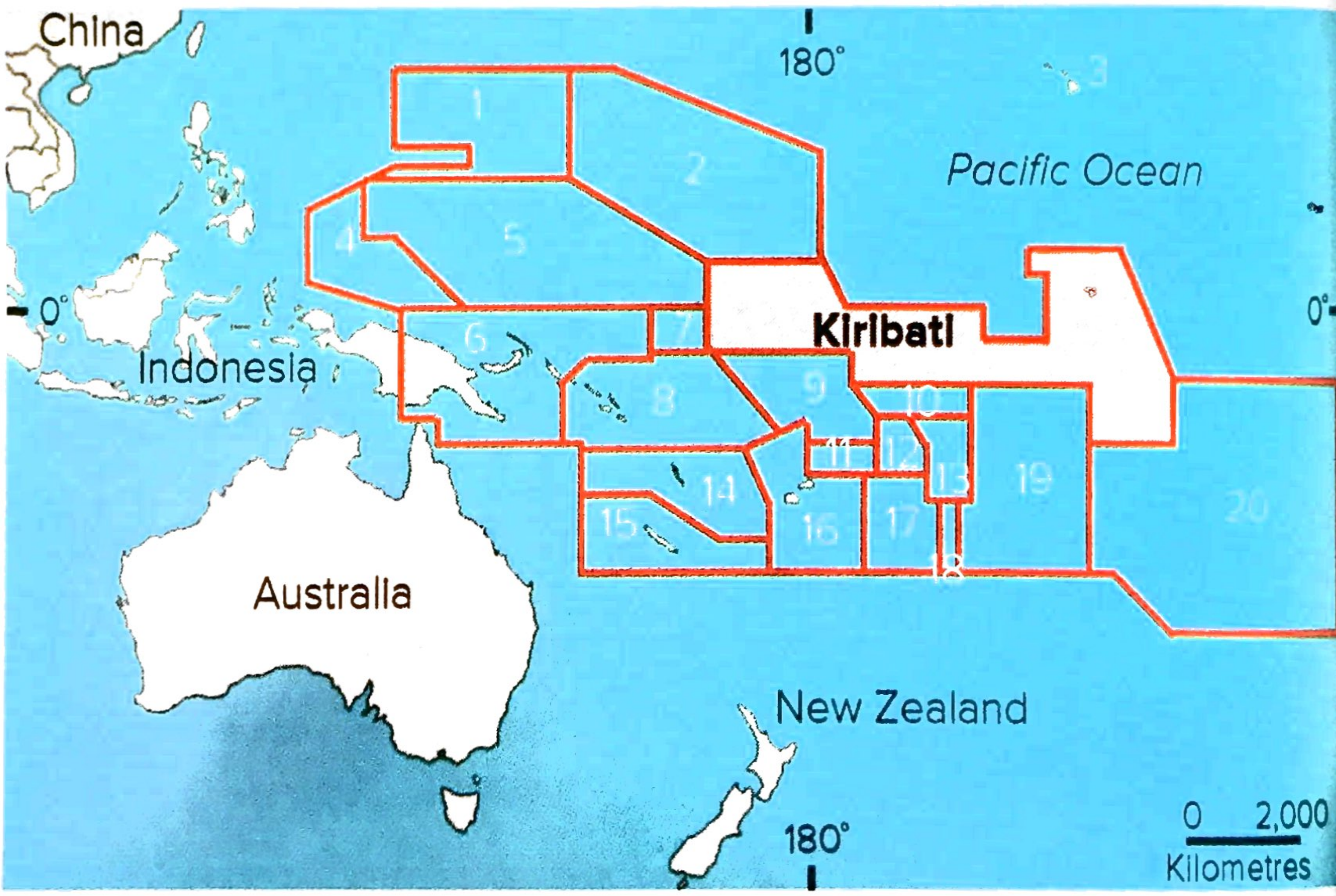
CASE STUDY
Kiribati

Location and demographics

Kiribati (pronounced *Kirri-bass*) is a republic located in the central Pacific Ocean. It is the only country in the world to straddle all four hemispheres as it spans both the equator and the



6.16 The location of Kiribati in relation to its neighbouring countries. 1 = Northern Mariana Islands. 2 = Marshall Islands. 3 = Hawaiian Islands (USA). 4 = Palau. 5 = Federated States of Micronesia. 6 = Papua New Guinea. 7 = Nauru. 8 = Solomon Islands. 9 = Tuvalu. 10 = Tokelau. 11 = Wallis and Futuna Islands. 12 = Samoa. 13 = American Samoa. 14 = Vanuatu. 15 = New Caledonia. 16 = Fiji. 17 = Tonga. 18 = Niue. 19 = Cook Islands. 20 = French Polynesia.

International Date Line. Specifically, Kiribati extends from latitude 5°N to 12°S, and longitude 168°E to 148°W.

Kiribati comprises 33 widely scattered islands that are dispersed across a 3.6 million square kilometre section of ocean that measures 800 kilometres north-south and 3,210 kilometres east-west. There are **three main clusters** of islands – the **Gilbert Islands** in the west, the **Line Islands** in the east and the **Phoenix Islands** in the middle. Most of the islands are **coral atolls** that have maximum elevations below 2 to 3 metres above sea level with one exception, Banabam which is an elevated coral island that rises to 81 metres above sea level, and was once a rich source of phosphate.

6.17 Most islands in Kiribati are long, thin atolls like Tarawa, the north-east section of which is shown here near Abaokoro. On the inside of the curved atolls, there are shallow lagoons with coral reefs, while deep, open ocean is found on the outsides of the atolls.

6.18 Most of the islands in Kiribati rise only a metre or two above the ocean. This low tide view shows some small islands that form part of Tarawa Atoll in the Abatao district.

The adjective of Kiribati, which is also used to identify people who live in Kiribati, is I-Kiribati (pronounced *E-Kirri-bass*). Kiribati has a **population** of 105,000 people, 50.7% of whom are female and 49.3% male. The **median age** of I-Kiribati people is 24.9 years, with 35% of the population being aged 14 years and below. The percentage of young people is growing, reflecting the country's **high birth rate** of 29 births per 1,000 people per annum.

The **highest population density** is on South Tarawa atoll in the Gilbert group, which is where the country's capital (Tarawa) is located. With an area of just 15.8 square kilometres, South Tarawa houses 48.7% of Kiribati's population, giving a population density of about 3,250 people per square kilometre. Population pressure and lifestyle choices in South Tarawa have already strained the area's **scarce water resources**, as the consumption of groundwater stores from the small underground lenses is exceeding the capacity of the groundwater to recharge.

6.19 Although Kiribati's main freshwater water reserves are stored as sub-surface groundwater, some small ponds such as this one in Teaoraereke supplement water resources for residents in small communities.

High population density in Tarawa also results in a build-up of **non-biodegradable wastes** as Kiribati has no waste collection service or sanitation management. Wastes from traditional foods were discarded on the beaches where they would decompose or be washed away by the ocean. However, a switch in preferences towards imported processed foods means that wastes no longer decompose, and Tarawa's beaches are now typically covered by large quantities of rubbish

6.20 Rubbish on the beach at Bairiki, Kiribati's political and administrative capital. The causeway in the background connects Bairiki Island to Betio island, which is where the main port is located.

(including plastics) that cause **water pollution** and are responsible for an increase in diarrhoeal and vector-borne **diseases**.

The second most populated atoll is Kiritimati (pronounced Christmas) in the Line Islands. With an area of 388 square kilometres, Kiritimati is the world's largest coral atoll, and it has a population of 6,500 people.

Kiribati's economy

Kiribati is a fairly **poor country** with a GNI per capita of US$3,390. There is **negligible agriculture** because of the poor quality of soils on the coral atolls, although there is some subsistence production of coconuts, breadfruit, pandanus and swamp taro. About 80% of the population is **unemployed.** Most I-Kiribati who are employed work in public service jobs for the government, the majority of which are funded by foreign aid. The country has three main sources of **foreign income: foreign aid** (mainly from Australia, New Zealand and Taiwan), **fishing rights** that permit foreign vessels (mainly from Japan, South Korea and Taiwan) to fish in I-Kiribati waters, and **remittances** from I-Kiribati living overseas.

Despite its location in the Pacific Ocean, Kiribati has almost **no tourism**. This is because there are no attractive beaches, no diving facilities, infrequent transport connections with other countries and poor infrastructure. Kiribati has been categorised by the United Nations as both a '**Small Island Developing State**' and a '**Least Developed Country**'.

Kiribati's climate

The climate of Kiribati is **hot, humid and tropical** with an average air **temperature** of 28.3°C that does not vary by more than 1C° throughout the year. The average annual **rainfall** in Tarawa is 2,100mm, most of which falls during the wet season that lasts from November to April. However, the climate of Kiribati is highly **variable.** In dry years, Tarawa may receive as little as 150mm of rain, and in wet years, rainfall may be as high as 4,000mm. The highly porous coral soils in Kiribati cannot retain moisture, so the highly variable rainfall poses problems for **water availability** and **water quality**, and thus people's health and livelihoods.

The main reason for Kiribati's variable climate is fluctuations in the **ENSO** (El Niño-Southern Oscillation). Because of its equatorial location, I-Kiribati islands become significantly warmer and wetter during an El Niño event, but cooler and drier during a La Niña event. The combination of Kiribati's fragile economy and fragile environment mean the country is **highly vulnerable** to both El Niño and La Niña events, with **little resilience** or capacity to manage or absorb climate hazard events.

Impacts and risks from climate change

Perhaps no country in the world is more threatened by the impact of climate change than Kiribati. The climate of Kiribati is changing and is expected to continue changing in the future. The changes that have been **observed** in Kiribati's climate are detailed in table 6.2, together with the climate changes that are **projected** in future decades.

The cause of most of the changes detailed in table 6.2 can be traced back to increasing concentrations of greenhouse gases in the atmosphere. The **enhanced greenhouse effect** is causing climates to warm around the world, including Kiribati.

For I-Kiribati people, the most alarming consequences of climate change relate to **rising sea levels**, caused by the combined impact of thermal expansion of warming water and the melting of glaciers and ice sheets. As shown in table 6.3, sea levels in Kiribati are expected to rise between 16cm and 58cm by 2090, depending on the level of

Table 6.2

Climate trends observed in Kiribati from 1950 to the present, and projected climate trends through the 21st century

Climate variable	Observed climate trends in Kiribati since 1950	Projected climate trends in Kiribati to 2100
Air temperature	Annual and seasonal mean air temperatures are getting warmer: • Maximum temperatures have increased at a rate of 0.18C° per decade. • Annual and seasonal minimum air temperatures have increased slightly more than the increase in maximum air temperatures.	Surface air temperature will continue to increase (very high confidence). Under a high emission scenario: • Annual and seasonal mean temperature will increase by 0.3-1.3C° in the Gilbert Islands and by 0.4-1.2C° in the Phoenix and Line Islands by 2030 (high confidence). • Annual temperature increases could be greater than 3C° by 2090 (moderate confidence). As there is no consistency in projections for future ENSO activity, it is not possible to project interannual variability in temperature.
Sea-surface temperature	Water temperatures have risen since the 1970s: • in the Gilbert Islands by approximately 0.15C° per decade. • in the Line Islands by approximately 0.10C° per decade. • in the Phoenix Islands by approximately 0.12C° per decade. Since 1950 the rise has been gradual in the waters around the Gilbert Islands, but it has been variable from one decade to the next in the Line and Phoenix Islands.	Sea-surface temperature will continue to increase (very high confidence): • Sea-surface temperatures will increase by 0.6-0.8C° by 2035 and by 1.2-2.7C° by 2100. As there is no consistency in projections for future ENSO activity, it is not possible to project interannual variability in sea-surface temperature.
Rainfall	Annual rainfall has increased: • Annual and wet season rainfall has increased for Kiritimati, but there have been no changes in the dry season. • At Tarawa, rainfall measurements show no clear trends. • At both Kiritimati and Tarawa, rainfall has varied substantially from year to year.	Rainfall patterns will change: • Wet season, dry season and annual average rainfall will increase (high confidence). • Annual and seasonal mean rainfall will increase (>5%) by 2030. The majority of models simulate a large increase (>15%) by 2090 (low confidence).
Extreme events	• Tropical cyclones (hurricanes) rarely pass through Kiribati. • Between 1969-70 and 2009-10, three hurricanes passed within 400 kilometres of Arorae Island in western Kiribati and three hurricanes passed within 400 kilometres of Caroline Island in eastern Kiribati. • Storm surges and extreme sea levels occur occasionally.	There will be more extreme rainfall and more very hot days: • The intensity and frequency of days with extreme heat and warm nights will increase, and cooler weather will decline (very high confidence). • The intensity and frequency of days with extreme rainfall will increase (high confidence).
Droughts	The impact of droughts, usually associated with La Niña, can be severe in Kiribati; for example: • In 1971, 1985, 1998 and 1999 annual rainfall was less than 750mm. • The drought from April 2007 to early 2009 severely affected the southern islands of Kiribati and Banaba. During this period, groundwater turned brackish and the leaves of most plants turned yellow.	The incidence of drought will decrease (moderate confidence): • In the Gilbert, Phoenix and Line Islands, mild drought will occur approximately seven to eight times every 20 years by 2030, decreasing to six to seven times by 2090 (low confidence). • The frequency of moderate drought is projected to decrease from two or three times every 20 years by 2030 to once or twice by 2090 (low confidence). • Severe drought will occur approximately once or twice every 20 years by 2030, decreasing to once every 20 years by 2055 and 2090 (low confidence).
Sea level	Sea level has risen: • Sea level measured by satellite altimeters has risen by 1 to 4mm per year (global average is 3.2 ± 0.4mm per year). • Sea level rise naturally fluctuates from year to year at levels of about 260mm. There are also decade-to-decade fluctuations. These fluctuations over both timeframes are the result of phenomena such as ENSO.	Mean sea level is projected to continue to rise (very high confidence): • Mean sea level will rise by approximately 5-15cm by 2030 and 20-60cm by 2090 under the higher emissions scenario (moderate confidence). • The sea level rise combined with natural year-to-year changes will increase the impact of storm surges and coastal flooding. Scientists warn that due to the melting of large ice sheets such as those in Antarctica and Greenland, rise could possibly be larger than predicted. However, not enough is currently known to make predictions confidently.
Ocean acidification	Ocean acidification has been increasing: • Since the 18th century, the ocean has been slowly getting more acidic. The aragonite saturation state has declined from about 4.5 in the late 18th century to an observed value of about 3.9 ± 0.1 in 2000.	The acidification of the ocean will continue to increase (very high confidence): • The annual maximum aragonite saturation state will reach values below 3.5 by about 2045 in the Gilbert Islands, by about 2030 in the Line Islands, and by about 2055 in the Phoenix Islands. The aragonite saturation will continue to decline thereafter (moderate confidence). • Ocean pH will decrease by -0.1 units by 2035 and by -0.2 to -0.3 units by 2100. • Coral reefs are projected to degrade progressively with losses of live coral of >25% by 2035 and >50% by 2050 due to rising sea-surface temperatures and more acidic oceans.

Source: Government of Kiribati (2014) *Kiribati Joint Implementation Plan for Climate Change and Disaster Risk Management (KJIP), 2014-2023*. pp.21, 23

Table 6.3

Climate change projections for Kiribati under different emissions scenarios

Climate variable and emission scenario	Time frame		
	2030	2055	2090
Temperature (change relative to the average of the period 1989 to 1999, Kiribati recorded data) in Celsius degrees C°.			
Low emissions	0.2 - 1.2	0.6 - 1.9	1.0 - 2.4
Medium emissions	0.2 - 1.4	0.9 - 2.3	1.6 - 3.5
High emissions	0.3 - 1.3	1.0 - 2.2	2.2 - 3.8
Sea-level rise (change relative to the average of the period 1989 to 1999) in centimetres.			
Low emissions	4 - 13	9 - 25	16 - 45
Medium emissions	5 - 14	10 - 28	19 - 57
High emissions	5 - 14	10 - 29	20 - 58

Source: Government of Kiribati (2014) *Kiribati Joint Implementation Plan for Climate Change and Disaster Risk Management (KJIP), 2014-2023.* pp.24.

6.21 The seawall at Betio Harbour was breached by wave attack during a storm, allowing waves to intrude and erode the coral sand foundations of this factory. As the sand was eroded, the factory partially collapsed.

6.22 This house in Bikenikora village was destroyed by wave attack after the seawall that was built protect it from wave attack was undermined and destroyed. The remains of the seawall can be still seen in the background.

greenhouse gas emissions in the coming decades. For a country that has an average elevation of just two metres (200cm), the possibility of a rise in sea level of 58cm is alarming as it would be enough to make the country uninhabitable.

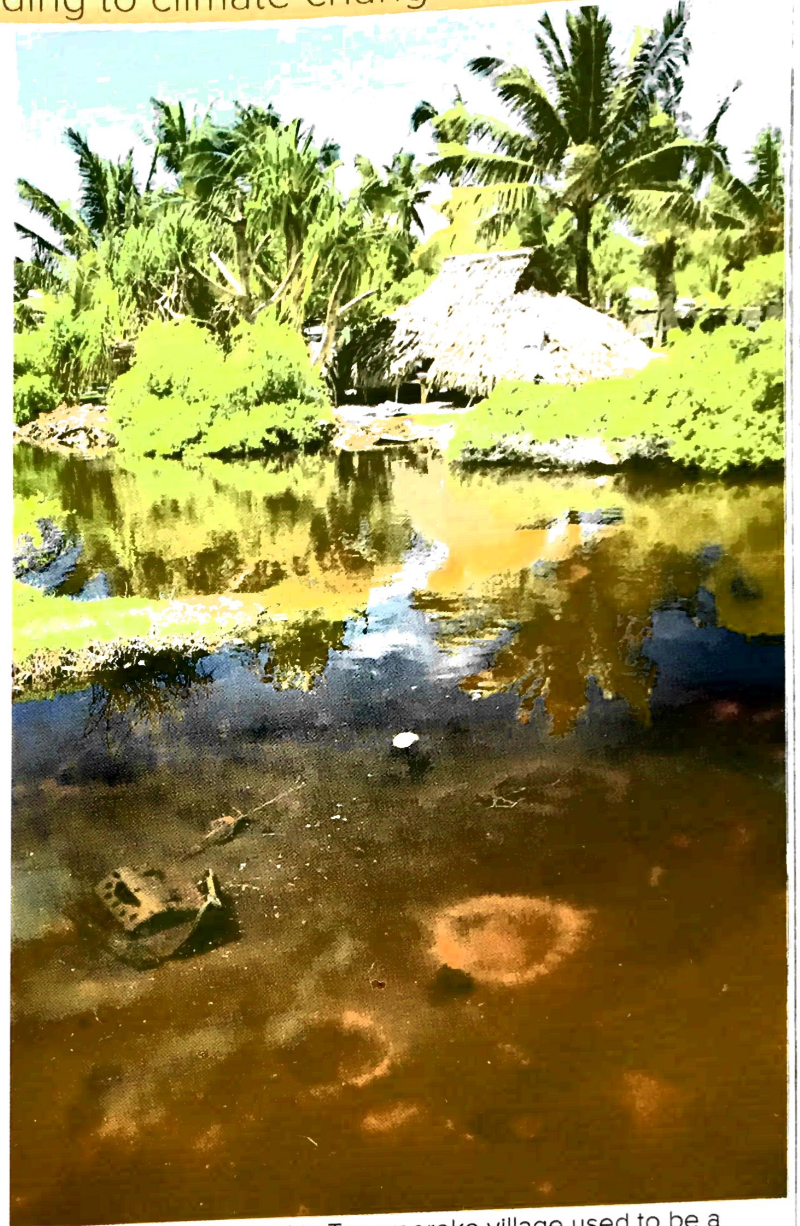
Even today, Tarawa experiences changes in sea level of about 0.5 metres, especially during tidal fluctuations that are caused by **ENSO events**. When high tides combine with spring tides, the sea level can rise as much as 2.8 metres, **flooding** most of the country and **damaging infrastructure** and property. Erosion of roads, houses, seawalls and other infrastructure is a growing problem in Kiribati.

Regular diurnal tidal fluctuations already flood parts of some villages at high tide twice each day, making **cultivation** impossible because of the salt water and rendering **transport** difficult as residents have to walk waist-deep in seawater to get from one part of a village to another. Several **houses have been destroyed** during storm surges by wave attack, and many residents have been forced to **build sea walls** to protect their homes from further wave attack. Rising sea levels are not only a flood threat, but higher seas add energy to waves during every storm that lead to widespread **erosion** of land and **undermining** of houses and roads.

Rising sea levels is affecting Kiribati's **scarce water reserves.** Kiribati has no surface dams or water reservoirs, and many people collect rainwater from their roofs in tanks. Many poorer residents cannot afford a rainwater tank and they rely on rainwater

6.23 Large sections of Buota Island are covered by seawater, even at low tide.

6.24 During every high tide in Bikenikora, seawater floods much of the central area of the village, forcing residents to wade through water that waist-high to get from one side of the village to the other.



6.25 This brackish pond in Teaoraereke village used to be a store of freshwater until rising sea levels forced salt water into the pond.

6.26 The tall stumps are palm trees in Bikenikora village that were killed when salt water seeped through the sand into the root zone. Seepage occurred as rising sea levels gave the saline ocean water increased gravitational force to penetrate the nearby sand.

from small land depressions. The porous, infertile, coral-based soils of Kiribati cannot hold water, so there are very few natural depressions where freshwater can be stored. Unfortunately, as sea levels rise, the hydraulic pressure causes **saltwater encroachment** as the nearby seawater rises and seeps through the porous soils into the freshwater ponds, salinising the water and making it unusable for human or animal consumption. Saltwater encroachment also enables saline water to seep into the root zone of trees and plants, and this has caused the **death of some palm** trees in Kiribati, most of which are food-producing species.

Rising sea levels also pose a **tsunami threat** to Kiribati. Although Kiribati is not in an earthquake zone, plate boundaries known as the Ring of Fire surround the Pacific Ocean. An earthquake anywhere on the Ring of Fire could trigger a tsunami that would completely obliterate Kiribati as sea levels rise. The risk of exposure to tsunamis varies from island to island in Kiribati as the atolls are widely dispersed and the shape of the surrounding seabed varies enormously.

Ocean acidification associated with climate change is another problem for Kiribati. Almost all Kiribati's land area has been formed from coral atolls, which are calcium carbonate that dissolves in acid. The seas around Kiribati are becoming more acidic, and this is shown by a decline in the **aragonite saturation rate**. Aragonite is one of the two common, naturally occurring forms of calcium carbonate, and it is formed by several biological and physical processes that include secretions from marine organisms.

Seawater aragonite saturation rates above 4.0 are optimal for coral growth and for the development of healthy reef ecosystems. Aragonite saturation values of 3.5 to 4.0 are adequate for coral growth, and values between 3.0 and 3.5 are marginal. Coral reef ecosystems are not found when seawater aragonite saturation states fall below 3.0. Kiribati's aragonite saturation rate has declined from 4.5 in the late 1700s to 3.9 today, and it is expected to decline further to less than 3.5 in the coming decades. This will **threaten the growth of coral** that sustains the atolls, **weakening resistance** to erosion and rising sea levels.

Kiribati experiences **drought conditions** during La Niña events as the clouds which often cover Kiribati migrate to the south-west, leaving a dry air mass over Kiribati. When Kiribati experiences droughts, **groundwater turns brackish** (slightly saline) as seawater intrudes, and many of the country's fruit-bearing **palm trees die**. If future predictions are correct, the frequency and intensity of droughts should **decline** in coming decades.

The effects of climate change and climate-related disasters are felt first and most acutely by **vulnerable and marginalised** members of the population, including women, children, youth, people with disabilities, minorities, the elderly and the urban poor. Violence against women and children is widespread within I-Kiribati society, and this is exacerbated in times of disaster when normal social protections may be missing or paralysed.

Responses to climate change

With its high rate of unemployment and low rate of secondary education, Kiribati's population is **poorly placed** to show initiative in responding to the threats and risks posed by climate change. Therefore, much of the drive to address the challenges of climate change begins with the **I-Kiribati Government**.

Anote Tong, who was Kiribati's President from 2003 to 2016, has been a passionate advocate of Kiribati's plight on the international stage, where he announced that I-Kiribati people will begin leaving Kiribati as **climate refugees** in 2020 when he predicted rising sea levels would be making life too difficult. Under Tong's presidency, Kiribati **purchased** an area of 20 square kilometres of land

6.27 A sandbag-and-cement seawall (background) has been partially washed away, so local residents have responded by erecting a barrier of old, disused metal gas bottles to absorb wave energy. This seawall is in Teaoraereke village.

6.28 Wave action has undercut a sea wall that was protecting the main road between Bonriki and Bairiki.

in Fiji in 2014 as a **contingency refuge** for I-Kiribati people who may be forced from their homes by rising sea levels.

A significant response by the I-Kiribati Government to rising sea levels has been to co-ordinate an extensive program of **building seawalls**. Most of the seawalls in Kiribati are made from bags of sand that are cemented together by teams of local people who are brought together and employed on a short-term basis. Other seawalls are built without government co-ordination by local communities. These community seawalls are usually more basic, being built from freely available materials such as lumps of coral, pandanus branches and leaves, old rubber tyres and discarded bottles.

The seawalls are a **controversial** solution to rising sea levels. Many people see them as an **essential defence** against flooding and erosion by wave attack. On the other hand, they are also seen as a **temporary response** because they cannot hold back rising seas for ever. Some I-Kiribati people therefore argue that it is a **misguided** and **futile** use of scarce financial resources to build seawalls for a country that will be underwater within a century.

One of the problems with seawalls is that they reflect wave energy back to the ocean, and this can **aggravate erosion** in front of the seawall. As the Shoreline Protection Guidelines of Kiribati state: "Seawalls can sometimes increase the rate of erosion in front of the seawall due to wave reflection and at the ends of the structure caused by wave focussing. When all available sediment has been removed in front of the wall, down drift areas will no longer receive sediment and erosion may be

6.29 This seawall on the northern side of Betio Island has been washed away, allowing waves to erode a substantial area of land that was behind the wall.

6.31 Workers repair a section of seawall that has been undermined, forcing it to collapse near Red Beach, Betio Island.

6.30 This seawall at Bairiki has been almost completely washed away, allowing the ocean water to inundate land that was previously about one metre above sea level.

6.32 A large section of seawall has collapsed in the face of wave attack, and a large group of about 30 workers is filling bags with sand before sealing the bags and cementing them in place to built a new seawall.

6.33 A new seawall being built on Betio Island.

6.34 Mangroves have been planted at Bonriki to stabilise the shoreline in the face of rising sea levels.

accelerated as a result of building the wall". This erosion may cause a seawall to become **undermined** by waves, causing it to **collapse**, which explains why **repairing damaged seawalls** is a significant, ongoing activity in Kiribati.

The people in one village on Abaiang Island near Tarawa, Aonobuaka, have made a community-wide decision to **ban seawalls** because of the erosion they caused to neighbouring properties. Rather than building seawalls, households in Aonobuaka have agreed to **construct fences** using tree branches, palm fronds and coconut fibre string to protect their beaches. Although these are **less effective** in preventing beach erosion and are easily damaged by wave attack, they are **easily replaced** and they have **solved the social friction** and disputes that were caused when one family's seawall caused erosion of their neighbours' land.

Coral atolls in Kiribati are long, thin formations that curve around a shallow lagoon on one side and face the open ocean on the other side. On the shallow lagoon side of atolls, an alternative to seawall construction is **planting mangroves**. Mangroves slow down and disperse incoming waves, **absorbing wave energy** and causing sediments to be deposited around the plants. An additional benefit of planting mangroves is that they provide a **habitat for marine species** that I-Kiribati people depend on for their livelihoods. They contribute to the carbon cycle by **absorbing carbon dioxide**, they act as **buffers** to storm surges and they **filter nutrient runoff** from the land, **reducing ocean pollution**. Unlike seawalls, mangroves are also relatively **maintenance-free**.

Almost 40,000 mangroves have been planted in Kiribati under the Government's supervision using plants that were jointly funded by the World Bank, GEF (the Global Environment Facility), AusAID (the Australian Agency for International Development) and the New Zealand Aid program.

In an effort to co-ordinate Kiribati's response to the threats posed by climate change, the Kiribati Government has developed a comprehensive **strategy** to identify and address the perceived risks. Known as the Kiribati Joint National Action Plan on Climate Change and Disaster Risk Management Implementation Plan (KJIP), the strategy covers the period to 2023 with the stated goal of "increasing resilience through sustainable climate change adaptation and disaster risk reduction using a whole of country approach".

The KJIP identifies **12 major strategies** (with the estimated percentage that each strategy will cost shown in parentheses, allowing 2% for flexibility):

- Strengthening good **governance**, policies, strategies and legislation (6%);
- Improving **knowledge** and information generation, management and sharing (5%);
- Strengthening and greening the **private sector**, including small-scale business (4%);
- Increasing **water and food security** with integrated sector-specific approaches and promoting healthy and resilient ecosystems (4%);
- Strengthening **health service delivery** to address climate change impacts (2%);
- Promoting sound and reliable **infrastructure** development and land management (50%);

- Delivering appropriate **education**, training and awareness programs (7%);
- Increasing effectiveness and efficiency of early warning and disaster and **emergency management** (4%);
- Promoting the use of sustainable, renewable sources of **energy** and energy efficiency (11%);
- Strengthening capacity to access **finance**, monitor expenditures and maintain strong partnerships (2%);
- Maintaining the existing sovereignty and unique **identity** of Kiribati (1%); and
- Enhancing the participation and resilience of **vulnerable groups** (2%).

The **estimated cost** of the KJIP to 2023 is US$75 million, almost all of which will be funded through **international aid programs**. Significant donors for components of the KJIP include the Asian Development Bank (ADB), AusAID, the European Union (EU), German Development Co-operation, Global Climate Change Alliance (SPC), New Zealand Aid Program, various NGOs such as Plan International, UNDP, UNESCO, UNICEF, and the World Bank.