# Kiribati

## Background

Kiribati consists of three main island groups scattered over three million km$^2$ of sea in the Central Pacific, between 4°N and 3°S, and 172° E to 157° W. The total land area is 810.8 km$^2$, divided into 33 low-lying coral islands, 10 of which are coral atolls.

The Gilbert Group consists of 17 islands (including Banaba, or Ocean Island) with a total land area of 285.7 km$^2$. Tarawa atoll, in the Gilbert Group, where the capital is located, consists of more than 20 named islets, six of which, in the south, are linked by causeways.

The Phoenix Group consists of eight largely uninhabited islands with a total land area of just 28.6 km$^2$, located some 1750 km east of Tarawa. The only inhabited island of the Phoenix group is Kanton (Canton) Island with a land area of 9 km$^2$.

The Line Group consists of eight islands with a total land area of 496.5 km$^2$, extending over a 2,100 km north-south line, between 3,280 and 4,210 km east of Tarawa, beginning some 800 km south of Hawaii. This Group includes the largest island in Kiribati, Christmas Island (Kiritimati), with an area of 388.4 km$^2$.

Kiribati exemplifies to an extreme degree the development challenges facing a small, remote and resource-poor island state during a period of rapid global change. Basic development indicators (for health, education, life expectancy, etc.) are among the poorest in the Pacific Islands subregion. There is a high degree of vulnerability to external events. The environment is fragile and - particularly in rapidly-growing urban South Tarawa - deteriorating. There is considerable difficulty in providing adequate basic services to its people, especially the outer island rural majority. Despite this, the I-Kiribati - the people of Kiribati - have the advantages of a strong and resilient culture, a highly egalitarian society, strong democratic principles, extensive sea resources, and a record of prudent fiscal management. With well-planned, carefully-targeted and soundly implemented external assistance in support of sound government policies, the quality of life of the I-Kiribati can be expected to improve over time.

The total population of Kiribati according to the November 2000 census is 84,494, 92.4% of which live in the Gilbert Group of islands. The population of South Tarawa is 36,470, which is 43 % of the national total.

## Water resources and supply

There are two major potable water sources in the country; namely groundwater and rainwater. The major water source being groundwater occurring in the form of a water lens below the islands where the width of island is sufficient for it to form, as a result of rainwater infiltration. Rainwater is also used in the form of collected rainfall.

The main water supply for South Tarawa is piped from a subterranean water lens in the northern part of the atoll. This limited supply is over-stressed by poor reticulation to homes, growing demand and illegal connections, is threatened by housing encroachment onto land above the water lens and the widespread use of inappropriately located pit toilets, water-seal toilets, and (less often) septic tanks.

Relatively few houses have rainwater catchment tanks. Although well water is used mainly for washing, contaminated drinking water is a common source of illness.
Rainfall varies between the islands, and from year to year. Droughts of up to 16 months duration are relatively common when as little as 200mm may fall in a year. There is also a large

difference between the islands in terms of rainfall average and distribution patterns. For instance, the annual rainfall in the Gilberts ranges from 1300mm near the equator to 2000mm on Tarawa, and over 3000mm in the northernmost islands.

Using rainfall as a source of water for drinking and other purposes has been the practice in Kiribati for many years. Water tanks of all sorts of materials and sizes have been installed by individuals and by public institutions to collect rainwater through roof gutters. The importance of collecting rainwater has long been recognised by the I-Kiribati, as shown by the recent enactment of regulations obliging house owners to construct gutters and tanks for the collection and storage of rainwater.

In principle, this collection of rainwater is a more efficient way of freshwater production than groundwater extraction, since fresh groundwater can only be extracted where sizeable lenses occur, and then only a small percentage of the mean annual rainfall on these lenses can be safely extracted over the long term. Rainwater catchments, by comparison, may catch up to 90% of the precipitation.

However, due to the unevenness of precipitation, frequently manifested in months-long droughts, the exploitation of rainwater for consumption requires construction of large storage facilities, whereas the atoll aquifers although relatively small in size, and sensitive to improper extraction have an inherent storage capacity that enables a constant withdrawal of their sustainable yield.

Consequently, rainwater collection can be regarded as a supplementary rather than a main source of water, as the storage tanks that are affordable by individuals and by institutions, do not have sufficient volume to store and supply water during prolonged droughts.

While freshwater lenses of sufficient yield appear to exist on all the Outer Islands, it is only on South Tarawa that utilising rainfall, as an additional source of water during prolonged droughts is considered economic in water production planning.

Significant quantities of usable groundwater are limited to the larger islands, where lenses of freshwater floating on seawater have developed underground. These “lenses” only occur where the central area of coral sands and rock is sufficiently wide, and the thickness is limited by the head of freshwater above sea level. The lenses are recharged through local rainfall, with the rate of permeation being high on porous ground. Some is lost by evaporation, particularly where there is vegetation, and the recharge rate is by the migration of fresh water towards the sea and through mixing with the underlying saline water.

These lenses are not symmetrical, being thicker towards the lagoon than towards the ocean due to the difference in permeability between the coarser-grained sediments usually occurring on the ocean side, and the finer-grained sediments on the lagoon side of the atoll. Other factors include the thickness of vegetation, and the rate of water extraction from the aquifer.

To date hydrogeological investigations have concentrated on Tarawa atoll and Kiritimati (Christmas) Island and have included drilling, geo-electrical soundings, water level observations, chemical and bacteriological analysis, pumping tests, analysis of rainfall and evaporation records and mathematical simulation of selected lenses under different extraction scenarios. In the Outer Islands some geo-electrical sounding has been carried out to identify exploitable lenses. Recent studies indicate that rainfall of greater than 50mm/day results in a capture of 17% of the total rainfall.

There are various types of water supply schemes found in Kiribati and include shallow wells and hand-pumps located in the villages and islands however there is no monitoring or recording of their operational status.

Open hand-dug wells are the traditional method used to obtain freshwater for basic needs. They are normally just a few meters deep, reaching the groundwater table, and are easily dug, supported by stonewalls and uncovered, leaving them open to contamination. They are often dug near to dwellings for convenience, but this exposes them to fouling by domestic animals and waste. Moreover, with the introduction of pit latrines in recent years, their proximity to the wells has caused many to become unsafe for drinking through cross-contamination, and in high-density housing areas old open dug wells have become a severe health hazard and must be earth filled and abandoned.

With the assistance of government and donor agencies, improvements have been made to these wells with supporting walls above the ground and a concrete apron and cover. Some of these wells have been equipped with a hand pump, mounted on top of the concrete cover, and while many of these pumps rapidly fall into disrepair, a simple diaphragm pump has proved to be reliable, and instruction in their manufacture and maintenance is being promoted.

This pump has proved to be the most effective and affordable method of extracting water from shallow wells, and will reduce the risk of transmitting disease through the traditional method of dipping a bucket in the well, however, these wells are still located too close to pit latrines.

Mainly on Kiritimati Island there are several open trenches some 150 m long and 3 m wide, dug to 50cm below the water table, from which diesel-operated pumps extract water. The sides of the trenches are supported by slabs of coral and are often covered with sheet metal or timber boards. Nevertheless, they are still open to contamination like the covered dug wells.

A more advanced design introduced in recent years uses in addition to a hand-dug well, a slotted plastic pipe, called a gallery, extending on either side of the well. This pipe is laid it a depth of 30-50cm below water level and the trench filled with gravel. The well and the gallery are located a few hundred meters away from the village in order to distance the source of water from sources of contamination, and to extract the water from the lens at a location where it is thickest. The freshwater is thus skimmed from the uppermost layer of the lens and from a larger water-table area, reducing the risk of “up-coning” of the underlying seawater.

Extraction of water from the well is by several methods. Simple diaphragm hand pumps are installed at convenient supply points in the village and suck the water from the well for a distance of up to 750m and are suitable for the conditions typical of a coral island; low, near-flat topography and small depths to the water table. Such systems consist of up to three pumps extracting water through a single main, each capable of supplying 10 families. The pumps are reliable and relatively easy to maintain with most problems attributable to air leakage.

With solar systems, electricity for the pump is generated by a set of photovoltaic panels, without a the use of a battery, and output is calculated on a conservative estimate of just 4 hours of sunshine per day. To supplement the supply during periods of little or no sunshine the design includes installation of gutters on roofs adjacent, and connected to ferro-cement or concrete block tanks raised on blocks.

A system of this type costs on average A$36,500, or A$105 per person and two villages on Tabiteuea North Island, 7 villages on Nikunau Island and one each on Arorae and Tamana Islands have been provided with systems funded by donor agencies.

Windmill pump designs have been erected in systems where later, solar pumps were installed to supplement or substitute the wind pumps; one or two still operate in a village on Arorae Island and one wind pump operates in a village on Tabiteuea South.

The New Zealand and Australian governments installed a basic reticulation system for South Tarawa in the early 1970’s providing water through public standpipes, however the increasing

population lead to an outbreak of cholera, and the Australian government funded the extension of a reticulated supply to the whole population. Water is supplied from galleries in two freshwater lenses, chlorinated, and distributed through a rising main extending along the South Tarawa island chain into storage tanks or ground level reservoirs

Extensive hydrogeological investigations, estimated the sustainable yield of the two lenses at 1300 $m^3$/day, which supplies a population of some 26,000, the port, hospital and several other large consumers. Delivery is restricted to 7 hours per day, while pumping from the lens remains constant. In the same area, seawater is piped inland to flush toilets and to dispose of the waste at sea. The increasing population in South Tarawa is placing strain on the limited water resources available, as most of the closest, suitable freshwater lenses have been utilised and extension to the lenses of North Tarawa would involve considerable cost. Compounding the situation is the under-utilisation of rainwater, with many houses and other buildings without rainwater collection facilities or in disrepair. Another issue is that of squatters on the water reserves with indications of pollution of the lenses.

The proximity of populated areas to the freshwater lenses, poses a threat to the quality of ground water and one of the principles of the design of improved systems for rural communities is to locate the source of water at a safe distance from the village and to provide latrines to prevent human excreta from being widely dispersed. Testing indicates that animal or human waste is polluting water lenses. The eviction of squatters and the declaration of water reserves have been partially successful, but may result in higher costs of compensation and lease payments and negotiations are continuing. One reserve is near the airport and there is concern that fuel and oil are contaminating the water, and any upgrade or expansion is likely to exacerbate the situation and would require barrier measures to prevent such pollution reaching the aquifer.

Chlorination is the only treatment applied to the water in South Tarawa. The water is chlorinated at source and at the farthest section of the system. However, the presence of hydrogen sulphide in the water makes chlorination ineffective as the majority of the chlorine dose is used to oxidise the hydrogen sulphide before it disinfects the water. It is proposed that an aeration chamber is incorporated before application of the chlorine. For rural water systems with the source some distance from the village it does not appear necessary to chlorinate the water. The WHO Drinking Water Quality Guidelines are being used in the absence of country specific water quality standards, however water quality data is non-existent, missing or difficult to locate. Lack of data also hampers estimates of safe water coverage, but for South Tarawa it is estimated at about 61%, and for rural areas it is estimated to be around 55%.

In rural areas water is provided free to people living in the outer islands while on South Tarawa the cost of water is charged on a flat rate basis to domestic users of approximately AUD$2.00 per 1000 litres. Commercial and industrial users are charged on a volumetric basis.

Food-borne and insect or animal-borne diseases are the other major causes of illness. There is only limited information available on food security and nutrition but highly processed, imported, nutrition-poor foods are quite common.

The major pollution sources for the water supply systems are from pit latrines, septic tanks, leaks from the sewer pipes and piggery effluents. On North Tarawa and most outer islands, the effects are minimal as the water sources are located in a designated unpopulated area. However, on South Tarawa traditional landowners of designated water reserve areas are demanding compensation and some still reside on the water reserve, and the Government is working on strategies for them to vacate this land.

Sanitation is generally poor throughout South Tarawa, especially on the islet of Betio. Traditionally, the I-Kiribati uses the sea as their toilet. On the sparsely populated outer islands, this poses little public health risk. On South Tarawa, 53% of households regularly use the ocean

beach or the lagoon beach (where fresh sea water circulates much more slowly) as their toilet. This is an improvement over 1995 but continues to put health at risk.

The most common types of toilet facilities are pit latrines, compost and pour flush toilets (septic tank and sewerage system) However, the use of compost toilets is not widely accepted, and a survey indicated that only 6% of the South Tarawa population uses this type of toilet.

The only sewerage system serves major centres on South Tarawa and raw sewage is disposed of into the ocean without treatment except for maceration by sewage pumps. Advanced wastewater treatment facilities are owned and operated by private companies assisted by the Public Utilities Board for maintenance.

Other sanitation problems include high volumes of uncollected household garbage, the prevalence of such toxic pollutants as waste oils and chemicals, and large numbers of derelict vehicles and machinery. Food-borne and insect or animal-borne diseases are other major causes of illness. An important source of food-borne disease, especially on South Tarawa, is shellfish from lagoon waters that have been polluted by sewage. Flies, mosquitoes, and scavenging dogs and pigs are other disease vectors. For water-borne disease, an increasing national trend over time (with recent declines) is evident.

Solid waste management is the responsibility of the local council who collect garbage and dispose of it in designated landfills. The landfills are to be improved under an ADB loan. This applies only on South Tarawa where households are charged. In the outer islands households manage their own solid waste.

## Water quality surveillance and monitoring

The key agencies responsible for water supply in Kiribati are:

- The Public Works Department (PWD) who provide overall coordination of major water development works and support the operation and maintenance of rural water supplies,
- Ministry of Environment and Social Development Urban Rural Community Participation
- Public Health Department of the Ministry of Health (MoH), responsible for water quality monitoring and health education
- Public Utilities Board for the operation and maintenance of water supply.

Major donors involved in water supply include: AUSAID, Asian Development Bank (ADB), JICA, UNDP and SPC while the World Health Organization (WHO) has been involved in the provision of materials for water well improvement, and provision of pit latrines in the outer islands of the Gilbert group and is currently assisting in the provision of water quality monitoring equipment to the MoH.

Water quality surveillance monitoring programmes in Kiribati is carried out by three agencies:

- Public Utilities Board (PUB) for urban water supplies,
- Public Works Department (PWD) responsible for urban and rural water supplies
- Public Health Department Ministry of Health (MOH) responsible for urban and rural water supplies

The PWD and PUB perform tests for some physical and chemical parameters for both system efficiency and for development and design. The PWD tests rural water and the PUB urban water supplies while the MOH performs bacteriological and physical and chemical testing for public health purposes in both the urban and rural water supplies and sea water. Sampling frequency is agency specific, but focuses on reticulated urban supplies. Very little monitoring is done in the rural areas or outer islands

The Ministry of Health laboratory is based at the Central Hospital in Tarawa and carries out sampling and bacteriological analyses of water samples once a month, from several sampling

points in the South Tarawa reticulated system, and annually from selected points in the outer islands. In urban areas water monitoring is carried out under an arrangement with the PUB, and in the outer islands in conjunction with the routine visits of health inspectors.

The only laboratory, which handles water samples in Kiribati, is located in the Betio Hospital manned by one full time technician. Although the laboratory has the facilities to undertake tests on major microbiological, physical and chemical parameters this lack of staff and resources limits testing.

Testing by the MoH has shown that water supplied by the Tarawa Water Supply System (TWSS) is of good quality and can be attributed to the fact that the water sources are located in uninhabited areas and that the water is chlorinated both at the source and in the reticulation system. Though no similar results are available from Outer Island systems water quality in such systems should also be good, since they too utilize groundwater from areas located away from population centres. However, open pits in these areas are prone to contamination and that these unprotected water sources and individual rainwater catchments do not meet WHO guidelines.

Despite the apparent good water quality, a recent WHO report found that the leading cause of death in Kiribati continues to be diarrhoea, reflecting the poor condition of the water supply and sewerage systems particularly in high-density urban fringe areas of South Tarawa, and in rural areas where many people still use unprotected dug wells near sewage pits and poorly maintained toilet facilities, making them prone to various diseases.

As well as diarrhoea, the data indicates high levels of ill-defined intestinal infections, the highest incidence occurring in the age group up to four years, with between 500 and 1000 cases per 1000 children. However, this high Incidence of diarrhoea has in recent years begun to decrease. This may be due to factors other than an improved water supply such as health and health-related intervention programmes and under-reporting, which is common.

Concern has been expressed by WHO health experts that the frequent emptying of the TWSS pipelines during daily water shut-off periods may cause bacteriological pollution through the seepage of contaminated groundwater into empty pipes, however, there have been no indication that this is actually happening, and is only expected to occur in reticulation systems not in the main transmission line.

The main chemical concern is salinity of the water and the WHO guideline value of 600-mg/l chloride is considered reasonable. In the Outer Islands, during prolonged drought, and the lack of an alternative source, people are sometimes forced to drink undesirably saline water, extracted from wells situated close to the beach, which has been polluted by seawater intrusion into the aquifer. In Kiritimati Island, groundwater collection trenches have also become saline because of over-pumping. In South Tarawa two lenses became unusable as a result of this over-exploitation and from surface pollution, during the 1970s and 1980s. Pumping from the Teaoraereke lens was discontinued in 1987 to allow the lens to recover from over-exploitation and seawater intrusion,

## Needs analysis

The most important identified need is the institutional strengthening *of* the existing three water-monitoring bodies. This may include identifying suitable field field-testing techniques, giving hands-on experience to the operators, and the provision of a database program relevant to water monitoring with technical training in information management.

There needs to be effective coordination among the drinking water stakeholders including the sharing and exchanging of information and ideas, and the revival of a coordinating committee.

Public health ordinances need to be reviewed and updated to include a national water quality standard.

Water quality monitoring and surveillance should be expanded to include the outer island communities.

On the regional level, Kiribati would like to recommend that WHO assist Pacific Island Countries to establish a regional laboratory to do chemical testing. This can be established within SOPAC or the Pacific Water Association in Suva, Fiji.

## Reference

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