ADB

Pacific Studies Series

Economic Costs of Inadequate Water and Sanitation

SOUTH TARAWA, KIRIBATI

Asian Development Bank

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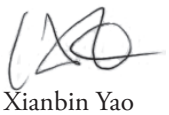
Foreword

Urban development, including water supply and sanitation, is an operational priority of the Pacific Approach 2010–2014 that guides ADB's assistance to its Pacific developing member countries (DMCs), based on the strategic agendas set out in ADB's long-term strategic framework, Strategy 2020.

As urban centers around the Pacific region expand, there is growing pressure on basic infrastructure services, including water supply and sanitation. This urban situation in many Pacific DMCs contributes to public health risks and deteriorating environmental quality. Sustainable social and economic development in the region's cities and towns requires significant investment and corresponding institutional reforms to improve the quality, and access to water supply and sanitation services.

This study seeks to estimate and quantify the total economic costs of the inadequate water supply and sanitation situation in Kiribati's main urban center, South Tarawa. This study also aims to demonstrate that vulnerable groups such as women are most likely to bear a disproportionate amount of the economic costs associated with low levels of access and poor quality of basic water supply and sanitation services.

It is hoped that this work will be used to inform the design of needed reforms in improving the urban water supply and sanitation sector performance as a means of supporting more sustainable urban development in Kiribati and serve as a useful reference to policy makers and advisors in other Pacific DMCs in planning for urban water and sanitation investment and policy changes.



Xianbin Yao
Director General
Pacific Department

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For the household survey, Jenny Tonganibeia of the NSO took charge of the survey implementation, including the recruitment of experienced enumerators and data entry staff, and checking and validation of the completed survey forms. She also answered many queries about the Kiribati 2010 Census of Population and Housing and other national statistics. Her assistance, and that of the survey team, was critical for the efficient and successful completion of the household survey.

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Abbreviations

ADB	–	Asian Development Bank
CSA	–	cost saving and avoidance
dia_dys	–	diarrhea and dysentery
GDP	–	gross domestic product
JMP	–	Joint Monitoring Program
KNTO	–	Kiribati National Tourism Office
MDG	–	millennium development goals
MHMS	–	Ministry of Health and Medical Services
PUB	–	Public Utilities Board
SOE	–	state-owned enterprise
STSISP	–	South Tarawa Sanitation Improvement Project
UNESCAP	–	United Nations Economic and Social Commission for Asia and the Pacific
UNICEF	–	United Nations Children's Fund
WASH	–	water, sanitation, and hygiene
WHO	–	World Health Organization
WTP	–	willingness to pay

Executive Summary

South Tarawa, the political and economic center of Kiribati, has been experiencing annual average population growth of 4.5%. The population of South Tarawa was estimated at 51,897 in 2010, and is expected to double by 2030. Tarawa Atoll consists of a series of low-lying islets connected by causeways, forming a combined area of less than 15 square kilometer with a maximum elevation of 3–4 meters above sea level. Overcrowding has put stress on critical public infrastructure and the surrounding natural environment. South Tarawa has very limited groundwater supplies, which are highly vulnerable to contamination due to thin atoll soils.

Kiribati is off track in meeting Millennium Development Goal 4, to reduce infant mortality; and 7, to ensure environmental sustainability. Underinvestment in water supply and sanitation infrastructure, and inadequate operations and maintenance, has led to poor quality of service delivery in South Tarawa. Piped water supplies are available for only 2 out of every 48 hours. The existing sewerage system serves only a small portion of the population and suffers from frequent blockages and overflows. In unsewered areas, the use of onsite sanitation options such as septic tanks or pit latrines have resulted in groundwater pollution due to poor construction and a lack of maintenance, or unsuitability for locations where the water table is high.

In addition, household surveys revealed high rates of open defecation, with around 60% of the population reportedly using the beach, ocean, or lagoons. This figure includes both households that only rely on open defecation, as well as households that rely on several sanitation options including open defecation.

It is recognized that water supply and sewerage tariffs are well below cost-recovery levels, which contributes to the poor quality of service delivery. However, there has been resistance to raising tariff levels due to concerns over affordability. There is little information on the resulting ripple effects of underinvestment in water supply and sanitation on other sectors, or details on which segments of society are most impacted by poor quality service delivery. This study seeks to estimate the significant hidden economic, social, and environmental costs associated with inadequate water supply and sanitation situation services in South Tarawa.

Poor water and sanitation services impose both direct and indirect costs that are experienced through multiple pathways. For example, groundwater supplies are contaminated by human and animal wastes. Inadequate sanitation contributes to pollution of the nearshore coastal environment resulting in bioaccumulation of bacteria on important food source like fish and shellfish. The decline in the aesthetic value of the environment negatively affects tourism.

Over the period 2010–2012, there were 35,000 reported cases of illnesses per year related to water, sanitation, and hygiene, including diarrhea, dysentery, conjunctivitis, and fungal infections including ringworm. However, many more cases are estimated to go unreported. The incidence of diarrhea and dysentery has increased over time. In 2010, one in four persons suffering from water-borne illnesses was treated in a hospital or clinic, whereas in 2012

this figure had increased to one in every two persons living in South Tarawa. Health officials report an average of three outbreaks of acute diarrheal disease in South Tarawa every year. During the 3-year period 2010–2012, a total of 48 people, an average of 16 per year, died from causes directly linked to poor water supplies, inadequate sanitation, unsafe practices, and poor public hygiene.

The economic costs of poor water and sanitation include market and nonmarket costs that could have been saved and/or avoided if adequate water and sanitation services were provided to South Tarawa's population. Costs include the following:

- Health expenditures. These include the costs of preventative and surveillance measures; costs of treatment in the form of medicine, clinics, and hospital staff time; and other recurrent operating costs.
- Loss in economic productivity. Costs include loss in productivity and/or wages due to illness and death caused by waterborne disease and lost time by caregivers.
- Reduced benefits from tourism. Dirty and polluted beaches reduce attractiveness of South Tarawa as a tourism destination, which results in reduced tourist revenue and follow-on benefits.
- Environmental pollution. Inadequate sewage disposal creates high nutrient and chemical pollution and adversely impacts fisheries.

In this study, data was collected from various sources, including the National Statistical Office, Ministry of Health and Medical Services, Kiribati National Tourism Office, Ministry of Fisheries and Marine Resources Division, Public Utilities Board. A survey of a stratified sample of about 10% of households across each of the South Tarawa villages was also conducted.

The total annual economic burden of poor water and sanitation on South Tarawa is estimated to be A$3.7–A$7.3 million. These costs include those borne by the government and households and the wider economy as a whole. This translates into an annual economic cost of A$553-A$1,083 per household, or 2%–4% of the country's nominal 2013 Gross Domestic Product. These estimates are conservative since not all impacts such as ecosystem and tourism costs could be quantified with certainty.

The study also finds that female children have a higher likelihood of suffering from diarrhea and dysentery than males, and that age influences the changes of individuals suffering from these diseases, which men having a greater chance of suffering as they get older when compared with women.

Individuals who live in households with no latrines are more likely to suffer from diarrhea and dysentery. Similarly, illness was found to be higher among households located in villages with high rates of open defecation. In addition, household members living in traditional houses are more likely to become ill than those living in permanent houses. The proportion of household members suffering from diarrhea and dysentery is high in households that use water from open wells and from neighbors. It is also high among households that use piped water supplies, which can likely be attributed to improper water storage at the household level that exposes water supplies to contamination, as well as contamination of piped water supplies to due system leaks and illegal connections.

There are public and private dimensions to the challenge of reducing the economic burden of poor water and sanitation services. While actions by both government and communities are necessary, the Government of Kiribati can play a decisive role in addressing these challenges. Women, children, and the elderly who bear a disproportionate share of the burden of inadequate water and sanitation services in South Tarawa, would benefit the most from improvements to the current situation. Key measures include the following:

- Financing improved water and sanitation services. Greater public investment in the provision of water and sanitation services, particularly in the provision of public goods, could reduce health expenditures as a result of the avoided costs of treating waterborne disease. Similarly, tariffs based on a "user pays" approach to improve cost recovery and service standards would result in avoided impacts at the household level. However, the study revealed that 25% of households were not willing to pay for improved water supply and sanitation services, such that it results in a reduction in serious water-borne disease, either due to affordability or because they believed that the supply of clean water and sanitation was entirely the government's responsibility.
- Education and awareness programs to promote better understanding of the links between water, sanitation, hygiene, and health. The study found that on average household willingness to pay for improved water supply and sanitation services is low, at around A$13/month. This could be due in part to low levels of awareness of the benefits of adequate water supply and sanitation in terms of avoided productivity losses and household health expenditures associated with waterborne disease.
- Integrated investments in water supply, sanitation, and hygiene. Reducing the economic burden associated with poor water and sanitation requires an integrated approach that simultaneously improves water supply and sanitation infrastructure, hygiene behavior, water storage practices, and traditional sanitation practices at the household and village levels.

Introduction

The Republic of Kiribati comprises 33 low-lying atolls and islands in the Central Pacific with a maximum height above sea level of 3–4 meters. Around half of the country's population of 105,000 lives on South Tarawa, the political and economic capital (Government of the Republic of Kiribati 2010). South Tarawa consists of a series of islets connected by a causeway forming a total area of less than 15 square kilometers, making it one of the most densely populated areas in the Pacific region.

Population pressures, combined with uncontrolled urban settlement, have resulted in overcrowding that has put stress on critical public infrastructure and the natural environment. The average household size in South Tarawa is 7.3 persons (Government of the Republic of Kiribati 2010). With an annual population growth rate of 4.5%, South Tarawa's population is expected to double by 2030. As an atoll, freshwater resources are limited, with the population dependent on groundwater sourced from the lenses in Bonriki and Buota, and supplemented by rainwater. Thin, porous atoll soils also make groundwater highly vulnerable to contamination from human and animal wastes. Existing water supply and sanitation infrastructure is currently in a dilapidated state. As a result of high losses and limited supplies of freshwater, piped water supply is only available for 2 out of every 48 hours. Centralized sewerage systems are available to residents in Bairiki, Betio, and Bikenibeu. However, the saltwater flush system is largely nonoperational; and the system suffers from frequent blockages and overflows, posing a major risk to public health. In unsewered areas, residents rely on open defecation, pit latrines or septic-based sewerage systems, which are often poorly constructed or not maintained. As a result, most sanitation systems in South Tarawa contribute to pollution of the freshwater lenses or surrounding coastal waters.

Kiribati is off track in meeting Millennium Development Goal (MDG) 4, to reduce infant mortality; and 7, to ensure environmental sustainability (Pacific Islands Forum Secretariat 2012). Diarrhea[1] and other water-borne diseases are linked to overcrowding and inadequate water supply, sanitation, and hygiene; and the major causes of mortality of infant and under-5 children. In 1977, South Tarawa experienced a cholera epidemic; and more recently, in 2013, a diarrhea outbreak affected around 500 people, and resulted in the death of six children.

For decades, considerable effort has been made, largely with support from external development partners, to improve water and sanitation services in South Tarawa. However, conditions that could result in another outbreak of cholera and diarrheal diseases still remain largely due to limited freshwater resources, high levels of pollution of ground and coastal waters, high population growth, and lack of sustainability of water supply and sanitation infrastructure.

[1] Including dysentery.

The Public Utilities Board (PUB), a state-owned enterprise (SOE), is responsible for the delivery of water supply services in Kiribati, as well as the operation of centralized sewerage networks and septage management. A flat fee of A$10 per month is charged to residential customers for the supply of water, while sewerage services are provided free of charge. Since revenues are significantly below costs of service delivery, the government provides PUB with an annual subsidy of A$500,000, and at times had been forced to write off PUB's losses. PUB's inability to increase water tariffs contributes to its difficulties to improve service delivery (Kiribati PUB 2012). In the absence of effective utilities regulation, PUB has faced limited performance incentives and has rarely been held accountable for the quality of service delivery. Policy makers have been reluctant to adopt a more effective charging policy for the supply of water and sanitation services in South Tarawa, concerned about the adverse impact of higher charges on household welfare. The government also recognizes the need to change public attitudes toward utility payment in South Tarawa, but little progress has so far been made in this direction.

To enable more informed policy responses to address the current situation in South Tarawa, this study seeks to estimate the total economic costs associated with inadequate water supply and sanitation services. Governments are generally expected to make decisions with the aim of maximizing social welfare. Decisions related to water supply and sanitation include the (i) allocation of resources to support public investments in water supply and sanitation infrastructure, (ii) approval of tariff proposals to ensure adequate service levels and cost recovery, and (iii) budgeting for community service obligations and subsidies. A main consideration in budgeting is to ensure the affordability of basic water supply and sanitation services among low-income households. Meanwhile, subsidies cover externalities, such as public health or environmental improvements associated with improved water supply and sanitation. However, private households cannot fully capture the benefits from these improvements, posing a challenge to setting tariffs at full cost recovery levels.

It is important that public policy is based on an assessment of the full economic costs and benefits. Economic costs are not just the narrow financial costs paid by households to access water supply and sanitation services, but the broader social and environmental costs borne by households and society as whole. The study does not seek to provide a full cost–benefit analysis of various water supply and sanitation investments options. Rather, its primary objective is to estimate the economic costs associated with the current inadequate water supply and sanitation condition in South Tarawa, including the

(i) preventative, curative, surveillance, and response measures associated with water-borne and vector-borne diseases incurred by households and the government;
(ii) impacts on tourism due to a decline in the aesthetic value of South Tarawa's beaches and lagoon; and
(iii) decline in coastal fisheries and overall environmental quality.

The findings of the study can be used to demonstrate that the households, government, and economy as a whole pay significant economic costs arising from the effects of inadequate water and sanitation in South Tarawa. Furthermore,

the findings of the study can be used to identify which groups in society bear the greatest costs, e.g., children, elderly, women, and low-income households. As part of the study, the relationship between disease burden and the underlying individual, household, and village level characteristics is also assessed. The results of the study can assist in identifying and prioritizing interventions to reduce the economic burden of water-borne diseases in South Tarawa.

Research Methodology

Water supply, water quality, sanitation, and hygiene collectively determine disease outcomes (L. Fewtrell et al. 2005, WHO 2008 and 2009). The economic costs of the effects of existing water supply and sanitation conditions are not limited to direct and indirect impacts in the health sector. Also, there are flow-on effects to other parts of the economy, such as the tourism industry and coastal fisheries.

Standard market and nonmarket-based valuation techniques (WHO 2009) are used to estimate the economic costs associated with inadequate water and sanitation on South Tarawa. The study is based on a mixed methodology, comprising a review of secondary literature and the analysis of primary data to address the following questions:

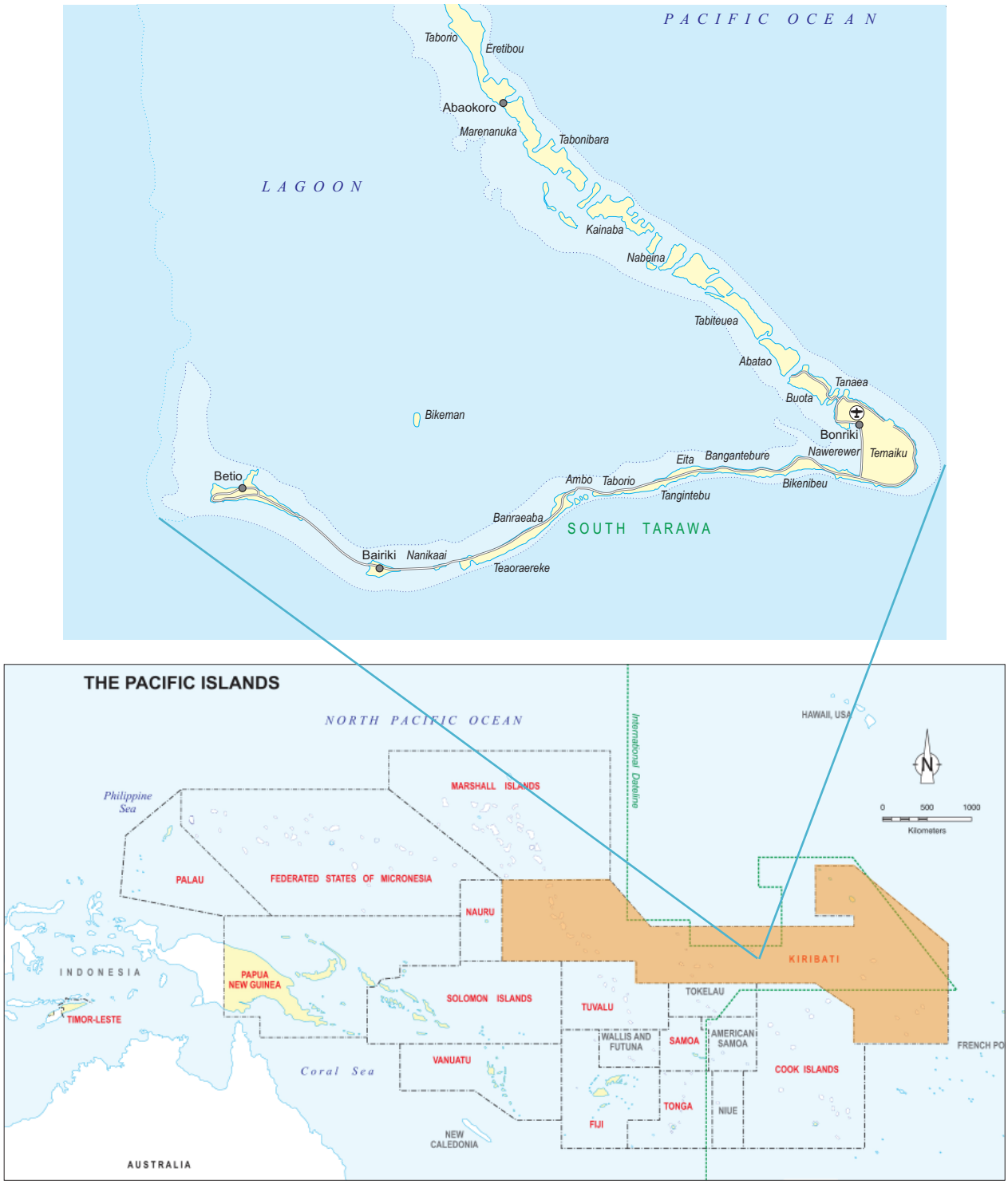
- What is the current water and sanitation situation in South Tarawa, including the key socioeconomic characteristics at the household and village levels that influence disease risks?
- What is the quality of drinking and coastal waters as a result of contamination by human and animal wastes?
- What are the common water- and vector-borne diseases,[2] and the incidence by age group and gender?
- What are the costs associated with water- and vector-borne diseases born by the government and households—preventative, treatment, and ameliorative costs associated with the diseases?
- What are the flow-on-effects and related economic costs of poor water and sanitation on other sectors, such as tourism and coastal fisheries?
- What is the willingness of households to pay for improved water and sanitation on South Tarawa?

To answer these questions, information was collected from published literature on water- and vector-borne disease burden, official government records, and unpublished data from government agencies.[3] Raw data from the Kiribati Census of Population and Housing (2010) was compiled to generate base information about water and sanitation characteristics of households and villages in South Tarawa. This was supplemented by a survey of a stratified sample 10% of households across all villages to obtain a better understanding of the underlying water- and vector-borne disease risks, and determine the distribution of the economic burden of inadequate water and sanitation among different population groups in South Tarawa.

2 The expression, "water- and vector-borne diseases," is used to refer to "WASH-related diseases;" and these two expressions are interchangeably used.

3 Including the Kiribati Tourism Office (KNTO), Ministry of Fisheries and Marine Resources, Ministry of Health and Medical Services (MHMS), National Statistics Office, and Public Utilities Board (PUB).

Figure 1: Map of South Tarawa with the Insert of Kiribati In Relation to the Rest of the South Pacific



Source: ADB.

However, all costs could not be quantified due to data constraints. Available empirical data was adjusted for use in the analysis following assumptions based on information obtained from in-country and regional experts and sector specialists, and from regional and global literature. The results of the household survey were used to triangulate assumptions made for different cost estimations, and to underpin key assumptions about specific parameter estimates where necessary for the valuation exercise. Detailed village level regression and other more sophisticated analysis were constrained by the absence of consistent village boundaries, making it difficult to arrive at population density estimation. Regression results make the assumption of absence of endogeneity. In addition, the selection of a random effects model is based on the assumption that individual effects are not correlated with independent variables. Difficulties were also encountered due to the differences between village descriptions used in the census database, on one hand, and the village and water distribution zone-based data maintained by PUB, and the coverage of health clinics, on the other hand. Despite these constraints, the economic cost estimates were based on the best information available, reflecting conservative estimates since costs such as of the impact on fisheries, which could not be estimated with confidence, were excluded from the analysis.

Analysis of the Water Supply and Sanitation Situation in South Tarawa

While the 2010 population and housing census provides basic statistics on access to improved water supply and sanitation in South Tarawa, the study seeks to present a more in-depth analysis of the actual situation in South Tarawa. Disease risk is linked to a number of inter-related factors including: (i) household water supply sources, (ii) water storage practices, (iii) sanitation behavior, and (iv) individual and household hygiene practices (L. Fewtrell et al. 2005).

The World Health Organization (WHO) and United Nations Children's Fund (UNICEF) Joint Monitoring Program (JMP) define "improved water supply" as: piped water into dwelling, yard or plot, a public tap or standpipe, protected dug well, or rainwater.[4] While the study adopted this definition, it considered and included treated tanker truck water delivered by private sector contracted to PUB as an improved water supply. Also, given high levels of groundwater contamination in most areas of South Tarawa, even protected

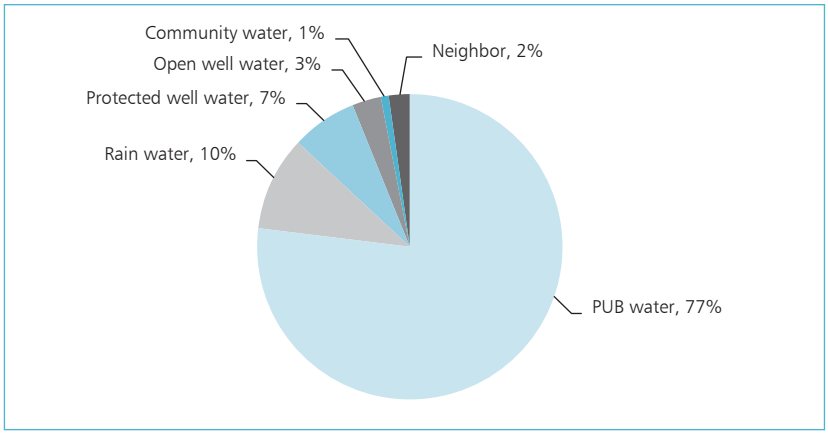
Traditional houses without any toilet facilities on the lagoon side, Eita

4 WHO/UNICEF Joint Monitoring Programme for Water Supply and Sanitation. http://www.wssinfo.org/definitions-methods/watsan-categories/

wells cannot be considered safe due to highly contaminated freshwater lenses. On the other hand, JMP defines "improved sanitation" as: flush toilet, piped sewer system, septic tank, flush/pour flush pit latrine, ventilated improved pit latrine, and compost toilet. It should be noted that, in Kiribati, given the fragile atoll environment, some improved sanitation options, such as pit latrines, have the potential to contribute to water-borne diseases. Pit latrines discharge directly into the shallow freshwater lens, resulting in contamination of groundwater supplies. Thus, in this study, pit latrines are regarded as unimproved sanitation.

According to the 2010 census, of the 6,705 households living in 16 villages on South Tarawa, 88% (or about 5,860 households) had access to an improved water supply (Government of the Republic of Kiribati 2010). The 2013 household survey carried out as part of this study finds that almost 77% of households reported PUB water as their main source of water (Figure 2).[5] PUB water includes both piped water supply and bulk delivery by tanker truck; and other sources of water are rainwater (10%), protected well water (7%), open well water (3%), neighbor's water (2%), and community water tank (1%). However, given high levels of groundwater contamination in most of South Tarawa, around 10% of households reported using protected and unprotected well water as their primary sources of drinking water.

Figure 2: Sources of Water Used in South Tarawa, July 2013 (%)



PUB = Kiribati Public Utilities Board.
Source: Household survey, July 2013.

These statistics, however, do not fully capture the actual water supply situation in South Tarawa, particularly in terms of disease risk. Access to an improved water supply source does not guarantee that the quality of water supplied meets safe drinking water standards.

Households in South Tarawa connected to the PUB water supply network receive water for only 2 hours every 48 hours. This means that households relying on piped PUB water supply alone do not have an adequate water

5 In comparison, in 2010, only 67% of the households had PUB water supply.

supply to meet their basic needs. On average, each person has available an equivalent of 21 liters per day of partially treated freshwater (Government of the Republic of Kiribati 2010a). This is less than 50 liters per person per day suggested by WHO.[6] On the other hand, a small number of households, who can afford to purchase water from PUB in bulk, have supplies delivered by tanker; thus, have an adequate and continuous water supply.

Detailed analysis of the 2013 household survey data shows a statistically significant relationship (at least at 5% or lower significance level) between the probability (or odds) of individuals suffering from diarrhea and/or dysentery and using PUB piped water supply, open well water, and water from neighbors (Table A4.2).[7] There are several possible reasons for the high correlation between use of PUB water, which is considered an improved water supply, and the chances of individuals suffering from water-borne diseases which appear counter-intuitive. First, the piped water supply system is susceptible to contamination from exterior water intrusion into pipes since the system is not fully pressurized. Second, illegal connections to the network are common, which also contribute to contamination of piped water supplies. Contamination may also be introduced through improper storage. Since PUB piped water is only available for a very short period of time, most households in South Tarawa store water using a variety of containers that are vulnerable to contamination (see photo below). These include open containers, such as 44-gallon drums, basins, and buckets.

The survey results also suggest that 60% of households who bought water from PUB used containers that could be considered "unsafe" to store extra

PUB piped-water collected and stored in unsafe containers and practices that increase the risk of contamination of water at the end point, Banraeaba village

6 UN Water. Statistics Graphs and Maps. http://www.unwater.org/statistics_san.html

7 Multicollinearity tests were carried out to ensure variables in the model were not highly correlated.

water as their first choice (Table 1). Those households, who used water tanks as the main means of storing water, also reported resorting to use of unsafe containers when their water tanks were full.[8]

Another reason for unsafe water could be that even with PUB water connections, households rely on other sources of water when their own stored water runs out, as well as water from protected wells and from their neighbors or communal water tanks. Households surveyed reported using water from alternative sources as their second option because their own water storage capacity (for PUB water or rainwater) was often limited. They reported relying on their neighbors (23%), with only a small proportion of households using water from communal tanks (Table 2). Particularly during drought, households relied on alternative sources of water, such as unsafe open well water.

The results of the limited water quality testing suggest that contamination of different sources of water is common in the villages. For example, PUB water sampled in the first half of 2013 from various locations in the villages, such as Ambo, Bairiki, Bonriki, Nawarewere, and Tearaereke, showed *Escherichia coli* (*E. coli*) counts well above the WHO standard; and, in some cases, *E. coli* and total *coliform* levels were found to be "too numerous to count." Similar results were also found in open well water in the villages, such as Banraeaba, Eita, and Temwaiku (MHMS 2013).

Even some rainwater tanks in Nawerewere and Teaoraereke also tested positive for *E. coli* contamination, with counts well above acceptable water quality standards (MHMS 2013). Similar results of high levels of E. coli and total coliform counts were also reported for water samples tested from various locations in the lagoon and ocean sides of South Tarawa, which are used for swimming and washing and subsistence and coastal fishing (MHMS 2013). These results suggest high risks of diseases associated with poor quality of water

Table 1: Households Using Different Types of Storage for Water Bought from Public Utilities Board, July 2013

Type of Water Storage	Rank 1		Rank 2	
	No. of Households	%	No. of Households	%
Rainwater tank[1]	77	40	1	1
Drums (44 gallon)[2]	68	36	52	28
Any large plastic containers[2]	39	20	95	51
Kitchen pots, pans, basins, etc.[2]	66	3	39	21
Others[2]	11	1		
1 Safe water container used	77	40	1	1
2 Unsafe water storage practice	184	60	186	99

Notes:
1. Rank 1 refers to the main source of water used by the household.
2. Rank 2 refers to the second most important source of water used by the household. (NB: Not all HHs reported second option)
Source: Household Survey, July 2013, carried out as part of this study.

8 Households had difficulty responding to the survey question related to the storage type for water bought from PUB. Many households did not think that when they are connected to the PUB piped water system, they bought water. On the other hand, most households did not pay water bills since water is regarded free.

Protected well water collected and stored in pots at the point of use, Bikenibeu

Table 2: Water Sources Used in South Tarawa, July 2013

Water Source	Rank 1 (%)	Rank 2 (%)
Public Utilities Board	77	
Rain	10	37
Protected well	7	17
Open well	3	7
Communal	1	9
Neighbor	2	23
Other sources	nil	2

Notes:
1. Rank 1 refers to the main source of water used by the household.
2. Rank 2 refers to the second most important source of water used by the household.
Source: Household survey, July 2013.

supply sources, as well as bioaccumulation of seafood, and other impacts of pollution and eutrophication of coastal waters.

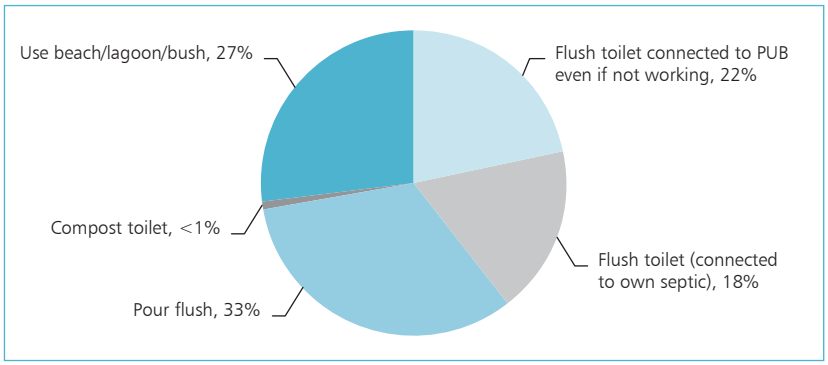
While these water samples were too small to make generalizations about the overall quality of improved water supplies in South Tarawa, they confirm that sources of improved water supply are at risk of contamination. On the other hand, the households reported that they boil water from all sources used for drinking, but its effectiveness depends on the length of time spent in boiling water. Furthermore, boiling water is not effective in addressing nitrates found in groundwater in South Tarawa. Excessive level of nitrate pollution in well water used to mix infant formula is linked to infant methemoglobinemia, commonly called "blue baby" disease (Knobeloch et al. 2000). Blue baby cases have been reported in South Tarawa (Taetao Tira, director of Environmental Health Service, personal communication, July 2013).

Sanitation

Only 40% of households in South Tarawa have access to improved sanitation facilities, such as flush toilets connected to the PUB sewerage system, flush toilets connected to septic tanks, or compost toilets (Figure 3). Of this, a little over half have access to centralized sewerage systems, with access unevenly distributed within and across villages. In 2012, two-thirds of households in Bairiki, Betio, and Bikenibeu (2,051) had PUB sewerage connections, whereas households in unsewered areas relied on onsite systems. In contrast, according to the 2010 census, 68% of households reported having access to improved sanitation, which indicates that fewer households in South Tarawa have access to improved sanitation than in 2010.

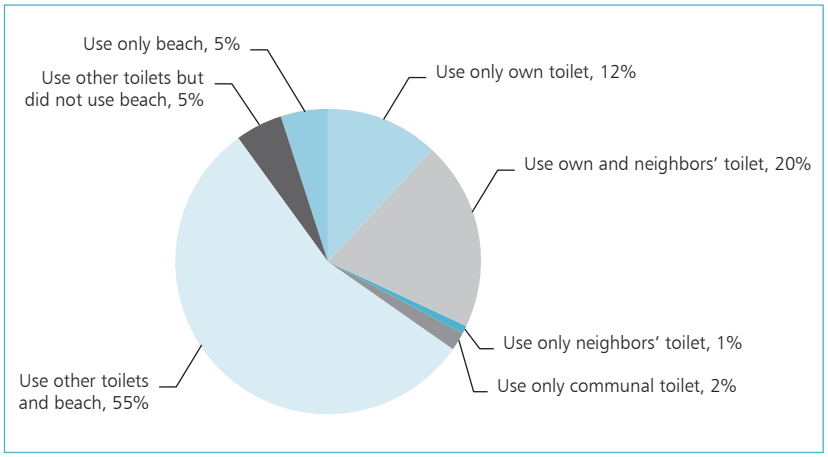
While the proportion of households in South Tarawa engaging in open defecation only is small (5% of the South Tarawa household), 55% of other households reported using the beach, lagoon, or bush for defecation from time to time even when they have access to other improved forms of sanitation (Figure 4). Open defecation was reported in all villages in South Tarawa (Figure 5). High rates of open defecation in some villages could be explained by cultural practice of accommodating relatives and the village lifestyle. With migration of family members from outer islands to South Tarawa, households often construct additional traditional houses for sleeping but they rarely construct additional toilets.

Figure 3: Households with Access to Improved and Unimproved Sanitation in South Tarawa, July 2013 (%)



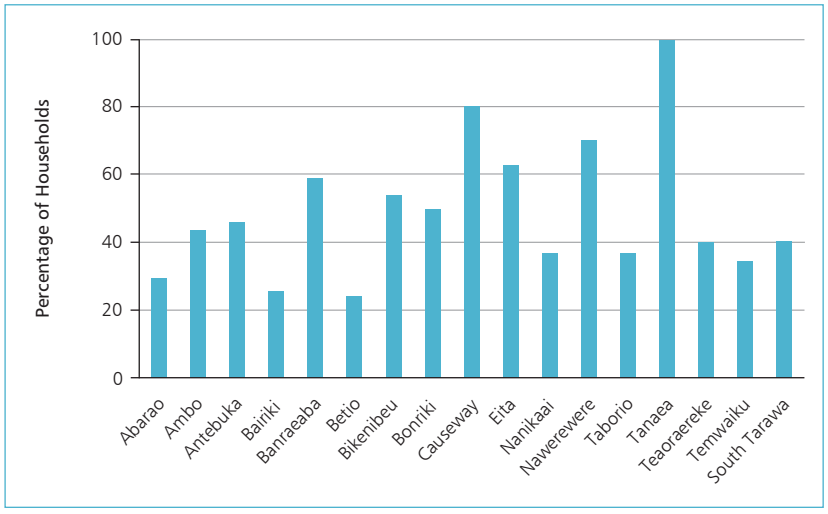
PUB = Kiribati Public Utilities Board.
Source: Household survey, July 2013.

Figure 4: Use of Toilet Types by Households in South Tarawa, July 2013 (%)



Source: Household survey, July 2013.

Figure 5: Households That Use Beach/Bush For Defecation, Even When They Have Access to Other Types of Toilets, July 2013



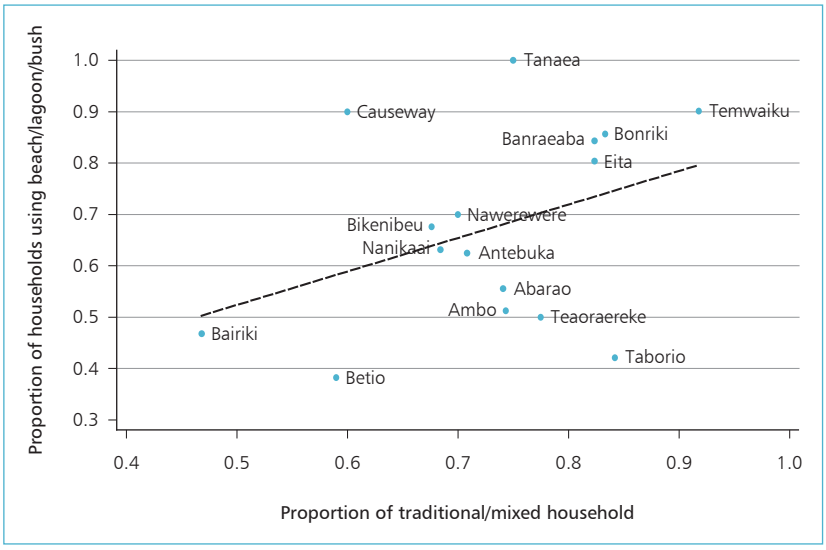
Source: Household survey, July 2013.

Statistical analysis of the household survey data confirms that the type of house is a significant predictor of open defecation. People who live in permanent houses (18%) or live in mixed types of houses that were constructed using a combination of local and permanent materials (26%) have a low probability of defecating in the open, compared with households in traditional houses that were constructed with local materials only (Annex 2).

Where there is a direct relationship between the proportion of households engaging in open defecation and the proportion of households within a village with traditional houses, it is a reflection of village lifestyle and traditional living (Figure 6).

The state of the sanitation infrastructure, both household septic systems and centralized sewerage system contributes to the poor ambient village condition. Almost 50% of the households surveyed in 2013 cited old age of their septic tanks or poorly designed as reasons for the overflow of their septic systems. Lack of maintenance is another reason for overflow, with almost 60% of households indicating they had never cleaned their septic tanks or could not recall when it was last cleaned. Even with the households connected to the PUB sewerage system, blockages are common, with 65% of households indicating their toilets blocked at least once in the previous four weeks prior to the survey in mid-July. These results suggest that even if a household uses improved sanitation systems, pollution of the surrounding environment may still contribute to increased disease risk.

Figure 6: Relationship Between the Prevalence of the Use of Beach and the Proportion of Traditional Houses in the Village, July 2013



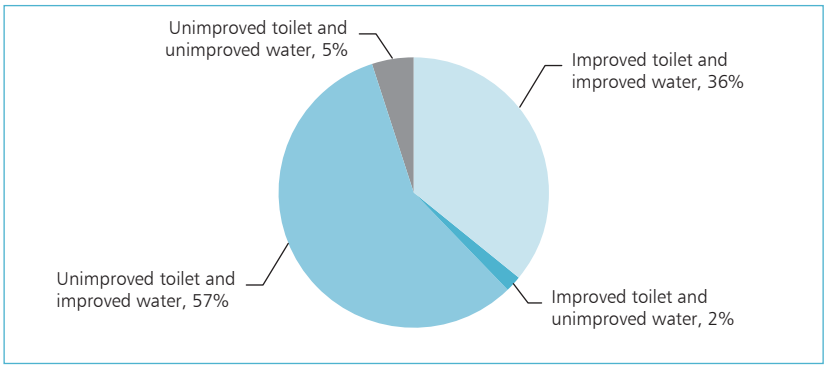
Source: Household survey, July 2013.

Combined Water and Sanitation Conditions

Disease risk prognosis is acute when one looks at water supply and sanitation conditions in South Tarawa simultaneously. In 2010, only 61% of households had an improved water supply and sanitation facilities of their own; 32% did not either have an improved water supply or sanitation facilities; and 3% had neither. The situation seems to have deteriorated in recent years, as indicated in the results of the 2013 household survey. Almost 67% of households in South Tarawa live in 'unsafe' conditions, i.e., conditions where households have unimproved sanitation facilities and/or unimproved water supply (Figure 7).

The risk of people suffering from water-borne diseases is also high due to poor environmental conditions in South Tarawa villages (Figure 8). In Bonriki, Causeway, Nanikaai, Nawerewere, Taborio, Tanaea, and Temwaiku, over 90% of households use unimproved facilities for water and/or sanitation. The effects on disease incidence is confirmed by the results of the mixed-effect multilevel regression analysis[9] of the household survey data (albeit at slightly lower significance level of $p<0.1$) (Table A5.1).

Figure 7: Households Using Different Combination of Water and Toilet System Types, July 2013 (%)



Source: Household survey, July 2013.

Animal Wastes

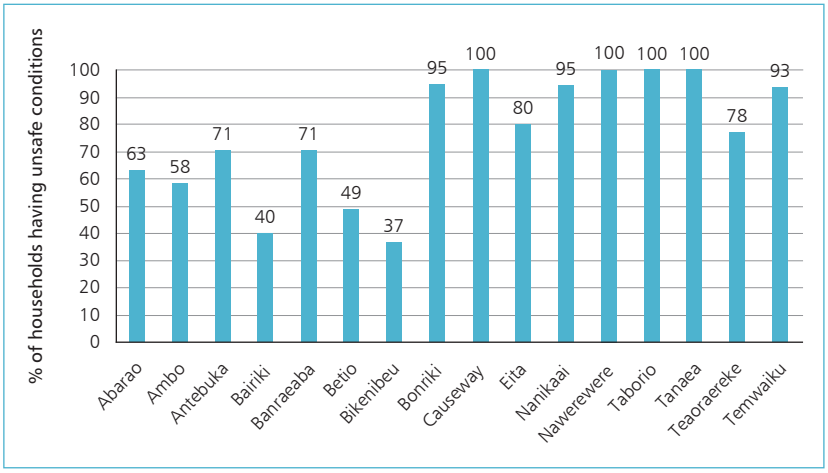
Health risk is further exacerbated by the large number of pigs and animals kept by households in South Tarawa. Animal wastes contribute to contamination of groundwater and nearby lagoon and ocean waters. The 2010 census recorded almost 14,500 thousand pigs, or almost four persons per pig, with much of the wastes disposed of directly into the surrounding environment. Pigs further increase microbial and chemical pollution.

Population Growth and Poverty

Rapid increase of population in South Tarawa due to migration from outer island, or high birth rates, contributes to high disease risks, especially when water and sanitation facilities are limited. Kiribati has among the fastest growing population in the Pacific islands, with South Tarawa population having an annual growth rate of 4.5% between 2005 and 2010. South Tarawa

9 Where the marginal effect of the parameter is tested keeping all other parameters constant.

Figure 8: Village Level Health Risk Due to the Use of Unsafe Water and/or Sanitation in South Tarawa Villages, July 2013



Source: Household survey, July 2013.

is expected to have a population of 62,500 by 2015 from 51,897 in 2010. The growth in population on South Tarawa in the past was attributed largely to internal migration from the outer island, being attracted to the urban areas for education and employment. Natural population growth due to high fertility rate is also driving population growth in South Tarawa. With cultural practices of supporting extended families, household sizes tend to be large, but often without corresponding improvements in basic water and sanitation facilities.

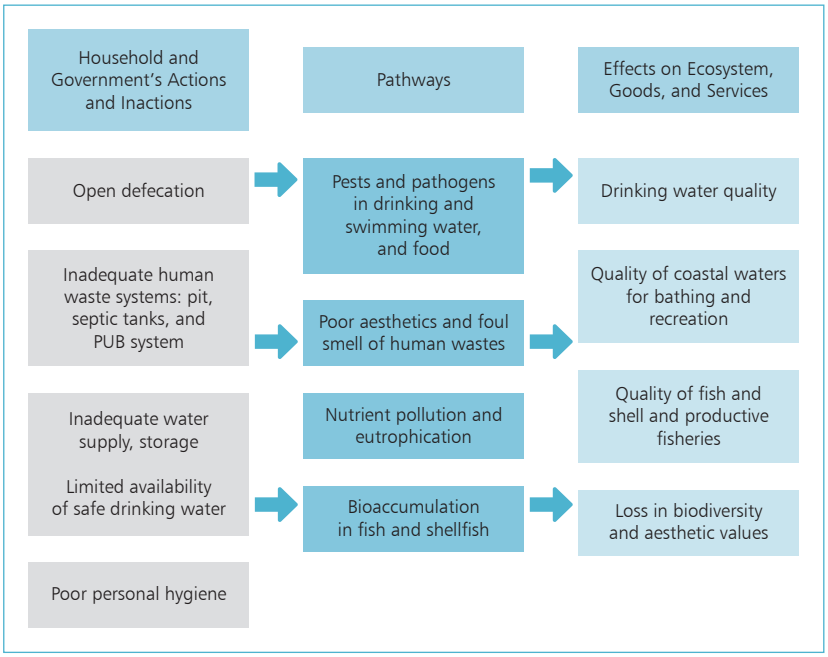
The level of household income and expenditure adds to the problem of inadequate water supply and sanitation. The average household annual income in South Tarawa is A$11,500, or approximately A$1,500 per capita, derived mainly from wage or salaried employment (Government of Kiribati 2006). The majority of the people (almost 67%) in the workforce are employed by the civil service or by the private sector, with close to 30% self-employed as fishermen, growers who produce for sale, or aggregate miners. Average household expenditure reported in the 2006 Household Income and Expenditure Survey (HIES) was about A$13,000, with around 75% of expenditures made on food, clothing, and schooling. According to the 2006 HIES, around 24% of South Tarawa's population was below the basic needs poverty line, with 2% living below even the basic food poverty line in 2006. The results from the HIES further suggest that many households have a limited ability to invest in improved water supply and sanitation facilities; or to bear high burden associated with the 'hidden costs' of inadequate water and sanitation, such as lost productivity resulting from water-borne diseases.

Impacts of Poor Water and Sanitation

Overview

Inadequate water supply, sanitation, and conditions impose a burden on Kiribati's economy through several pathways that include (i) pathogens and microorganisms in human and animal wastes, (ii) poor aesthetics and foul smell associated with human and animal wastes, ; and (iii) nutrient pollution from the breakdown of human and animal wastes, and (iv) bioaccumulation in fish and shellfish (Figure 9). Pathogens and microorganisms contribute to contamination of water supply, coastal waters, and marine resources, such as shellfish and fish, and illnesses and diseases. Foul smells associated with human and animal wastes lessen the aesthetic value of the surrounding environment. On the other hand, nutrient pollution adversely impacts on marine ecosystems and species, e.g., through algal blooms and eutrophication that result in the decline in fisheries productivity.

Figure 9: Multiple Pathways Through Which the Effects of Inadequate Water and Sanitation Services Affect Changes in Ecosystem Goods and Services



PUB = Kiribati Public Utilities Board.
Source: Author.

These impacts of poor waste and sanitation translate into economic costs to the country through losses in productivity; foregone earnings because of work absences; and other household losses in terms of opportunity cost of caregivers' time, and treatment costs associated with water-borne and vector-borne diseases. Degradation of the coastal environment, such as beaches and coral reefs, contributes to reduced tourist numbers and revenues and disease risks due to bio-accumulation of pathogens; while a decline in the productivity of fisheries adversely impacts commercial and subsistence fishing. In addition, people are required to take defensive measures to mitigate or reduce these adverse impacts, such as boiling water to reduce chances of contracting water-borne disease, purchasing canned foods rather than consuming locally harvested contaminated shellfish, or moving to farther places to more pristine and productive fishing grounds but would entail higher transport costs.

Health Impacts

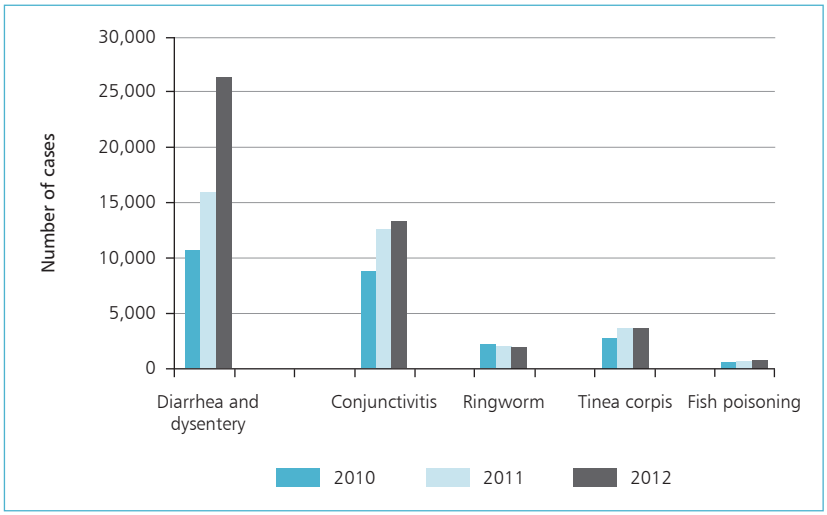
The link between inadequate water supply, sanitation, and hygiene, on one hand, and disease incidence, on the other hand, is well-established. Pathogenic microorganisms are transmitted through the consumption of contaminated freshwater, which results in water-borne diseases. These diseases can be caused by protozoa, e.g., cryptosporidiosis and giardiasis; viruses, e.g., gastroenteritis and hepatitis A; or bacteria, e.g., typhoid, cholera, salmonellosis—many of these are intestinal parasites. Bathing in coastal waters contaminated with fecal waste from humans and animals can also contribute to other skin, ear and eye infections, such as conjunctivitis.

Kiribati has a very high incidence of water-, sanitation-, and hygiene-related diseases; and it has among the highest rates of infant mortality in the Pacific region. Diarrheal disease, which is often linked to inadequate water supply, sanitation, and hygiene, is one of the three leading causes of under-5 mortality in Kiribati.[10] During 2010–2012, about 35,500 cases per year were reported by the clinics and hospitals in South Tarawa, such as diarrhea, dysentery, conjunctivitis, tinea, and ringworm. An average of three outbreaks of diarrheal disease are reported every year. Disease outbreaks often occur during large national celebrations, such as Independence Week; or major public holidays, such as Christmas. There are also outbreaks of other types of diseases related to water, sanitation, and hygiene (WASH), such as scabies; but these are not officially reported. There has been an increase in the incidence of diarrhea and dysentery (dia_dys) over time. In 2010, one in four people were treated (as first cases) in hospitals and clinics in South Tarawa for WASH-related illnesses. In 2012, this had increased to one in every two persons living in South Tarawa, i.e., 26,400 cases of dia_dys cases (Figure 10). However, the 2013 household survey suggests that the incidence of WASH-related diseases could be much higher, to have reached an estimated annual incidence of 50,000–55,000 cases.[11]

10 MHMS. 2011. Annual Report. Government of Kiribati. Bairiki.

11 Based on a 4-week of disease incidence reported by the household respondents during the July 2013 survey. It is noted that this estimate could be on the high side as the survey period coincided with part of the Independence Week celebration. During the celebration, the government reported an outbreak of diarrhea, which was subsequently confirmed by diagnostic tests carried out in Fiji and Queensland.

Figure 10: Water-borne Diseases Over Time, 2010–2012, June 2013



Source: Ministry of Health and Medical Services, June 2013.

Official statistics does not always reflect the full health effects associated with poor WASH conditions in South Tarawa. Many people suffering from WASH-related illnesses do not seek treatment from public healthcare providers; and as a result, these cases are not reported. At the same time, public health officials have limited capacity to maintain regular surveillance of diseases.

Kiribati does not regularly report many water-borne diseases, such as scabies; or vector-borne diseases, such as dengue and typhoid. It is important to also note that much of the health statistics are based on symptomatic diagnosis and not on confirmatory analysis because of the lack of diagnostic laboratory facilities in the country. Thus, in some cases, it is likely that the reported incidence of the disease may have been confused with other illnesses with similar symptoms. The health information system also needs substantial strengthening to improve the coverage and reliability of the data they produce (Damian Hoy, Epidemiologist, Secretariat of the Pacific Community, personal communication, August 2013).

From the 2013 household survey, it is evident that even for officially reported diseases, the record may reflect only those patients who sought treatment from public clinics and hospitals. Among the households surveyed, 83% sought treatment from clinics and hospitals for dia_dys cases, while the rest sought treatment from traditional medicine (or traditional "doctors") or did not receive any treatment (Table 3). On the other hand, only 44% of tinea cases were treated in clinics and hospitals; 42% used traditional medicine, and 14% did not seek any treatment.

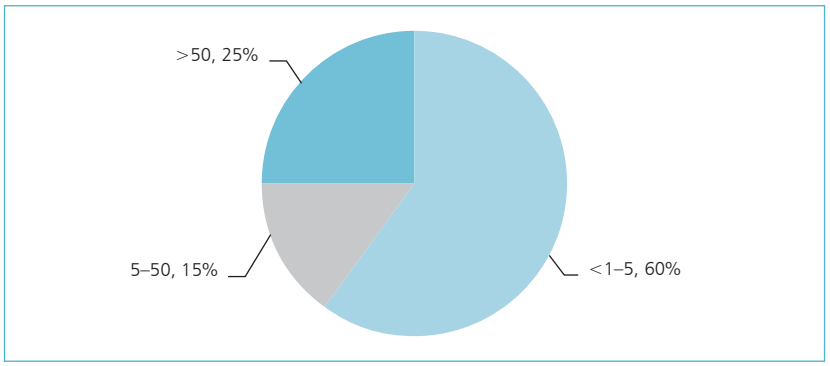
The young and the elderly are most susceptible to the fatal effects of water-borne diseases. During the period 2010–2012, a total of 48, or an annual average of 16 persons, died, all directly linked to poor water supplies, inadequate sanitation, unsafe practices, and poor public hygiene (Statistics and Information Unit, Ministry of Health, personal communication). By age group, 60% of all lives lost were children less than a year old up to 5 years and 25% were more than 50 years of age (Figure 11).

Table 3: Cases of Water- and Vector-Borne Diseases by Treatment Outlet in South Tarawa, July 2013

Disease	Total Number of Reported Cases	Clinics and Hospitals	Traditional Medicine	No Treatment
Dengue	163	85%	9%	6%
Diarrhea	332	83%	10%	7%
Dysentery	40	78%	3%	20%
Conjunctivitis	201	76%	0%	14%
Ciguatera	22	77%	0%	23%
Boil	75	39%	12%	49%
Worm	28	93%	4%	4%
Scabies	78	68%	12%	21%
Tinea corpis	117	44%	42%	14%
Ringworm (*Tinea vesicolor*)[1]	33	76%	0	9%
Total Number of Incidence	1,089	801	168	120
% of treatment type	100%	74%	15%	11%

[1] MHMS data also includes cases of *tinea vesicolor* disease, which is water-related but not water-borne.
Source: Household survey, July 2013.

Figure 11: Average Mortality Caused by Diarrhea by Age Group, 2010–2012, August 2013 (%)



Source: Ministry of Health and Medical Services, August 2013.

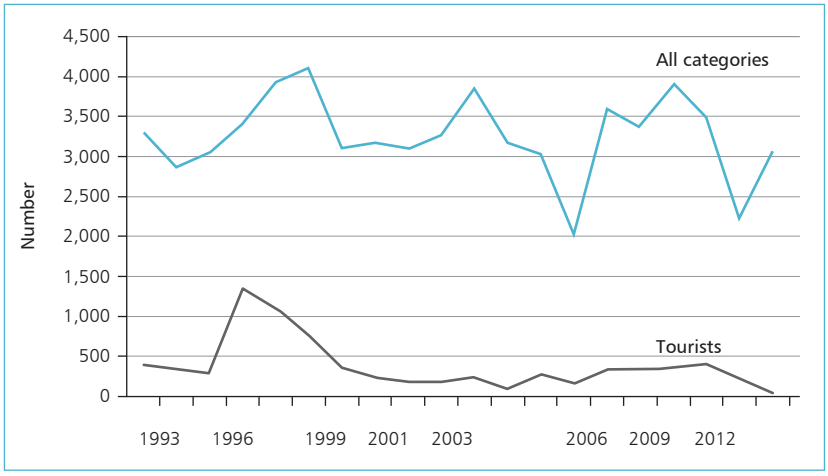
Impact on the Tourism Industry

The tourism industry is generally highly sensitive to image and perceptions. For example, in the Pacific region, tourists are drawn to pristine natural environments, such as those with unspoiled beaches and clear ocean waters. Tourism in Kiribati is no different. At its peak, Kiribati saw 1,350 recreational tourists, or about 40% of all arrivals, to the country in 1996. Since then the number of tourist arrivals have declined although Kiribati has the potential to attract tourists (ADB 2008, United Nations Economic and Social Commission for Asia and the Pacific [UNESCAP] 2003). In 2012, South Tarawa only saw

55 tourists, or less than 10% of total arrivals (Figure 12). The reasons for the decrease are multiple.

The limited number of flights, small supply of quality accommodation, and limited amenities for tourism are constraints to the development of Kiribati's tourism industry (UNESCAP 2003). The polluted condition of lagoons and beaches is also likely to be a contributing factor in South Tarawa. Poor liquid and solid waste management practices, combined with inadequate water supply, add to the degradation of the surrounding environment in South Tarawa, making it unclean, unappealing, and unsafe for swimming. With improved environmental management practices, including improved sanitation, tourism numbers could increase; and Kiribati may experience

Figure 12: Tourist and Total Visitor Arrivals to South Tarawa, 1993–2012



Source: Kiribati National Tourism Office.

a growing contribution of tourism to the country's economy. However, complementary improvements in flight schedules tourism accommodation, and improved marketing to raise awareness on Kiribati as a holiday destination are also required.

Tourism in Kiribati generates direct and indirect benefits to the country. Direct benefits include tourism expenditures on goods and services, such as accommodation and transport. Wider indirect benefits include an increased demand for inputs that go into the production of goods and services consumed by tourists, e.g., fish caught and sold to restaurants that cater to tourists, and expenditures on goods and services in the local economy made by those employed in the tourism industry.

Detailed information about the contribution of tourism to the national economy as a whole is not available. Limited information shows that, for example, in 2000, there were 373 persons directly employed in the tourism industry. A recent tourist satisfaction survey suggests that tourists in South Tarawa spend an average of A$135 per day for about 8.2 days per tourist (Kiribati National Tourism Office 2010 and 2012). This could suggest that at

its peak (in proportionate terms during 1996–2000), South Tarawa could have experienced at least an additional gross revenue of about A$840,000 (in 2012 dollars) a year from direct spending by additional foreign tourists.

Effect on Coastal Fisheries

The lack of adequate residential sanitation has been cited as the main contributors to pollution of coastal waters in South Tarawa (Storey and Hunter 2010). The discharge of untreated sewage; leakage from septic tanks, as well as direct defecation; and pig wastes all contribute to increased bacterial and chemical pollution of coastal waters. High nutrient accumulation associated with the breakdown in human and animal wastes disrupts normal ecosystems functions. For example, excessive nutrient levels, e.g., nitrates and phosphorus, contribute to algal and plankton blooms. The resulting problems include depletion of oxygen, loss of fish and shellfish, and reduction in biodiversity; and impacts on human health include ciguatera poisoning caused by the bioaccumulation of toxic dinoflagellates, *Gambierdiscus toxicus* (Chan et al. 2011, Llewellyn 2010, McCarthy and Tebano 1991). Hence, the sustainability of coastal fisheries is threatened by increased human activities. Subsistence and commercial fisheries supply approximately 7,000 tons of fish and invertebrates, valued at about A$18.5 million annually to the South Tarawa urban population.

Records of water quality for lagoon and ocean water are patchy. In 2013, lagoon water tested during the first three months showed the number of *E. coli* and total *coliform* to be "too numerous to count." These cases were observed in places near, for example, the Parliament wharf, Nanikai landfill, and Bairiki wharf (MHMS 2013). Empirical information about the impact of wastes on coastal fisheries productivity is not known, just as the effect of human wastes in ciguatera poisoning of fish is not understood. The exact relationship between individual human activity and ciguatera outbreak is difficult to determine due to multiple causes.

Algal and seaweed bloom in the coastal waters in South Tarawa—a sign of increased nutrient levels from human and animal wastes, Causeway

There has been an increase in the number of reported cases of fish poisoning, or what is believed to be ciguatera poisoning, around South Tarawa, almost doubling from 169 cases in 2010 to 302 cases in 2012. During the July 2013 household survey, 17 cases of ciguatera or fish poisoning were reported in Banraeaba, Betio, Bikenibeu, and Causeway (Nawerewere). However, not all cases of fish poisoning reported by public health officials can be attributed to ciguatera. Ciguatera poisoning and "normal" fish poisoning share similar symptoms (MHMS and WHO 2011 (draft)). Often, fish poisoning cases are reported around where *Gambierdiscus* species of dinoflagellates are known to occur on reefs around Bairiki, Banraeaba, Betio, and Nippon Causeway (Chan et al. 2011, McCarthy and Tebano 1991, Tebano 1992). However, public health records do not show the type of fish consumed at the time of the patient arriving at the clinic or hospital, which makes it difficult to estimate the likely cases of ciguatera in South Tarawa.[12]

12 Common ciguatera-affected fish species are: *Acanthurus lineatus* (Stripped surgeonfish); *Cephalopholis argus* (Peacock rock cod); *Gymnothorax javanicus* (Giant moray eel); *Scarus altipinnis* (Minifin parrotfish); *Sphyraena barracuda* (Great barracuda); *Lutjanus bohar* (Red bass); *Caranx ignobilis* (Giant trevally); and *Lutjanus monostigma* (Onespot seaperch). Source: T. Tikai. 1988. Ciguatera fish poisoning in Kiribati. *Twentieth Regional Technical Meeting on Fisheries.* Noumea.

Economic Costs of Inadequate Water and Sanitation

Valuation Method

In this study, the cost savings and avoidance (CSA) valuation method is used to assess the costs of inadequate water supply and sanitation in South Tarawa. Using CSA, the costs incurred to avoid water-borne disease and disease treatment costs, as well as the value of loss of life that could have been avoided, are assessed from the perspective of the private household, government, or the economy as a whole (Keeler et al. 2012, WHO 2009). Costs on other sectors of the economy transmitted through the effects of high nutrient and chemical pollution on ecosystems services, such as tourism, are also assessed.

In using CSA, caution is used in the counterfactual scenario assumed, as emphasized by WHO (WHO 2009). It is important to also note that CSA provides only gross measures associated with inadequate water and sanitation services. It does not provide the net benefits associated with improvements in water and sanitation since it involves considering the costs associated with improvements.

The value of traded goods and services, such as medicine, doctors' fees, and transportation, can be directly estimated in monetary terms. On the other hand, it is more difficult to assign prices to nonmarket goods and services, such as biodiversity, aesthetic values associated with nature, and human suffering due to water-borne illnesses. For nonmarket goods, proxy valuation methods must be used. For example, the value of loss in life is based on loss in per capita economic contribution that could have been expected had that person lived. However, it si recognized that the valuation of human life is a controversial topic. Other valuation methods used to determine nonmarket goods include continent valuation, hedonic valuation, and choice modelling (Costanza 1999, Hajkowicz et al. 2005, Hufschmidt et al. 1983, Lal 2004, Spurgeon 1992, Wegner and Pascual 2011). Table 4 summarizes the different valuation methods commonly used to estimate the economic costs associated with poor water and sanitation.

This section describes the economic cost measures estimated in this study, data used, and counterfactual conditions assumed, particularly on the human health effects due to reduced quality of drinking and contact water and food contamination; and loss of lives due to water- and vector-borne diseases.

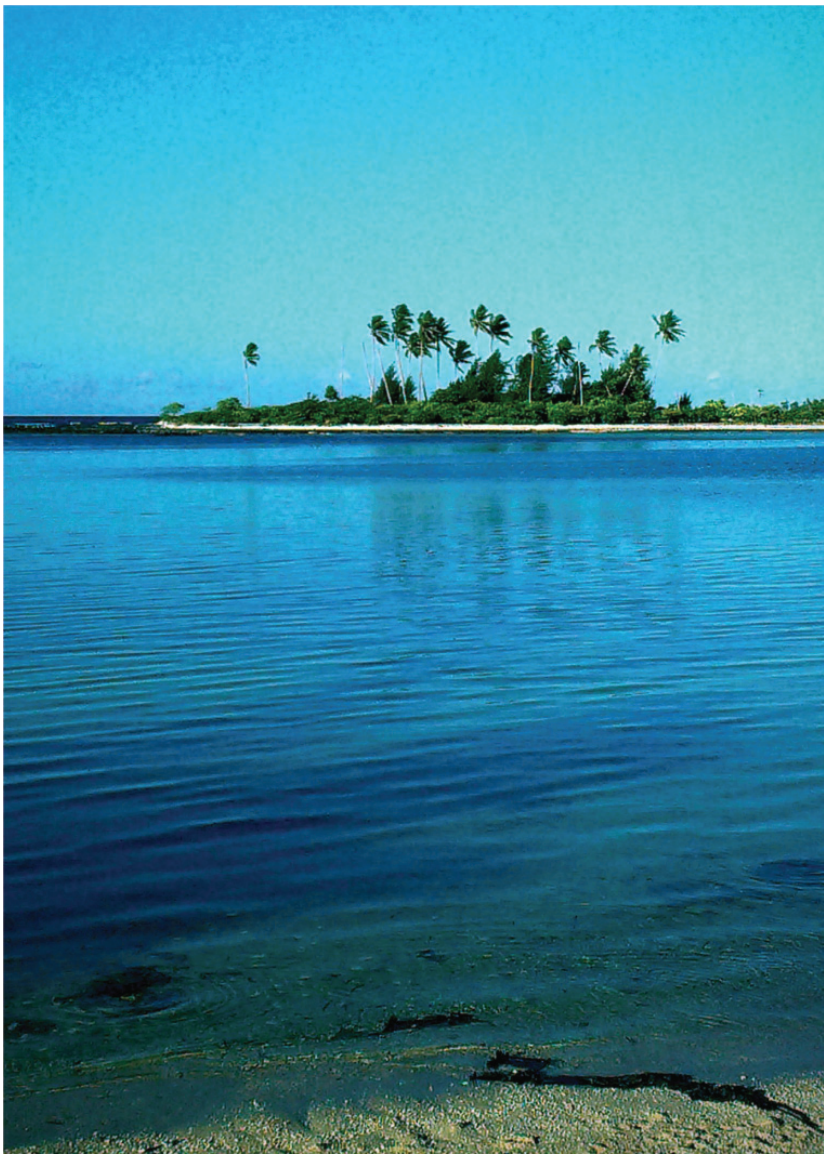
Table 4: Impact of Inadequate Water and Sanitation on Ecosystem Services That Humans Value, and Associated Common Valuation Approach

Services Valued by Humans (Ecosystem Services)	Impact of Poor Water and Sanitation	Endpoint Affected	Users Affected	Valuation Approach (Cost Savings and Avoidance Methodology)
Clean drinking water	Nutrient level	Groundwater	Community and government for avoiding infection, treating diseases, and avoiding risk of mortality	• Avoided treatment costs for nutrients • Avoidance costs (bottled water) • Remediation costs (improved water sources)
	Concentration of pathogen and pests	Groundwater and contaminated rainwater Contaminated water sourced from the Public Utilities Board poorly stored		• Disease avoidance costs • Disease treatment costs (transportation costs, costs of traditional and modern medicines, operating costs of hospitals/clinics) • Decreased risks of disease-caused mortality times value of life
Safe contact water	Quality of swimming/ bathing waters	Toxins, bacteria, or other contaminants in the coastal water	Swimming population, avoiding infection, and community and government treating diseases	• Disease-avoidance costs • Disease-treatment costs • Decreased risks of disease-caused mortality times value of life
Quality and productive fish and shellfish products	Quality of fish and shellfish	Coastal fisheries	Commercial and subsistence fishermen	• Decreased value of fish/shellfish sold/consumed due to poor quality
	Productivity of fish and shellfish		Community and government for avoiding infection, treating diseases, and avoiding risk of mortality	• Decreased risks of disease-caused mortality times value of life • Decrease in avoidance costs • Avoided costs of treatment
Free of foul smell and clean environment	Aesthetics and environment amenity	Air and beach biodiversity	Community and country through increased tourism	• Gross benefits of tourism foregone • Loss in economic value of biodiversity

Source: Based on Keeler, et al. 2012.

Due to inadequate information on drivers of tourism in Kiribati, and the extent to which poor environmental quality associated with inadequate water and sanitation, impact tourism, compared with other factors such as in frequent flights and limited accommodation options, estimate of the economic costs of tourism losses have not been included in the study.

In this study, only market goods and services are estimated together with those goods and services for which close proxies could be found. Due to the lack of availability of detailed underlying scientific data, this study does not provide estimates of the economic loss in environmental values, such as biodiversity, or loss in the outputs of coastal commercial and subsistence fisheries.



Area popular with women and children for shellfish collection particularly during low tides, Eita village

Human Health Costs

This study assesses both the economic costs of officially reported cases of diseases treated in clinics and hospitals; and through alternative means, e.g., traditional medicine. The economic costs associated with the officially reported cases of illness were estimated using the following data and sources:

- **Number of incidences by age of patient reported, by government clinics and hospitals.** The diseases covered by the report include diarrhea; dysentery, conjunctivitis; *Tinea corpis*; and ringworm, including *Tinea vesicolor*. Other diseases, such as worms; and other skin diseases, such as scabies, are not included because the government does not maintain

these records. Ciguatera was also excluded because of the difficulty in distinguishing fish poisoning and ciguatera from the government records.

- **Volume and cost of medicine.** The data covered medicines used to treat each water-borne disease by individual clinic and hospital maintained by the government pharmacy, the sole supplier of medicine in Kiribati.
- **Operating cost.** It included the costs of running clinics, hospitals, and the pharmacy, including doctors, nursing and other staff costs.
- **Average time spent travelling by patients and caregivers to clinics and hospitals for treatment.** It comprised the costs of first and second outpatient visits, plus other costs, such as special food, etc., as well as average time spent in hospitals as inpatient care. Such time estimates were derived from discussions with the MHMS staff, and information collected from the households surveyed in this study.

The sources of data are summarized in Table 5.

Government Recurrent Costs Attributable to Water- and Vector-borne Diseases on South Tarawa

The total recurrent cost for MHMS in 2012 is A$7.4 million, excluding administration and support services, incurred in treating 458,828 patients. Of this, there were 29,606 water-borne disease cases, or 7% of all cases treated by clinics and hospitals in the country. Therefore, apportioning each of the relevant costs across the different cost-centers to the number of water-borne diseases reported in South Tarawa, the weighted costs borne by the government is A$16.3 per patient (Table 6).

Table 5: Sources of Data Used to Determine Health-Related Costs of Poor Water and Sanitation

Information	Source	Comments
Water- and vector-borne diseases	Kiribati Health Information Unit, Ministry of Health and Medical Services (MHMS) (2013)	Diseases covered: diarrhea; dysentery; conjunctivitis; *Tinea corpis*; and ringworm, including *Tinea vesicolor*
Operating costs	MHMS (Riema Mareko, Senior Accountant) Ministry of Finance (2013)	Covers Kiribati-wide recurrent costs of clinics, hospitals, pharmacy, and administration cost centers of MHMS (2012)
Pharmacy purchase records of all medicines by South Tarawa clinics and hospitals	Government Pharmacist Biribo Kararati (2013)	Covers all medicines and other supplies purchased by the government and distributed to individual clinics and hospitals
Patient and caregiver's average time (travelling and in clinic and hospital)	MHMS (Taetao Tira and Bungia Kaitake, personal communication, July 2013	Patient and caregiver's time broken down by 1st visit, 2nd visit, and inpatient care
Cost of travel and other miscellaneous costs, such as for special food, etc. for sick patients	Household Survey conducted by the consultant, July 2013	Weighted average cost used to estimate household costs for the 2012 reported cases
Patient and caregiver's time cost	Reference to casual wage rate of A$35/day, which is equivalent to per capita gross domestic product value of A$6,629 (National Statistics Office)	Range of wage rate used to give high, medium, and low estimates as no consensus about minimum wage in Kiribati

Number of Patients Treated for Each Water-Borne Disease Officially Reported by MHMS

The following data for 2012 by age group was used to estimate the costs of treating individual cases, weighted by age class, by first visit, second visit, and inpatient care (Table 7).

Table 8 summarizes the key assumptions made in this study about the proportion of dia_dys patients who visited the clinics a second time, and the proportion of those first-time outpatients with serious conditions admitted to the hospital. On the other hand, patients with ringworm are assumed to make second visits in limited cases, whereas patients with conjunctivitis and *Tinea corpis* are assumed to make only one visit to clinics and hospitals as outpatients. In each case, the recurrent cost of clinic and hospital used A$16.3 per patient-equivalent, which is determined per age class and the proportion of each class of patients that went for first visit, second visit, and in-patient treatment.

Opportunity Cost of Patient and Caregiver's Time

To estimate the opportunity cost of time spent by a patient and the caregiver, scenarios were assumed (Table 9). These scenarios are based on the current casual wage rates in South Tarawa, which is the assumed wage rate for a caregiver's time-equivalent and the reported gross domestic product (GDP) per capita in 2012.

Cost of Medicine

The cost of medicine to treat water-borne diseases by clinics and hospitals was estimated using data from the government's pharmacy records (Table 10). It also includes the wholesale/tender purchase price plus freight (Kiribati

Table 6: Actual Expenditure by Cost Centers Attributable to Water-Borne Diseases in South Tarawa, 2012

Item	Cost attributable to South Tarawa
No. of total patients (Kiribati)	452,828
No. of water- and vector-borne-disease related (South Tarawa)	29,606
Imputed MHMS costs attributed to water- and vector-borne diseases (South Tarawa)	7%
Preventative costs attributable to water borne-diseases (South Tarawa) (A$)	27,413
Costs of curative treatment (Bikenibeu and Betio Central Hospitals) (A$)	41,621
Operating cost of Pharmacy, excluding medicines (A$)	27,368
Nursing staffing (A$)	329,297
Other Operating cost (A$)	481,929
Weighted cost per patient treatment (A$)	16.3

Source: Based on information obtained from the Ministry of Health and Medical Services, July 2013, Kiribati Health Information Unit. 2013. Tarawa; Ministry of Finance. 2013.

Table 7: Number of Patients That Visited Clinics and Hospitals for Water-Borne Disease in South Tarawa by Age Group, 2012

Disease	<1 year	1–4 years	5–14 years	>15 years	Total
Diarrhea	2,156	7,094	1,219	3,087	13,556
Dysentery	176	1,682	616	1,750	4,225
Conjunctivitis	510	1,658	1,714	5,097	8,979
Tinea corpis	8	80	184	1,624	1,896
Ringworm, including *linea vesicolor*	13	44	120	789	966

Source: Kiribati Health Information Unit, Ministry of Health and Medical Services. 2013.

Table 8: Assumptions on Patient Visits to Clinics and Hospitals for Treatment By Age Group, July 2013

Item	<1 year	1–4 years	5–14 years	>15 years
% of cases (1st visit)	100	100	100	100
Patient and caregiver's time (1st visit)	5 hours	5 hours	5 hours	5 hours
% of first visit cases that come back a second time	80	80	60	40
Patient and caregiver's time (2nd visit)	5 hours	5 hours	5 hours	5 hours
% of first visit cases who were admitted as inpatient	20	20	10	10
Patient and caregiver's time (in-patient)	120 hours	120 hours	120 hours	120 hours

Source: Based on discussion with Teatao Tira, director of Health, Ministry of Health and Medical Services. July–August 2013.

Table 9: Opportunity Cost Scenarios to Estimate Loss in Economic Productivity Due to Water-Borne Illnesses and the Value of Caregiver's Time

Item	High	Medium	Low
Patient (age <15)	Zero	Zero	Zero
Patient time (age over 15 years)	A$35.00	A$26.52	A$17.50
Comments	100% of current casual wage rate of A$35.00 per day	75% of current casual wage of A$35.00 per day, which is also equivalent to per capita GDP	50% of current casual wage of A$35.00 per day
Unit value of caregiver's time	A$26.52	A$13.25	A$10.00
Comments	75% of the current casual wage of A$35.00 per day	Half of 75% of the current casual wage of A$35.00 per day	Based on current debate about absolute minimum wage rate for Kiribati

GDP = gross domestic product.
Source: Author.

Government Pharmacy 2013). Medicine used to treat each type of disease and the dosage was identified based on discussion with the MHMS[13] and the disease treatment manual (WHO and UNICEF 2008). A range of freight costs is used from a high rate of 50% of the declared cost to a low rate of 20%, with a medium rate of 30%.

Household Costs Associated with Alternative Treatment Outlets

Costs associated with alternative treatment outlets, such as traditional medicine and traditional "doctor," were estimated using two-step-based approach. First, from the household survey, the proportion of reported incidence of each disease treated through alternative outlets was estimated. These estimates were then used to determine the number of cases that may have sought alternative treatment for each disease type in 2012 (Table 11). Second, for each disease type, the average cost of transport and other miscellaneous expenses reported in the survey was used to determine the total costs associated with alternative treatment outlets.

Table 10: Medicine Used to Treat Water- and Vector-Borne Diseases in Kiribati

Disease	Medication
Diarrhea and dysentery	Oral rehydration salt Zinc Sulphate Normal saline solution Ringers Hartmann Solution Metronidazole (tablets/suspension)
Conjunctivitis	Chloramphenicol eye drops
Tinea corpis	Miconazole cream
Ringworm, including *Tinea vesicolor*	Miconazole cream (Griseofulvin in persistent cases)

Note: The strength and doses, and when used depend on age, seriousness, and whether a patient is treated in the outpatient clinics and hospitals as inpatients.
Sources: Ministry of Health and Medical Services. 2013; World Health Organization (WHO) and United Nations Children's Fund (UNICEF). 2008.

Table 11: Estimate of Water- and Vector-Borne Incidence Where Alternative Treatments May Have Been Sought in 2012

Disease	Reported Use of Alternative Treatment Outlets (%)	Estimated No. of Cases of Alternative Treatment (%)
Diarrhea	10	2,692
Dysentery	3	1,227
Conjunctivitis	0	2,812
Tinea corpis	42	2,370
Ringworm	0	309

Sources: Reported use of alternative treatment outlets is based on the 2013 household survey data. The cases that sought alternative treatment are based on officially reported data on disease incidence by the Kiribati Health Information Unit multiplied by the proportion of reported use of alternative treatment outlets.

13 Director of Health Services and the Government Pharmacist, personal communication, August 2013.

Results

The estimated economic cost associated with treating water-borne diseases in government clinics and hospitals, and through other outlets, ranges from A$2.5 million to A$4.0 million a year under three scenarios (Table 12).

Economic Burden: Loss of Human Lives

To estimate the economic value of loss in human lives, the following information was collected (Table 13):

- **Mortality by age group:** data obtained from MHMS (summarized in Figure 11);
- **Per capita productivity in Kiribati adjusted for growth in GDP and labor force between 2010 and 2011:** data obtained from the NSO. It is assumed that average growrh is per capita gross national product is 1.03%; and
- **Discount rates:** range of social discount rates to reflect different social rate of preference for the value of human life as compared with physical capital.

Result: Economic Value of Lives Lost

The foregone annual economic value of mortality due to water-borne diseases, weighted by lives lost per age group, ranges from A$69,000 to A$183,00 (Table 14). Assuming social discount rate reflecting a low future value of life (5%) to high future value of life (1%), 16 lives were lost each year due to poor water and sanitation, and lost A$1.1 million–A$2.9 million worth of contribution to the economy. This is based on an optimistic assumption that the number of persons dying due to water-borne disease will not increase beyond the last 3-year average mortality rate.

Table 12: Economic Burden of Water-Borne Diseases in South Tarawa Under Three Scenarios of Social Discount Rates, 2012 (A$)

Item	Low	Medium	High
Total Government Costs	**1,078,303**	**1,177,670**	**1,299,118**
Medicine only	331,221	430,588	552,036
Clinic and hospital recurrent costs, excluding administrative and support	747,082	747,082	747,082
Household Hidden Costs (family and carergiver's time, transport, food, and alternative treatment)	**1,436,065**	**2,239,353**	**2,718,263**
Family and patient time plus transportation	1,427,083	2,221,389	2,691,317
Household costs of alternative treatment	8,982	17,964	26,945
Total Costs	**2,514,368**	**3,417,023**	**4,017,380**

Source: Author.

Table 13: National Base Data Used to Estimate the Economic Value of Lives Lost, 2010 and 2011

Item	2010	2011	% change
Annual gross domestic product (GDP)	A$253,181,994	A$261,537,000	1.0331 in productivity each year
GDP 2012 = GDP 2011 * 1.0331			
Workforce (no.)	39,034	39,884	1.0218 in population entering workforce (based on the change in population between 2005 and 2010 census)
Workforce 2012 = Workforce 2011 * 1.0218			
Labor productivity for each year (i+1) = GDP_{i+1}/Labor $force_{i+1}$			

Notes:
1. Discount range assumed: High value of life (or low discount rate of 1%); medium value of life (or social discount rate of 3%); low value of future earnings (high discount rate of 5%).
2. Productive life = at the age of 15 years and above.

A child is assumed to have productive economic value of zero until reaching the age of 15. A person of age 50 years will have productive life of only 4 years, that is, until the person reached 54 years.
Source: Basic data from the Kiribati National Statistics Office, 2013.

Table 14: Present Value of Loss of Lives (A$) Due to Poor Water and Sanitation Condition Under Three Scenarios of Social Discount Rates in South Tarawa, Average for 2010–2012

Parameter Item	Low Value of Life	Medium Value of Life	High Value of Life
Discount rate	5%	3%	1%
Annual value of life lost per person	A$69,122	A$111,125	A$183,060
Average number of lives lost (2010–2012)	16	16	16
Economic benefits of life foregone	$1,105,958	$1,777,997	$2,928,956

Source: Based on mortality data from the Ministry of Health and Medical Services; and per capita productivity, and rate of change in the labor force between the 2005 and 2010 Census of Population and Housing from the Kiribati National Statistics Office.

Total Economic Burden of Poor Water and Sanitation

The total annual economic burden of poor water and sanitation in South Tarawa is estimated to be between A$3.7 million and A$7.2 million (Table 15). This translates to an annual economic cost of A$550–A$1,083 per household, or an equivalent A$71–A$140 per resident of South Tarawa. It is noted that the estimates of "hidden cost" are conservative because many costs could not be determined.

Table 15: Total Annual Economic Costs Associated with Poor Water, Sanitation, and Hygiene Conditions in South Tarawa (A$)

	Scenario		
	Low	Medium	High
Economic Burden on the Government of Diseases treated through Clinics & Hospitals			
Treatment cost (recurrent clinic and hospital cost to the Government)	747,082	747,082	747,082
Medicine only	331,221	430,588	552,036
Patient and family time lost and miscellaneous cost (HHs)	1,436,065	2,239,353	2,718,263
Productive value of lives lost (Country)	1,195,971	1,897,577	3,242,226
Total	3,710,339	5,314,600	7,259,607

Note: The low, medium, and high scenarios are based on the respective assumptions about opportunity cost of patients' and caregiver's time; cost of freight charges for medicine; cost of alternative treatment costs; proportionate decline in tourism attributable to poor water, sanitation, and hygiene related conditions; and loss in economic contribution due to lives lost.

Costs Not Included

Costs associated with many water-borne diseases, such as scabies, boils and wound infections, and worms, are not included because these illnesses are not formally recorded by the clinics and hospitals. The cost estimate does not include administration and support costs of running the clinics and hospitals, which are known but could not easily be apportioned to water- and vector-borne disease treatments. This estimate excludes the costs associated with ciguatera poisoning since ciguatera cases could not be differentiated from other types of fish poisoning. In addition, the economic value of human suffering and loss of biodiversity and other environmental values are also not included, as well as the cost of preventative measures taken by households, such as the costs of using kerosene or firewood for boiling water,[14] and the costs of cleaning of septic systems and pit toilets.[15]

Who Bears the Economic Burden of Poor Water and Sanitation?

In the discussion below, medium level cost estimates are used to provide an indication of who bears the costs of inadequate water supply and sanitation in South Tarawa. Kiribati society as a whole losses on economic contribution from lost lives and reduced tourism revenue (46%), followed by opportunity costs of time lost by those suffering from water-borne diseases and their caregivers, and other miscellaneous expenses, such as on transport and special

14 Households could not easily separate the cost of boiling water from the cost of other household cooking.

15 The number of households that undertook such preventative measures was very small to provide meaningful basis for estimating Kiribati-wide costs of these measures.

food (35%). Medicine and recurrent health-related costs account for 19% of the total costs (Figure 13). These are all "hidden costs" of poor water supply and sanitation. Even government's expenditure on addressing water- and vector-borne disease is hidden even though health service costs are reported to the Parliament but not disaggregated by type of disease.

Household Level Costs

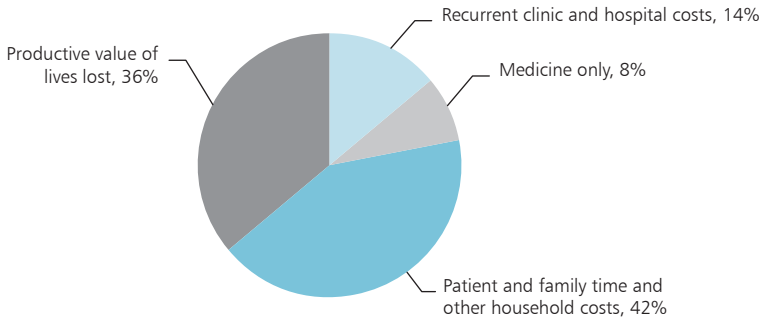
Who bears the economic costs of the health effects of poor water and sanitation within a household? What are the key characteristics of the households and villages that contribute to the burden borne by individuals, households, and the government?

The following conclusions are drawn from detailed analysis of the 2013 household survey data (Annexes 3–5). The findings from the survey demonstrate that both the household and village characteristics determine who bears the costs of dia_dys.

- Females are found to have significantly higher likelihood of suffering from dia_dys than males (at $p<0.05$), taking into account household and village characteristics, and controlled with other variables. This is not surprising given gender inequality in practices that are evident in traditional i-Kiribati social structures, including discriminatory feeding practices between boy and girl-child and access to health services (Rasanathan and Bhusan 2011) (Table A4.2).
- Age influences the chances of individuals suffering from diarrhea and/or dysentery ($p<0.01$). Younger persons have a greater chance of suffering from dia_dys, keeping everything constant. As a person gets older, with each year there is 18% lower odds of suffering from the two diseases (Table A4.2). There is also an interaction between age and sex—boys having lower chances of suffering from dia_dys than girls when young.

Figure 13: Economic Burden of Inadequate Water and Sanitation

Total cost = $5.3 million



Source: Ministry of Health and Medical Services, August 2013.

But men have a greater risk of getting sick with dia-dys as they get older when compared to women (switching point is from around 30 years and onwards) (Figure A4.1). The magnitude of difference in disease incidence between sex-age relationship of children and adults needs to be compared with detailed sex-age analysis of the clinic and hospital data. The difference between older men and women, too, needs further research; one reason could be an increasing social practice of men drinking kava in kava bars, where water may not be boiled before making the kava or not adequately washing hands before mixing the kava.

Household and Village Characteristics

- Both households and villages contribute to the chance of people suffering from dia_dys (Table A4.1).
- The average proportion of household members that suffers from diseases is 6.6%, which varies across villages (Table A3.1).
- Individuals who live in households that have no latrines (i.e., use beach, lagoon, and/or bush) are more likely to suffer from dia_dys. The proportion of household members suffering from dia_dys in households with no latrines is on average about 5% higher compared to the households with latrine connected to, for example, PUB sanitation system (Table A5.1).
- The proportion of household members living in permanent houses suffering from dia_dys is lower ($p<0.01$) when compared with those living in traditional and mixed houses (Table A5.1). There is though an indication of interaction effects between the type of household and type of latrine. In this case, the negative effects of having no latrine is less important in permanent households than in traditional/mixed household. On average, the proportion of people from traditional/mixed households without latrine, who get sick, is about 10%; while the figure for permanent households with no latrine is about 5% (Figure A5.1).
- The proportion of household members suffering from diarrhea and/or dysentery is higher (albeit at $p<0.01$) in households that are located in villages with higher proportion of households that use only the beach, bush, or lagoon (Table A5.1). This means that where the ambient sanitary condition in the village is poor because of high proportion of households using the beach, there is a higher proportion of household members suffering from dia_dys (Figure A5.2). One point increase in the proportion of households that do not have latrine is associated with a 9% increase in the proportion of household members suffering from dia_dys.
- The probability of household members suffering from dia_dys is mixed when it comes to the effect of the type of water used (Table A5.1). The relationship is unclear when one examines the situation from the perspective of individual suffering from dia_dys. For example, the results suggest that there is a positive relationship between the probability of individuals suffering from dia_dys ($p<0.05$) and the use of own rainwater and protected well water; and to the use of PUB water but only a $p<0.1$,

which is contrary to what would be expected. Individuals using water from open wells and neighbor did not show significant correlation. However, analysis of the households shows a significant association between the type of water source and dia_dys incidence. The proportion of household members suffering from dia_dys is higher in the households that use water from open well and neighbors ($p<0.05$), which is the case with the use of PUB water ($p<0.01$). On the other hand, the use of rainwater did not show any significant relationship with dia_dys incidence. These results suggest that any other factors, in addition to water source, may underpin the disease risks.

In summary, it is clear that those who bear the economic burden of poor water and sanitation practices is a product of a complex interaction between many different factors relating to inadequate water supply, sanitation, and hygiene at both individual and village levels. Other factors include the sex and age of individuals, household characteristics of the type of water and toilets used, and conditions in the village on sanitation, particularly the prevalence of open defecation.

Reducing Economic Burden of Poor Water and Sanitation

The government and South Tarawa communities can avoid and/or save annually A$3.7 million–A$7.3 million, or A$550–A$1,083 per household, by taking appropriate steps to improve WASH conditions in South Tarawa.

Public Investment

PUB provides households in South Tarawa with water supply for a flat fee of A$10/month; and sewerage services to households in Bairiki, Betio, and Bikenibeu are free of charge. PUB has been constrained in adjusting tariffs to a level that better reflects the actual costs of service delivery. Many politicians and members of the public are of the view that water supply and sanitation, as essential services, should be free. The government provides annual subsidies of A$500,000 to PUB to address shortfalls in revenue. However, subsidies are insufficient to support adequate investments in infrastructure upgrading and operation and maintenance to improve access and quality of service delivery. Also, PUB, as a public enterprise, is not held accountable for the quality of its service delivery.

It is clear that underinvestment in the water and sanitation sector, which has reduced the quality and access to water supply and sanitation services, has increased the economic burden on other sectors, in particular, the health sector. The government provides health services free of charge to the population and health expenditure has increased as a result of the need to treat a growing number of patients suffering from WASH-related illnesses. Similarly, the tourism sector growth has been constrained by degradation of the surrounding environment, making South Tarawa an unappealing destination for tourists caused by inadequate sanitation and solid waste management.

Under the "user pays" principle, where possible, households and the private sector, as direct users of water and sanitation services, would finance the costs of these services. However, investments, such as for sanitation improvements, have public goods features as well and that serve as justification for government support for investments in water supply and sanitation. In such cases, the full benefits of improved sanitation in public health and environmental quality cannot be fully captured by individual households; thus, full cost recovery through tariffs is difficult.

Preventative public investments to improve water supply and sanitation are likely to be more cost-effective than health expenditures to treat WASH-related illness alone, and will also benefit other sectors of the economy. The Government of Kiribati, through the Asian Development Bank and

Australian Aid, supported the South Tarawa Sanitation Improvement Sector Project (STSISP), to finance the rehabilitation of sewerage infrastructure. However, a significant level of investment is needed to improve water supply and expand sanitation coverage in South Tarawa. Information on economic costs of inadequate water supply and sanitation estimated in this study can inform economic analyses of various options for improving the existing situation in South Tarawa.

Improved Cost Recovery in Service Delivery

Despite efforts by policy makers to keep tariffs for water supply and sanitation services at "affordable levels," there are substantial "hidden costs" borne by households as a result of such policies. Low levels of cost recovery in service delivery translate into poor quality water supply and sanitation services, resulting to costs borne by households, such as lost productivity causing income losses and expenditures on treating water-borne diseases.

Households externalize many costs associated with inadequate sanitation through open defecation and poorly constructed septic tanks to the wider community in South Tarawa. For example, as a result of underinvestment in sanitation facilities for households, they may opt to engage in open defecation, or refrain from maintaining their septic tanks in good condition. While this results in lower financial costs for individual households, the economic costs of such actions through WASH-related disease and environmental degradation are borne by the entire community and the government.

There is a need to review user charging policies to promote a shift toward greater cost recovery in water supply and sanitation service delivery. While the willingness to pay (WTP) survey conducted in this study indicates households are willing to pay about A$13.02 per month (Standard deviation = A$13.42) on average, the WTP varies across villages (Table A6.3). There is no significant relationship between the household's WTP and factors related to the level of education in the household (or the highest level achieved by any member of the household), number of household members suffering from dia_dys, or even recent deaths in the household from acknowledged water-borne diseases (see Annex 6 more detailed discussion).

The efforts to implement "user pays" principle to recover water charges are likely to face difficulties, particularly when some people do not seem to fully understand the relationship between poor water and sanitation conditions, water borne diseases and deaths.[16] The survey also reveals that, of those not willing to pay (25%), almost half believe that the supply of safe water is government's responsibility; while the rest indicates that they could not afford to pay (see Annex 6 for further discussion). PUB currently faces difficulties in recovering payment for water supplied to households, and the transaction cost of recovering monthly charges that are nontrivial because of factors, such as illegal connections. In view of these, the government and PUB need to jointly review the charging policy, taking into account the full benefits and costs to include transaction costs.

16 This lack of understanding among some members of the society was confirmed during a community mobilization workshop conducted under the TSISP in August 2013 (Cecily Neil, community engagement and gender specialist, TSSIP, personal communication, August 2013).

The analysis clearly highlights the need to invest in public awareness programs, so that households understand better the links between inadequate WASH, on one hand, and health outcomes and other flow on effects in sectors such as tourism and fisheries, on the other hand. The ability to pay must also be considered given the high proportion of households living below the poverty line in South Tarawa. Targeted subsidies may be required to ensure basic access to services. It is clear that the current policy of keeping tariff levels low for all households to ensure affordability is not an effective policy. This has resulted in low levels of access and poor quality of service delivery. As demonstrated in the study, those who pay the highest costs of the current charging policy in terms of the economic costs of inadequate water supply and sanitation are the vulnerable groups, i.e., women, children, and elderly, who are the intended beneficiaries of the current charging policy.

Improved monitoring and enforcement of existing building codes and environmental regulations can also address the pollution of freshwater lenses and the surrounding environment caused by poorly constructed and maintained septic tanks. To date, there is little incentive for households to consider the consequences of their actions in terms of underinvesting in household sanitation facilities, and its wider economic costs for the community and economy.

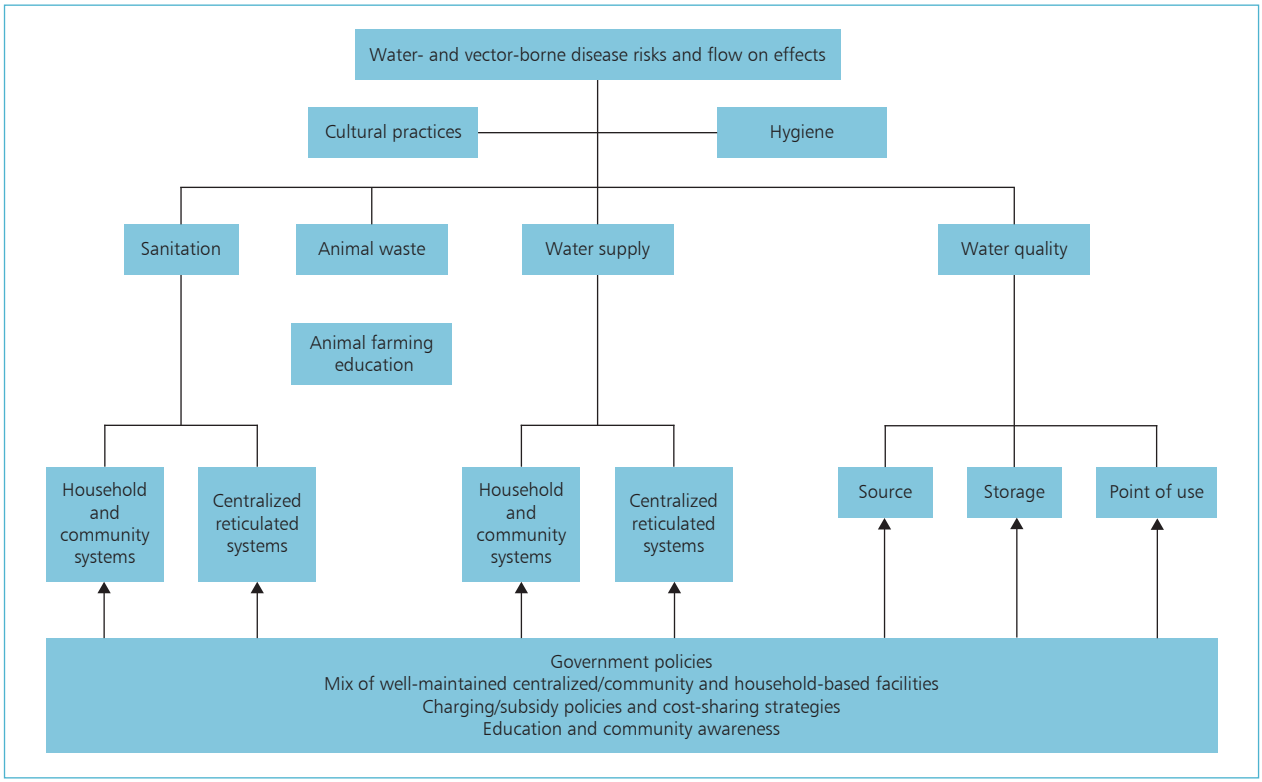
Actions by both government and communities are necessary, with the government playing a decisive role in addressing the challenges.

Integrated Water, Sanitation, and Hygiene Improvements

Given the links between WASH and disease, there is a need to consider adopting a more integrated approach to improving public health outcomes in South Tarawa, including the following:

- **Adopting a systems approach for improvements in water and sanitation services and practices** (Figure 14). The interventions recognize that disease risk due to poor water and sanitation depends on the condition of the individual household level characteristics regarding access to, storage, and use of water and sanitation systems and practices, as well as animal raising practices. It further recognizes that village characteristics about toilet types and water sources also underpin individual chances of suffering from these diseases due to factors such as the common practices of sharing food, using neighbor's water and toilets, and basic hygiene. This would mean that
  - government adopt a more systems approach where all facets of the household's water quantity and quality and toilet systems used are simultaneously addressed, in addition to the overall conditions of the villages;
  - households to simultaneously improve their own sources of water used, water storage practices, and toilet systems, including repair and regular cleaning of septic tanks and improving basic hygiene within the house; and also encourage and help their neighbors and others in the community to change their practices regarding water and toilet systems and hygiene; and

Figure 14: Key Components of a System-Based Intervention for Improvements in Water and Sanitation Services and Practices for Reduced Economic Burden



Source: Author.

- key government agencies, such as PUB and MHMS, to systematically target individual households and each village as a whole; and jointly conduct their community awareness and education program that integrates water and sanitation, household systems and practices, and the effects of traditional practices in relation to gender and health.

- **Adopting appropriately sequenced or phased interventions.** Greater impact could be generated if a combination of interventions is appropriately sequenced or phased. And greater emphasis is also placed not only on components that are thought to be central to the input-based interventions, i.e., the centrally provided water and sanitation facilities and education, but also on the quality of water and sanitation in the households. It includes, for example, improving water storage practices and undertaking maintenance of household septic tanks.

Conclusion

Kiribati and South Tarawa, in particular, continue to experience high economic burden due to poor water and sanitation conditions in South Tarawa. The government, individual households, and economy as a whole share the burden of annual economic costs between A$3.7 million–A$7.3 million, or 2%–4% of national GDP.[17] These are conservative estimates, as many costs could not be determined because of the lack of formally recorded disease information, difficulty in differentiating the costs, and/or difficulty in estimating the nonmarket nature of many of the direct and flow-on-costs.

If appropriate action is not taken now to address the current risks associated with inadequate water and sanitation, the hidden costs are expected to grow due to:

- increased population in South Tarawa on account of high fertility rates and internal migration;
- continued increase in the settlement of people in the catchment area that supports groundwater lens in Bonriki and Bouta, resulting to pollution of the main source of groundwater and higher water treatment costs; and
- effects of climate change from increased level of rainfall and air temperature, and rise in sea level (Australian Bureau of Meteorology and Commonwealth Scientific and Industrial Research Organisation 2011); and to result in increased incidence of flooding and mosquito populations that will ultimately increase the incidence of water- and vector-borne diseases and in ground water salinity [MHMS and WHO 2011 (draft)].

Urgent actions are needed to address current and changing risks of water- and vector-borne diseases. There are both private and public dimensions to the challenge, and a multipronged approach is needed to reduce the economic costs of inadequate water and sanitation facilities and practices. It includes the following measures:

- investments in adequate water supply and sanitation infrastructure that can be sustainably operated and maintained;
- tariffs that better reflect 'user pays' principles to ensure improved cost recovery in the delivery of water supply and sanitation services;
- sustained public awareness campaigns on the links between health, water supply, sanitation, and hygiene; and
- integrated approaches to simultaneously improve water supply, sanitation, and hygiene conditions in South Tarawa communities.

The results of this study can be used as the basis for carrying out further economic analysis on appropriate options for improving existing WASH conditions in South Tarawa.

17 IMF. 2013. *Kiribati 2013 Article IV Consultation*. IMF Country Report No 13/158. Washington D.C.

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Annex 1

ADB TA7359-KIR: Tarawa Sanitation Improvement Project

Assessment of the Economic Costs of Inadequate Water Supply and Sanitation Services in South Tarawa, Kiribati

Household Survey Questionnaire

Enumerator's Name	Household Number (in the village) .....
Enumerator's Code	Church denomination .....
Village Name ..... Village Code (Census)	Type of Household (circle one) 1. Traditional 2. Permanent 3. Mixed
Date Survey Completed | | | / | | | / | | | | | D D M M Y Y Y Y	Respondent Gender (circle one): 1. Female 2. Male

Thank you for agreeing to be part of this survey. This survey is conducted under an ADB-funded study on the "assessment of the economic costs of inadequate water supply and sanitation services in South Tarawa." (Please see attached brief)

Enumerators please explain to the respondent the context of this survey and its purpose. Also, in each section of the questionnaire, there is a short description about the reasons for asking those questions. Please explain these to the respondent before asking each of those questions in the set.

Context

ADB is supporting South Tarawa Sanitation Improvement Sector Project (STSISP) to improve water supply and sanitation services on the Island of South Tarawa. As part of this initiative, the Government of Kiribati wishes to identify direct and indirect costs to the people of South Tarawa and the government due to the effects of inadequate (poor) water supply and sanitation services, that is, the current business as usual situation. People suffer from many diseases caused by poor water and sanitation services. Such diseases are transmitted through water called water-borne diseases, like dysentery, diarrhea, cholera, typhoid, etc. There are also diseases transmitted via mosquitoes. These diseases are called insect-borne diseases, like dengue.

Purpose

The main purpose of this survey is to obtain from the individual households information that can help us to assess

- the financial costs to people due to the effects of poor water and sanitation services—costs associated with direct human health effects, such as water-borne diseases, vector infectious diseases, that include the costs associated with doctor visits, medicine, hospitalization, loss of income, etc.;
- the amount households pay to reduce health problems caused by poor water and sanitation by, for example, boiling water, buying water tank filters, etc.; and
- household conditions that may contribute to increased incidence of water- and insect-borne diseases, including loss of lives directly linked to these illnesses.

A. Household Characteristics

Please note:

A **'household'** – *a family (or a number of families) that live together **and eat** from the same kitchen*

A **family** – *a couple with or without children and/or one or more parent, eating from the same kitchen (even if they sleep in different 'sleeping' houses)*

1a. Are you the head of the household? (**Circle**) 1. Yes 2. No

1b. If not head of the household, how would you describe your relation to the head of the household? **Circle** one.

1. Husband/wife/partner
2. Adult child
3. Grandchild
4. Parent/Parent in-law
5. Other (specify) _____

1c. Number of families living in this household (give a number) _____

1d. Number of persons living in the household _____

1e. What is the **highest level of education in the household** (**Circle** as relevant):

1. Primary school
2. Secondary school
3. Tertiary Institute (such as USP, KIT, Fisheries, etc.)
4. Kiribati Maritime College

2. Please enter for each member of the household, their age, education, employment status, hours worked, etc.

For children, at school, enter N/A in relation to employment questions and tick (please insert extra rows if necessary).

Family members (starting with the oldest progress to the youngest)	Sex: 1-Male 2-Female	Age (year)	Relationship with the household head	Formal employment status	Type of work (if Column [5] is coded 1, 2, or 3)	Number of days worked in the last 2 weeks	Income earned in a day $$	Income earned in the last fortnight by that person $$	At school (Please tick as relevant)	For calculating fortnightly income
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
Person #										
1										
2										
3										
4										

continued next page

Continued

Family members (starting with the oldest progress to the youngest)	Sex: 1-Male 2-Female	Age (year)	Relationship with the household head	Formal employment status	Type of work (if Column [5] is coded 1, 2, or 3)	Number of days worked in the last 2 weeks	Income earned in a day $$	Income earned in the last fortnight by that person $$	At school (Please tick as relevant)	For calculating fortnightly income
5										
6										
7										
8										
9										
10										
11										
12										
13										
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24										
25										
26										
27										
28										

Codes for Column 4
1. Household head
2. Husband/wife
3. Child
4. Grandchild
5. Parent/Parent in-law
6. Other

Codes for Column 5:
Formal employment status
1. Working full-time for someone else
2. Self-employed
3. Working part-time for someone else
4. Not working

Codes for Column 6: Types of work
1. Government employee
2. Private employee
3. Employer
4. Agriculture, fishing for sale
5. Aggregate mining
6. Producing goods for own consumption
7. Unpaid voluntary work
8. Unpaid family work
9. Other

B. Sanitation type

The following questions will help us understand if there is any relationship between the level of diseases suffered by the members of the household, which are known to be transmitted through water and by mosquitoes, and the type of sanitation system used by the family.

1.i. What type (s) of toilet system does your family use? **Circle** all the ones used.
- a. Own toilet
- b. Neighbor's toilet
- c. Communal toilet
- d. Ocean/lagoon/bush

ii. In the next column, rank the **three** most used types of toilet system (in order starting with the most important at the top, and then the second most important, and the third most important on the lowest box).

Rank 1. ☐
Rank 2. ☐
Rank 3. ☐

2. Circle the type of latrine system your household has? **Circle** the one that is relevant.
- a. Flush toilet connected to PUB, even if not working (Answer Qs 6 and 7)
- b. Flush toilet (connected to own septic) (Answer Qs 3, 4, 5)
- c. Pour flush (pit) (Go to 8)
- d. Compost toilet
- e. None (Use ocean/lagoon/bush)

3. If you have a flush toilet with septic tank system, how many times did it **overflow** in the **last 12 months**? **Circle one.**
- a. Every time it rains
- b. At least once in 6 months
- c. At least once last year
- d. Did not overflow in the last 12 months.

4. If you use a septic tank-based toilet system, and have **had overflow problems** in the past, what is the **main reason** for your septic tank overflow? **Circle** the relevant one.
- a. Old and leaking
- b. Poorly designed
- c. Other (specify)

5. If you use a septic tank-based toilet system when did you last have the septic tank cleaned? Please **circle** one.
- a. This last year
- b. 5 years ago
- c. 10 years ago
- d. Cannot recall
- e. Never – explain why not ……

6. If your toilets are connected to the PUB system, how many times did it overflow in the last 12 months? Please **circle** one.
- a. Every time it rained
- b At least once in the last month
- c. At least once in the last 3 months
- d. Did not overflow in the last 3 months.

7. If your toilets are connected to the PUB system, how many times did it get blocked (or had other kinds of problems) in the last month. Please **circle** one.
- a. At least once in the last month
- b. At least 2 times in the last month
- c. More than 2 times in the last month

8. If you used pour toilet with pit, how many times did you have to clean it out in a year. Please **circle** one.
- a. Once a year
- b. Twice a year
- c. Once in more than 2 years

9. In relation to the cost of constructing the type of toilet system you have (confirm with B 2 above).

i. How much money did you spend to buy the material (such as timber, toilet pan, pipes, cement, etc.)? $_____

ii. a. How many persons were involved in building the toilet system _____
- b. How many days did they spend _____ days
- c. How many hours did they spend each day _____ (hours a day)

10. How much did it **cost** the last time when you had to **repair, fix, clean, or maintain** your toilet system? (**Select the one** – refer to Q2, and use the same as Q9)
- a. Flush toilet (connected to PUB) ……..
- b. Flush toilet (connected to own septic) ……..
- c. Pour with pit (e.g., For PUB to empty it out) ……..
- d. Compost toilet ……..
- e. Don't know ……..
- f. Did not do any repairs, etc. (Note relevant) ……..

C. Drinking and Other Water Sources

The following questions will help us understand if there is relationship between the level of water and vector-borne diseases suffered by the household and the source of water used for drinking and/or washing.

1. i. What **sources of drinking water** does your household use? **Circle** as relevant.
   a. Pipe system (PUB)
   b. Own rainwater tank
   c. Open well water
   d. Protected well water
   e. Community water
   f. Get water from neighbors
   g. Buy water from the PUB (tanker)
   h. Buy bottled water

   ii. Rank the three most important sources of drinking water in the next column. (Please **enter the letter**, starting with the most important at the top, and the next most important, and third most important in the bottom box)

   Rank 1. ☐
   Rank 2. ☐
   Rank 3. ☐

2. When your **own** source of drinking water is not sufficient to meet your household's needs, where do you get additional drinking water from? **Circle** only once.
   a. Own rainwater tank
   b. Open well water
   c. Protected well water
   d. Use community water
   e. Get water from neighbors
   f. Buy water from the PUB (tanker)
   g. Bottled water

3. Do you buy water from PUB Tanker? **Circle** one.
   i. Yes → (Answer Q4)
   ii. No → (Answer Q5)

4. If you regularly buy water from PUB (tanker) (to supplement your main sources of drinking water), how much water to do you purchase and how much does it cost you?
   i. **Tons** (cubic meters) ……/per tanker-trip
   ii. **Number** of tanker-trips per month .....
   iii. **Payment** per tanker-trip $.....

5. Do you normally buy bottled water? **Circle one.**
   i. Yes → (Go to Q6)
   ii. No → (Go to Q7)

6. If you use bottled water, answer the following questions for **normal** periods and during **drought** period (i.e., there is no rain for at least 3 months).
   a. **Normal period**
      i. Number of bottles : ...../week
      ii. Size of bottles : .....mls/bottle
      iii. Total cost of bottled water purchased per week $_____
   b. **During drought** (Drought condition arises when there was no rain for at least 3 months.)
      i. **Number** of bottles : ...../week
      ii. **Size** of bottles : .....mls/bottle
      iii. **Total cost** of bottled water per **week** $_____

   Space for calculating

7. i. Do you treat water for drinking? Please **circle** one.
   a. Yes ……. (If yes, go to ii)
   b. No .....
   ii. For each of the drinking water sources you use, indicate how you treated it. (**Tick relevant cell**)

	Boil	Chlorine	Stand	Water filter	Other (specify)
	(1)	(2)	(3)	(4)	(5)
a. Pipe system (PUB)					
b. Own rainwater tank					
c. Open well water					
d. Protected well water					
e. Community water					
f. Get water from neighbors					
g. Buy water from the PUB (tanker)					

8. If you treated your drinking water using material bought from the shop, how much did it cost you to use the different methods where you had to buy material?

	Chlorine (liquid or tablets)			Water filter	
	Last week ($$)	Last month ($$)		Last week ($$)	Last month ($$)
	(1)	(2)		(3)	(4)
a. Pipe system (PUB)					
b. Own rainwater tank					
c. Open well water					
d. Protected well water					
e. Community water					
f. Get water from neighbors					
g. Water bought from the PUB (tanker)					

9. When there is drought (i.e., there is no rain for at least 3 months),
   i. What sources of water do you use? **Circle all** types that are relevant.
      a. PUB piped
      b. Own rainwater tank
      c. Open well water
      d. Protected well water
      e. Community water
      f. Get water from neighbors
      g. Buy water from the PUB (tanker)
      h. Buy bottled water (from shop)

   ii. Of those sources of drinking water you use, what are the **top three**. (Please indicate in order of importance, writing the most important source—insert a letter from above in the top box, second most important source [a letter from above in the middle box, and third most important letter] in the last box.)

   Rank 1. ☐
   Rank 2. ☐
   Rank 3. ☐

10. If you had bought water during the last drought (i.e., there is no rain for 3 months), how often did you ask PUB (or the private supplier) to come around to your house to deliver tanker of drinking water; how much water did you buy each trip; and how much did you pay for the supply of drinking water for your household?

	In a week	In a month	During the drought entire period
	(1)	(2)	(3)
a. How many times did you ask the PUB to come around to your house (please fill in 1, 2, 3 as relevant)?			
b. How much water did you buy each trip (i.e., how many tons of water did you buy per trip?)			
c. How much did you pay ($) per trip?			

11. Where do you normally store the water you buy/or get from PUB?
   i. Circle each of the key types of containers that you use to store water bought from PUB.
      a. rainwater tank
      b. drums (44 gallon)
      c. any large plastic containers (cans, etc.)
      d. kitchen pots, pans, basins, etc.
      e. other – specify _____

   ii. Of those storage types, what are the **top three**. (Please indicate in order of importance, writing the most important source [insert a letter from above in the top box], second most important source [a letter from above in the middle box], and third most important [insert a letter in the last box].)

   Rank 1. ☐
   Rank 2. ☐
   Rank 3. ☐

D. Water-borne and vector infectious diseases and related costs

This set of questions is designed to identify the costs associated with water- and insect-borne diseases to your family.

1. Has anyone in the house suffered from these water- and vector-borne diseases in the last **4 weeks**? **Circle** all those that are applicable.
   a. Dengue (If Yes, Answer Q2a)
   b. Diarrhea (If Yes, Answer Q2b)
   c. Dysentery (running stomach with blood/pus in the stool) (If Yes, Answer Q2c)
   d. Conjunctivitis (eye infection) (If Yes, Answer Q2d)
   e. Ciguatera (fish poisoning) (If Yes, Answer Q2e)
   f. Boil (includes wound infection) (If Yes, Answer Q2f)
   g. Worm (If Yes, Answer Q2g)
   h. Scabies (If Yes, Answer Q2h)
   i. Tinea (white spot) (If Yes, Answer Q2i)
   j. Ringworm (If Yes, Answer Q2j)

2. **For Enumerators Information.** For each of the diseases you will ask respondent about things like:
   i. How many adults, children, and infants in your household suffered from that illness?
   ii. How many days did the disease last for each sick person in the family?
   iii. How many days an adult was away from work?
   iv. How many days a child was away from school sick?
   v. What treatment was sought? Please enter the code (00: Traditional Medicine 01: Local Hospital/Clinic/Health Center 02: Shop 03: No treatment sought 05).
   vi. How much did the family spend for the treatment of the illness in each case (include cost for transportation, consultation, medication, special food, if relevant)?

Fill out the answers to the above questions by filling in the appropriate table cells.

NB. Make sure you include all members of households that had the disease, in each table for the different diseases. Make sure the age and sex of the person is consistent with what was reported in A2.

2a. **DENGUE FEVER**

i. How many members of the household suffered from this illness in the last 2 week? ☐☐

ii. Write down the ages of people who suffered from this disease in the **LAST 4 WEEKS**. Enter these ages below in the first column, making reference to ages listed in Question A 2 above (p3&4). For each person, then fill each box in each column.

Person #	Age (year)	Sex of the person (Insert M, F)	# of days sick	# Days away from work (or could not do any work at home)	# Days away from school (as relevant)	Treatment Outlet (see Code below)	Cost ($ treatment) (bus fare, medicine, special food, etc.)	Days admitted in hospital	Comments (such as if someone died from the illness; or had repeat illness this year, and/ or was admitted to the hospital; got traditional medicine from bush)	Column for adding costs
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(8a)	(9)	(10)

Code for Column 7: Treatment Outlets, 00 Traditional Medicine, 01 'Traditional doctor', 02 Shop, 03 Hospital/Clinic/Health Center, 04 From overseas, 05 No treatment sought.

2b. **DIARRHEA**

i. How many members of the household suffered from this illness in the last 2 weeks? ☐☐

ii. Write down the ages of people who suffered from this disease in the **LAST 4 WEEKS**. Enter these ages below in the first column, making reference to ages listed in Question A 2 above (p3&4). For each person, then fill each box in each column.

Person #	Age (year)	Sex of the person (Insert M, F)	# of days sick	# Days away from work (or could not do any work at home)	# Days away from school (as relevant)	Treatment Outlet (see Code below)	Cost ($ treatment) (bus fare, medicine, special food, etc.)	Days admitted in hospital	Comments (such as if someone died from the illness; or had repeat illness this year, and/ or was admitted to the hospital; got traditional medicine from bush)	Column for adding costs
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(8a)	(9)	(10)

Code for Column 7: Treatment Outlets, 00 Traditional Medicine, 01 'Traditional doctor', 02 Shop, 03 Hospital/Clinic/Health Center, 04 From overseas, 05 No treatment sought.

2c. **DYSENTERY (Diarrhea with blood/pus in stools)**

i. How many members of the household suffered from this illness in the last 2 weeks? ☐☐

ii. Write down the ages of people who suffered from this disease in the **LAST 4 WEEKS**. Enter these ages below in the first column, making reference to ages listed in Question A 2 above (p3&4). For each person, then fill each box in each column.

Person #	Age (year)	Sex of the person (Insert M, F)	# of days sick	# Days away from work (or could not do any work at home)	# Days away from school (as relevant)	Treatment Outlet (see Code below)	Cost ($ treatment) (bus fare, medicine, special food, etc.)	Days admitted in hospital	Comments (such as if someone died from the illness; or had repeat illness this year, and/ or was admitted to the hospital; got traditional medicine from bush)	Column for adding costs
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(8a)	9	(10)

Code for Column 7: Treatment Outlets, 00 Traditional Medicine, 01 'Traditional doctor', 02 Shop, 03 Hospital/Clinic/Health Center, 04 From overseas, 05 No treatment sought.

2d. **CONJUNCTIVITIS (Red eye infection)**

i. How many members of the household suffered from this illness in the last 2 weeks? ☐☐

ii. Write down the ages of people who suffered from this disease in the **LAST 4 WEEKS**. Enter these ages below in the first column, making reference to ages listed in Question A 2 above (p3&4). For each person, then fill each box in each column.

Person #	Age (year)	Sex of the person (Insert M, F)	# of days sick	# Days away from work (or could not do any work at home)	# Days away from school (as relevant)	Treatment Outlet (see Code below)	Cost ($ treatment) (bus fare, medicine, special food, etc.)	Days admitted in hospital	Comments (such as if someone died from the illness; or had repeat illness this year, and/ or was admitted to the hospital; got traditional medicine from bush)	Column for adding costs
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(8a)	(9)	(10)

Code for Column 7: Treatment Outlets, 00 Traditional Medicine, 01 'Traditional doctor', 02 Shop, 03 Hospital/Clinic/Health Center, 04 From overseas, 05 No treatment sought.

2e. **CIGUATERA (Fish Poisoning)**

i. How many members of the household suffered from this illness in the last 2 weeks? ☐☐

ii. Write down the ages of people who suffered from this disease in the **LAST 4 WEEKS**. Enter these ages below in the first column, making reference to ages listed in Question A 2 above (p3&4). For each person, then fill each box in each column.

Person #	Age (year)	Sex of the person (Insert M, F)	# of days sick	# Days away from work (or could not do any work at home)	# Days away from school (as relevant)	Treatment Outlet (see Code below)	Cost ($ treatment) (bus fare, medicine, special food, etc.)	Days admitted in hospital	Comments (such as if someone died from the illness; or had repeat illness this year, and/ or was admitted to the hospital; got traditional medicine from bush)	Column for adding costs
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(8a)	(9)	(10)

Code for Column 7: Treatment Outlets, 00 Traditional Medicine, 01 'Traditional doctor', 02 Shop, 03 Hospital/Clinic/Health Center, 04 From overseas, 05 No treatment sought.

2f. **BOIL (Includes wound infection)**

i. How many members of the household suffered from this illness in the last 2 weeks? ☐☐

ii. Write down the ages of people who suffered from this disease in the **LAST 4 WEEKS**. Enter these ages below in the first column, making reference to ages listed in Question A 2 above (p3&4). For each person, then fill each box in each column.

Person #	Age (year)	Sex of the person (Insert M, F)	# of days sick	# Days away from work (or could not do any work at home)	# Days away from school (as relevant)	Treatment Outlet (see Code below)	Cost ($ treatment) (bus fare, medicine, special food, etc.)	Days admitted in hospital	Comments (such as if someone died from the illness; or had repeat illness this year, and/ or was admitted to the hospital; got traditional medicine from bush)	Column for adding costs
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(8a)	(9)	(10)

Code for Column 7: Treatment Outlets, 00 Traditional Medicine, 01 'Traditional doctor', 02 Shop, 03 Hospital/Clinic/Health Center, 04 From overseas, 05 No treatment sought.

2g. **WORMS**

i. How many members of the household suffered from this illness in the last 2 weeks? ☐☐

ii. Write down the ages of people who suffered from this disease in the **LAST 4 WEEKS**. Enter these ages below in the first column, making reference to ages listed in Question A 2 above (p3&4). For each person, then fill each box in each column.

Person #	Age (year)	Sex of the person (Insert M, F)	# of days sick	# Days away from work (or could not do any work at home)	# Days away from school (as relevant)	Treatment Outlet (see Code below)	Cost ($ treatment) (bus fare, medicine, special food, etc.)	Days admitted in hospital	Comments (such as if someone died from the illness; or had repeat illness this year, and/ or was admitted to the hospital; got traditional medicine from bush)	Column for adding costs
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(8a)	(9)	(10)

Code for Column 7: Treatment Outlets, 00 Traditional Medicine, 01 'Traditional doctor', 02 Shop, 03 Hospital/Clinic/Health Center, 04 From overseas, 05 No treatment sought.

2h. **SCABIES**

i. How many members of the household suffered from this illness in the last 2 weeks? ☐☐

ii. Write down the ages of people who suffered from this disease in the **LAST 4 WEEKS**. Enter these ages below in the first column, making reference to ages listed in Question A 2 above (p3&4). For each person, then fill each box in each column.

Person #	Age (year)	Sex of the person (Insert M, F)	# of days sick	# Days away from work (or could not do any work at home)	# Days away from school (as relevant)	Treatment Outlet (see Code below)	Cost ($ treatment) (bus fare, medicine, special food, etc.)	Days admitted in hospital	Comments (such as if someone died from the illness; or had repeat illness this year, and/ or was admitted to the hospital; got traditional medicine from bush)	Column for adding costs
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(8a)	(9)	(10)

Code for Column 7: Treatment Outlets, 00 Traditional Medicine, 01 'Traditional doctor', 02 Shop, 03 Hospital/Clinic/Health Center, 04 From overseas, 05 No treatment sought.

2i. **TINEA (White Spot)**

i. How many members of the household suffered from this illness in the last 2 weeks? ☐☐

ii. Write down the ages of people who suffered from this disease in the **LAST 4 WEEKS**. Enter these ages below in the first column, making reference to ages listed in Question A 2 above (p3&4). For each person, then fill each box in each column.

Person #	Age (year)	Sex of the person (Insert M, F)	# of days sick	# Days away from work (or could not do any work at home)	# Days away from school (as relevant)	Treatment Outlet (see Code below)	Cost ($ treatment) (bus fare, medicine, special food, etc.)	Days admitted in hospital	Comments (such as if someone died from the illness; or had repeat illness this year, and/ or was admitted to the hospital; got traditional medicine from bush)	Column for adding costs
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(8a)	(9)	(10)

Code for Column 7: Treatment Outlets, 00 Traditional Medicine, 01 'Traditional doctor', 02 Shop, 03 Hospital/Clinic/Health Center, 04 From overseas, 05 No treatment sought.

2j. **RINGWORM**

i. How many members of the household suffered from this illness in the last 2 weeks? ☐☐

ii. Write down the ages of people who suffered from this disease in the **LAST 4 WEEKS**. Enter these ages below in the first column, making reference to ages listed in Question A 2 above (p3&4). For each person, then fill each box in each column.

Person #	Age (year)	Sex of the person (Insert M, F)	# of days sick	# Days away from work (or could not do any work at home)	# Days away from school (as relevant)	Treatment Outlet (see Code below)	Cost ($ treatment) (bus fare, medicine, special food, etc.)	Days admitted in hospital	Comments (such as if someone died from the illness; or had repeat illness this year, and/ or was admitted to the hospital; got traditional medicine from bush)	Column for adding costs
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(8a)	9	(10)

Code for Column 7: Treatment Outlets, 00 Traditional Medicine, 01 'Traditional doctor', 02 Shop, 03 Hospital/Clinic/Health Center, 04 From overseas, 05 No treatment sought.

3. i. Did the household lose someone (i.e., someone died) in the last 5 years **due to any of the above diseases**?
1. Yes 2. No (**Circle** the relevant answer below)

ii. Please indicate the age of the person(s) who died.
a. Infant (less than 12 months) : _____ months old
b. child (1–15 years) _____ years old
c. adult (15–60 years) _____ years old
d. elderly (> 60)

E. Household income and expenditure

This set of questions will help us understand the costs for your illnesses relative to what the household income may be (indicative only) as well as relative to your overall household expenses.

1. i. List main sources of income in the family (if any). **Circle** the ones that are relevant below.
a. Wages and salaries
b. Agriculture and fishing
c. Aggregate mining for sale
d. Home produce sales, including sewing
e. Casual employment
f. Pension
g. Money from abroad and gifts
h. Other: (specify) _____

ii. In the adjacent column indicate the **three most important sources** of income in the household (insert the letter in the order of importance—highest income source at the top, second most important in the middle box, and the lowest at the bottom box.

Rank 1. ☐
Rank 2. ☐
Rank 3. ☐

2. Which range would best describe your household's **TOTAL FORTNIGHTLY** income? (**Circle** the relevant answer) a. Nil b. Up to $199 c. $200–$499 d. $500–$799 e. $800–$1,199 f. Over (state the amount) $ _____	
3. How much money and in-kind gift does your household receive from family members in Kiribati or abroad (excluding contribution from visitors from other islands)? a. Cash: $_____ /**month** b. Describe the kinds of in-kind contribution (such as food, clothing, etc.) you get from family **in the last 12 months** _____ _____ c. Value of the in-kind support/gifts you received last year in $_____ in the last **6 months**	**Space for calculation**
4. What is your household's **average expenditure in a fortnight**? Enumerators use next column to estimate costs per fortnight costs for things that may be spent in month (like electricity), in a year (like lease rent). **Total expenditure $ ...../fortnight**	**For Expenditure calculation** Add the costs of items such as Food and household items (soap, etc.) Electricity Medical treatment Kerosene and cooking gas Mobile phone Children clothes, fees Bus fares Gas for boat Bingo Church contribution Kava etc.
5a. If the government used money raised to improve these services such that no one in the family would suffer from serious water- and insect-borne disease, how much would your household be willing to pay for better water and sanitation services? (**Circle** only one) 1. Yes → (Answer Q6) 2. No → (Answer Q5b) b. If not willing to pay, explain why _____	
6. If you are willing to pay, how much will the household be willing to pay? a. $ _____/fortnight b. $ _____/month	

F. Other comments

Any other comments about the state of water and sanitation services in the country, your experiences about diseases, and what can be done.

Thank you very much

Annex 2
Logit Regression Analysis of the Relationship Between House Type and Use of Beach

Table A2: Logit Regression Analysis of the Relationship Between the Use of Beach (Yes/No) and Type of House People Live In, Compared with the Use of Beach by People Who Live in Traditional House as a Reference

Logistic regression				Number of observations = 763 LR chi2 (2) = 58.78 Prob>chi2 = 0.0000 Pseudo R2 = 0.0573		
Use of beach/ bush/lagoon	**Odds ratio (Probability)**	**Std. Error**	**Z**	**P > l z l**	**95% Confidence Interval**	
Permanent house	0.2196923 (18%)	0.0459291	–7.25	0.000	0.145835	0.3309543
Mixed House	0.362426 (27%)	0.0718566	–5.12	0.000	0.2457284	0.5345430
Constant	3.714286	0.59777885	8.15	0.000	2.309445	5.091788

Source: Based on household survey, July 2013.

Annex 3

Relationship Between the Proportion of Household Members Suffering from Diarrhea and Dysentery and Villages in South Tarawa

Ordinary least square analyses without including any other explanatory variable reveals that the average of the proportion of household members who suffer from diarrhea and/or dysentery (dia-dys) in the household is 0.066 (or 6.6%).

The model specification is

$$Y_{hv} = \beta_0 + \beta_1 X_{hv};$$

where:

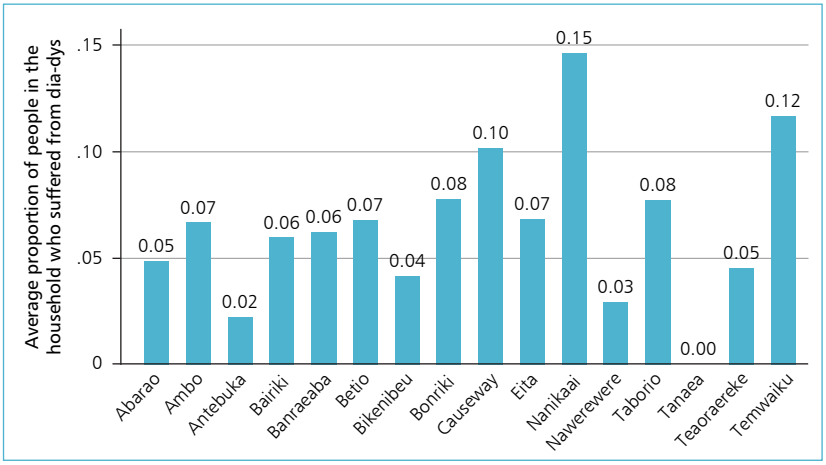
Y_{hv} is the proportion of household members from household h and village v, suffering from dia-dys.

β_0 is the overall intercept.

u_{0v} and u_{1hv} represent the error terms at the village and household levels, respectively.

However, the average proportion of household members suffering from dia-dys varies across villages, as presented in Figure A3.1.

Figure A3.1: Average Proportion of Household Members Who Suffered from Diarrhea and Dysentery by Village



Note: There is a large variation and the actual number should be treated with caution; for example, in Tanaea, the sample size is small with 27 individuals from 4 households.
Source: Author.

Two-Level Analysis

The two-level analyses reveal the statistically significant variation across villages in the proportion of household members suffering from dia-dys. The larger log-likelihood ratio (10.87), compared to the Chi-square at 5 percentage point with one degree of freedom (3.84), confirms that village level characteristics matter in determining the variation of the proportion of household members suffering from the dia-dys (Table A3).

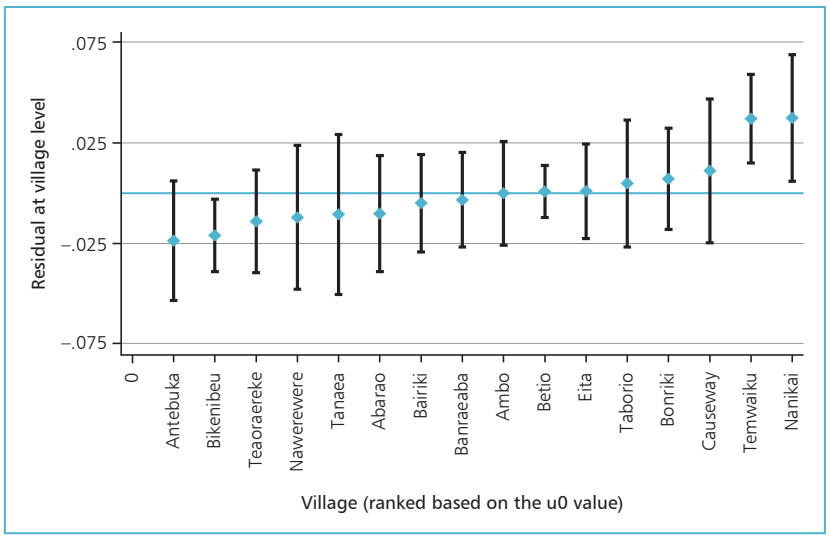
Table A3: Two-Level Analyses of the Relationship Between the Proportion of Household Members Suffering from Diarrhea and Dysentery and Villages

	Coefficient	Std Error	z	P>z	95% Confidence Interval		Log Likelihood	Log Likelihood Ratio
One-Level								
Constant	0.066	0.004	17. 65	0.000	0.059	0.074	646.20	
Residual	0.1037	0.003						
Two-Level								
Constant	0.067	0.007	9.28	0.000	0.053	0.081	651.55	10.70
Random effects Parameters	Variance	Std. Error						
Between village variance	4.85E-04	3.08E-04						
Residual	1.04E-02	5.4E-06						

Key Result

- The average proportion of households that suffer from diseases is 6.6% and varies across villages (Figure A3.2).

Figure A3.2: Caterpillar Plot of Distribution of Proportion of Household Members Suffering from Diarrhea and Dysentery Across Villages



Source: Author.

Annex 4

Probability of Individuals Suffering from Diarrhea and Dysentery as a Function of Household and Village Characteristics

The probability of an individual suffering from diarrhea and dysentery (dia-dys) is expected to depend on the conditions in the house, as well as in the village as a whole.

Household and Village Level Effects

A series of multilevel analysis was undertaken. The null model (model without any explanatory variables) show that both household and village levels contribute to the chance of people suffering from dia-dys. Household and village levels, respectively, contribute about 6.1% and 2% of the variation on the probability of someone to suffer from the two diseases.

Table A4.1: Aggregate Effect of Households and Villages on the Chances of People Suffering from Diarrhea and Dysentery

One-Level Logit Model	
Coefficient (SE)	2.641 (0.054)
Log likelihood	1341.68
Two-Level Logit Model	
Coefficient (SE)	2.764 (0.077)
Between household variance	0.0276
Log Likelihood	1337.92
Log Likelihood ratio	7.530
VPC	7.7%
Three-Level Logit Model	
Coefficient (SE)	2.758 (0.019)
Between village variance	0.072
Between household variance	0.219
Log likelihood	1335.07
Log likelihood ratio	5.693
VPC-Village level	2.0%
VPC-Household level	6.1%

Source: Author.

Key Result

- Household and village level characteristics contribute to the chance of people suffering from dia-dys, of about 6.1% (household) and 2.0% (village) of the variation in the probability of someone to suffer from the two diseases.

Multilevel Effects, Including the Effect of Household and Village Level Characteristics

The following model is used to determine the key factors that influence an individual's chances of getting sick with dia-dys.

$$Log\left[\frac{\pi_{ij}}{1-\pi_{ij}}\right] = \beta_0 + \beta_1 X_{ihv} + \beta_2 X_{hv} + \beta_3 X_v + \beta_4 X_{1ihv} X_{2ihv} + u_{0v} + u_{1hv} + u_{3ihv};$$

where:

$Log\left[\frac{\pi_{ij}}{1-\pi_{ij}}\right]$ is the response for individual i in household h and village v, whether the individual suffered from dia-dys.

β_0 is the overall intercept interpreted as the log-odds that the response equals to 1.

$\beta_1 X_{ihv}$ represents the vector of individual variables.

$\beta_2 X_{hv}$ is the vector of household variables.

$\beta_3 X_v$ is the vector of village level variables.

$\beta_4 X_{1ihv} X_{2ihv}$ is the notation for individual level interaction.

u_{0v}, u_{1hv}, and u_{3ihv} represents error terms at village, household, and individual levels, respectively.

Household survey data is analyzed using a mixed-effect multilevel regression analysis using STATA software, and the results are presented in Table A4.1.

Key Results

- Females are found to have significantly higher likelihood of suffering from dia-dys than males (at $p<0.05$), taking into account household and village level characteristics, and controlled with other variables. This is perhaps not surprising given gender inequality practices evident in traditional I-Kiribati social structures, including discriminatory feeding practices between boy and girl-child and access to health services (Rasanathan and Bhusan 2011) (Table A4.2).
- Age influences the chances of individuals suffering from diarrhea and/or dysentery ($P<0.01$). Younger persons have a greater chance of suffering from dia-dys, keeping everything constant. As a person gets older with each year, there is 15% reduction in the probability of suffering from the two diseases (Table A4.2). There is also an interaction between age and sex—boys in having lower chances of suffering from dia-dys than girls when young. But men have a greater risk of getting sick with dia-dys as they get older when compared to women (switching point is around

Table A4.2: Mixed Effect Multilevel Regression of the Probability of Individuals Suffering from Diarrhea and Dysentery as a Function of Household and Village Level Characteristics

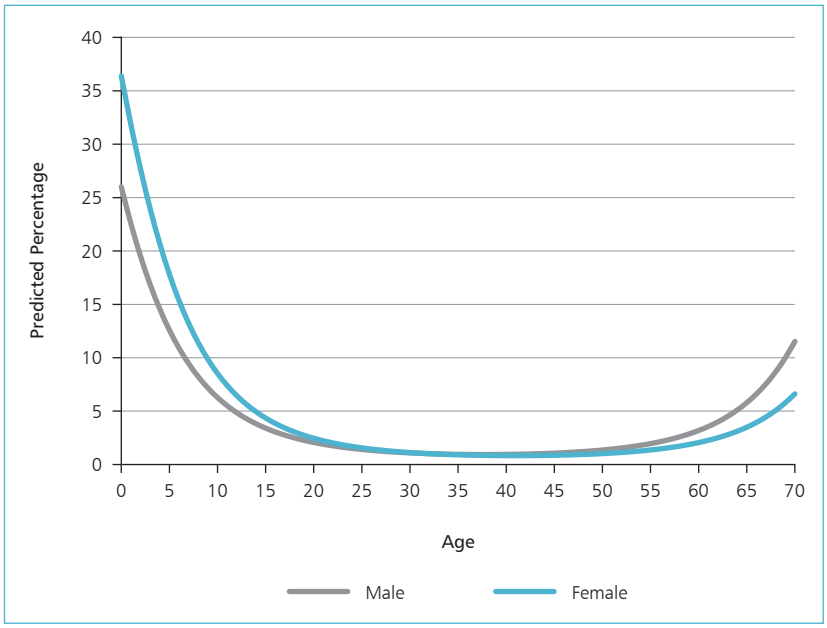
Probability of individual suffering from dia-dys = sex + age + Type of house + Toilet type + Source of water + Village condition (proportion of household using beach/lagoon/bush)

Variable	Coefficient	Standard Error	z	P>z	95% Confidence	Interval	Mean
FIXED EFFECTS							
Individual Variables							
Female[1]	0.48740	0.15843	3.08	0.002	0.176905	0.797922	0.507748
Age[1]	–0.19100	0.01194	–16.01	0.000	–0.214490	–0.1677	25.02315
Age-squared	0.00252	0.00017	15.29	0.000	0.002204	0.002851	626.158
Permanent house	0.16276	0.22843	0.71	0.476	–0.284960	0.610485	0.317773
Mixed house	–0.07540	0.18173	–0.41	0.678	–0.431590	0.28078	0.418213
Type of toilet							
Flush toilet (connected to own septic[3])	–0.42850	0.24459	–1.75	0.080	–0.907900	0.050892	0.186532
Pour flush (pit)	–0.04713	0.22209	–0.21	0.832	–0.482430	0.388149	0.339009
Compost toilet	–1.09740	1.12251	–0.98	0.328	–3.297480	1.102671	0.008418
Beach/lagoon/bush[3]	0.40684	0.24447	1.66	0.096	–0.072310	0.885996	0.237995
Type of water use							
Whether household use drinking water from pipe system[2]	0.61822	0.24738	2.50	0.012	0.133363	1.103088	0.816530
Whether household use drinking water from own rainwater tank	–0.06832	0.18230	–0.37	0.708	–0.425620	0.288962	0.498565
Whether household use drinking water from open well water[2]	0.51139	0.23609	2.17	0.030	0.048673	0.974117	0.114980
Whether household use drinking water from protected well water	0.23934	0.16936	1.41	0.158	–0.092600	0.571276	0.397934
Whether household use drinking water from community water	0.06460	0.20451	0.32	0.752	–0.336240	0.465443	0.153052
Whether household use drinking water from neighbors[2]	0.36467	0.16466	2.21	0.027	0.041950	0.687386	0.444232
Whether household buy drinking water from Public Utilities Board (PUB)	0.39635	0.56753	0.70	0.485	–0.716000	1.508687	0.014731
Whether household buy bottled water	0.09327	0.52407	0.18	0.859	–0.933880	1.120418	0.016836
Proportion of households that use only beach	0.07321	0.54973	0.13	0.894	–1.004240	1.150656	0.596898
Proportion of households that mostly use drinking water from pipe system (PUB)	–0.661684	0.421302	–1.57	0.116	–1.48742	0.164053	0.773214
Female X Age**	–0.015674	0.006748	–2.32	0.02	–0.0289	–0.00245	13.27683
Constant	–1.393501	0.603557	–2.31	0.021	–2.57645	–0.21055	
RANDOM EFFECTS			**Variance**	**Standard Error**	**95% Confidence Interval**		
Between villages			0.038	0.046	0.004	0.412	
Between households			0.338	0.149	0.143	0.800	
Log likelihood	–1047.026						
Number of observations	5,227						

[1] Significant at p<0.01.
[2] Significant at p<0.05.
[3] Significant at p<0.1.
Source: Household survey, July 2013.

30 years and onwards) (Figure A4). The magnitude of difference in disease incidences between sex-age relationship of children and adults needs to be compared with detailed sex-age analysis of the clinic and hospital data. The changed difference between older men and women, too, needs further research; one reason could be an increasing social practice of men drinking kava in kava bars, where water may not be boiled before making the kava drink.

Figure A4: Interaction Between Gender and Age-Probability of Males and Females Suffering from Diarrhea and Dysentery



Source: Author.

Annex 5

Relationship Between the Proportion of Household Members Suffering from Diarrhea and Dysentery (as a Continuous Variable) and Household and Village Level Characteristics

The proportion of households suffering from diarrhea and dysentery (dia-dys) is expected to depend on the conditions in the household as well as in the village as a whole. The following model is used to determine the key factors that affect the proportion of household members getting sick with dia-dys.

$$Y_{hv} = \beta_0 + \beta_1 X_{hv} + \beta_2 X_v + \beta_3 X_{1hv} X_{2hv} + u_{0v} + u_{1hv};$$

where:

Y_{hv} represents the dependent variable, which is the proportion of household members suffering from dia-dys in household h located in village v.

β_0 is the overall intercept.

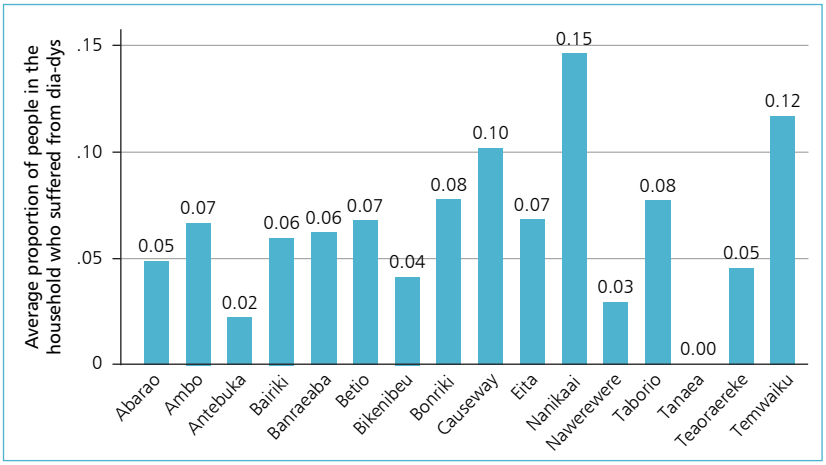
$\beta_1 X_{hv}$ is the vector of household variables.

$\beta_2 X_v$ is the vector of village level variables.

$\beta_3 X_{1hv} X_{2hv}$ is the notation for household level interaction.

u_{0v} and u_{1hv} represent the error terms at village and household levels, respectively.

Figure A3.1: Average Proportion of Household Members Who Suffered from Diarrhea and Dysentery by Village



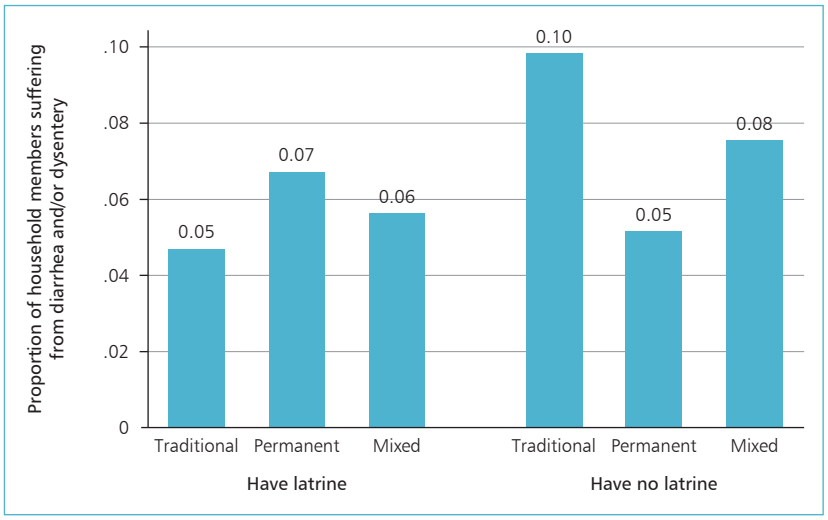
Note: There is a large variation and the actual number should be treated with caution; for example, in Tanaea, the sample size is small with 27 individuals from 4 households.
Source: Author.

Table A5: Mixed Effect Multilevel Regression of the Proportion of Household Members Suffering From Diarrhea and Dysentery as a Function of Household and Village Level Characteristics

Model specification						
Proportion of household members suffering from diarrhea and dysentery = Type of house + Toilet type + Source of water + Village condition (proportion of household using beach/lagoon/bush)						
Variable	**Coefficient**	**Standard Error**	**z**	**P>z**	**95% Confidence Interval**	
FIXED EFFECT						
Household Variable						
Type of Household (Control: Traditional)						
Permanent	0.020	0.013	1.530	0.125	–0.006	0.046
Mixed	0.009	0.012	0.780	0.438	–0.014	0.033
Type of Latrine [Control: Flush toilet connected to Public Utilities Board (PUB)]						
Flush toilet (connected to own septic)	–0.017	0.012	–1.450	0.148	–0.039	0.006
Pour flush	0.014	0.011	1.260	0.207	–0.007	0.035
Compost toilet	–0.017	0.051	–0.340	0.735	–.116	0.082
None (use beach/lagoon/bush)[1]	0.051	0.015	3.360	0.001	0.021	0.081
Source of drinking water that household use						
Whether household use drinking water from pipe system[1]	0.036	0.012	2.910	0.004	0.012	0.060
Whether household use drinking water from own rainwater tank	–0.006	0.009	–0.640	0.524	–0.025	0.012
Whether household use drinking water from open well water[2]	0.028	0.013	2.180	0.029	0.003	0.053
Whether household use drinking water from protected well water	0.005	0.009	0.600	0.551	–0.012	0.022
Whether household use drinking water from community water	0.016	0.011	1.490	0.138	–0.005	0.037
Whether household use drinking water from neighbors[2]	0.018	0.009	2.100	0.036	0.001	0.035
Whether household buy drinking water from PUB	0.013	0.034	0.390	0.696	–0.053	0.080
Whether household buy bottled water	0.011	0.028	0.390	0.695	–0.044	0.067
Village Variables						
Proportion of households that have no latrine (use beach/lagoon/bush)[1]	0.093	0.034	2.740	0.006	0.027	0.160
Proportion of households that mostly use drinking water from pipe system (PUB)	–0.020	0.021	–0.940	0.345	–0.061	0.021
Interaction Effect						
Permanent household X Have no latrine[2]	–0.067	0.034	–1.980	0.047	–0.133	–0.001
Mixed household X Have no latrine[3]	–0.032	0.019	–1.650	0.099	–0.070	0.006
Constant	–0.007	0.027	–0.240	0.811	–0.060	0.047
RANDOM EFFECT	**Estimate**	**Standard Error**	**95% Confidence Interval**			
Between village (Variance)	9.10E-16	8.83E-15	4.96E-24	1.67E-07		
Residual (Variance)	0.010	0.001	0.009	0.011		
Log likelihood	678.21					

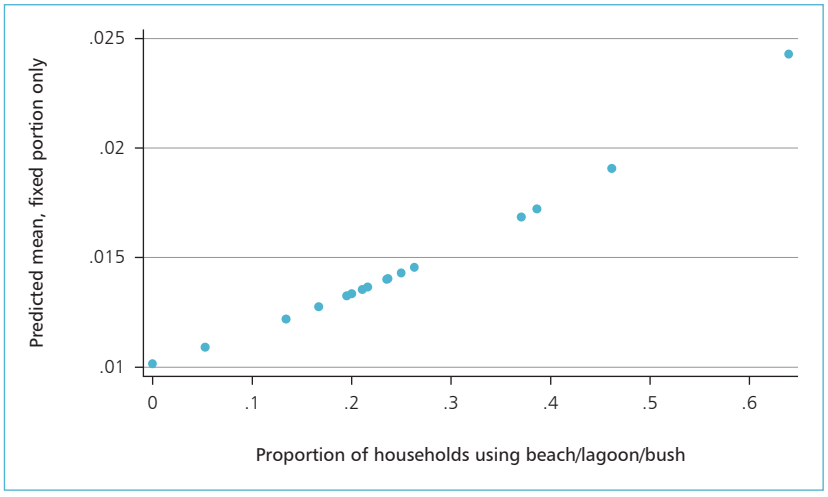
[1] Significant at $p<0.01$.
[2] Significant at $p<0.05$.
[3] Significant at $p<0.1$.
Source: Household survey, July 2013.

Figure A5.1: The Effect of the Interaction Between the Type of Household and Type of Toilet [With Toilet and No Toilets (Use of Beach/Lagoon/Bush)] on the Proportion of Household Members Suffering from Diarrhea and Dysentery



Source: Household survey, July 2013.

Figure A5.2: The Marginal Effect of Village Condition (Proportion of Households Using Beach/Lagoon/Bush) on the Proportion of Household Members Suffering from Diarrhea and Dysentery



Source: Household survey, July 2013.

Household survey data is analyzed using a mixed effect multilevel regression analysis using STATA software, and the results are presented in Table A5.

Annex 6
Willingness to Pay for Improved Water and Sanitation Services

Currently, households are expected to pay A$10 a month for the treated water supplied by the Public Utilities Board (PUB). Very few households actually pay for water, with PUB expected to make a loss of about A$254,000 over its expected revenue from domestic consumers of A$620,000. Most households regard PUB supplied water to be free as evidence from the informal discussions during the household survey. Reticulated sanitation services are provided free of charge to the villages of Betio, Bairiki, and Bikenibeu although not all households are connected in each of these villages.

Willingness to Pay Methodology

To determine the quantum of money that households may have the willingness to pay (WTP) to minimize their disease risks, a simple revealed preference-

$$Log\left[\frac{\pi_{ij}}{1-\pi_{ij}}\right] = \beta_0 + \beta_1 X_{hv} + u_{0v} + u_{1hv};$$

based contingent valuation methodology (CVM) was used. Each household surveyed was asked a two-part question:

- Are they willing to pay for improved services so that no one in the family would suffer from serious water and insect borne diseases? (Yes/No). For those who indicated their unwillingness to pay, they were asked to explain why.
- Those who indicated their willingness to pay, they were then asked to indicate how much they were willing to pay a fortnight.

Care was taken to minimize biases, which CVM-based assessments are commonly known for (Alberini and Khan 2006). To reduce scope for biases, households were helped to contextualize their responses by asking them to state their other household income, including cash and other gifts received from family members on a regular basis, and their regular fortnightly/monthly expenditure on household goods. Following these questions, respondent was asked an open-ended question as to their WTP. The data was then analyzed in three steps, asking the following questions: who is willing to pay or who

Table A6.1: Results of the Mixed Effects Logistic Regression Analysis of Willingness To Pay (Discrete Yes/No) Against Key Household Characteristics

Log likelihood = –388.7183				Number of observations = 722 Number of groups = 16 Mininum observations = 3 Average observations = 45.1 Maximum observations = 213		
Willingness to pay	**Odds ratio**	**Standard Error**	**z**	**P l z l**	**95% Confidence Interval**	
No. of households (HH) members	1.020355	0.0336002	0.61	0.541	0.9565803	1.088382
No. of HH members suffering from dia-dys	1.028056	0.1259350	0.23	0.821	0.8085945	1.307082
Any household member died (0 = No; 1= yes)	0.394483	0.1738079	–2.11	0.350	0.1663381	0.935546
Income 2[2]	4.742279	3.0122420	2.45	0.044	1.3655680	16.48750
Income 3[1]	6.241097	3.8910380	2.94	0.003	1.8389750	21.180980
Income 5[1]	7.949141	5.8052770	2.84	0.005	1.8997030	33.262490
Income 6[2]	5.956601	5.1703340	2.06	0.040	1.0868130	32.646910
Improved toilet	1.350408	0.2807850	1044	0.149	0.8941710	2.029794
Improved water	1.746724	0.5732095	1.7	0.089	0.9181036	3.232020
Constant	0.258246	0.1830353	–1.91	0.056	0.0643773	1.035939

Random effects parameter	Estimate	Standard Error	95% Confidence Interval	
Village: identity variable (_constant)	0.1554837	0.1348507	0.284079	0.8510018

[1] Significant at p<0.01.
[2] Significant at p<0.05.
Source: Author.

is not willing to pay; what is the quantum of payment; and what household characteristics underpinned the WTP responses.

Willingness to Pay Results

The following results are based on the information provided by 753 households who responded to the question about WTP.

Who is willing to pay?

Of the households surveyed (or 562), 75% indicated their WTP. Households who had significant odds regarding WTP (at p<0.05) include those who reported regular source of income. Households that have improved water source had 175% odds for WTP (p<0.09). On the other hand, households with improved toilet types had insignificant relationship with WTP, i.e., the response from household WTP did not depend on the presence of improved toilet perhaps because there are no user fees to connection to the central sanitation system. There is no correlation between household members

$$Log\left(Y_{hv}\right) = \beta_0 + \beta_1 X_{hv} + u_{0v} + u_{1hv};$$

suffering from diarrhea and dysentery (dia-dys), or households where at least one person died in the last 5 years from dia-dys and WTP. This suggests that some people do not fully understand the link between poor water and sanitation conditions and water-borne diseases (or death); this inference was confirmed during the community mobilization workshop conducted under the community mobilization subproject of the Tarawa Sanitation Improvement Project, TSIP (Cecily Neil, community engagement and gender specialist, TISP, personal communication, August 2013). The statistical results are summarized in Table A6.1.

Model Specification

The probability of household's WTP is proposed to be a function of household level characteristics, which considered the type of house (trad 1, trad 2); number of household members who suffered from dia-dys; any death in the family in the last 5 years; whether improved toilet (imp toilet), and improved water (imp_water) are used by the household.

The following model is specified and a logit regression analysis was undertaken using STATA software:

where:

$$Log\left(Y_{hv}\right) = \beta_0 + \beta_1 X_{hv} + u_{0v} + u_{1hv};$$

Y_{hv} is the response for household h located in village v on whether the household is willing to pay for better sanitation and water services.

β_0 is the overall intercept interpreted as the log-odds that the response equals to 1.

$\beta_1 X_{hv}$ is the vector of household variables composed of the number of household members, proportion of household members suffering from dia-dys, whether there is any member of the household who died, dummy variables of income groups, whether the household has improved toilet, and whether the household has improved water source.

u_{0v} and u_{1hv} represent the error terms at village and household levels, respectively.

Who is not willing to pay?

Almost 25% of the households surveyed were not willing to pay. Of the ones who were not willing to pay, about half (53%) said it was government's responsibility, whereas 43% noted they could not afford to pay. Those who could not afford to pay were from Abarao, Ambo, Bonriki, Causeway, Nanikai, and Taearaereke. On the other hand, at least 50% of the households in villages that received government-supplied water and sanitation—Bairiki, Bikenibeu,

Table A6.2: Results of the Mixed Effects Logistic Regression Analysis of Log Willingness To Pay (Continuous Quantum) Against Key Household Characteristics, Including Expenditure

Variable	Coef.	Standard Error	z	P>z	95% Confidence Interval	
FIXED EFFECT						
Type of household (Control: Traditional)						
Permanent[1]	0.312	0.098	3.190	0.001	0.121	0.504
Mixed	0.126	0.085	1.480	0.139	–0.041	0.293
Number of household members[1]	0.052	0.011	4.640	0.000	0.030	0.074
Number of household members suffering from dia-dys	–0.062	0.045	–1.360	0.173	–0.151	0.027
Any household member died (0 = No, 1 = Yes)[2]	–0.499	0.199	–2.510	0.012	–0.888	–0.110
Log of expenditure[2]	–1.209	0.607	–1.990	0.047	–2.400	–0.019
Log of expenditure (squared)[3]	0.124	0.058	2.140	0.032	0.010	0.239
Improved toilet (0 = No, 1 = Yes)[1]	0.227	0.081	2.810	0.005	0.069	0.386
Improved water (0 = No, 1 = Yes)	–0.014	0.150	–0.090	0.925	–0.308	0.280
Constant[2]	3.884	1.576	2.460	0.014	0.796	6.973
RANDOM EFFECT	**Variance**	**Standard Error**	**95% Confidence Interval**			
Between villages	0.084	0.043	0.032		0.227	
Residual	0.581	0.036	0.515		0.655	
Log likelihood	–646.91					
Number of observations = 553 Number of groups = 16	Mininum observations = 3 Average observations = 44.6		Maximum observations = 151			

[1] Significant at p<0.01.
[2] Significant at p<0.05.
Source: Author.

Table A6.3: Mean and Standard Deviation of Willingness To Pay by Village

		Fortnightly		Monthly	
Village	N	Mean ($)	SD	Mean ($)	SD
Abarao	21	4.79	2.76	9.57	5.53
Ambo	28	7.86	9.60	14.46	14.58
Antebuka	22	8.93	10.57	17.86	21.14
Bairiki	38	4.63	2.89	9.25	5.78
Banraeaba	35	4.14	3.01	8.29	6.03
Betio	151	5.93	6.72	11.84	13.45
Bikenibeu	77	8.20	7.08	16.40	14.17
Bonriki	36	7.43	4.80	15.97	10.48
Causeway	8	2.75	1.54	5.50	3.07
Eita	38	4.60	3.29	9.20	6.58
Nanikaai	17	7.50	3.85	15.00	7.71
Nawerewere	9	10.56	3.00	21.11	6.01
Taborio	18	11.44	7.79	22.89	15.57
Tanaea	3	10.67	12.50	41.67	59.23
Teaoraereke	29	8.17	9.61	16.34	19.21
Temwaiku	32	3.12	2.79	6.23	5.59
Total	**562**	**6.45**	**6.56**	**13.02**	**13.24**

Source: Author.

Table A6.4: Results of the Mixed Effects Logistic Regression Analysis of Log Willingness To Pay Against Key Household Characteristics, Including Income

Variable	Coefficient	Standard Error	z	P>z	95% Confidence Interval	
FIXED EFFECT						
Type of household (Control: Traditional)						
Permanent[2]	0.255	0.100	2.540	0.011	0.058	0.452
Mixed	0.107	0.087	1.220	0.223	–0.065	0.278
Number of household members[1]	0.045	0.011	4.060	0.000	0.023	0.067
Number of household members suffering from dia-dys	–0.031	0.046	–0.680	0.498	–0.121	0.059
Any household member died (0 = No, 1 = Yes)[1]	–0.505	0.195	–2.590	0.010	–0.888	–0.122
Income group (Control: Nil)						
<A$50–A$199	0.418	0.396	1.050	0.292	–0.359	1.194
A$200–A$499	0.392	0.389	1.010	0.314	–0.371	1.155
A$500–A$799	0.548	0.394	1.390	0.164	–0.224	1.320
A$800–A$1,1991	0.927	0.413	2.250	0.025	0.119	1.736
Over[2]	1.226	0.451	2.720	0.007	0.343	2.110
Improved toilet (0 = No, 1 = Yes)[2]	0.209	0.083	2.520	0.012	0.046	0.371
Improved water (0 = No, 1 = Yes)	–0.024	0.146	–0.170	0.867	–0.310	0.261
Constant	0.618	0.413	1.500	0.135	–0.192	1.427
RANDOM EFFECT	**Variance**	**Standard Error**	**95% Confidence Interval**			
Between villages	0.105	0.050	0.042	0.265		
Residual	0.562	0.035	0.497	0.635		
Log likelihood	–613.14					
Number of observations = 530 Number of groups = 16 Min observations = 3 Average observations = 33.86 Maximum observations = 151						

[1] Significant at p<0.01.
[2] Significant at p<0.05.
Source: Author.

Betio, and Banraeaba—were unwilling to pay saying that it was government's responsibility.

Model with expenditure as the explanatory variable

The amount a household is willing to pay is expected to depend on key household characteristics, such as the number of persons in the household, proportion of members who suffered from dia-dys, type of water currently in use, type of toilet in use, and income/expenditure.

The following model is specified, and a logistic regression analysis undertaken using STATA software:

where:

Y_{hv} represents the amount of money that household h that is located in village v is willing to pay for better sanitation and water services.

β_0 is the overall intercept interpreted as the log-odds that the response equals to 1.

$\beta_1 X_{hv}$ is the notation for a vector of household variables composed of number of household members, the proportion of household members suffering from dia-dys, dummy variables representing type of household, whether there is any member of the household who died, expenditure (its log equivalent), whether the household has improved toilet, and whether the household has improved water source.

u_{0v} and u_{1hv} represent the error terms at village and household levels, respectively.

Quantum of payment

The average WTP amount was A$13.02 a month (SD = A$13.40); A$10.00 a month was median WTP amount indicated by the households. There is though a large variation in the amount households were willing to pay across the villages, with average WTP ranging from A$5.50 a month in Causeway to A$22.89 in Taborio, excluding Tanaea where only three households had responded and gave an average of A$41.67 (SD = 59) (Table A6.3).

Willingness to pay model where income is the explanatory variable

The following model is specified, and a logistic regression analyzed undertaken using STATA software:

where:

Y_{hv} represents the amount of money that household h that is located in village v is willing to pay for better sanitation and water services.

β_0 is the overall intercept interpreted as the log-odds that the response equals to 1.

$\beta_1 X_{hv}$ is the notation for a vector of household variables composed of number of household members, the proportion of household members suffering from dia-dys, dummy variables representing type of household, whether there is any member of the household who died, expenditure (its log equivalent), whether the household has improved toilet, and whether the household has improved water source.

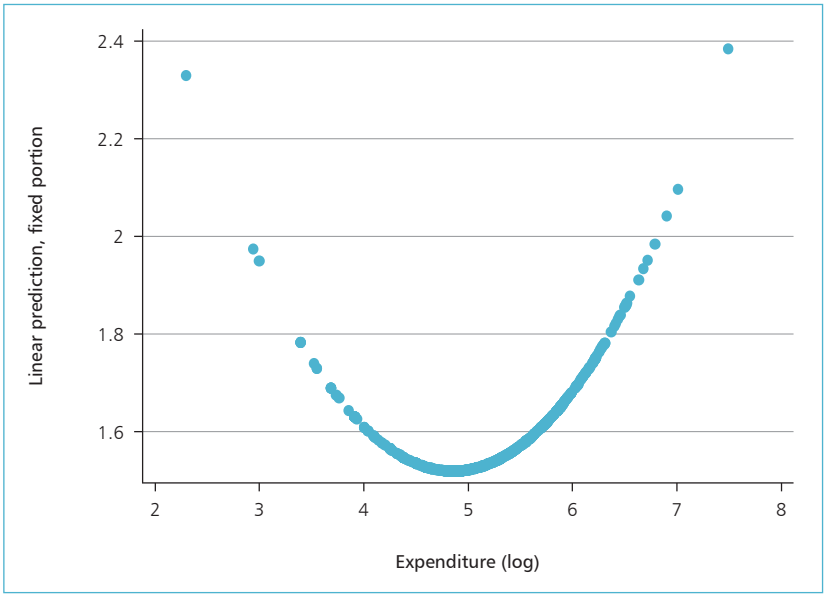
u_{0v} and u_{1hv} represent the error terms at village and household levels, respectively.

Factors that influence payment

The statistical analysis of the survey data, as summarized in Tables A6.2–A6.4, suggests the following:

- Traditional households tend to have lower WTP than permanent households. In an "average village," the results suggest that permanent and mixed households have WTP about 31% and 13% higher than traditional households. This could be an indication of the ability to pay of people living in permanent and mixed houses.

Figure A6: Non-Linear Relationship Between Prediction of the Quantum of Willingness To Pay (Log WTP) and Household Expenditure, as a Proxy for Ability to Pay



Source: Author.

- The relation between the number of household members who get sick from diarrhea and/or dysentery (but controlling for number of households members) has an insignificant (albeit a negative one) relationship with WTP. Also, contrary to expectation, households that have member who died are less willing to pay for better sanitation and water services ($p<0.01$). Their willingness to pay is only about 50% of what households were WTP, where no member of household had died. These two findings may suggest that people do not necessarily see a relationship between improvements in water and sanitation services and practices, on one hand, and the disease risks, on the other hand. Discussion during a community mobilization workshop under the TISP confirmed this lack of understanding and/or acceptance of the link (Cecily Neil, community engagement and gender specialist, TISP, personal communication, August 2013).
- Households with improved toilet are significantly more willing to pay than those with unimproved toilet. They are willing to pay about 23% higher than households with unimproved toilet. This perhaps suggests that households with improved toilets recognize its value toward health and the environment, as well as their ability to pay. On the other hand, households with improved water have insignificantly different WTP than those with unimproved water. Perhaps, ability to access to improved water is not a relevant indication of household expectation toward healthy environment as many households access the water sources for free.

- Using expenditure as a reflection of the ability to pay,[1] the analysis shows that it is difficult to predict the quantum of WTP at least when household expenditure is low. But the ability to predict WTP increases when the expenditure increases, as illustrated in Figure A6.3 (see also Table A6.3). This is consistent with the Pacific Islands Forum Secretariat assessment of the poverty status of I Kiribati, where many households struggle to pay for their basic needs and improved water and sanitation are not necessarily seen as one of them.
- On the basis of multilevel analysis of WTP, and considering income (instead of expenditure), the results show that WTP is positively correlated with income. The relationship becomes statistically significant only after fortnightly income is reported to be over A$800–A$1,100, which is higher than the average estimated household fortnightly income for Kiribati of about A$600.[2] This also confirms that ability to pay has a significant impact on a household's decision to invest in improved water and sanitation that emphasizes the relevance of government's intervention.
- Education, the highest level achieved by any member of the household, does not influence the quantum of WTP by the household, and was thus excluded from the model reported here.

1 The reason for using expenditure as a measure of the ability to pay, instead of income, is that many households not only rely on their own income to meet their household consumption needs but also on remittances from family members living abroad.

2 Estimated using 2006 HIES data and Kiribati inflation figures reported by the International Monetary Fund, http://www.indexmundi.com/kiribati/inflation_rate_(consumer_prices).html

In conclusion, while majority of the households are willing to pay for improved water and sanitation services, and an average WTP amount is about $13 dollars, there is a large variation across households and across villages. It is though difficult to predict the behavior of households as to how much different types of households would be willing to pay. One key exception to this lack of clarity is that households living in permanent houses are WTP more than those living in mixed and traditional houses, perhaps a clear reflection of their ability to pay.

Economic Costs of Inadequate Water and Sanitation
South Tarawa, Kiribati

The inadequate water supply and sanitation situation in South Tarawa has contributed to high rates of water-borne diseases and environmental degradation in the country's main urban center. There has been limited capital investment in water supply and sanitation infrastructure and ongoing operations and maintenance in South Tarawa, in part, as a result of low cost recovery in service delivery. To enable more informed policy responses to address the current situation, this study seeks to estimate the total economic costs associated with inadequate water and sanitation services in South Tarawa.

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