Abaiang Island, Kiribati – A Whole-of-Island Integrated Vulnerability Assessment

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Jointly prepared by the
Government of Kiribati and Kiribati National Expert Group (KNEG),
Pacific Community (SPC),
Secretariat of the Pacific Regional Environment Programme (SPREP), and
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ABBREVIATIONS

EU	European Union
GCCA	Global Climate Change
GIZ	Deutsche Gesellschaft für Internationale Zusammenarbeit
GoK	Government of the Republic of Kiribati
IDC	Island Development Committee
IVA	Integrated Vulnerability Assessment
KiLGA	Kiribati Local Government Association
KNEG	Kiribati National Expert Group
KJIP	Kiribati Joint Implementation Plan for Climate Change and Disaster Risk Management
KMS	Kiribati Meteorological Service
MELAD	Ministry of Environment, Lands and Agriculture Development
MFMRD	Ministry of Fisheries and Marine Resources Development
MISA	Ministry of Internal and Social Affairs MoE Ministry of Education
MHMS	Ministry of Health and Medical Services
MPWU	Ministry of Public Works and Utilities
OB	Office of te Beretitenti (The President)
SOPAC	South Pacific Applied Geoscience Commission
SPC	Pacific Community
SPREP	Secretariat of the Pacific Regional Environment Programme
USAID	United States Agency for International Development
WoI	Whole of Island (approach)
WoI-IVA	Whole of Island – Integrated vulnerability assessment

EXECUTIVE SUMMARY

This report presents the outcomes of a Whole-of-Island Integrated Vulnerability Assessment (WoI-IVA) conducted on Abaiang Atoll in Kiribati in September 2013. The WoI approach to vulnerability assessment and resilience development was initiated by the Government of Kiribati, and Abaiang Atoll was selected as the first site to trial this approach. The 2013 vulnerability assessment was guided by the first draft of the WoI-IVA framework (SPC 2014), which was conceptualised and developed by the Kiribati National Expert Group (KNEG) in collaboration with the Pacific Community (SPC), Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ), and Secretariat of the Pacific Regional Environment Programme (SPREP).

Abaiang lies one degree north of the equator and is the closest outer island to Tarawa, the capital of Kiribati. Over 5,000 people live on Abaiang, making it the fourth largest population of any atoll in the nation. The unique culture of Kiribati is evident on Abaiang. Limited external influences have meant that the traditional way of life and village governance is largely intact.

This report assesses the socioecological context of Abaiang Atoll in relation to climate change and disaster risks, and examines the capacity of the atoll community to reduce risks and adapt to the impact of environmental change. As such, an understanding of the atoll's vulnerability was developed by identifying Abaiang's key socioecological features and the experienced and anticipated pressures stemming from demographic, developmental and climatic change. The gradual impact of climate change is expected to have a 'multiplier effect' on the impacts of population growth, land-use practices and resource extraction. Abaiang's adaptive capacity is determined by the natural, infrastructural, financial and human resources the atoll community *has* to adapt, and the ability of local institutions to utilise accessible resources efficiently and effectively to adequately meet livelihood (settlement, water, food, income) needs on a daily basis, as well as in periods of climatic and disaster-related stress (Office of *te Beretitenti*).

The people of Abaiang face many challenges in daily life. Human habitation on the atoll is only possible due to the presence of an underground freshwater lens. But this water supply is easily contaminated and rapidly becomes too salty for consumption during periods of drought, and is extremely vulnerable to saltwater intrusion caused by storm surges, king tides and sea level rise. Atoll soils are among the poorest in the world, making agriculture difficult. The lagoon, reefs and ocean waters contain a diversity of fish and invertebrate species that are relied on as the main source of protein in the local diet. However, the pressure on fisheries is ever increasing. At the time of the assessment, no community-based fisheries management practices existed and recent surveys found that these resources are being depleted at an unsustainable rate.

The WoI-IVA approach is a shift from the more sector-based vulnerability assessments. The term 'integrated' implies the integration between: sectors, scales, disciplines and space. A continuous and dynamic process of decision-making linked at multiple-levels and scales reflects the learning of lessons over the long term that is necessary to successfully adapt to climate change (SPC 2014). The key principles of the IVA framework include: 1) inter-connectedness of social and ecological systems and sectors (e.g. water, forestry, agriculture, fisheries) and livelihood assets (natural, infrastructural, human, financial and institutional); 2) long-term and continuous lessons being learned based on knowledge of co-production between local communities and technical practitioners and incorporating lessons learned into island-level decision-making; 3) an emphasis on participatory learning and action tools that value, draw and build on traditional and local knowledge experience so as to give local communities 'ownership' and empowerment; 4) facilitation of inclusive decision-making to create opportunities for engaging vulnerable groups (SPC 2014). These principles incorporate the value of local and traditional knowledge and the full engagement and ownership of the procedures and projects by beneficiaries in all stages of the development process.

A variety of assessment methods were used to address the aims of the Abaiang WoI-IVA. These included: 1) a national consultation with sector experts on vulnerability indicators, data needs and appropriate methods of assessment; 2) reviews of previous research, field assessments, policies and reports relating to climate change, disasters and development in Kiribati and Abaiang; 3) participatory consultations with men, women and youth in eight villages on Abaiang to gather information about local perceptions of climate and disaster risks on livelihood assets; 4) a household survey of 17 of Abaiang's 18 villages, covering 10% of the island's 425 households; and 5) a rapid technical assessment of the eight consulted villages whereby housing, water and local food production systems were assessed via field observations, and soil and water quality testing. Data sourced via these combined efforts were collectively analysed and compiled by the Kiribati National Expert Group, SPC, SPREP and GIZ.

IVA content summary

Section 1 briefly describes the purpose of this report and the various national and regional agencies that were involved in the IVA field assessment and analysis.

Section 2 explains the background and conceptual development of the WoI approach, the rationale behind such an approach, and its objectives. The criteria by which Abaiang was selected to pilot the WoI-IVA approach are also described in this section. This is followed by a summary of the various programmes working on various sectoral and thematic issues, and how an IVA process seeks to better coordinate and address overlapping development efforts.

Section 3 describes the principles and components that make up the IVA framework and where concepts were sourced. The asset-based components of adaptive capacity are distinguished from institutional adaptive capacity; the former being what a social system *has* to adapt, while the latter refers to what a system *do*es to use resources efficiently and effectively to address livelihood needs in good times and in periods of climate and disaster-related stress.

Section 4 provides an overview of the vulnerability context of Abaiang by describing experienced and anticipated demographic and development changes that have occurred, or may occur, at the national level. The current and projected effects of climate change are also featured. The Kiribati Joint Implementation Plan is then presented to highlight the national policy and institutional framework for climate change adaptation and disaster risk reduction. A similar description of the context driven factors that determine vulnerability on Abaiang then follows with a more detailed comparison of the technical and local observations of climatic change.

Section 5 describes the adaptive and coping capacity of Abaiang and the sensitivity of livelihood-based resources to climate change and disaster risks. In this section, the analysis of Abaiang's adaptive capacity and sensitivity is divided according to livelihood assets, particularly ecosystems, infrastructure, finance, human capabilities and institutions. Each subsection describes:

- the capacity of the relevant livelihood assets in supporting the basic livelihood needs of the island community, in particular the housing, water, food and basic income needs of Abaiang's current population;
- local activities that increase vulnerability;
- the sensitivity of livelihood assets to climate change and disasters; and
- the recommended adaptation options.

A summary of the capacity and sensitivity of each livelihood asset is then summarised in a tabulated form to present an overview of the capacity of Abaiang's natural, infrastructural, financial and human resources that support its settlement, housing, water, food and income needs in normal times as well as during periods of climate and disaster-related stress. The institutional adaptive capacity of Abaiang is then examined via a brief overview of the island's governance structure, decision-making processes, and the effectiveness of its leaders in generating collective action toward resilient development goals.

Section 6 summarises the outcomes of the Abaiang WoI-IVA and links these findings to the key themes in the Abaiang Island Council Strategic Action Plan. The Strategic Action Plan was developed in November 2013 and informed by preliminary findings of the IVA conducted in September 2013 and officially endorsed by the Island Council in May 2014.

1. INTRODUCTION

This report was prepared for the Abaiang Island Council and Island Development Committee, the Government of Kiribati, interested media, experts and programmes in the field of climate change and disaster risk management, and the Abaiang Whole-of-Island approach partners who are implementing or intending to implement climate change adaptation and risk reduction activities on Abaiang; these include programmes implemented by SPC, SPREP, GIZ, the University of the South Pacific (USP), the Coastal Communities Adaptation Program, the United Nations Development Programme (UNDP), the United Nations Children's Fund (UNICEF), and non-governmental organisations on behalf of a range of donors such as the United States Agency for International Development (USAID), the German Federal Ministry for Economic Cooperation and Development, the Global Climate Change Alliance and the European Development Fund of the European Union (EU), Australia's Aid Program, and the Global Environment Facility (GEF).

The report is designed to support decision-making processes for resilient development and improved coordination among all partners on Abaiang.

A field assessment was undertaken in September 2013 and Kiribati National Expert Group members presented the preliminary results of this assessment to the people of Abaiang in November 2013 (in *te-Kiribati* language). A short synthesis report will be published in both English and *te Kiribati* to ensure a broader audience can access the key findings of this comprehensive vulnerability assessment report.

2. THE WHOLE-OF-ISLAND APPROACH

In 2011, the Government of Kiribati (GoK) formed a multi-sectoral ministerial working group to initiate discussions in developing a more holistic and integrated approach to strengthening the capacity of outer island communities in addressing climate change and disaster risks. With the development of the Kiribati Joint Implementation Plan (KJIP) the working group evolved into a multi-stakeholder group known as the Kiribati National Expert Group on Climate Change and Disaster Risk Management (KNEG). Numerous consultations in the course of two years resulted in the conceptualisation of the 'Whole-of-Island' (WoI) approach. Implementing climate change and disaster risk projects and programmes as a means to support and promote sustainable development in Kiribati is central to the WoI approach. This innovative development model involves partners from multiple sectors and fields (regional and international implementing agencies and development partners) working in a coordinated way to support national and local government efforts on a selected island. This approach aims to address capacity constraints in Kiribati's outer islands and to strengthen coordination among partners at the national level, local government level and community level.

2.1 Rationale

Climate change and disasters have complex and numerous effects on the capacity of ecosystems, infrastructure and society to support basic livelihood needs, including settlement and housing, water, food and household income security and ultimately culture and identity. A single sector-focused approach risks not responding to the interconnectedness of social and ecological systems that shape atoll peoples' livelihood needs. Inappropriate adaptation actions can unintentionally harm ecosystems, livelihood assets and other areas of island life. Integrated approaches recognise the interconnectedness of social and ecological systems and have the potential to create synergies and increase effectiveness and efficiency in a sustainable manner.

Communities, ecosystems and sectors in all of Kiribati's 22 atoll islands are exposed and sensitive to climate change and disaster risks. At the same time, all have the potential to reduce vulnerabilities via adaptation and disaster risk reduction measures, and the various village-based and sector-based adaptation projects that have emerged in Kiribati exemplify this. The WoI approach was developed to link various village-based and sector-based adaptation and risk reduction projects under a common integrated vulnerability approach to assessment, planning, implementation, and monitoring and evaluation at the island governance level. By doing this, the GoK wishes to get beyond 'project-by-project' approaches towards a better coordinated, informed and more programmatic approach for the benefit of the I-Kiribati people.

2.2 Objective of the Whole-of-Island approach

The objective of the WoI approach is to increase capacities of island communities to cope and adapt to impacts of climate change and hazards for sustainable development.

2.3 Towards conceptual foundations

The WoI approach was conceptualised and driven by KNEG with the support of a range of regional partners, including the climate change programmes of SPC, SPREP and GIZ. The concept and practice of the WoI approach is at its infancy, and Abaiang was the first outer island selected by the GoK Cabinet (criteria see Section 2.5) to test this approach. The following conceptual elaborations were made via consultations with the KNEG:

- The term 'integrated' implies the integration between sectors, scales, disciplines and space of which a continuous and dynamic process of decision-making linked at multiple levels is central.
- Climate change and disaster risks are most profoundly experienced and observed at the local level and where an understanding of impacts and the development, implementation, monitoring and evaluation of response and risk reduction measures will have to be made with the support of national experts and regional development partners. Hence, the WoI approach aims at ensuring local and national ownership in the process of building local adaptive capacity to climate change and disasters.
- Vulnerability assessments and adaptation action towards climate change and disaster risks are integral to development (and vice versa) and, hence, adaptation actions should reflect local and national development priorities and plans (e.g. Strategic Island Council and Village Development Plans).
- A common island strategic development plan should be developed, monitored and reviewed with KNEG's facilitation so as to overcome project-by-project approaches and improve coordination between partners working in a particular island community. New and existing partners are invited to contribute to the implementation, monitoring and evaluation of one strategic action plan for the island.
- By avoiding duplication of activities and facilitating joint learning between the island community, KNEG and partners, the WoI approach can become a platform for coordination and exchange.
- A Kiribati-specific and owned integrated vulnerability assessment approach is needed, to which various national and regional expertise can contribute. Data gathered during vulnerability assessments belong to the GoK. The National Statistics Office will enter the data into appropriate formats. Other ministries, island representatives and supporting partners have access to that data.
- The WoI approach has strengthened partnerships and coordination efforts at the regional level as multiple partners contribute to its development and implementation.
- Development plans that incorporate adaptation measures should (in the long term) be managed locally by the respective mayor and Island Development Committee. Currently the Island Development Committee's function is limited to approving island development project proposals without engaging in operational or strategic development planning. Hence, participatory approaches with inclusive decision-making and implementation processes should always be applied. Specific capacity building is needed for the local government and the Island Development Committee to take on steering the development, implementation and reviewing of the island strategic development plan.
- With additional funding, the WoI is to be replicated and further developed on other outer islands within Kiribati (e.g. Tabiteuea North) with the long-term intention of initiating a similar development approach on all of the remaining outer islands of Kiribati.

2.4 Outer island selection process

It was evident early in the WoI conceptual discussion that there were insufficient resources to distribute support to all outer islands evenly and simultaneously. Furthermore, the supporting programmes did not present specific criteria and did not want to select implementation sites themselves. Hence, several criteria had to be developed to allow for a transparent and needs-based assessment of potential outer islands to receive support (to adapt to climate change and to reduce disaster risks) under the WoI approach.

The following criteria, developed by the GoK through KNEG (Office of *te Beretitenti*), was based on the vulnerability extent of the various islands using data sourced from existing databases, such as the Kiribati national census.

1. Decreased household accessibility to food crops and livestock (comparative analysis of population census data from 2005 (KNSO 2007) with 2010 (KNSO 2012).
2. High dependency on fishing: A high proportion of fishing households and bigger populations were under the assumption that climate change is impacting coastal fisheries, and this, combined with these factors lead to greater destruction of fisheries resources. This is based on recent Ministry of Fisheries and Marine Resource Development fisheries artisanal surveys conducted on each of the islands between 1999 and 2011 (MFMRD no date).
3. Low average sustainable groundwater yield per capita as a drought vulnerability score (based on the Ministry of Public Works and Utilities Water Resource Assessment Report, 2003).
4. High incidence of diarrhoea as the most visible impact of either insufficient water quality or food safety (based on Ministry of Health and Medical Services morbidity data for diarrhoea for the years 2010, 2011 and 2012).
5. High extent (length) of coastal erosion, based on dividing the total length of eroded shoreline by the perimeter of the atoll (data from Gillie 1993 and 1994; Webb 2006; Rankey 2011; Biribo 2012; Kiribati Second National Communications 2012).
6. High biodiversity: The presence of critically endangered or vulnerable species (as classified under the International Union for Conservation of Nature (IUCN) Red List species), total number of IUCN Red List species present, important habitats (based on geomorphic cover include pinnacles, lagoon and passage areas) and national significance to livelihoods, culture and economy (MELAD, SPREP, CI; 2013).

The assessment rating proposed to Cabinet was: 1) most vulnerable, 2) medium vulnerable and 3) less vulnerable. Abaiang and Tabiteuea North were selected out of the 'most vulnerable' group because of other factors — such as the inland shift of 80 metres of the coastline threatening the settlement of Tebunginako on Abaiang, and the comparatively large population size and proximity to Tarawa (in the case of Abaiang). The WoI approach, the selection criteria and the development of an integrated vulnerability assessment framework received Cabinet approval in August 2013.

2.5 Whole-of-Island partners

The WoI approach is owned by the GoK and developed and promoted by the KNEG. It is open to incorporate further partners, especially given the limited resources each individual programme has available and the need to coordinate in order to enhance benefits.

To support Abaiang in achieving its development priorities as well as climate change adaptation and disaster risk reduction goals under the WoI approach, the following development and climate change programmes have come together (see Table 1) to better coordinate and collaborate towards locally prioritised development objectives: SPC, SPREP, GIZ, the Pacific Centre for Environment and Sustainable Development (PACE-SD) at the University of the South Pacific, United Nations Development Programme and United Nations Children's Fund.

Table 1: Whole-of-Island approach partners for Abaiang.

Programmes	Focus areas in Kiribati	Focus area on Abaiang	Duration
SPC/USAID Vegetation and Land Cover Mapping and Improving Food Security for Building Resilience to a Changing Climate in Pacific Island Communities	Agriculture, Livestock, GIS (development of Whole of Island Approach)	Integrated vulnerability assessment, development & adaptation planning, agriculture, livestock, GIS	2012-2015
SPC/GIZ Coping with Climate Change in the Pacific Island Region (CCCPIR); on behalf of BMZ (German Development Cooperation)	Strategy development (KJIP, development of Whole of Island Approach), Good Governance, Education, Energy, Fisheries, Livestock	Integrated vulnerability assessment, development & adaptation planning, education, fisheries	2011-2015
KIRIBATI/SPREP/USAID Climate Change Adaptation Partnership	Water (development of Whole of Island Approach)	Integrated vulnerability assessment, development & adaptation planning, water	2012-2015
SPC/SOPAC EU African Caribbean Pacific Natural Disaster Facility	Disaster preparedness & response, Strategy development (KJIP, NDRMP)	Integrated vulnerability assessment, disaster preparedness & response	2013-2016
SPC/Ausaid International Climate Change Adaptation Initiative: Building resilience in fisheries, agriculture and health. Implemented by SPC and funded by the Australian Agency for International Development (ICCAI) Project	Food Security (resilient crops, fisheries)	Climate ready crop collection	2012-2013
SPC/Global Climate Change Alliance (EU): Pacific Small Island States (SPC GCCA: PSIS)	Health (national & local level), Public Finance Management, Communication & Coordination (national level)	Implementation of selected health & climate change related measures	2012-2015
SPC/IFAD POETCOM Pacific Organic and Ethical Trade Community	Organic Farming	Organic Farming	2012-2014
USP EU Global Climate Change Alliance (USP PACE SD GCCA)	Community Engagement and Applied Research in Climate Change, Training	Vulnerability assessment, planning, rainwater harvesting and good governance in the village of Ewena	2010-2014
Coastal Communities Adaptation Program (USAID / C - CAP) funded by the United States Agency for International Development (USAID)	Community level: Climate change vulnerable infrastructure (risk assessments & cataloguing & prioritization)	Community-based infrastructure projects identified by the Infrastructure Prioritization Index (IPI) in Borotiam, Ewena and Taniau. (Tebwanga)	2014-2017
SPC EU SciCOFish (Scientific support for the management of coastal and oceanic fisheries in the Pacific Islands region) funded by the EU	Fisheries management	Fisheries management	2010 -2015
SPREP/Ausaid International Adaptation Climate Change Initiative (ICCAI) Project. Implemented by SPREP and funded by the Australian Agency for International Development	Coastal zone management	Coastal zone management (Ribono, Abaiang)	2012 -2013
Water and Sanitation in Outer Islands of the Republic of Kiribati (KIRIWATSAN Project Phase I), EU EDF10, MPWU/UNICEF/SPC	Water Resources Assessments, Rainwater Harvesting and Sanitation and Hygiene	Rainwater Harvesting, Community approaches to total sanitation, and WASH in Schools	2011-2016
Water and Sanitation in Kiribati Outer Islands Phase II (Kiriwatsan II), EU EDF10, Implemented by SPC and GoK together with partners UNICEF.	Increased access to safe drinking water supplies and appropriate sanitation facilities. Expanded participation, ownership and capacity to maintain safe drinking water and sanitation facilities and practices.		2014 – 2018

(SPREP/GIZ/SPC WoI Briefing Note, 2014)

There are a range of additional programmes that have or will have implementation components on Abaiang, but are not necessarily operating through the WoI approach.

3. INTEGRATED VULNERABILITY ASSESSMENT APPROACH

In 2011, the GoK (through its Climate Change Study Team) and the Environment Conservation Division under the Ministry of Environment, Lands and Agricultural Development drafted a Framework Approach to Vulnerability and Adaptation Assessment as a tool to assess studies and assessment reports that have already been prepared. The need arose because the government found itself in a situation where it received information from technical studies and reports undertaken by external scientists and consultants. It was found that:

- most of these reports were not easy to understand;
- few reports adopted climate scenarios against which vulnerability assessment is based;
- some reports did not consider climate change as a cause of environmental problems, particularly those that highlight the vulnerability to sea level rise;
- most reports are site specific, and single-sector based (as should be); and
- nearly all reports do not take into consideration local knowledge and information (GoK 2011:4–5).

A profile of all outer islands of Kiribati was prepared to inform the development of the Kiribati Development Plan 2012–2015 on issues related to climate change. Abaiang's profile describes its physical features, population, land and marine resources, environment (including coastal erosion), education, economy, health and transportation, and identifies some of the key issues with probable causes, impacts and remedial actions. Under the University of the South Pacific - Pacific Centre for Environment and Sustainable Development – Global Climate Change Alliance community component, the village of Ewena was selected as a pilot site and a Vulnerability and Adaptation Assessment of Climate Change was conducted in 2012 (USP 2012). These two assessments have been very useful in informing this mission and this report. However, the following reasons led to the need to develop and implement an integrated vulnerability assessment approach.

1. The Abaiang Atoll profile did not provide enough in-depth information on site-specific and sector-specific exposure, sensitivity and adaptive capacities of ecosystems and the people of Abaiang.
2. KNEG members were to be trained and introduced to integrated and participatory vulnerability assessment tools.
3. That assessment will not only focus on local knowledge and information but also facilitate a community prioritisation process to support development decision-making.
4. With an increase in the number of partners and, hence, their varied approaches and tools employed for vulnerability assessments, there was a need to harmonise partner activities to avoid duplication and over consultation at the local level. These were initially the SPC/USAID Food Security, SPC/GIZ 'Coping with Climate Change in the Pacific Islands Region', and Kiribati/SPREP/USAID programmes. Over the past few years, SPC, SPREP and GIZ and other regional organisations and programmes have developed their own respective vulnerability assessment methodologies, each varying in approach, scale, sector and tools.

The IVA methodology presented here describes the steps and tools that were utilised during the Abaiang vulnerability assessment conducted in September 2013. In addition, the IVA framework was further reviewed and modified to incorporate lessons from having tested it on Abaiang (with the GoK, SPC, SPREP and GIZ).

3.1 Integrated vulnerability assessment framework

This IVA framework adaptively combines the principles and components of other frameworks that have guided previous assessments in the Pacific. Key frameworks include the generic GIZ climate change vulnerability framework (GIZ no date) and the Sustainable Livelihoods Framework (DFID 1999). The broad categories of analysis in generic vulnerability framework pertain mainly to climate-specific vulnerabilities in terms on exposure, sensitivities and adaptive capacity while the sustainable livelihoods framework focus is on people's access to various resource types (natural, infrastructural, human, finance) to support their livelihood needs and the institutional structures and processes that influence people's resource access and use as shown in Figures 1 and 2 below. Disaster risks are then considered in a vulnerability assessment as exemplified in Figure 3. Key elements of these three assessment approaches were drawn from to form the IVA framework as shown in Figure 4.

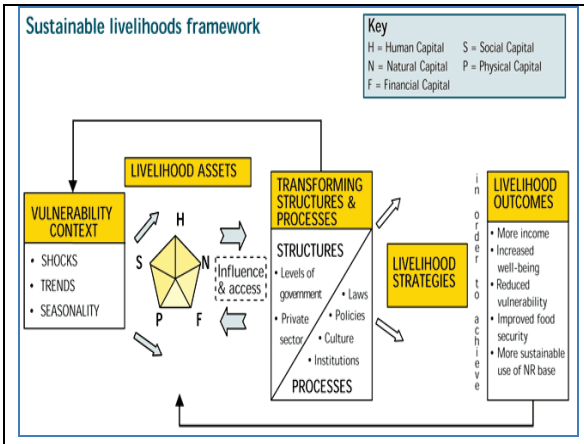

Figure 1: The sustainable livelihoods framework.

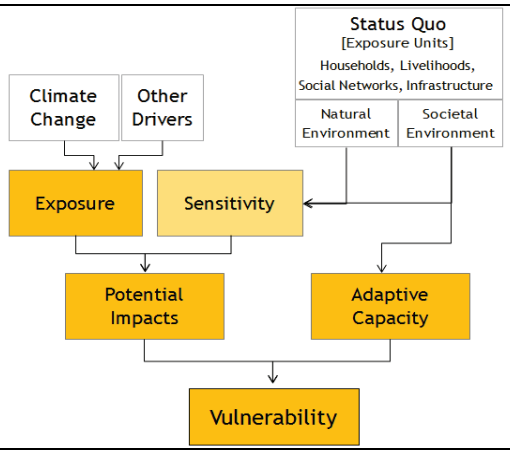

Figure 2: Generic vulnerability framework.

Figure 3: Disaster risk framework.

The first field test of the IVA on Abaiang was guided by the above three frameworks by KNEG, SPC, SPREP and GIZ practitioners in September 2013. The IVA framework in Figure 4, along with the indicators, tools and step-by-step assessment process, was developed via lessons learned from the desk study, consultative workshops, and drafting and outcomes of the Abaiang IVA field assessment. The IVA framework 1) specifies climate-associated risks and sensitivities; 2) recognises social capital as an integral part of the transformative process within the functions of institutions; and 3) simplifies analysis to suit smaller island communities by reducing the range of analytical elements to six, which include: the general context, natural capital, infrastructural capital, financial capital, human capabilities and institutions. It also puts a more detailed focus on adaptive and coping capacity that is contextualised to local Pacific Island communities that are vulnerable to climate change impacts and disasters.

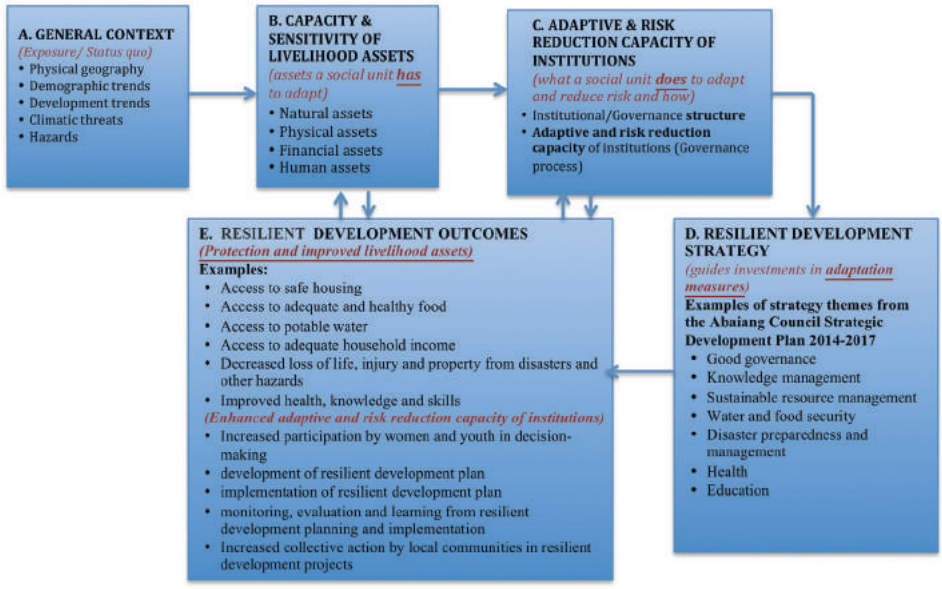

Figure 4: The integrated vulnerability assessment framework.

The IVA framework (as shown in Figure 4) divides adaptive and risk reducing capacity between resources or capital (what a social system *has*) and institutions (what a social system *does*). Institutional adaptive capacity is defined as the informal mechanisms (e.g. values, norms, culture and customs) and formal rules (e.g. policies, laws and regulations) that shape the way people and groups channel livelihood resources (natural, infrastructural, financial and human) to respond to climate change and disaster risks and impacts. Institutions that are flexible, decentralised, democratic, participatory and based on sustainable development principles are regarded as more resilient. Good leadership and collective action, inclusive decision-making and the continuous incorporation of lessons learned into decision-making are key elements of institutional adaptive capacity. In this way, institutions are very similar to the definition of social assets in the sustainable livelihoods framework (DFID 1999).

Another key feature of the IVA framework is that the assessment of adaptive capacity is based on the ability of institutions to effectively acquire and use accessible resources to meet livelihood needs, particularly food, water, settlement and housing, and income as defined in Table 2. In this way, the assessment of adaptive capacity for Abaiang is guided by the rationale and focus as shown in Table 3.

Table 2: Definitions of livelihood needs.

Security of place	The adequate protection of village, settlement or local community boundaries and people's dwelling place from climate and disaster risks.
Water and sanitation security	'Water security involves the sustainable use and protection of water systems, the protection against water related hazards (floods and droughts), the sustainable development of water resources and the safeguarding of (access to) water functions and services for humans and the environment.' (UNESCO-IHE 2007).
Food security	'Food security exists when all people, at all times, have physical, social and economic access to sufficient, safe and nutritious food to meet their dietary needs and food preferences for an active and healthy life.' (FAO 2009).
Livelihood income security	The adequate and sustainable access to income, needed to pay for basic needs, health, education and political participation.

Table 3: The determinants, rationale and focus of adaptive and risk reducing capacity for Abaiang.

Determinants of adaptive and risk reducing capacity	Rationale	Areas of focus (capacity to support food, water, shelter (housing and settlements) and income
Institutions	Values, norms, culture and customs and formal rules (such as policies, laws and regulations) determine social actors' ability to respond to short and long-term impacts of climate change and disasters (Gupta et al. 2010).	▪ Governance structure and processes ▪ Leadership and collective action ▪ Inclusivity of decision-making processes ▪ Networking capacity (accessing markets and other external technical and financial agents) ▪ Capacity to adaptively manage development plans
Ecosystem capacity (natural capital)	The availability and accessibility of marine and land-based natural resource stocks, flows and services determine people's ability to meet their livelihood needs (food, water, shelter, income) in normal times and periods of stress. This is a particularly critical adaptive capacity determinant for semi-subsistent atoll communities.	Natural resources for: ▪ Settlement, housing and local sources of energy ▪ Water supply ▪ Food (marine and land-based) supply ▪ Natural resource-based commodities for household income
Infrastructure capacity	Infrastructural capital that support adaptive and risk reduction capacity need to be: sufficiently robust to cope with disaster and climate risks; movable (for relocation or retreat) when necessary; able to have alternative or 'back up' options; relevant to supporting livelihood needs; and open to wide ownership.	▪ Housing and public buildings ▪ Water and sanitation ▪ Economic enabling infrastructure (transport and communications) ▪ Educational infrastructure ▪ Health infrastructure

Determinants of adaptive and risk reducing capacity	Rationale	Areas of focus (capacity to support food, water, shelter (housing and settlements) and income
Human capabilities	Population health, knowledge and skills are indicative of people's capability to plan, implement and appraise climate change adaptation projects and processes. However, the number of 'capable' people relative to accessible resources (natural, infrastructure and finance) within a social unit also determines adaptive capacity and so demography and mobility are critical factors.	▪ Productive population and dependency ratio ▪ Knowledge and skills (traditional and modern) ▪ Population health
Financial capacity	Financial resources that support adaptive and risk reduction capacity have the following combined features: improved prevention, preparedness and management of risks, microcredit ('smart' risk taking) to develop business or diversify sources of income), risk transfer (insurance), and risk reserves (savings).	▪ Income ▪ debt ▪ savings ▪ access to credit ▪ insurance

3.2 IVA methods

Guided by the vulnerability, disaster risk and sustainable livelihood frameworks (as shown in Figures 2, 3 and 4), the Abaiang IVA utilised several methods of data collection to carry out this assessment, which involved desk-top and scientific studies, national consultations, fieldwork, participatory appraisals in selected villages, household surveys, and sector-specific surveys.

3.2.1 National consultation

KNEG, including the National Statistics Office (NSO), the Kiribati Local Government Association, and the mayor and a Member of Parliament of representing Abaiang were consulted on the suitability of the draft IVA framework, the proposed participatory assessment tools and the IVA household survey as methods for field data gathering. The drafting of these resources were generally based on previous IVA toolkits developed and used by the GoK, SPC, SPREP and GIZ climate change and other solicited views from across its respective divisions regarding data gaps and needs (ranging from water to disaster risk management, or DRM), agriculture, fisheries, health, gender, education and energy to governance. Feedback from KNEG was used to further develop the IVA toolkit design and fieldwork plan. KNEG also identified members of a national team who were briefed and trained to facilitate field-based studies on Abaiang. Final adjustments to the Abaiang IVA field study design were based on those comments and key tools such as participatory rural appraisals and household surveys translated into *te-Kiribati*.

3.2.2 Field-based studies

The following field-based studies were undertaken on Abaiang Atoll in September 2013 by the WoI team, which comprised representatives of the ministries and organisations shown in Table 4.

Table 4: Whole-of-Island team for Abaiang.

Ministry/Office	Number of staff		
Office of *te Beretitenti*	2	Enumerators (Abaiang based)	14
Environment and Conservation Division, Ministry of Environment, Lands and Agricultural Development	1	Agriculture and Livestock Division (external officer)	1
Agriculture and Livestock Division, Ministry of Environment, Lands and Agricultural Development	3	Water Engineering Unit (outer island Water Technician)	1
Water Engineering Unit, Ministry of Public Works and Utilities	1	Abaiang mayor	1
Fisheries and Minerals Divisions, Ministry of Fisheries and Marine Resources Development	2	SPC/SPREP/GIZ	5
National Statistics Office	1		

3.2.3 Participatory appraisals in selected villages

Several participatory rural appraisal (PRA) methods were used in 8 of the 18 villages on Abaiang to enable communities to analyse their own perceived vulnerabilities and adaptive capacities to climate change and natural disasters. PRA tools, as listed in Table 5, were used to generate discussions around local perceptions of climate and disaster risks and local accessibility to livelihood resources (natural resources and ecosystems, infrastructure, human capabilities and finance) to support their basic needs from which local knowledge on agriculture, fisheries and water supply resource management and governance issues at a community level was generated. The villages were selected on the basis of geographic representativeness of the northern islets of Abaiang to the southern end, within resource limits (time, personnel and transport infrastructure) of the WoI team.

In each village, traditional welcoming protocols were followed, with the field assessment team presenting the purpose of its visit. These were then followed by two- to four-hour group discussions, facilitated by trained KNEG WoI team members in the *te-Kiribati* language. Village members were divided into three groups consisting of approximately 10 men, 10 women and 10 youth representatives, the *unimane* (village elders), the village councillor and the chair person. Each group completed the PRA tools to assess exposure, sensitivity and adaptive capacity (in some cases either tool 3 or 4 were used).

Table 5: Participatory appraisal tools used for the Abaiang integrated vulnerability assessment.

Assessment	Tool	Groups were to identify
Exposure	1. Seasonal weather calendar	• weather parameters • time scales (before and today) • periods (months or seasons during a year) • perceived changes as long as community remembers • scale of change (high, medium, low)
	2. Seasonal plant and animal behaviour calendar	• plant and fruit parameters (varieties and behaviour such as fruiting and spawning) • time scales (before and today) • periods (months or seasons during a year) • perceived changes • scale of change
Sensitivity	3. Sensitivity template	• important livelihood parameters from community perspective, such as agriculture and fisheries and food security, forests and biodiversity, infrastructure, water and health • hazards these parameters are exposed to • perceived changes • scale of change
Adaptive capacity (but also exposure through threats and sensitivity through weaknesses)	4. Strengths, Weaknesses, Opportunities and Threats (SWOT) based on livelihood assets (human, natural, financial, social and physical)	• human, natural, financial, social and physical assets of the village • strengths, weaknesses, opportunities and related to their assets • rating of importance
Organisational and stakeholder identification	5. Network template	• Organisations or networks that are of relevance • Rate importance by placing them farther or closer to the village centre

3.2.4 Household surveys

A household survey was conducted in 17 of Abaiang's 18 villages, covering 10% of all households on the atoll. This included a total of 92 respondents representing 425 household members as detailed in Table 6. Local enumerators, previously trained to conducted census surveys by the Kiribati National Statistics Office (NSO), administered the survey. The NSO coordinated the IVA household survey in the *te-Kiribati* language. Quantitative data and personal opinions that were collected at the family level covered household profile, education level, skills and movements of family members, general climate change and vulnerability awareness, security of place, water security, food security (including agriculture and fisheries), household income security, transport and communications, health and community norms, values, beliefs and 'inclusiveness' in decision-making processes as detailed in the IVA questionnaire enclosed in Annex 1.

Table 6: Number of households per village surveyed, Abaiang.

Village	Total no. of households (MFAT 2012)	No. of households surveyed	No. of family members from surveyed households
Ribono	54	9	39
Takarano	62	5	29
Ubwanteman	24	2	8
Tebunginako	70	10	34
Borotiam	61	6	16
Aonobuaka	53	6	29
Koinawa	53	7	37
Ewena	32	3	18
Taburao	51	5	32
Tebero	30	3	20
Tabwiroa	32	5	22
Tuarabu	98	7	26
Tanimaiaki	45	5	27
Taneau	n\a	4	20
Aoneaba	8	1	2
Tabontebike	67	4	17
Nuotaea	85	10	49
Total	926	92	425

3.2.5 Field assessment

Sector-specific field assessments — field observations, a transect walk, soil quality testing, and water quality testing — were conducted in the eight villages. In total, 17 water samples were collected from 10 households and 4 community wells, 1 *tamana* pump and 1 tap outlet. Water samples were stored in ice and then tested for bacterial and physical properties within 24 hours by the Environmental Health Unit in Tarawa.

3.2.6 Review of previous scientific studies, policies and reports

A review of previous research, field assessments, policies and reports relating to climate change, disasters and development in general in Kiribati was also conducted. This method of assessment was key to ensuring that all relevant policies and national priorities informed the IVA process. Assessments of existing technical and socioeconomic data sources, including the 2010 national census, vulnerability assessments conducted by other projects, past modelling studies for sea level rise and rainfall, and other published information related to climate change in Abaiang and Kiribati were gathered, reviewed and incorporated into the analysis of this report.

3.2.7 Meta-analysis

The results of components 2 (a) and (b) were translated into English with responsibilities distributed among the regional WoI team members based on their area of expertise. Regional and national teams of sector experts analysed their specific area of interest utilising different methods based on all analysis components. The different sections were compiled and reviewed within a time frame of three months. The household surveys have been handed over to NSO, which started to compile all the information into a database.

4. THE CONTEXT

This section provides an overview of the socioeconomic factors that influence the way people live and access their livelihood needs on Abaiang so as to understand the island community's 'exposure' to climate change and disasters. The effects of climate change and disasters have a 'multiplier effect' on existing unsustainable environmental, economic and social practices that already pressure natural ecosystems, physical infrastructure and society. Hence, this section first gives a brief overview of climatic and demographic changes occurring at the national level and policy developments that have sought to address these, particularly the Kiribati Joint Implementation Plan and Institutional Framework for Climate Change and Disaster Management. This is then followed by a similar, yet more localised, focus on Abaiang.

Definitions of 'exposure'

Intergovernmental Panel on Climate Change 2014: The presence of people, livelihoods, species or ecosystems, environmental services and resources, infrastructure, or economic, social, or cultural assets in places that could be adversely affected.

United Nations Office for Disaster Risk Reduction 2009: People, property, systems, or other elements present in hazard zones that are thereby subject to potential losses.

4.1 Kiribati

The Republic of Kiribati, which lies in the central Pacific, covers 3.5 million km^2 of ocean, and consists of 33 flat atoll islands and 1 raised coral island. Twenty-two of the islands are inhabited. The total land area of Kiribati is only 811 km^2. Most of this land is, at the most, 2 km wide between lagoon and ocean shorelines, with the highest point being less than 2 m above sea level (MFAT 2012). According to the 2010 national census (KNSO 2012), Kiribati has 103,058 people living in 6,526 households. Most of the population is of Micronesian descent and lives in the Gilberts Islands, the western-most group that is indigenously known as 'Tungaru'. More than half of the national population lives in South Tarawa. Kiribati has an annual average population growth rate of 1.8% with a growth rate of 1.9% for urban areas (PRISM 2011). The rest of the country is made up of the central group of islands — the Phoenix islands — which has only one inhabited atoll, the eastern-most group — the Line islands — where there are three inhabited atolls, and the inhabited raised island of Banaba, which is west of the Gilbert Islands towards Nauru (Fig. 5).

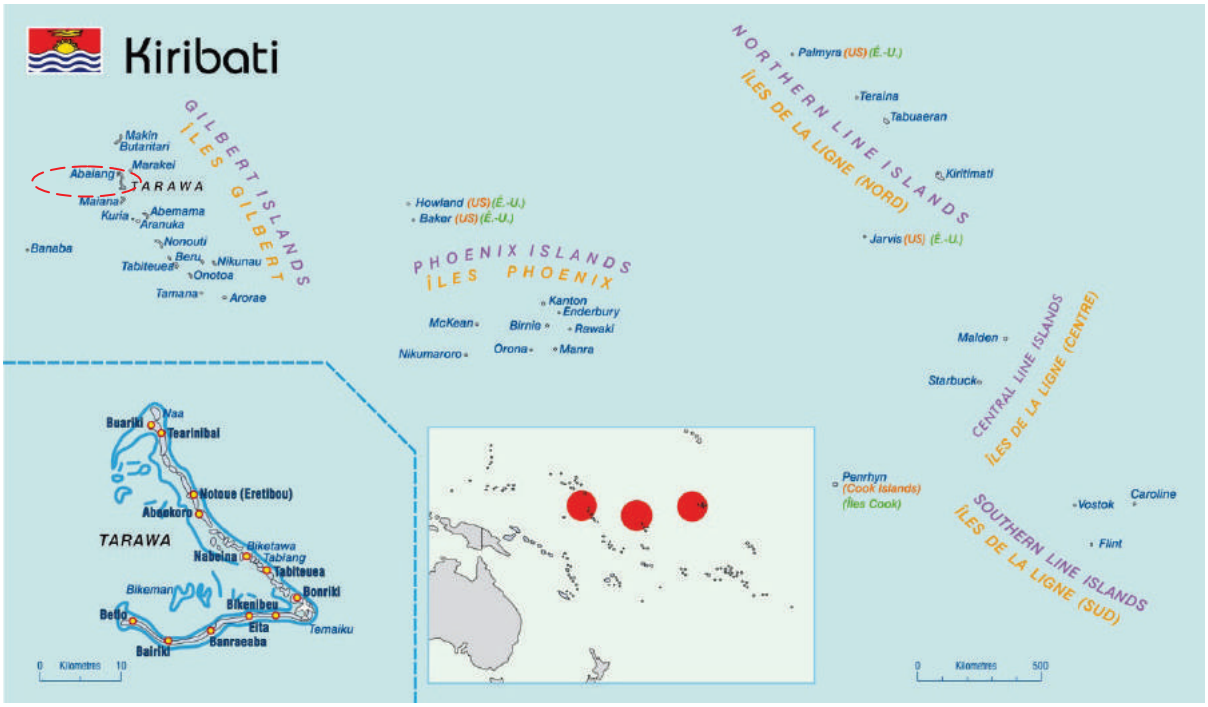

Figure 5: The Republic of Kiribati.

Source: GoK 2014

Kiribati is categorised as a 'small island developing state' and a 'least developed country' (GoK 2014). Approximately one-quarter of the 'working age' population is employed in the cash economy and the value of national imports is over six times the value of exports (World Bank 2013). A high birth rate has resulted in an average national age under 25 years and, hence, the national population is expected to double by 2025 (WHO 2012). Almost 10% of the population describe themselves of an 'ethnic mix' and there are 116 Tuvaluan nationals and 776 nationals from other countries residing in Kiribati. The people of Kiribati share one national language referred to as *te-Kiribati*, and most follow Christian religious beliefs. Over half the country is Catholic and roughly one-third is Protestant (KNSO 2012).The remainder of the population is spread among smaller Christian churches and some non-Christian faiths.

4.1.1 The experienced and anticipated climate

Kiribati has a relatively hot, humid tropical climate with an average and relatively constant air temperature of 28.3°C, and an average rainfall of about 2,100 mm per year, which varies significantly from year to year (see Figure 6). For example, Tarawa can receive more than 4,000 mm of rainfall during the wettest years, but only 150 mm in dry periods (GoK 2014), which can have significant impacts on water availability and quality, crop production and health. The El Niño–Southern Oscillation is the main reason for this high variability in rainfall. Kiribati's climate is closely related to the temperature of the oceans surrounding it. Kiribati has two seasons: *te au maiaki*, the dry season (June to October) and *te au meang* (November to April), the wet season. The highest rainfall occurs from January to March, peaking with a mean of 268 mm in January (GoK 2014). The highest rainfall usually occurs when the Intertropical Convergence Zone is farthest south and closest to Tarawa; there are also high rainfalls, though to a lesser extent, when the South Pacific Convergence Zone is strongest and the average sea surface temperature is 29.2°C (1980–1999) (GoK 2014). Depending on the location, periods of the seasons vary and are strongly influenced by the seasonal movement of the South Pacific Convergence Zone and the Intertropical Convergence Zone (KMS, BoM and CSIRO 2011).

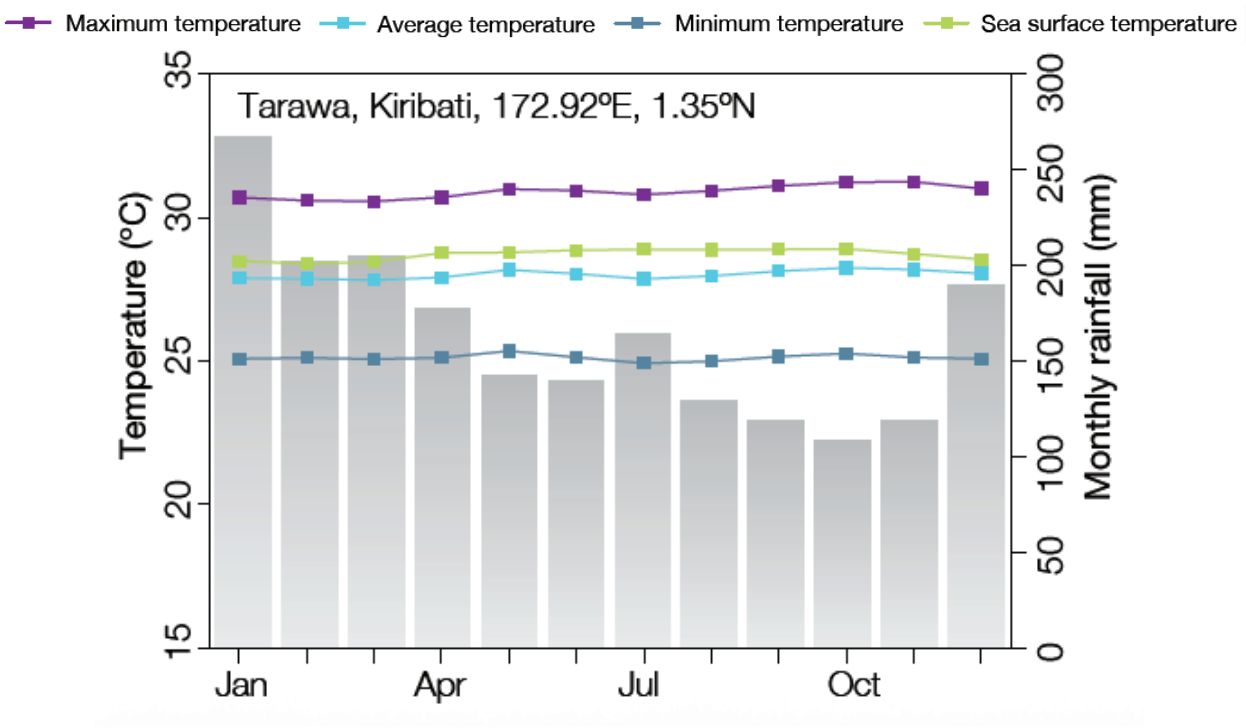

Figure 6: Seasonal rainfall and temperature at Tarawa, Kiribati.

Source: KMS, BoM and CSIRO 2011

Climate modellers observed the following experienced and anticipated changes in climate for Kiribati and their possible effects on rainfall and sea levels:

- Temperature has increased in the last 50 years and will continue to increase by up to 3.2^{0}C into the next century.
- Droughts are projected to become less frequent throughout this century.
- Extreme rainfall days are likely to occur more often.
- Sea level has increased over the past 20 years and is predicted to continue to increase by 5–62 cm into the next century.

4.1.2 The Kiribati Joint Implementation Plan and institutional framework for climate change and disaster management

National policy efforts are already underway to respond to the experienced and anticipated effects and impacts of climate change. Key among these is the development of the Kiribati Joint Implementation Plan (KJIP), which has been designed to respond to the challenges of climate change and disaster risks as well as to mainstream climate change and disaster risk management into various sectoral planning and implementation processes. The GoK endorsed the KJIP in August 2014, and the WoI approach is geared towards achieving the plan's vision and goal at the local level over a nine-year period from 2014 to 2023.

KJIP vision	KJIP goal
I-Kiribati unique culture, heritage and identity are upheld and safeguarded through enhanced resilience and sustainable development.	To increase resilience to climate change and disaster risks through a whole-of-country approach.

The 12 KJIP strategies are formulated for the whole country. Most strategies provide a clear set of results to be achieved at the community and island levels. The WoI approach is expected to contribute to achieving those results.

KJIP strategies		
1: Strengthening good governance, strategies and legislation	5: Strengthening health-service delivery to address climate change impacts	9: Promoting the use of sustainable renewable sources of energy and energy efficiency
2: Improving knowledge and information generation, management and sharing	6: Promoting sound and reliable infrastructure development and land management	10: Strengthening capacity to access finance, monitor expenditures and maintain strong partnerships
3: Strengthening and greening the private sector, including small-scale businesses	7. Delivering appropriate education, training and awareness programmes	11: Maintaining the existing sovereignty and unique identity of Kiribati
4: Increasing water and food security with integrated and sector-specific approaches and promoting healthy and resilient ecosystems	8: Increasing effectiveness and efficiency of early warnings and disaster and emergency management	12: Enhancing the participation and resilience of vulnerable groups

The KJIP formalised the role of the newly established KNEG to become the main coordination mechanism and entry point for climate change and disaster risk management initiatives guided by the Development Coordination Committee. KNEG conceptualised the WoI approach and remains the driving force.

4.2 Abaiang

Abaiang's 5,502 people represent 5.3% of the national population; as such, Abaiang is the fourth-most populated atoll in Kiribati (after North and South Tarawa in the Gilbert Group, and Kiritimati in the Line Islands) (Office of *te Beretitenti* and T-Makei Services 2012). Abaiang was selected by KNEG to pilot the WoI approach based on a set of vulnerability criteria applied on various islands as detailed in Section 2.5.

4.2.1 Physical geography

Abaiang lies one degree north of the equator (latitude 1° 51' 29.62" N, longitude 172° 56' 28.58" E) and is considered part of the Northern Group of the Gilbert Islands. It is the closest outer island to the capital at approximately 9.5 km from the northern coast of Tarawa (SOPAC 2000). The other nearest atoll is Marakei, just over 40 km to the east of Abaiang. Like many other Kiribati islands, Abaiang lies within the equatorial waters that warm significantly during an El Niño event, resulting in much higher rainfall than normal. During a La Niña event, the equatorial waters are cooler and there is much lower rainfall during that period. During El Niño years, maximum air temperatures tend to be higher than normal and are driven by the warmer oceans surrounding the islands. During the dry season, minimum air temperatures in El Niño years are below normal (SOPAC 2000).

A large lagoon of over 240 km^2 dominates Abaiang (Fig. 7). The lagoon opens into the ocean through several passes in a barrier reef on the western side of the atoll. Abaiaing's land area is about 17 km^2 and the atoll is approximately 37 km long, but no more than 1 km wide (Office of *te Beretitenti* and T-Makei Services 2012). Most of Abaiang's 18 villages are accessible by roads. Ribono and Nuotaea are located on separate islets in the north and can only be accessed by boat. The smaller islets of the west are mostly used for fishing, collecting copra, and tourism and generally do not have permanent structures for housing. About 71% of Abaiang Island is covered by vegetation, mainly coconut palms; non-vegetated areas are either bare land or water bodies as shown in Figure 7 (Forstreuter et al. 2013).

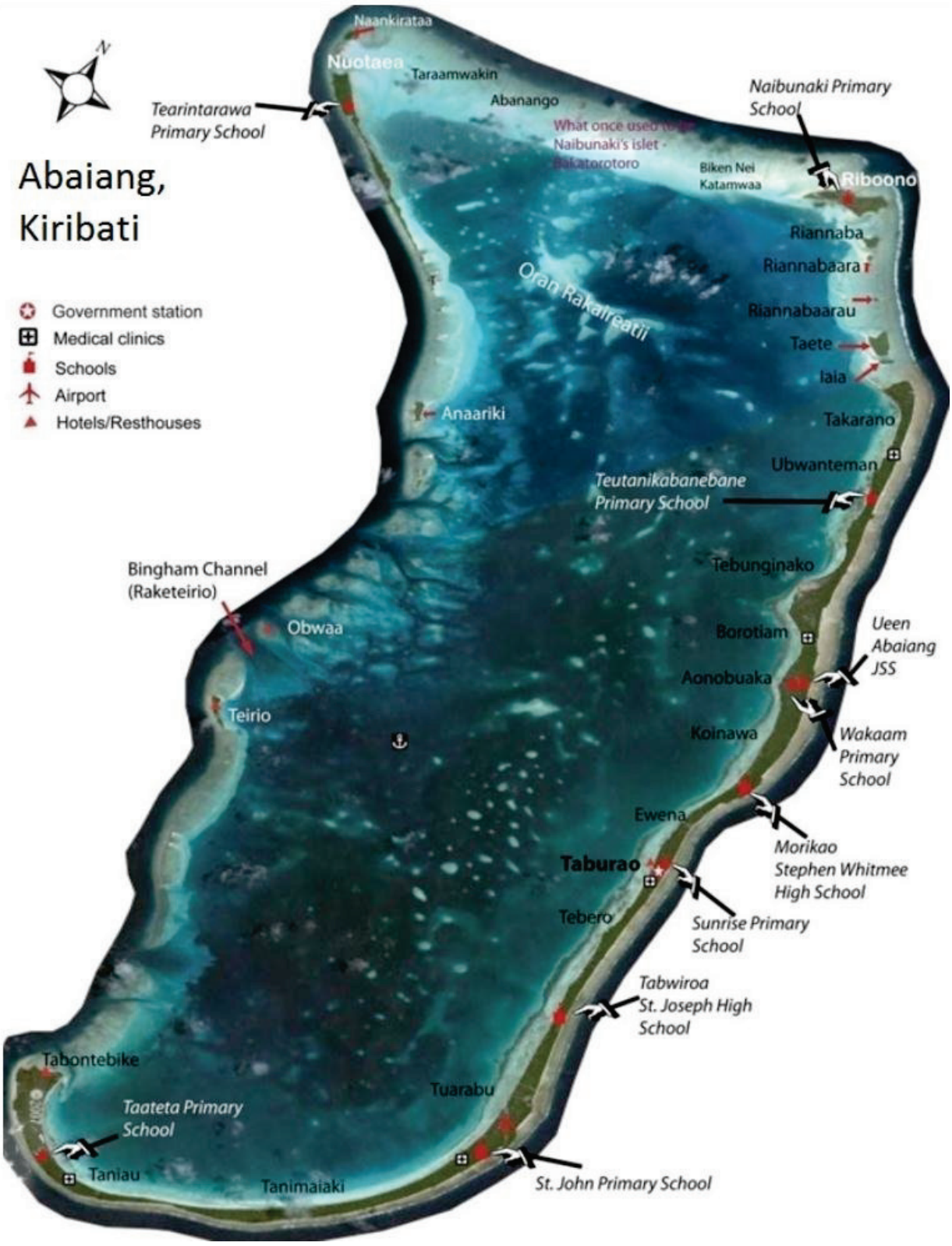

Figure 7: Abaiang Atoll, Kiribati. Source: OB, 2012

4.2.2 Demography

With 5,502 people recorded in 2010, Abaiang has the fourth largest population of any atoll in Kiribati, after North and South Tarawa in the Gilbert Group and Kiritimati in the Line Islands. This population is spread across 926 households in 18 villages, averaging 5.8 people per household. A history of rapid population growth was experienced on Abaiang prior to 1995, as shown in Figure 8, but the population is now stabilised as a result of internal migration to Tarawa (KNSO 2012).

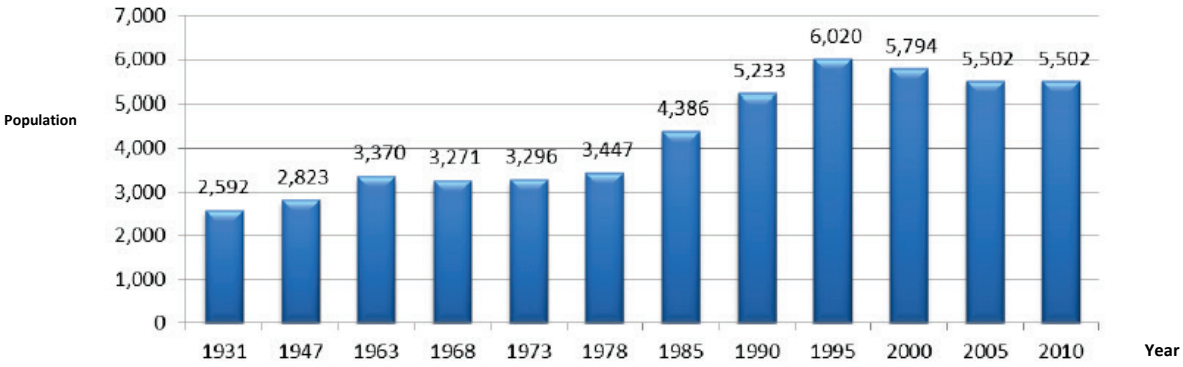

Figure 8: Abaiang's population from 1931 to 2010.
Source: OB, 2012

4.2.3 Local resource use

Copra is a key source of cash income on Abaiang, and it is mostly sold through a cooperative system. Income for copra can vary greatly due to factors such as market prices and low production due to events such as droughts. Farmed seaweed and harvested sea cucumbers are other sources of cash income. The main employers are the Island Council and schools although temporary labour work is also available when required for construction, maintenance and logistical work for development projects (MISA 2008).

4.2.4 Exposure to climate change and disaster: Comparisons of technical and local observations

Abaiang's communities and ecosystems are exposed to a range of inter-related phenomena that affect soft beaches, including inundations, saltwater intrusion, coastal erosion and sea level rise. Trade winds from the northeast and southeast dominate the Gilbert Islands of Kiribati, although rare westerly wind conditions can be experienced during El Niño events. The shores on the eastern side of Abaiang's lagoon, where the majority of villages are located, are protected from the easterly trade winds (SOPAC 2000). There is a consistent ocean swell from the east driven by these trade winds. More powerful, longer period swells generated by distant storms can also break on the reefs of Abaiang. These tend to arrive from the south in the Southern Hemisphere winter and from the north during the Northern Hemisphere winter. Cyclones can occasionally produce large swells from other directions. Pacific cyclones will not make landfall on the atoll due to its equatorial location, although associated weather systems can result in strong local wind conditions on Abaiang.

Semi-diurnal tides are experienced, with most days having two low tides and two high tides. Tidal difference is generally between 1.1 m and 1.3 m (SOPAC 2000). The tidal change drives currents within Abaiang's lagoon as water is moved from the ocean and back through reef passes. This movement can create currents up to 0.8 m/second (SOPAC 2000). Currents that are part of the Pacific Equatorial Current system also flow in deeper ocean waters surrounding the atoll.

Abaiang's exposure to the effects of climate change and disaster risks has been articulated from a technical as well as local community perspective. When the characteristics and patterns of temperature, rainfall and other climate elements change from what is considered normal, communities and ecosystems are exposed to either climate variability or climate change. The effects of such a change often have a 'multiplier effect' on existing problems, particularly when people's basic needs are directly dependent on the health of ecosystems. Public perceptions of problems were assessed during the IVA household survey and the outcomes (as shown in Fig. 9) suggest that the key concerns of communities relate to accessing drinking water, coastal erosion, increasing temperature and diminishing land and marine resources.

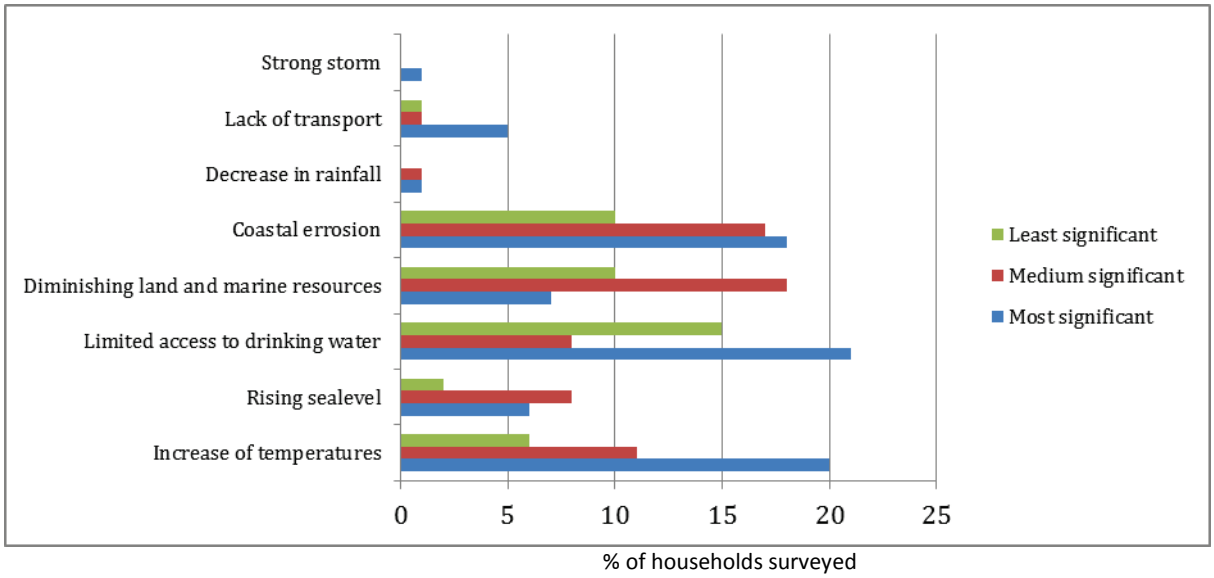

Figure 9: Abaiang community perceptions of problems resulting from climate change.

4.2.4.1 Air and sea surface temperature

Men and women in all eight villages were consulted on observed temperatures; generally, hotter days with colder nights were reported in six villages. The men from Ribono also linked cooler temperatures and increasing incidences of oil solidification (in a bottle), which rarely occurred previously. These community observations of generally hotter days are consistent with long-term weather records in Tarawa, suggesting warmer seasonal mean air temperatures with maximum temperatures having increased at a rate of 0.18°C per decade as shown in Figure 10 (KMS, BoM and CSIRO 2011).

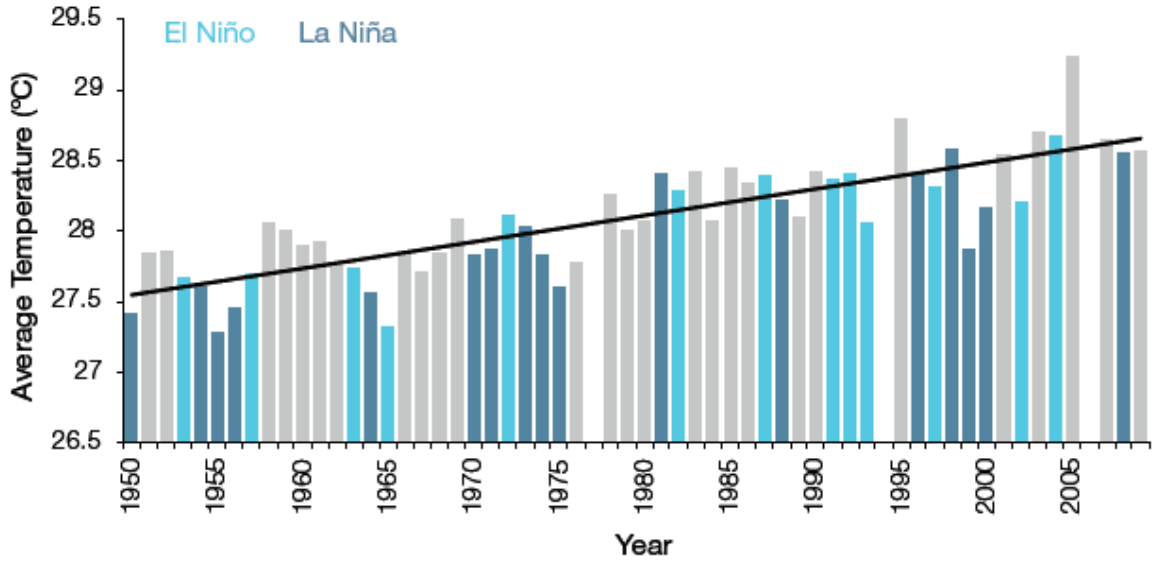

Figure 10: Annual mean air temperature at Tarawa, Kiribati.

Source: KMS, BoM and CSIRO 2011, vol 2:99

The locally perceived and reported cooler nights are, however, inconsistent with the weather observations, which show an increase in minimum temperatures as shown on Table 7. This may be due to records showing only average yearly maximum and minimum temperatures as opposed to day-by-day temperatures. Further to this, temperature fall at night time may be perceived higher with higher maximum temperatures.

Table 7: Annual maximum, minimum and mean temperature and rainfall at Tarawa for the period 1950–2009.

	Tarawa Tmax (°C per 10 yrs)	Tarawa Tmin (°C per 10 yrs)	Tarawa Tmean (°C per 10 yrs)	Tarawa Rain (mm per 10 yrs)
Annual	+0.18	+0.20	+0.19	+60
Wet season	+0.19	+0.20	+0.19	-15
Dry season	+0.17	+0.20	+0.19	+53

Abaiang, like the rest of Kiribati, can expect a continuous increase in air temperature (high confidence). Under a high emission scenario:

- Annual and seasonal mean temperature will increase by 0.3–1.3°C for the Gilbert Islands by 2030 (high confidence).
- Annual temperature increases could be greater than 3°C by 2090 (moderate confidence).

Because there is no consistency in projections of future ENSO activity, it is not possible to project inter-annual variability in temperature (KMS, BoM and CSIRO 2011). Sea surface temperatures have risen gradually since the 1970s in the waters around the Gilbert Islands by approximately 0.15°C per decade with the rise in air surface temperatures. Sea surface temperature will continue to increase by 0.6–0.8°C by 2035 and by 1.2–2.7°C by 2100 (KMS, BoM and CSIRO 2011).

4.2.4.2 Rainfall

The majority of communities (7 out of 8) on Abaiang noted a decrease in rainfall, especially during the wet season over the last three decades. Long-term rainfall records for Tarawa show no clear trends, but substantial variation from year to year is shown in Figure 11.

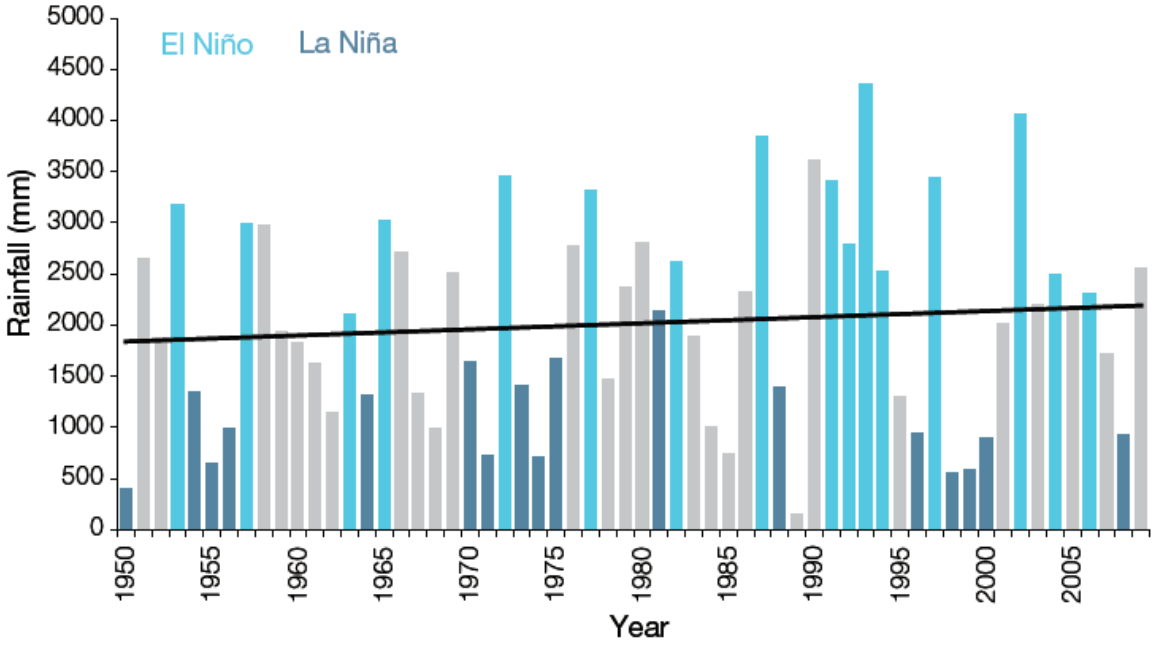

Figure 11: Annual rainfall for Tarawa, Kiribati.

Source: KMS, BoM and CSIRO 2011 Vol 2:100

The differences in community observation and rainfall records can be explained by highly localised rainfall, with Abaiang differing from Tarawa and the trends reflecting averages, whereby La Niña-associated droughts might have impacted Abaiang between 2007 and 2009 (see Fig. 11). In the future, it is projected that rainfall will increase during both the wet and dry seasons (high confidence) as will the annual average (low confidence) (KMS, BoM and CSIRO 2011).

4.2.4.3 Droughts

Due to the high correlation between annual rainfall and the Southern Oscillation Index or the position of the Pacific warm pool means that Kiribati is subject to frequent, long and severe droughts (SOPAC 2007). According to weather records and observations, 'the impact of droughts, usually associated with La Niña, can be severe in Kiribati; for example:

- in 1971, 1985, 1998 and 1999 annual rainfall was less than 750 mm
- the recent drought from April 2007 to early 2009 severely affected the southern Kiribati islands and Banaba. During this period, groundwater turned brackish and the leaves of most plants turned yellow' (GoK 2014).

According to climate projections, the incidence of drought will decrease in the future (moderate confidence) (KMS, BoM and CSIRO 2011).

4.2.4.4 Sea level rise

Past measurements by satellite altimeters around Tarawa show that sea level has risen by 1–4 mm per year, which is higher than the global average of 3.2 ± 0.4 mm per year (KMS, BoM and CSIRO 2011). Sea level rise naturally fluctuates from year to year at levels of about 26 cm and there are also decadal variations. These fluctuations over both time frames are a result of the ENSO phenomena. Over the course of the 21st century 'the mean sea level is projected to continue to rise (very high confidence)' (KMS, BoM and CSIRO 2011):

- Mean sea level will rise by approximately 5–15 cm by 2030 and 20–60 cm by 2090 under the higher emissions scenario (moderate confidence).
- Inter-annual variability of sea level will lead to periods of lower and higher regional sea levels with levels similar to the past.
- Sea level rise, combined with natural year-to-year changes, will increase the impact of storm surges and coastal flooding.

Scientists warn that due to the melting of large ice sheets such as those in Antarctica and Greenland, sea level rise could possibly be greater than predicted. But currently not enough is known to make predictions confidently (GoK 2014).

4.2.4.5 Ocean acidification

Although communities did not specifically mention ocean acidification they did notice damages to fish habitats, reefs and a decline in fish stocks. A recent scientific study (KMS, BoM and CSIRO 2011) on the Pacific Ocean states that:

'Since the 18th century, the ocean has been slowly becoming more acidic. The aragonite saturation state has declined from about 4.5 in the late 18th century to an observed value of about 3.9 ± 0.1 by 2000. Based [on] the large-scale distribution of coral reefs across the Pacific and the seawater chemistry, Guinotte et al. (2003) suggested that seawater aragonite saturation states above 4 were optimal for coral growth and for the development of healthy reef ecosystems, with values from 3.5 to 4 adequate for coral growth, and values between 3 and 3.5, marginal. Coral reef ecosystems were not found at seawater aragonite saturation states below 3 and these conditions were classified as extremely marginal for supporting coral growth.'

The acidification of the ocean in Kiribati is predicted to continue to increase (very high confidence):

- The annual maximum aragonite saturation state will reach values below 3.5 by about 2045 in the Gilbert Islands, by about 2030 in the Line Islands, and by about 2055 in the Phoenix Islands. Aragonite saturation will continue to decline thereafter (moderate confidence) (KMS, BoM and CSIRO 2011).
- Ocean pH will decrease by –0.1 units by 2035 and by –0.2 to –0.3 units by 2100 (Bell et al 2011).

4.2.4.6 Other hazards

Apart from climate-related hazards such as inundations and droughts, Abaiang, like the whole of Kiribati, is exposed to other natural and human-caused hazards. The following shows a combination of what the communities and households identified as threats and what the National Disaster Risk Management Plan 2012 identified.

Fire

The risk of fire exists but is generally considered to be low by the households that were interviewed and by the local police (see Fig. 12). Only 14 % of households considered the risk of fire to be high or medium.

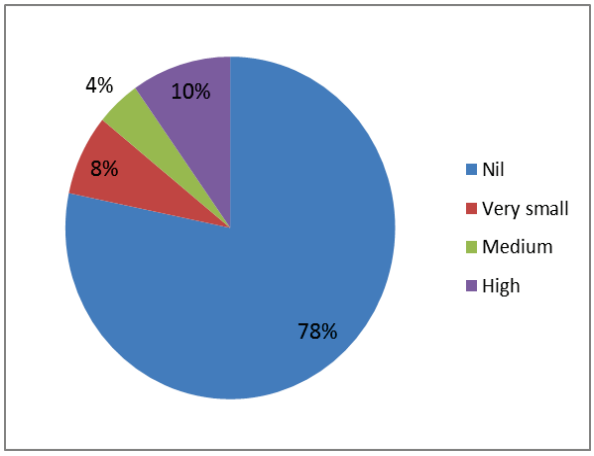

Figure 12: Perceived risk of fire on Abaiang Atoll.

Tsunami

Tsunami risk modelling and the limited historical records of tsunami events suggest that Kiribati has a lower tsunami risk than other Pacific Island countries and territories. Kiribati is farther away from the Pacific ring of fire and the distance from an earthquake underneath the ocean is much greater than for other Pacific Islands. Hence, a potential tsunami wave has to travel a long distance and its height decreases over time. While tsunamis have hit Kiribati, the wave amplitude and size of them has been low (e.g. 10 cm for the last tsunami). This does not, however, mean that the risk of a tsunami occurring is 0. Since 1994 there have been three small tsunami events detected at the Tarawa sea level gauge from the Kuril and Japan Trench. These were 8.3 Mw events on 4 October 1994 and 15 November 2006 and a 9.0 Mw event on February 2012. Two events in 1994 and 2006 resulted in waves less than 10 cm in height, while the 2012 event resulted in wave heights of 20 cm recorded at the Tarawa tide gauge. Most recently, Kiribati has been placed under a 'tsunami warning' by the Pacific Tsunami Warning Centre (GoK 2014:25–26). Tsunami risks were not raised during the PRA process and 88% of household representatives who were interviewed did not see it as a risk (see Fig. 13). Those that did view the tsunami as a risk (11 %) were mainly from Ribono, Rotiam, Taburao, Tabontebike and Nuotaea.

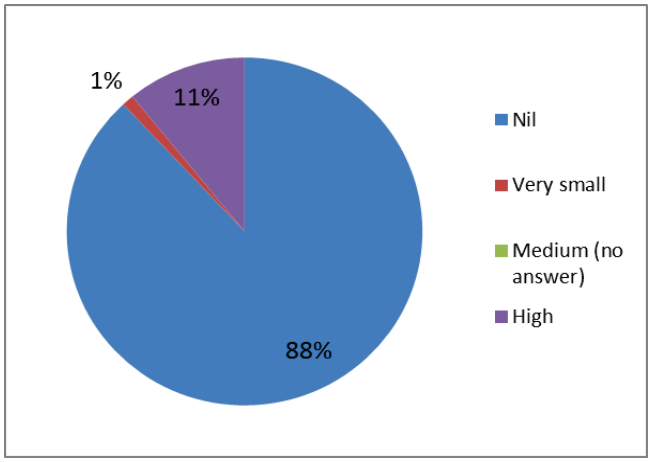

Figure 13: Perceived risk of a tsunami on Abaiang Atoll.

Epidemics

Kiribati was threatened by epidemics of severe acute respiratory syndrome (SARS) in 2002–2004 and H1N1 (swine flu) in 2009 (KMS, BoM and CSIRO 2011). Other epidemics have a stronger relationship with climate such as water and food- and vector-borne diseases, and are expected to increase because of climate change. A key informant interview with the nurse on Abaiang revealed that skin diseases and non-communicable diseases are most common illnesses and cases of diarrhoea are increasing. In July 2013, five children under the age of 5 years died in Takarano due to severe dehydration caused by diarrhoea. Health workers link these diarrhoea-related deaths with well water contamination or a rotavirus.

Maritime disasters (including oil spills)
Maritime disasters were not reported to have impacted Abaiang. However, they are considered a risk because many foreign fishing vessels pass in between Kiribati's atoll islands. Any maritime disaster could lead to oil spills that threaten marine and coastal ecosystems with immediate impacts on the population's food security (as they are highly dependent on marine resources).

Overall, these comparisons between local risk perceptions with risks determined via technical studies as summarised in Table 8 present an interesting perspective on Abaiang's exposure to climate change and disasters. These findings may also be indicative of aspects from which local knowledge can inform technical knowledge and vice versa, and provide background information from which the design of future climate change and disaster risk awareness programmes may draw from.

Table 8: Summary of technical and local observations of climate and disaster exposure on Abaiang Atoll.

Community observation	Scientific or technical studies
• Increase in the number of hot days and cold nights • Decrease in the amount of wet season rainfall and the general unpredictability of rainfall • Increase in coastal erosion • Increased seawater intrusion and brackish groundwater • Increase in the frequency of droughts • Increase in the number of saltwater inundations • Small increase in the number of strong storms	• Increase in sea level rise • Increase in air and sea surface temperatures • Increase in ocean acidification • Substantial variation in rainfall from year to year, and associated droughts • Increase in extreme events • Risk of epidemics (vector-, water- and foodborne diseases • There exists a relatively small likelihood of fire, tsunami and maritime-related disasters

5. THE ADAPTIVE CAPACITY OF ABAIANG AND THE SENSITIVITY OF LIVELIHOOD RESOURCES TO CLIMATE CHANGE AND DISASTERS

This section describes the adaptive and coping capacity of Abaiang's local communities and the sensitivity of their livelihood resources to climate change and disasters. Sensitivity is defined as:
…the degree to which a system or species is affected, either adversely or beneficially, by climate variability or change. The effect may be direct (e.g. a change in crop yield in response to a change in the mean, range, or variability of temperature) or indirect (e.g. damages caused by an increase in the frequency of coastal flooding due to sea level rise) (IPCC 2007).

The ability of local communities to adjust to and use available skills and resources to respond to adverse conditions is a positive indication of an adaptive and coping capacity (UNISDR 2009) . The IVA framework recognises that an adaptive capacity comprises the livelihood assets that people have access to for adaptation, and the institutions that determine the accessibility and distribution of these resources in normal times and in periods of adversity. Hence, an adaptive capacity comprises two functions: the more 'tangible' asset-based natural, physical, human and financial resources that people *have* to adapt, and the 'less tangible' formal and informal institutional functions that shape *how* or what people *do* to adapt (WRI 2009). Moreover, all livelihood assets will either be directly or indirectly affected by climate change and disasters, and how effectively people respond to these challenges will depend largely on the capacity of local institutions (e.g. the island councils, village committee, youth and women's groups) and their networks (e.g. government, non-governmental organisations, development partners). The next section describes the adaptive capacity of Abaiang's communities and their sensitivity to the effects of climate change and disasters.

5.1 Ecosystem capacity to support livelihood needs and sensitivity to climate change and disasters

This section describes the natural assets that the 18 villages on Abaiang have access to for meeting their basic water, food, housing and income needs and the sensitivity of these assets to climate change and disasters. Natural assets refer to marine and land-based natural resource stocks, flows and services that support people's livelihood needs, ranging from the more intangible public goods such as the atmosphere and biodiversity to the more tangible dividable assets such as fishing grounds and land used for food production and water sourcing. Natural assets are the most exposed and sensitive of the four livelihood asset categories, the other three being infrastructure, human resources and finance. These all contribute to making the 18 villages on Abaiang particularly vulnerable to the effects of climate change and disasters given their direct and high reliance on the health of their natural environment. For example, Abaiang's marine and land resources provide natural protection for settlements (e.g. mangroves and coastal vegetation protect shorelines), food (e.g. fish and coconuts), house building material (e.g. mangrove and coconut trees, pandanus), water (underground freshwater lens), income (copra), and nearly all of the islands' cooking fuel (coconut fibre). The natural environment also provides recreational, aesthetic and spiritual benefits associated with cultural identity (*te aba*). As such, recognising natural resource services to support human livelihoods is critical. As shown in Figure 14, ecosystem-based adaptation (EbA) incorporates the use of biodiversity and ecosystem services to help people adapt to the adverse impacts of climate change (SPREP 2013). For an atoll community that is highly reliant on natural resources to meet basic needs, an ecosystem-based approach to vulnerability assessment and adaptation planning is of critical importance.

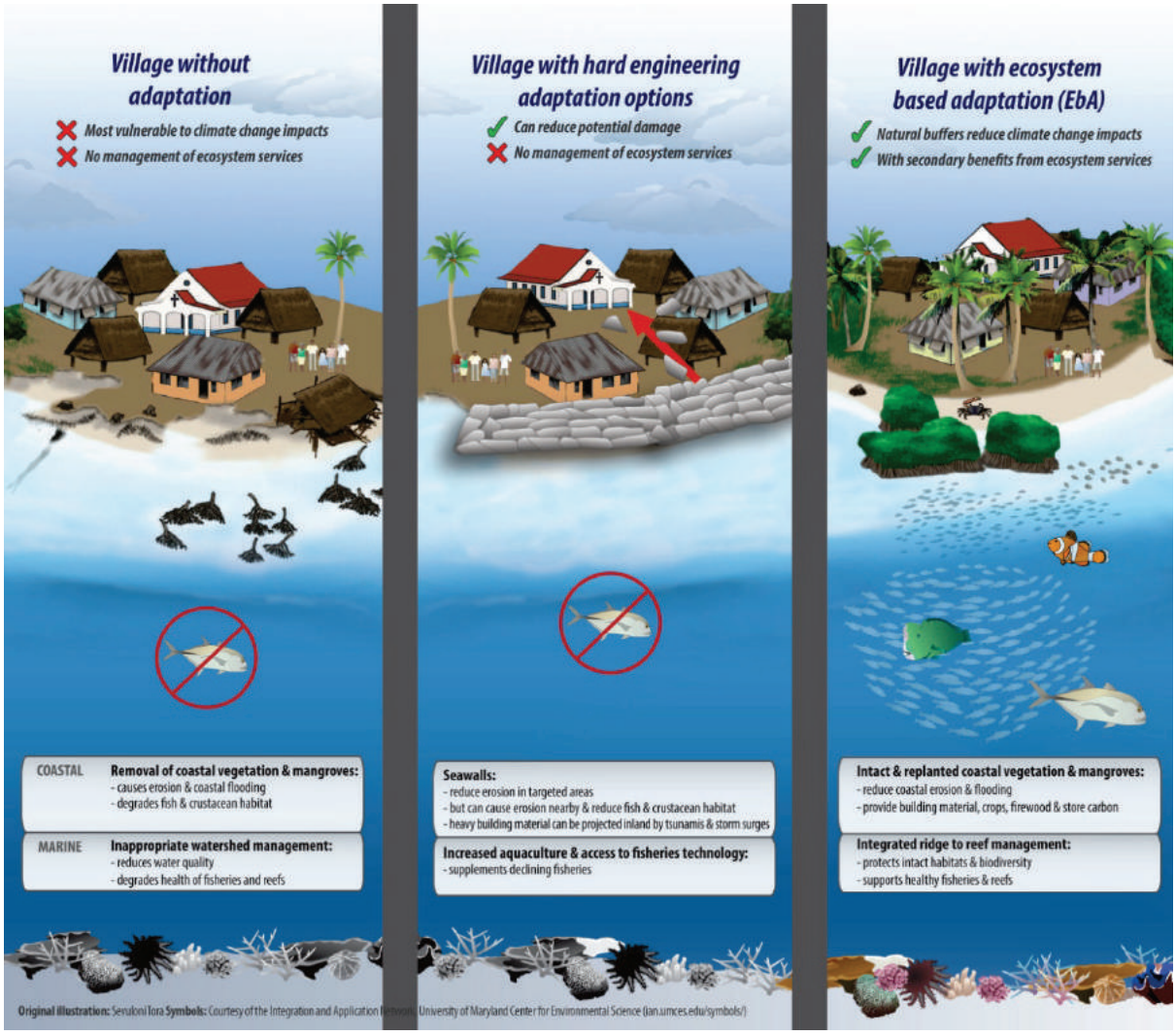

Figure 14: Comparison of ecosystem-based adaptation scenarios.

Source: SPREP 2013

5.1.1 Settlement, housing and local sources of energy

Abaiang Atoll's ecosystem supports 18 villages that include 926 households and 5,502 people. A majority of the settlements are located on the eastern side of the atoll (connected by a road) while the villages of Ribono and Nuotaea are located on separate islets in the north. Multi-temporal image analysis (comparisons of aerial photos taken of one particular place at different times) of Abaiang Atoll in 1968 and in 2011 suggests an increase in land area by 46 hectares (ha) as shown in Tables 9 and 10 (Forstreuter et al. 2013). While contrary to perceived threats of 'shrinking islands' due to climate change, such changes explain the dynamic nature of island landforms responding to natural processes and conditions of which sea level is one of several factors (Webb and Kench 2010). For example, the same imagery analysis also showed that erosion and accretion occurred at various parts of the island: approximately 128 ha of settled area in 2011 used to be covered with seawater in 1969, and 18 ha of previously settled areas in 1969 is now covered in seawater (Forstreuter et al. 2013). As such, the location of a village or house is an important determinant of vulnerability.

An image analysis study by Forstreuter et al. 2013 also showed that the total settlement area on Abaiang has increased from 231 ha in 1969 to 373 ha in 2011, whereby settlements expanded into 147 ha of what was previously dry or bare land. Settlements have also expanded into about 58 ha of newly accreted or propagated areas. Such settlement expansion may have been driven by the local population, which increased from 3,271 in 1968 to 5,502 in 2010 (KNSO 2012). About 70% of households own the land they reside on while 11% have made informal or personal arrangements with landowners for the land they live on. Other land tenure arrangements are via government or private lease, or other arrangement (KNSO 2012).

There continues to be a high reliance on locally sourced, traditional building materials (coconut palms, trees and shrubs) for house construction and cooking fuel. The 2010 census recorded that 91% of households had traditional roofing, 87% had traditional floors and 75% had thatched walls. About 97% of households rely on locally sourced firewood and coconut shells as fuel for cooking (KNSO 2012). Population increases suggest negative consequences on vegetation cover, particularly in localities where people have settled due to the demand for building material and cooking fuel. Nevertheless, dry land vegetation cover has increased overall by 66 ha when comparing 1969 and 2011 maps (Forstreuter et al. 2013).

Table 9: Abaiang land cover change detection summary, 1969 and 2011.

ID	ClassName	NoPixels	Hectare	% SUM
00	Dry land 2011 and Seawater 1969	959133	96	7
20	Settlement 2011 and Seawater 1969	581176	58	5
10	Bare land 2011 and Seawater 1969	10147	1	1
40	Water body 2011 and Seawater 1969	3856	0	1
30	Mangrove 2011 and Seawater 1969	164	0	1
43	Seawater 2011 and Dry land 1969	878126	88	7
03	Dry land 2011 and Dry land 1969	9029002	903	58
23	Settlement 2011 and Dry land 1969	1284147	128	9
13	Bare land 2011 and Dry land 1969	119503	12	2
43	Water body 2011 and Dry land 1969	82305	8	2
33	Mangrove 2011 and Dry land 1969	6706	1	1
42	Seawater 2011 and Settlement 1969	178154	18	2
02	Dry land 2011 and Settlement 1969	422632	42	4
22	Settlement 2011 and Settlement 1969	1662417	166	11
12	Bare land 2011 and Settlement 1969	23207	2	1
42	Water body 2011 and Settlement 1969	33457	3	1
32	Mangrove 2011 and Settlement 1969	153	0	1
41	Seawater 2011 and Bare land 1969	33236	3	1
01	Dry land 2011 and Bare land 1969	1615293	162	11
21	Settlement 2011 and Bare land 1969	193689	19	2
11	Bare land 2011 and Bare land 1969	105347	11	2
41	Water body 2011 and Bare land 1969	48636	5	1
31	Mangrove 2011 and Bare land 1969	796	0	1
40	Seawater 2011 and Water body 1969	509	0	1
00	Dry land 2011 and Water body 1969	29949	3	1
20	Settlement 2011 and Water body 1969	18643	2	1
10	Bare land 2011 and Water body 1969	8137	1	1
40	Water body 2011 and Water body 1969	106663	11	2
30	Mangrove 2011 and Water body 1969	2654	0	1
		17437837	1743	

Source: Forstreuter et al. 2013

Table 10: Abaiang land cover types in 1969 and 2011.

ID	Land Cover 1969	Hectare	ID	Land Cover 2011	Hectare
0	Seawater 1969	0	0	Seawater 2011	0
10	Water 1969	17	1	Water 2011	27
20	Settlement 1969	231	2	Settlement 2011	373
30	Bare land 1969	200	3	Bare land 2011	27
40	Dry land vegetation 1969	1140	4	Dry land vegetation 2011	1206
50	Mangrove 1969	0	5	Mangrove 2011	1
	Sum	**1588**		**Sum**	**1634**

Source: Forstreuter et al. 2013

Mangroves stabilise coastlines by trapping sediments, and this controls the erosive action of waves and currents. As such, mangroves function as natural protection structures for atoll villages. Abaiang is home to two types of mangrove species: red mangrove and oriental mangrove. Mangrove areas around Abaiang appear in thin patches as shown in Figure 15. Multi-temporal image analysis has determined that the total mangrove forest cover on Abaiang was approximately 1 ha in 2011, while mangrove cover appears to have been insignificant to nil in 1969 as shown in Tables 9 and 10 (Forstreuter et al. 2013). These findings also indicate that mangrove covered areas in 2011 used to be either dry land (6,706 m^2), water bodies (2,654 m^2), bare land (796 m^2), seawater (164 m^2), or settled areas (153 m^2) in 1969.

Mangrove forests provide important ecosystem services to communities. Data gathered via PRAs indicates that mangrove trees are commonly used as a hardwood for building materials and firewood. Mangrove flowers are often used for medicine and garlands during dancing ceremonies. The communities, supported by the Environment Conservation Division of the Ministry of Environment, Lands and Agricultural Development are active in replanting mangroves for coastal protection. Restoring mangroves provides protection from coastal erosion, while also generating habitat for fish and crustaceans, thereby improving food security. Abaiang communities, through GoK projects with development partner support, have already shown their expertise and willingness to replant mangroves, particularly in highly eroded areas such as Tebunginako via the Knowledge, Attitudes and Practice II project implemented by the Environment Conservation Division of the Ministry of Environment, Lands and Agricultural Development. Yet awareness of the ecosystem benefits that come from ecosystem-based measures does not appear to be high on Abaiang. Survey results found that the majority of residents preferred seawalls to mangroves as a primary means to control coastal erosion, even though seawalls are known to cause erosion on adjacent beaches. With minimal mangrove cover and limited opportunities for mangrove regeneration, villages are less protected from erosion threats.

Figure 15: Location of Abaiang's mangroves

Source: SPREP/PACMAN, 2013

5.1.1 Sensitivity of settlements to climate and disasters

The village of Tebunginako has gained international media attention and was visited many times by the GoK in recent years due to its extreme exposure to erosion. Previous studies by Harper in 1989, Holden in 1992, Gillie in 1993, and Webb in 2006 suggest that up to 80 m of erosion has occurred on the lagoon side since 1964 (Webb and Kench 2010). Erosion has affected the church, *maneabas* and several households in the village especially on the western side. As a result of erosion, lagoon waters have infiltrated freshwater ponds south of the village (Webb 2006). The village members that were consulted reported that families were retreating inland due to seawater encroaching towards village houses and the church that were once the centre of the village.

Mangroves are being replanted and new fisheries habitats are now forming (*te bun fishery*) in those areas (Fig. 16).
Recent studies indicate that Pacific Island mangroves are highly likely to decrease substantially because sea level rise is outpacing, most mangrove sediment surface elevations, and thereby limiting opportunities for the landward migration of the plants (Uriam and Tebano 2011). However, further long-term analysis of such trends needs to take place, and regional monitoring networks will need to be developed so as to develop 'adaptation measures that can offset anticipated mangrove losses and improve resistance and resilience to climate change' (Uriam and Tebano 2011).

Figure 16: Loss of land and mangrove rehabilitation at Tebunginako village

Local perceptions of coastal risk

The IVA household survey conducted in September 2013 assessed local perceptions of coastal risk. Inundations caused by severe storms and king tides occasionally occur on Abaiang and, as shown in Figures 17 and 18, slightly more respondents considered risks from inundations to be higher from severe storms than king tides.

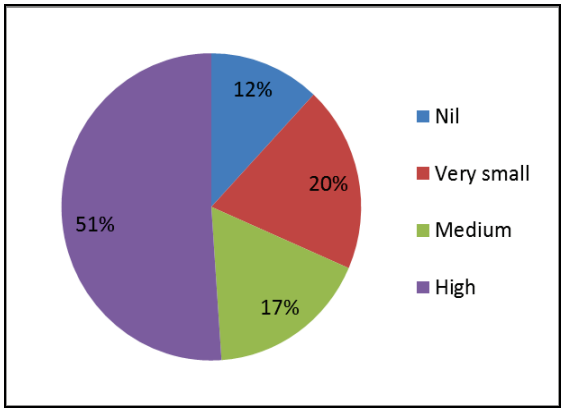

Figure 17: Perception of risk of sea water inundation caused by severe storm on Abaiang.

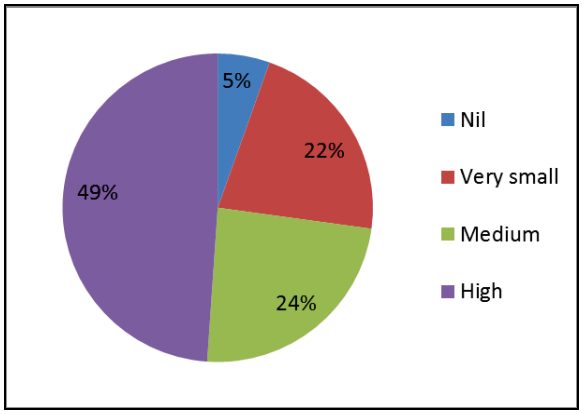

Figure 18: Perception of risk of seawater inundation caused by king tide on Abaiang.

The household survey outcomes also showed that the same villages — Ribono, Tebunginako, Taburao, Aoneaba and Nuotaea — similarly considered seawater inundation from storms and king tides to be of high to medium risk (Figs. 19, 20 and 21).

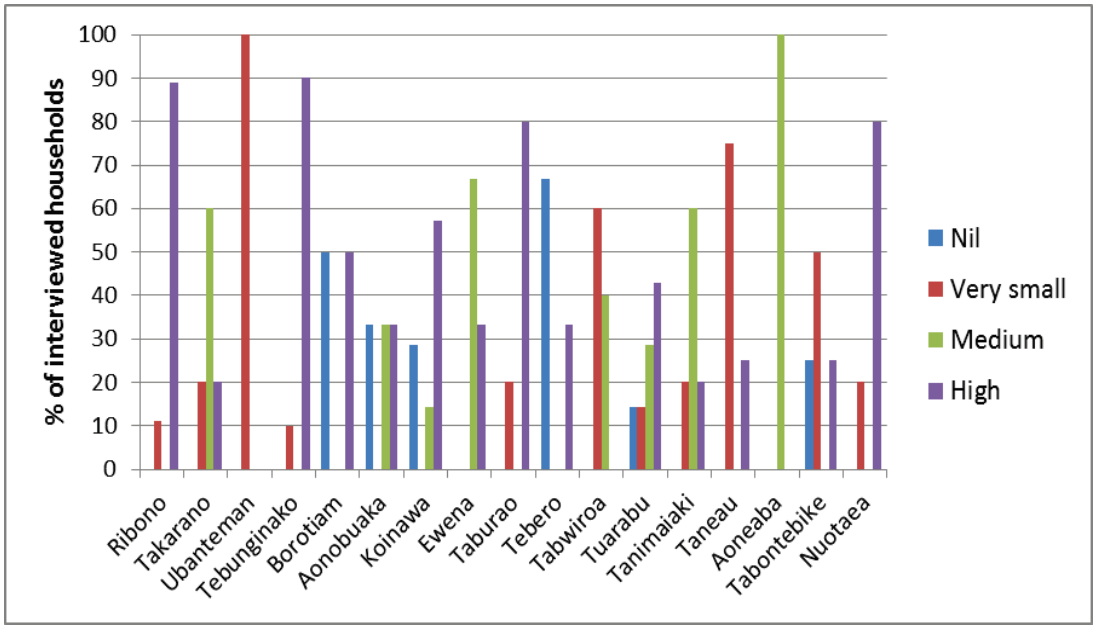

Figure 19: Perception of risk (by village) to seawater inundation caused by severe storms, Abaiang Atoll.

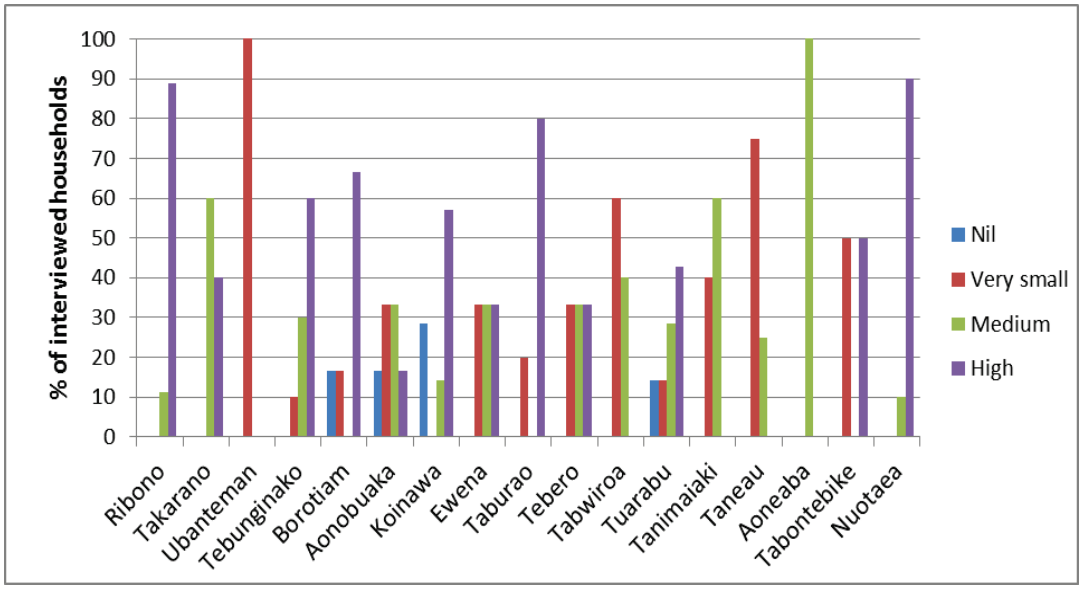

Figure 20: Perception of risk (by village) to seawater inundation caused by king tides, Abaiang Atoll.

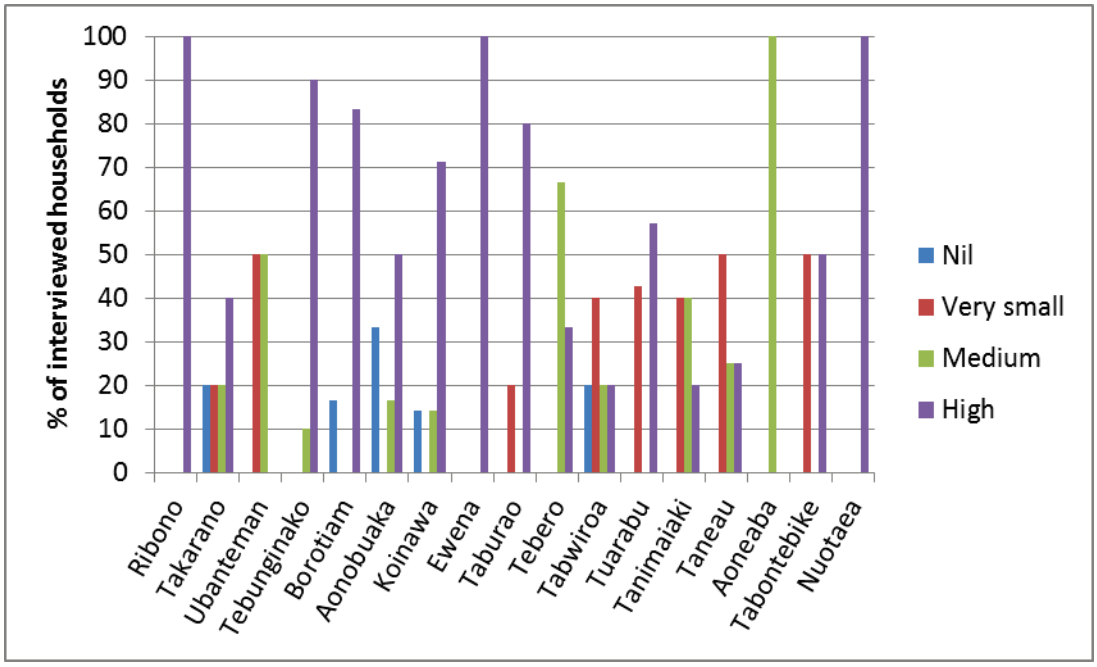

Figure 21: Household perception (by village) of the level of risk to coastal erosion, Abaiang Atoll.

The outcomes of the PRA showed that there was little consensus between villages and within villages (and among men and women) on the causes of inundation. For instance, in Tuarabu, both men and women stated that inundation occurs predominately during spring tides and during strong winds, as compared to responses from Koinawa village where both men and women stated that inundation occurred only during high tides. Women in Ribono and Ubwanteman noted two incidences of seawater intrusion and inundation only during high tides, while the men from both villages stated that inundation occurs more frequently during spring tides and high wind periods. In Takarano village both men and women stated that inundation no longer occurs – although the household survey indicates otherwise.

Based on observations and community discussions, the atoll's coastline continuously faces threats from storm surges and changing tides as well as from the constant extraction of sand, mangroves and coral for construction. Evidence of eroded coastlines, vegetation dieback as well as loss of land towards the lagoon and ocean side has made some parts of the coastline very narrow and vulnerable to subsidence. Sea level rise caused by climate change additionally contribute to perceived risks of coastal erosion.

Local community observations gathered during the September 2013 IVA fieldwork, confirmed findings of a previous report by Uriam and Tebano (2011) of significant threats to the atoll's coastline. Coastal erosion has become a major problem resulting in flooding in some areas, threatening homes and infrastructure, loss of vegetation and causing destruction to the public road. The villages where more than 70% of the households consider themselves to be at high risk from coastal erosion include Ribono, Tebunginako, Borotiam, Koinawa, Ewena and Nuotaea (see Fig. 20 and Section 5.1.1).

Seven out of eight villages consulted observed increased frequency of saltwater intrusion, especially during extreme high tides (such as the annual king tide and monthly spring tides) and prolonged periods of drought when freshwater lenses diminish and salinity increases.

Figure 22: Daily life and adaptive traditional dwelling on Abaiang Atoll.

Similarities and contrasts in local observations and technical assessments suggest the need for further knowledge sharing between local communities and technical experts regarding settlement expansion or relocation and appropriate locations to construct permanent structures and other infrastructure in the immediate and distant future. Current, yet limited, technical knowledge on the coastal change process occurring in Abaiang only indicates the need for further analysis to better understand the way and the rate in which erosion and accretion will occur within the next century. Such knowledge exchanged with local observations, values and culture is likely to better inform adaptation decision-making in low-lying atoll islands such as Abaiang.

5.1.2 Natural water resources

Human habitation on Abaiang is only possible due to the presence of a freshwater lens beneath the surface of the atoll, as no surface freshwater lakes or rivers exist. The freshwater lens actually floats on the mix of saltwater and sediments beneath it. This groundwater supply is replenished by rainfall that filters through the highly permeable soil which, as a result, can become more saline during times of limited rainfall (Fig. 23).

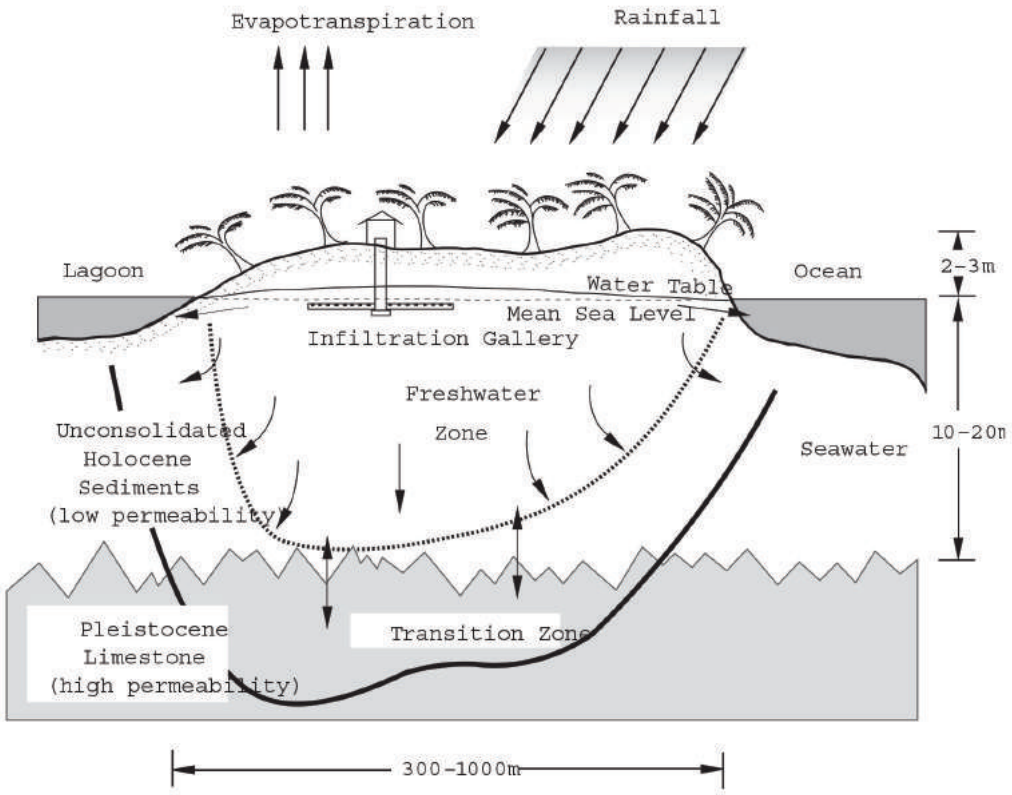

Figure 23: Cross section of an atoll freshwater lens.

Source: Burns, 2002.

Accessibility of freshwater resources

Groundwater is the primary source of drinking water for 96% of Abaiang's 926 households, sourced directly via open or protected wells. Competition for water by different sectors for different uses (crops, animals and humans) is putting more pressure on the atoll's already limited water resources. During PRAs community members reported that water is getting increasingly brackish and unsuitable for plant growth.

The sustainable yield for groundwater on Abaiang is estimated to be 2,766m^3/day (SOPAC 2007). Assuming a demand of 100 L/person/day, such groundwater quantity could cater for up to 27,660 people (SOPAC 2007). However, this estimation does not differentiate drinking water of a quality that can become unfit for consumption due to bacterial contamination or high salinity.

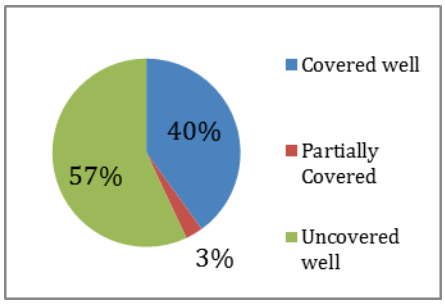

Figure 24: Well types on Abaiang Atoll.

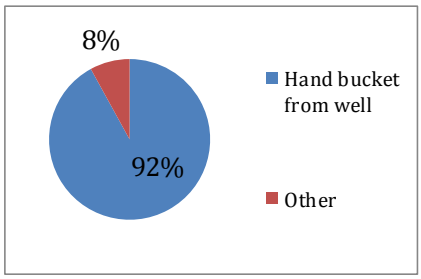

Figure 25: Abstraction method from well on Abaiang Atoll.

Uncovered or partially covered wells are common on Abaiang. Unfortunately, they are easily contaminated, as organic matter such as plant and animal waste can easily enter the well. Using a hand bucket to abstract water creates an additional opportunity for the well to be contaminated because the bucket is often stored on the ground and is exposed to animal and human contact (see Figure 24 and 25). Many families also have to cart water from wells that are far from their households. In the household survey, 16% reported that their primary water source is over 50m away.

Rainwater harvesting on Abaiang is becoming more common where iron roofs are present. The majority of village homes have thatched roofs with no gutters (Fig. 26), which are essential for the effective use of rooftops as catchment areas. Open and unscreened rainwater tanks and pipes are plainly visible in many villages on Abaiang and hand bucketing from rainwater tanks is also common (Fig. 27). These maintenance and daily use practices lead to rainwater tanks also being susceptible to contamination from external sources.

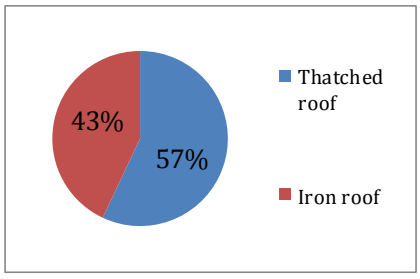

Figure 26: Roofing construction on Abaiang Atoll.

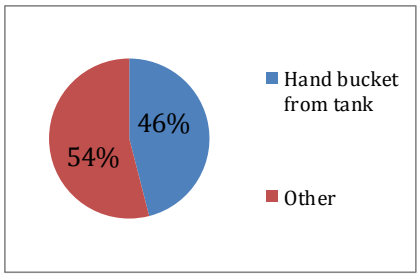

Figure 27: Abstraction method from rainwater tank, Abaiang Atoll.

Quality of water resources

Bacterial contamination and high salinity are the primary causes of reduced water quality on Abaiang. The September 2013 IVA conducted water quality testing at 17 groundwater sources on Abaiang (Fig. 28). These sources included 10 household wells and 4 community wells, 1 cistern, 1 *tamana* pump and 1 tap outlet connected to a micro-filtration unit that is detailed in Annex 1. The results showed levels below the World Health Organization's acceptable drinking water quality standards at several sites as detailed in Table 11.

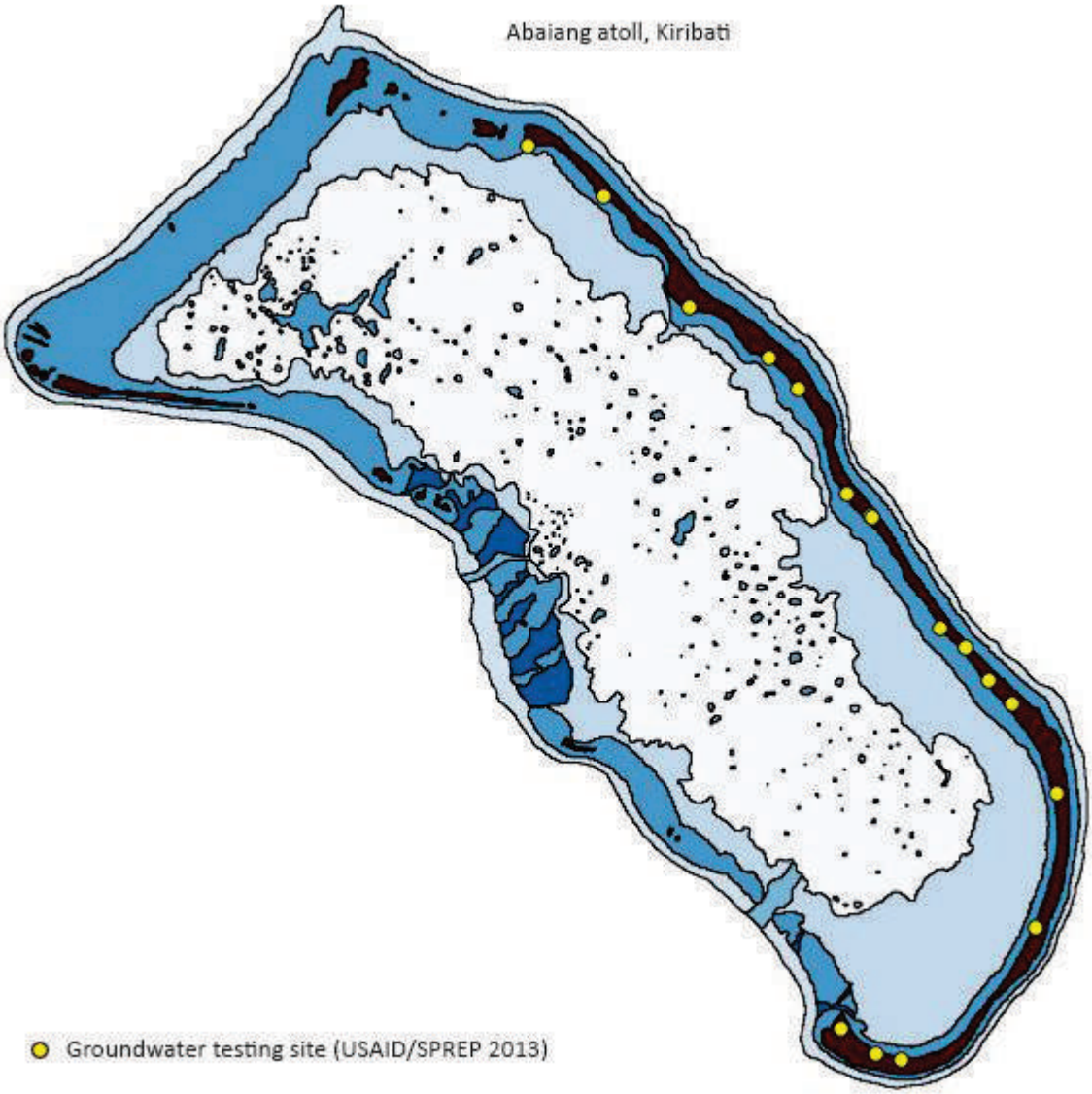

Figure 28: The 17 groundwater test sites on Abaiang Atoll during IVA, September 2013

Table 11: Physical and microbiological results of the 17 samples collected compared with World Health Organization drinking water standards.

	Physical				Microbiological (100 ml)	
	Conductivity	Dissolved oxygen (mg/L)	pH	Turb (NTU)	Coliform	*E. coli*
WHO standards	**1500 µS/cm**		**6.5–8.5**	**5 NTU**	**0/100 mL**	**0/100 mL**
Sample site						
Takarano HH	1309	9.63	7.65	5.38	TNTC	1000
Ubanteman CW	812.0	8.93	7.53	0.50	TNTC	0
Tebunginako HH	499.5	8.5	7.79	0.24	TNTC	28
Borotiam HH	706.1	9.46	7.62	0.97	TNTC	528
Aonobuaka HH	4620.0	9.74	7.74	0.78	TNTC	30
Koinawa HH	959.1	9.83	7.47	1.05	TNTC	36
Morikao tap	2333.0	10.49	7.6	0.34	212	0
Kiribati Protestant Church RW Cistern	83.7	10.98	9.46	0.04	180	0
Ewena HH	1205.0	10.52	7.75	0.64	TNTC	108
Taburao (tamana pump)	379.5	10.18	7.92	0.41	13	0
Tebero HH	637.4	10.05	7.76	0.83	TNTC	680
Tabwiroa CW	579.8	9.82	7.52	0.30	TNTC	0
Tuarabu HH	2079	8.79	7.53	0.23	136	86
Tanimaiaki HH	1092	9.72	7.74	0.68	TNTC	544
Taneau CW	922.6	9.12	7.55	0.94	TNTC	32
Aoneaba HH	705.8	9.42	7.68	0.90	TNTC	42
Tabontebike CW	739.5	8.53	7.62	2.89	TNTC	400

HH = household well, CW = community well, TNTC = too numerous to count, RW = rainwater

Comparisons of the September 2013 water quality test results with World Health Organization's drinking water standards as shown in Table 11 suggest that:

- Well water in Takarano, Tebero, Tanimaiaki, Borotiam, Tabontebike is highly contaminated with *Escherichia coli* (*E. coli*) bacteria and unsuitable for drinking. Open wells increase the risk of contamination from debris, animals, humans and other surrounding materials, but still remain the primary access point to source water for the communities of Abaiang (56% of households).
- With regards to the saltiness of water (measured using electrical conductivity (BSGWA 2007), samples tested ranged from as low 379.5 (Taburao) to as high as 4620.0 (Aonobuaka). While further tests are required for better founded conclusions, this preliminary finding, which indicates a high concentration of ions, is due to the water demand exceeding the amount of water available to the villages (UNEP 2008) of Tuarabu, Morikao, Aonobuaka, which results in up-coning due to high pumping rates and consequently increasing salt water intrusion. Sea level rise and land inundation are also contributing factors.
- The dissolved oxygen (DO) level for groundwater sources normally ranges from 7.0 mg/L to 10 mg/L at temperatures ranging between 15^{0}C and 31^{0}C (APHA 1981). DO is vital for aquatic animals and is an indicator of the presences of algae, organic matter and other aquatic plants. Based on field observations, the excessive or limited levels of DO can indicate contamination as a result of plant matter or other aquatic animals such as *E. coli* in wells.
- Most of the samples complied with the WHO drinking water standards for pH, which is the measure of acidity and alkalinity of samples. The KPC rainwater cistern had the highest reading of 9.46, which is assumed to be a result of materials washed from the rainwater catchment area (roofs) or underground storage (cement).

- Turbidity readings for most of the samples were within WHO standards. The well at Takarano was highly contaminated, and was turbid with plant debris and potentially animal waste due to poor management and maintenance. As expected, *E. coli* readings were very high (1000 mg/L).
- Coliform is an indicator of contamination by other bacteria such as *E. coli*, which is often found in animal and human faeces. Results show that most of the samples with too numerous to count (TNTC) coliform readings with *E. coli* tests confirming contamination.

Poor sanitation is suspected to be the main source of groundwater contamination. The 2010 national census report states that of the 926 households interviewed, 631 defecate on the beach. Such practices pose threats to the health and wellbeing of communities on Abaiang because the presence of faecal coliform in well water may indicate recent contamination of the ground water by human sewage or from other animals, which could contain other bacteria, viruses and disease-causing organisms (UNEP 2008). A wide range of human activities can impact the quality of groundwater (the information in Table 12 was produced for a community education programme in Kiribati to describe activities that may pollute water near infiltration gallery pump systems).

Table 12: The effects of various human activities on the quality of groundwater.

Negative impact	No impact/minor impact
Growing giant swamp taro	Harvesting pandanus
Improper disposal of rubbish	Local medicine
Dogs	Cutting toddy
Graves	Collecting firewood
Nearby houses	Collecting crabs
Pigs and pig pens	Harvesting breadfruit
Chickens	Walking and playing
Growing vegetables	Growing fruit (without fertiliser)
Washing clothes	Picking flowers
Washing dishes	Growing vegetables
Improper disposal of oils, chemicals and batteries	Playing sport
Improper disposal of human faeces and diapers	
Unprotected well	
Car and truck wrecks	

Source: Adapted from KAPII, 2012

Sensitivity of natural water resources

An increase in wet and dry season rainfall as well as annual average rainfall is predicted to occur over the course of the 21st century (KMS, BoM and CSIRO 2011). Abaiang is, therefore, expected to have more rain than the annual average. However, during PRAs, all communities clearly observed extended dry periods during the last few years, leading to brackish water, water scarcity and decreased agricultural productivity. This can mainly be explained by climate variability — the El Niño Southern Oscillation as a predominant factor on rainfall. Records show that Abaiang has quite likely been impacted by La Niña-associated droughts from 2007 to 2009 (see Section 4.2.4.3).

The impacts of climate change on water resources is continually monitored and reported on by various global organisations such as the World Meteorological Organization, International Panel on Climate Change, and United Nations Environment Programme Technical Paper VI on Climate Change and Water. The UNEP report foresees the continual vulnerability and negative impacts of climate change on freshwater resources with a wide range of consequences on human societies and ecosystems (UNEP 2008). Multi-models have predicted impacts on precipitation extremes, with rainfall intensifying in the tropics and high latitude areas while also having a tendency for drying in mid-continental areas during summer, indicating a greater risk of drought.

Other sensitivities of groundwater resources to climate change that were identified in atoll islands include:

- contamination of aquifers and wells from storm surge, debris and salt spray;
- saltwater intrusion due to sea level rise;
- water sources may be affected by changes in rainfall patterns and frequency;
- infiltration rates can be affected by temperature changes that influence soil moisture and plant water uptake; and
- lack of water for recharge into freshwater lens due to evapotranspiration.

5.1.3 Natural food resources

The September 2013 IVA field assessment investigated the diet of an average person in six selected villages (Borotiam, Nuotaea, Ribono, Takarano, Tebunginako and Ubwanteman). The findings suggest that about one-half (44–53%) of food consumed is sourced locally, and are mainly seafood and agricultural crops. A description of the availability and accessibility of natural food sources for local communities on Abaiang follows.

5.1.3.1 Natural land-based food resources

Abaiang is a low-lying atoll with soil originating from the reef. Over time, a range of plants have been introduced to Abaiang. Coconut trees, breadfruit, pandanus and giant swamp taro are common and can be found on almost all available land. Native birds and insect species are still found on the island such as the common noddy (*te io*), ringed-bill gull (*te taarariki*), reef heron (*te kaai*) and frigate birds (*te eitei*), the latter two being listed as endangered species (MELAD 2010). In and nearby the villages, fauna mostly comprises introduced pigs, chickens, dogs, rats and cats (MISA 2008). About 1,160 ha (or 71% of Abaiang) are covered by vegetation, mainly coconut trees (Table 10).

Land-based crops on Abaiang consist of giant swamp taro (*bwaibwai*), breadfruit, bananas, pawpaw, wild fig (*te bero*) and pandanus (*te kaina*), all of which are harvested mainly for subsistence use. However, Abaiang currently faces challenges in producing enough quality food to feed its people. Successfully addressing this will require making a few small farmers on the atoll more productive. Food production on atolls, including Abaiang, is influenced by many factors. Based on findings from the field visit as well as secondary data (MELAD 2010) these factors include the following.

1) **Poor soil conditions:** Because atoll soils originate from the reef (coral), they are generally shallow, highly permeable and highly alkaline. These soils are considered to be some of the poorest in the world (MELAD 2010), which makes agriculture very difficult. As a result, there is a high reliance on composting and the breakdown of organic matter to create better growing conditions. On Abaiang, there are coral rock outcrops in some places, and in others there is little or no sand but many stones. In general, there is a layer of sand above the underlying coral rock. Well-developed soil is a horizon of brown to dark brown sandy material (up to about 20 cm in some places) with organic matter overlying a pale brown horizon (20–40 cm in some places). Below this is coarse yellowish white sand. The underlying coral rock is frequently seen in village wells. These soils usually do not have the structure described above and textures are sandy or coarser.
   Soil tests conducted during the September 2013 IVA indicated that the Abaiang agricultural production environment is chemically, physically and biologically poor:
   - The pH in water ranged from 8.19 to 9.04;
   - Electrical conductivity ranged from 155 µS/cm to 451 µS/cm;
   - Phosphorus and nitrate ranged from traces to medium with a few soil samples testing high;
   - Potassium in soil samples ranged from low to high (more than 70% of the samples had low available potassium);
   - Salinity ranged from 150 µS/cm to 750 µS/cm;
   - The physical texture of the soil was sandy; BD – low <1g/cm^3, with a high infiltration rate; and
   - The soil shows low biological activity.

2) **Limited availability and quality of water:** Competition for water for different uses (crops, and drinking water for animals and humans) is putting pressure on the already limited water resources on the atoll. During PRAs, community members reported that water is getting increasingly brackish and unsuitable for plant growth. Many houses have thatched roofs, making harvesting rainwater difficult. Many families must cart water from wells that are far from the households. The trend to move giant swamp taro pits into villages may have negative impacts on the freshwater quality, but research is needed to verify this.

3) **Narrow genetic base:** There are a few food plants that are native to atolls and are tolerant of atoll conditions such as pandanus. Coconut, taro, banana and breadfruit were introduced by indigenous people. The cultivation of these plants requires control and modification of the environment. Most of the introduced food plant and forestry species are not very tolerant of salinity and atoll conditions. This is coupled with the fact that some varieties of species of pandanus, taro, breadfruit, coconut, dwarf banana, local fruits and some traditional medicinal plants are now considered as being endangered.

4) **Limited and decreasing access to fruits and vegetables:** Only 5% of households have access to cabbage, 43% to banana and 45% to pawpaw (KNSO 2012). The share of households growing cabbage decreased by 3% from 2005 to 2010, and pawpaw by 23%. Household access to pandanus has been decreasing since 2005. Shops do not offer any fruits or vegetables. The household survey shows that the consumption of vegetables and fruits is very low, which correlates to emerging high incidences of vitamin and mineral deficiencies.

5) **Pests and diseases:** A major problem with introduced crops is their susceptibility to pests and diseases, but traditional crops such as coconuts and breadfruit are also at risk. During PRAs, communities reported, for example, that rats feed on coconuts and giant swamp taro pits are damaged. Most communities also reported that pigs are more prone to diseases than they were in the past.

6) **Challenges for livestock:** There are limited choices for livestock production on atolls in general with the most viable being pigs and poultry. Households mainly have access to local pig and chicken breeds; only very few have access to cross-breeds or exotic breeds. Cross-breeds are said to be more productive and are potentially more adaptable to heat stress and water scarcity. More than half of all households on Abaiang do not have access to chickens. Communities reported that pigs nowadays give birth to fewer piglets as compared to the past. All households reported increasing animal pests and diseases. The scarcity of food and water is another challenge for livestock production, and communities also have issues with managing waste from livestock.
The production system for local chickens is based on 'wild scavenging' which means there are little or no management inputs. Local chickens are small and less productive, which is likely due to inbreeding. Dogs, cats and rats eat eggs laid in the bushes. Feeds for chickens are nutritionally inadequate.

During PRAs the following local activities were identified as threatening to local land-based food production:

- A decline in the number of trees and palms and loss of their productivity (especially pandanus, mangroves and coconuts), caused by overuse, a lack of re-planting, cutting down of trees, and slash and burn practices as a means of land clearing;
- Improper waste disposal;
- Limited availability of land for planting of trees;
- An increase in the demand for timber due to an increase in the number of buildings and houses on the islets;
- Banana and frangipani (aka plumeria) dieback was observed in Ubwanteman;
- Rats feeding on and destroying coconut trees; and
- Water quality testing found pollution from human, animal and plant sources.

Sensitivity of natural land-based food resources

From the community perspective, agricultural food production and income generation on Abaiang is vulnerable to the following climatic changes and risks:

- plant growth is stifled by extended drought periods and brackish groundwater;
- fruits are more prone to pests due to changes in fruiting seasons;
- decline in copra productivity due to reduced coconut size, numbers and shape (becoming oval shaped);
- loss of productive land due to coastal erosion;
- pigs are smaller and slower growing due to reduced wild plant pig feed as a result of droughts;
- soil fertility appears to be decreasing.

Both men and women in all communities on Abaiang observed in the last three decades an increase in the frequency of droughts, which is consistent with their perception of decreased rainfall. Weather records also show decreasing amounts of rainfall. Communities also report impacts on the productivity and physical structure of fruit plants such as coconut, pandanus and breadfruit. Women from Ribono report that tilapia ponds and taro pits often dry out during these periods, illustrating the local effects of presently occurring droughts.

Scientific studies suggest that:

- outbreaks of invasive species, pests and diseases may intensify with increasing temperatures and changing rainfall;
- death of crops and livestock is likely caused by soil salinisation, which is a result of rising sea level; and
- reduced livestock productivity is due to heat stress, increased susceptibility to diseases, periodical lack of freshwater, and water-borne diseases.

5.1.3.2 Natural marine-based food resources

Abaiang Atoll possesses a wide variety of marine habitats, various coral reef types, and a rich marine biodiversity (Fig. 29). Abaiang has been identified as an atoll of environmental significance in Kiribati. A key biodiversity assessment of globally threatened species prioritised Abaiang as the atoll in the Gilberts group with the greatest potential for protecting two endangered and three vulnerable species in lagoon areas (MELAD 2010). Reefs, lagoons and ocean waters hold a wide variety of fish and invertebrate species, many of which are relied upon as the main source of protein in the diet of Abaiang people (MISA 2008). Fresh fish is consumed almost every day and is the primary source of income and protein for the atoll's villages. The quality of the atoll's fisheries is determined by the health of the surrounding coral reefs and mangroves. The men usually fish from boats while women are more engaged in invertebrate fishing, reef gleaning and processing fish. Gleaning is mostly done on foot but sometimes canoes or sailboats are used to reach particular fishing grounds. Invertebrate fishing is mostly limited to reef habitats and some intertidal and soft benthos areas, while finfish fishing targets the sheltered coastal or outer reef and lagoon area. Finfish species such as bonefish (*te ikarii*), spangled emperor (*te morikoi*) and humpback red snapper (*te ikanibong*) are caught for consumption.

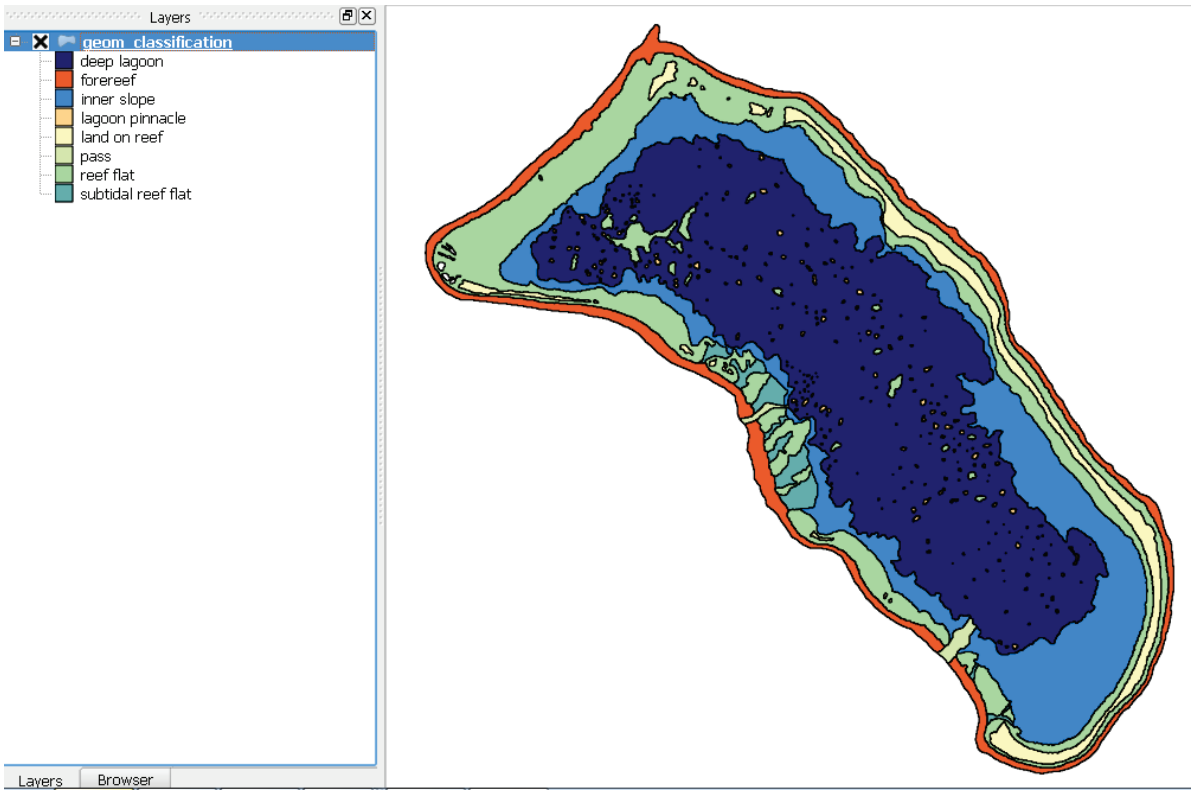

Figure 29: Coral reef types and habitats on Abaiang Atoll.

No underwater surveys were conducted during the IVA, although recent scientific and socioeconomic surveys conducted by SPC identified important coral reef habitats around the atoll (see Fig. 29). The results of the SPC in-water surveys revealed a high abundance of fish and invertebrate species in all reef systems, suggesting relatively rich ecosystems supporting healthy fish stocks. Nevertheless, demographic and development trends pose threats to marine health that will only be enhanced by increased temperatures. The atoll's growing population and, hence, increased fishing effort for food as well as uncontrolled fisheries exports have shown to have damaging effects on fish health (SPC 2008).

During PRAs, Abaiang communities raised concerns about the amount of rubbish washing up on its shore from the capital (Tarawa), which pollutes Abaiang's lagoon and reef areas. Serious outbreaks of crown-of-thorns starfish on most reef areas along with coral bleaching around the island were also identified as threats to coral reefs. Communities on Abaiang are highly dependent on coastal fisheries for subsistence, especially as their main protein source. The PRA revealed that communities also perceive the lack of proper resource management arrangements on the island as a major threat to the sustainability of the fisheries resources.

- Overfishing of bonefish (*te ikarii*) and spangled emperor (*te morikoi*) was reported from some villages;
- Some marine species such as ark shell (*te bun*), seashell, sharks (*te baibureb*ure) and seagrass beds are now hard to find in the lagoon near Koinawa Village;
- The numbers of turtles and common silver-biddy (*te ninimwai*, living in mangrove ecosystems) has decreased;
- Overfishing of brown marbled grouper (*te maneku*), fin-striped goatfish (*te maebo*), and bonefish (*te ikarii*) has been reported;
- To a certain extent, some villages feel that other villages overharvest resources in lagoon areas that are considered to be theirs;
- There is no law recognised at the village level for regulating the exploitation of marine resources;
- Traditional fishing skills and knowledge of marine habitats is becoming lost because of changes in fish behaviour (to which the traditional knowledge does not apply anymore) and changes in lifestyle;
- Ark shell is processed by boiling and salting the shells, and then extracting the meat. The meat is sold in buckets on Tarawa at Australian dollar (AUD) 30/bucket (one bucket holds roughly three rice sacks full of ark shell meat, or roughly 800 animals). Processing is limited to drying, smoking and salting.

Previous household survey results have reported decreasing numbers of giant clams (*te were*), trochus, pearl oyster and the bivalve *Anadara* sp. (ark shell*, te bun*), which is the result of overfishing for commercial purposes and a lack of management of fisheries resources in general (SPC 2008). Other marine species mentioned during the household survey include:

- the elongate clam *Tridacna maxima* and fluted clam *T. squamosa*, which communities report are still in good condition;
- all other giant clam species have become rare;
- sea cucumber diversity is very low; and
- other shellfish (e.g. *Strombus luhuanus*, *te nouo*) is still relatively common.

Sensitivity of coral reefs to climate change and disasters

Coral reefs are projected to degrade progressively, with anticipated losses of live coral estimated at >25% by 2035 and >50% by 2050 due to increasing sea surface temperatures and ocean acidification (Bell et al. 2011). Coastal and marine ecosystems are vulnerable to the following threats caused by climate change and other hazards (Bell et al. 2011; GoK 2014):

- more frequent coral bleaching due to higher ocean temperatures;
- coral reefs, crustaceans and molluscs are expected to have weaker or damaged skeletons and shells due increased ocean acidity;
- fish and invertebrates will be exposed to pests and diseases due to higher sea surface temperatures;
- uncertainties surrounding shellfish population as sea level rise will progressively convert the large areas of intertidal lagoon habitat on Abaiang to subtidal areas;
- sedimentation of reefs as a result of larger intertidal lagoon areas and coastal erosion;
- loss of marine biodiversity and degradation of important habitats such as coral reefs and mangroves (including observed sedimentation and erosion of mangrove forest areas);
- contamination and damage to coastal ecosystems from maritime disasters and oil spills;
- increased amount tidal flat areas due to coastal erosion; and
- discussions with the community revealed that some fish species, such as groupers, bonefish (*te ikarii*), *te bari* and *te tarabuti* have changed behaviour, especially spawning runs and seasons, with some communities already questioning the relevance of their own traditional knowledge and practices.

5.1.4 Natural resource-based commodities for household income

Fisheries resources provide the primary source of income for village communities on Abaiang. Commercial fishing is mainly based on ark shell (*te bun*), giant clams (*te were*), all *Tridacna* clam species (*te komera*), sea cucumber and spider conch (*te ang*) and, to a lesser extent, seaworm (*te ibo*). Approximately 50 seaweed farmers (mainly family-based) are currently operating on the island. Farming is done in lagoon areas, with cultured seaweed hung from floating lines anchored to the bottom (Fig. 30). The seaweed *Kappaphycus alvarezii* is cultured mainly as an export commodity for the production of carrageenan, an extract that is used mostly in the food industry as an additive to various products such as ice cream. The communities confirmed that most invertebrate species are commercially harvested because they fetch a good return in Tarawa.

Figure 30: Seaweed farming in Abaiang Atoll's lagoon.

Copra is commercially produced for income generation. Recently, women have started to produce cocosap sugar, supported by the SPC Pacific Organic and Ethical Trade Community project. Virgin coconut oil, which has a higher value than copra, is now also produced. These local commodities are reliant on the volume, health and production capacity of coconut palms on the atoll. As mentioned earlier, 91% of Abaiang's 1,160 ha of vegetated land (excluding the 29% of total area covered by settlement, bare land and water bodies) is made up of coconut palm trees. About 54% (624 ha) of the coconut cover is regarded as dense or semi-dense. Semi-dense coconut stands of between 50 and 150 palms/ha (an ideal harvest as palms are not too far apart or close to each other) while dense coconut stands are between 150 and 300 trees/ha. However, unlike forest vegetation the smaller and younger palms are important as they are more productive than the taller and older palms (Forstreuter et al. 2013).

Findings on ark shell

- There is a large number of *Anadara holoserica* (referred locally as *te bun*).
- A creel survey showed that 1) independent of packaging sizes (usually large quantities) the unit price of 1 ark shell remains the same and 2) labour costs are not reflected in the price.
- The selling of *te bun* is the main source of cash income.
- There is a lack of data on *te bun* exports to Tarawa.

Sensitivity of natural resource-based local commodities to climate and disasters

The sensitivity of natural resource-based local commodities to climate change and disasters are similar to those raised in Section 5.1.3.2, with additional points as follows:

- reduced efficiency of culturing seaweed, giant clams and sea cucumbers because water temperatures will increase and oceans will acidify progressively;
- reduced efficiency of coastal aquaculture operations due to higher water temperatures and ocean acidification;
- increased incidences of ciguatera fish poisoning, shellfish contamination and algal blooms.

5.2 Infrastructure capacity to support livelihood needs and sensitivity to climate change and disasters

This section seeks to describe Abaing's infrastructural capital in terms of its capacity to support livelihood needs in normal times and in periods of environmental stress. Infrastructural capital that supports adaptive and risk reduction capacity needs to be: sufficiently robust to cope with disaster and climate risks; movable (for relocation or retreat) when necessary; able to have alternative or 'back up' options; relevant to supporting livelihood needs; and open to wide ownership. Infrastructure and technology may be categorised according to those that: support basic services such as housing, water and sanitation; deliver government health, education, justice and other essential services; and enable economic activities, including transport (roads, bridges, airports, ports and jetties), information and communication technology, energy, agriculture, fisheries, forestry and tourism and other sectoral industries.

5.2.1 Housing and public buildings

Since the 2005 census, the number of households on Abaiang has increased from 853 to 926 (Webb and Kench 2010). Most houses (86%) are privately owned while 7% are owned by the government, 5% by the Island Council, and 2 houses are rented from private owners (see Fig. 31).

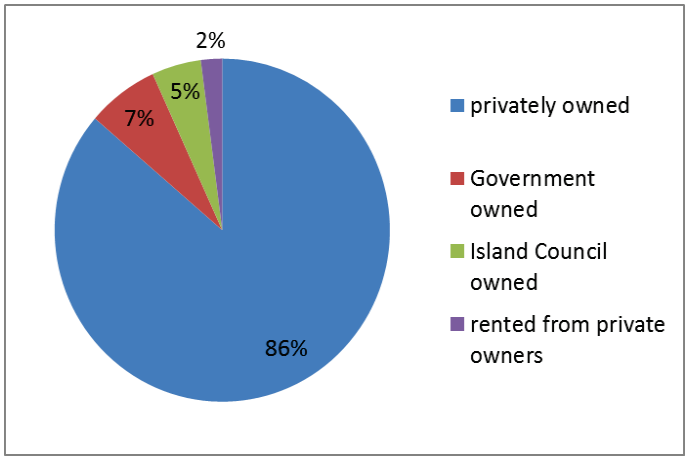

Figure 31: House ownership on Abaiang Atoll.

Source: KNSO 2012

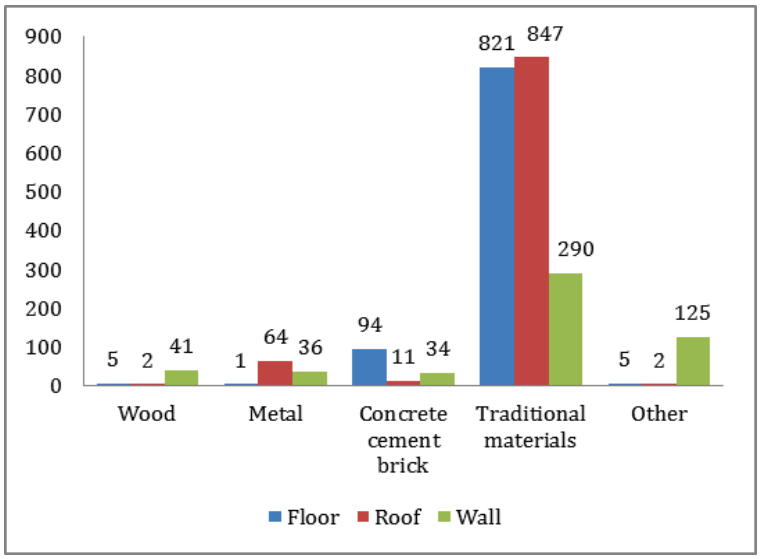

Figure 32: Materials used for floors, roofs and walls of houses on Abaiang Atoll.

Most houses are made from local materials and 847 are covered with thatched roofs. These houses require regular maintenance, thus a few families (64) have opted to use a combination of iron roof slats with local wood as support frames (see Figure 32). Some *maneaba*s and churches and all secondary school buildings have iron slats as roofs. Having iron roofing also enables rainwater harvesting by households. Coconut fronds require maintenance every two years while pandanus thatches can last for more than four years in dry weather (MISA 2008). There are also positive aspects to the wide use of traditional housing in that they are more economical and flexible in terms of retreating or relocating to less environmentally exposed areas when the need arises, such as the case of Tebunginako Village.

Sensitivity of housing and public building structures to climate and disasters risks

Based on data gathered from IVA fieldwork, the following types of housing and public buildings were considered to be sensitive to climate change and disasters:

- seawater inundations due to severe storms or king tides were considered a high risk for half of the households surveyed, especially the two islets of Ribono and Nuotaea, but also the mainland villages of Tebunginako, Taburao, Borotiram and Koinawa;
- seawater inundations (from the ocean side) are also considered a high risk for the primary school of Nuotaea;
- private and public buildings in Taburao, Ribono and Nuotaea may experience damage through severe storms (although this risk is considered lower than for saltwater inundations);
- coastal erosion is a continuous threat on both the lagoon and ocean side of the atoll, particularly for the villages of of Nuotaea, Tebunginako, Ribono, Borotiam, Koinawa, Ewena and Taburao;
- generally, the risk of damage to houses and other infrastructure caused by strong winds is perceived to be lower than from saltwater inundations. However, 32% of interviewed households on Abaiang consider the risk of damage high, 23% as medium and 45% as very small or non-existent;
- households in Taburao (80%), Ribono (67%) and Nuotaea (60%) perceive the risk of damage to buildings and infrastructure from strong winds to be high;
- the risk from a tsunami is perceived to be low;
- the risk of fire is considered to be low and there are no reports about severe fires; and
- a decrease in the productivity of palms, trees and shrubs will negatively impact on the supply of traditional construction materials.

5.2.2 Water and sanitation infrastructure

Access to adequate and climate-proof water and sanitation infrastructure reflects positively on people's capacity to cope with and adapt to the effects of climate change and disasters. For the purpose of this IVA, water infrastructure relates mainly to groundwater abstraction and rainwater harvesting equipment as well as storage and reticulation facilities. Sanitation infrastructure relates to toilet facilities and liquid and solid waste facilities (e.g. septic tanks and incinerators).

5.2.2.1 Water infrastructure

Groundwater is the main source of drinking water for about 71% of the population, with only 25% of people accessing water from protected wells (KNSO 2012), and the remaining obtaining water from unprotected wells. There are a few groundwater reserves on Abaiang such as those in Morikao and Tabwiroa. Only 13% of households on Abaiang having access to a manual pump (KNSO 2012). This means that the 87% that do not have pumps draw water directly from wells with the use of hand buckets, which increases the chances of groundwater contamination.

Figure 33: Ubanteman community well located 200 m away from the residential area.

Test results from protected wells in Ubanteman and Tabwiroa (Fig. 33 and 35), tap water in Morikao (Fig. 34), the *tamana* pump, and the cistern in Taburao detected far lower counts of *E. coli* and coliform. Samples from these sites were from closed protected wells and reserve areas, away from residents and animals.

Figure 34: Morikao groundwater reserve, Abaiang Atoll.

Figure 35: Tabwiroa groundwater reserve, Abaiang Atoll.

A significant number of schools, churches, health centres, *maneaba*s and other buildings with iron roofing are connected to large tanks for harvesting rainwater. Over 90% of houses on Abaiang have thatched roofs (KNSO 2012), which makes rainwater harvesting at the household level problematic. There is also a rainwater cistern in Taburoa. The 2013 IVA assessment team reported that current tank capacity is less than the available rooftop area harvesting potential. The tanks and cisterns were reported to have provided freshwater to villagers during drought periods.

5.2.2.2 Toilets and waste disposal facilities

About 27% (252) of households in Abaiang use flush toilets connected to a septic tank and only about 6 households use pit latrines (KNSO 2012). Most people on Abaiang defecate directly into the environment with the majority doing so on the beach (68% of households), the sea or in the bush (KNSO 2012).

The use of improvised composting toilets (introduced by the Water Engineering Unit of the Ministry of Public Works and Utilities under the Kiribati Water and Sanitation project) is increasingly evident on Abaiang. The example of households following the building guidelines provided, and using their own resources to construct these facilities indicates that the expertise and willingness exists for communities to use their own time and materials to assist in project implementation. It should be noted that the use of human waste in compost is restricted in organic certification. Because Abaiang is going through an organic certification process, education and awareness on the acceptable use of human waste in compost needs to be provided alongside the introduction on composting toilets.

Field observations suggest that water has limited governance and management practices on Abaiang, with a few groundwater reserves areas in the villages of Morikao and Tabwiroa (see photos above). Water quality tests show that water from these areas is in compliance with World Health Organization drinking water standards.

Sensitivity of water and sanitation infrastructure to climate change and disasters include:

- strains to water storage capacity due to droughts;
- contaminants from leaking septic tanks and other pollution sources are more 'mobile' due to sea level rise and high rainfall; and
- storms and high rainfall events can block or damage water intakes, storage facilities or other water-related infrastructure and contaminate water supplies.

5.2.3 Economically enabling infrastructure

Access to adequate and climate-proof transport, communication, energy and industry infrastructure is reflective of access to markets, services and adaptation and risk reduction information and options. Infrastructure that enables the mobility of people and goods for household incomes include: roads, bridges, airports, ports and other transportation-related infrastructure. Communications infrastructure refers to: information and communication technology services that improve access to markets and income. Energy infrastructure includes all energy sources that support local industries as well as health and education services. Industry-specific infrastructures are those that specifically support local commodity production (e.g. tourism infrastructure such as hotels, extension stations, availability of climate-resilient crop varieties).

5.2.3.1 Transport

Transport to and from Abaiang is via boat or airplane from Tarawa. The two most common forms of on-island transport are motorcycles and bicycles (Fig. 36). Island Council trucks are also available to transport students to school and for community functions. There is road that runs the length of the main Island of Abaiang. Most households have access to more than one form of transport because they have a first and second option to move within and to other islands (Fig. 36).

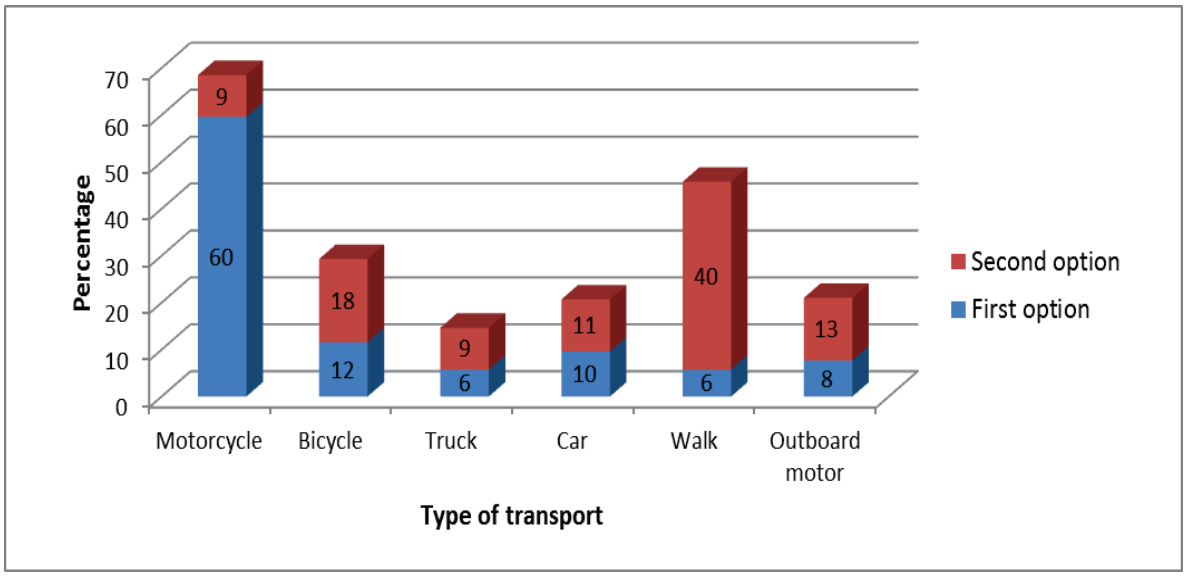

Figure 36: Main form of transport within Abaiang Atoll.

The household survey revealed that men travel on a weekly basis, women on a monthly basis and children travel daily for school (Fig. 37). Movement around the island is closely related to peoples' day-to-day activities, which include fishing, gathering, shopping and attending school (children mainly).

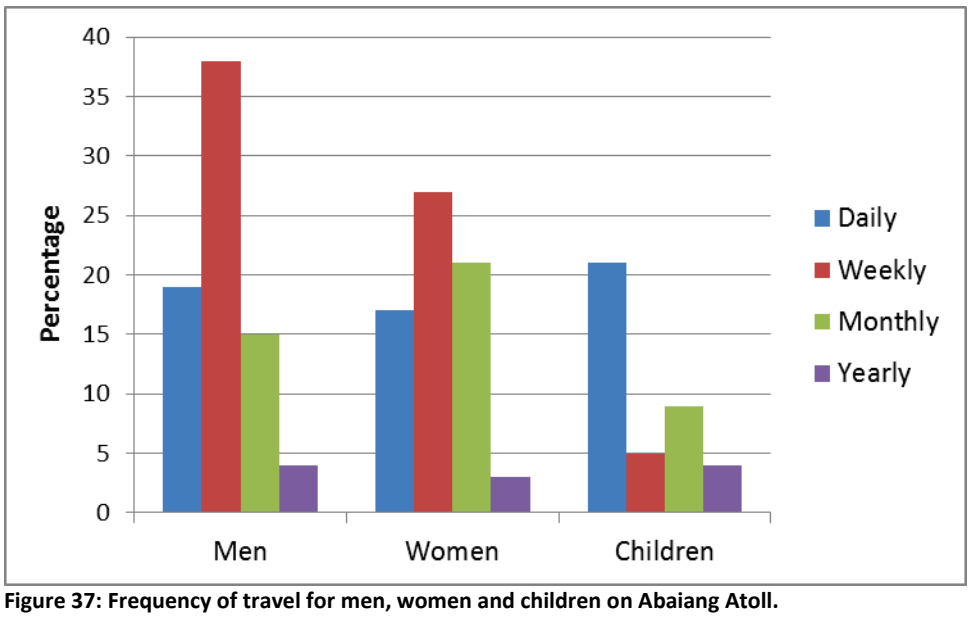

Figure 37: Frequency of travel for men, women and children on Abaiang Atoll.

In contrast, travel between islands is on an annual basis for men, women and children, mainly during school breaks, Christmas and long holidays (Fig. 38).

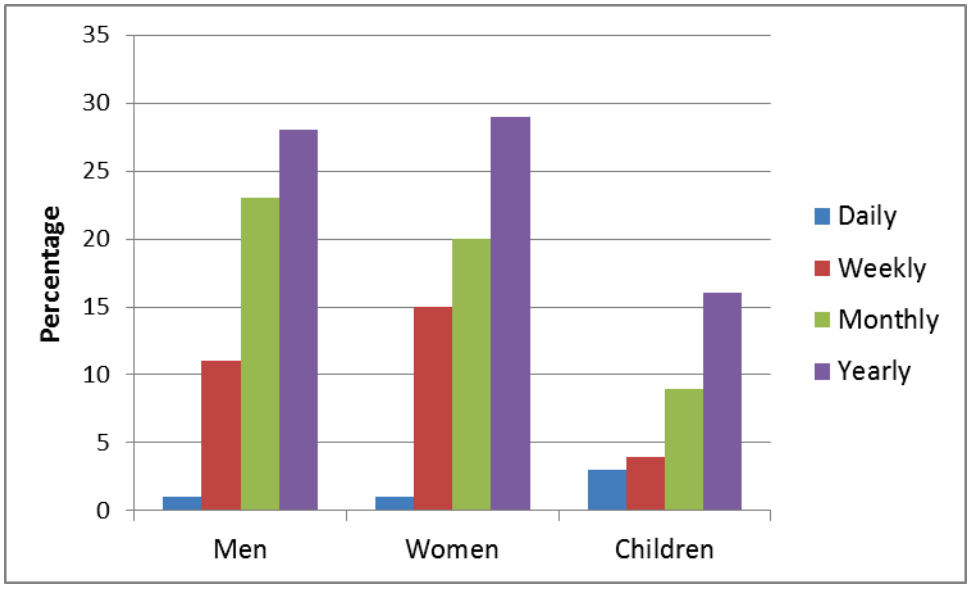

Figure 38: Frequency of inter-island travel for men, women and children on Abaiang Atoll.

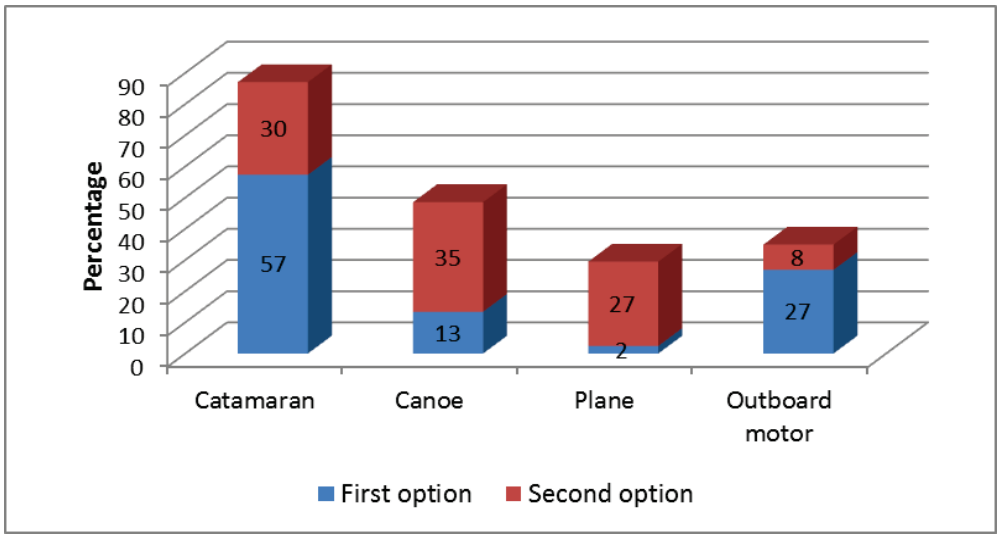

Figure 39: The main forms of transport between Abaiang and other islands.

The two main villages on the islets of Ribono and Nuotaea in the north are usually accessed by boat or canoe, although at low tide, it's possible to access Ribono by foot across a series of uninhabited islets starting from Takarano village. Access to a traditional canoe is far more common than access to a motor boat (KNSO 2012). Passenger ferries also travel from Betio Harbour on Tarawa to Abaiang. Departure times can vary, however, because ferries may not depart until there is a sufficient amount of passengers or cargo on board.

Roads are very dusty during dry spells, but then flooded when heavy rain falls (MISA 2008). With climate change, some of the roads close to the coast have been slowly eroding whiles other roads experience flooding during high tides. On mainland Abaiang, the main road is constructed around the villages close to the lagoon side. It is made of compact sand and stones and is in poor condition. Minor roads, pathways and bicycle tracks can be found leading away from the main road and into the bush or to the ocean side (MISA 2008). The road is unsealed, and thus there is a great deal of wear and tear on motor vehicles.

Air access to Abaiang from Tarawa is regular, with three flights every week provided by Air Kiribati. Flight costs are subsidised by the GoK, and are about AUD 56.00 per person for a return flight. Although Abaiang is in close proximity to Tarawa, cargo supplies are often delayed due to bad weather.

Sensitivity of transport infrastructure to climate change and disaster risks include:

- increased difficulties in travelling within the island due to road damage from heavy rainfall, storms surges, king tides, erosion and inundation.

5.2.3.2 Communication

Communication on Abaiang is possible through mobile phone and radio although word of mouth remains an important common communication form as shown in Figure 40. Recently, communication infrastructure was improved with the construction of a mobile phone tower at Tuarabu Village in 2012 and the opening of an Internet cafe at the Island Council (also Tuarabu Village) in 2014 (the latter supported by United Nations Development Programme/Global Environment Facility). Telecommunication services are provided by Telecom Services of Kiribati Ltd.

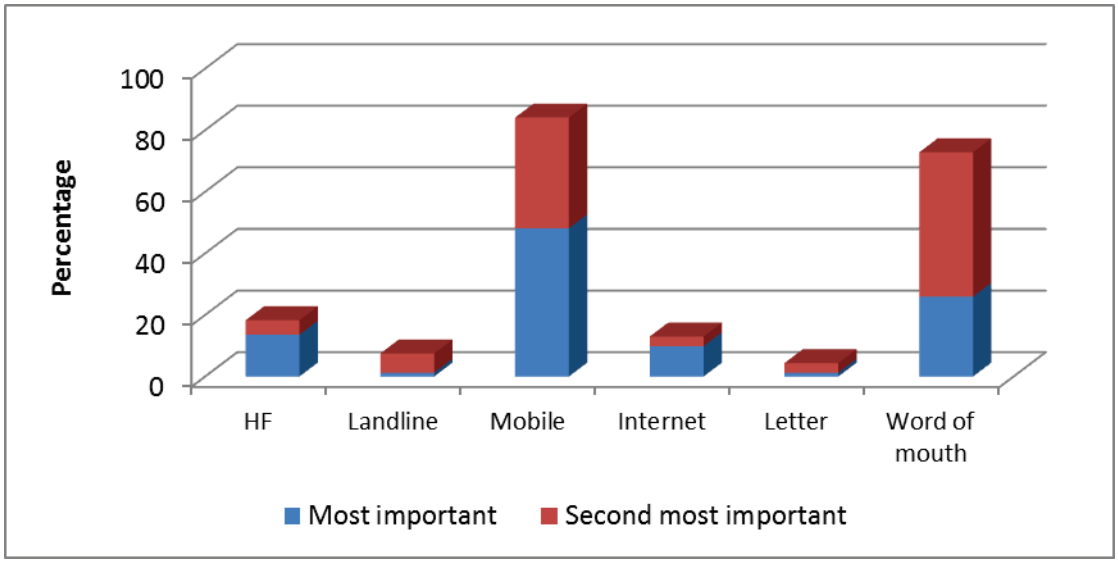

Figure 40: Method of communication on Abaiang Island

The mobile phone tower at Tuarabu Village has allowed easier communication with Tarawa through a 2G network. In the past, only a limited number of landlines and short wave radio sets were available for communicating outside of Abaiang. Mobile phone access has increased significantly in recent years given that the 2010 census data showed that only 14 households out of 924 had access, while the 2013 IVA household survey reported that 48% of a total of 92 interviewed households had a mobile phone.

News is generally received via the national radio broadcast. The 2010 census found that of the 926 households on Abaiang, 307 owned a radio and 52 owned a power-generated DVD player (KNSO 2012). Community members who do not own a radio or DVD player generally listen to or view the radio or DVD of a relative or friend, or do so at the *mwaneaba* where people can watch DVDs or listen to the radio together. Computer use and Internet access has improved with the new Internet cafe at the Island Council, but access requires travelling to Tuarabu. The St. Joseph secondary school also provides Internet for teachers and visitors. Most of the 92 households interviewed have access to more than one form of communication as shown in Figure 40 and mobile phones are the most preferred method of communication.

Overall, communication continues to be a challenge for Abaiang people, especially those 52% of households that do not have access to a mobile phone. Mobile phone connectivity is restricted to villages around Tuarabu where the cell tower is located. There is no mobile phone coverage at the far ends of the atoll in the village of Takarano in the north and Tabontebike in the south. The landline connection at the Island Council office is used for interisland calls, especially to South Tarawa (MISA 2008), and often the connection is bad, either due to poor transmission or a lack of spare parts for maintenance. The assistant police officer at the Island Council's premises has reported that the police lack radios and mobile phones and that the communication with Tarawa is only possible once a day for about one hour by radio, although at the time, the battery was not functioning. While mobile phone and Internet access is improving on the island, the operation and maintenance of infrastructure remains an issue.

Sensitivity of communication infrastructure to climate change and disaster risks includes:

- increasing incidences of telecommunication problems due to coastal erosion, severe storms, sea spray and humidity given that maintenance of communication infrastructure is currently sporadic and
- telecommunication infrastructure damage from coastal erosion and corrosion from sea spray.

5.2.3.3 Energy

Access to reliable energy continues to be a challenge for people on Abaiang, with 478 households (52%) depending on kerosene and 365 (39%) on solar energy as a source of lighting (Fig. 41). The promotion and provision of solar energy in 2000 has provided the people of Abaiang with a renewable source of electricity for light and electrical appliances (MISA 2008).

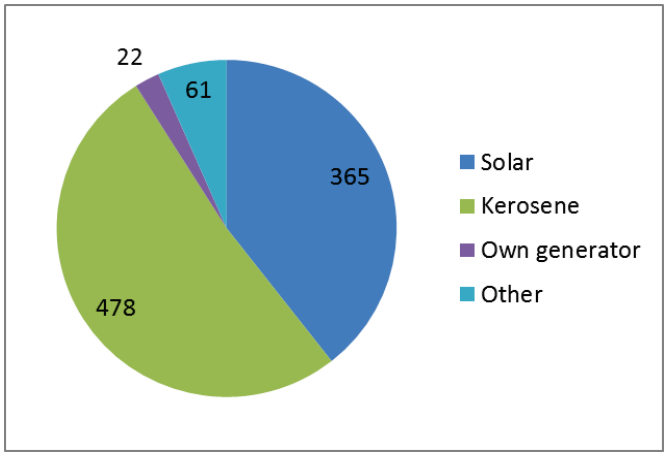

Figure 41: Household source of lighting of 926 households on Abaiang Atoll.

Source: KNSO 2012

Nearly all households still rely on firewood, coconut husks, dry coconut leaves and wood from trees for cooking fuel (Fig. 42).

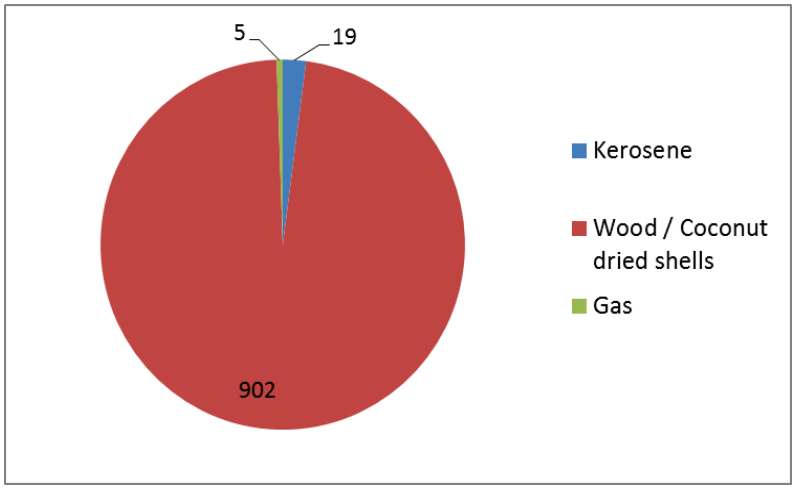

Figure 42: Household sources of cooking energy of 926 households on Abaiang Atoll.

Source: KNSO 2012

There is no power grid on Abaiang, and according to the Ministry of Public Works and Utilities it would also not be economically viable. A small photovoltaic system supplies the mobile phone tower with electricity. As such, most of the houses in all the villages use kerosene for lighting as shown in Figure 41. Because nearly all households rely on wood and coconut husks for cooking, and because communities reported increasing deforestation during the PRA, it can be concluded that forests, palms and other vegetation are not managed sustainably.

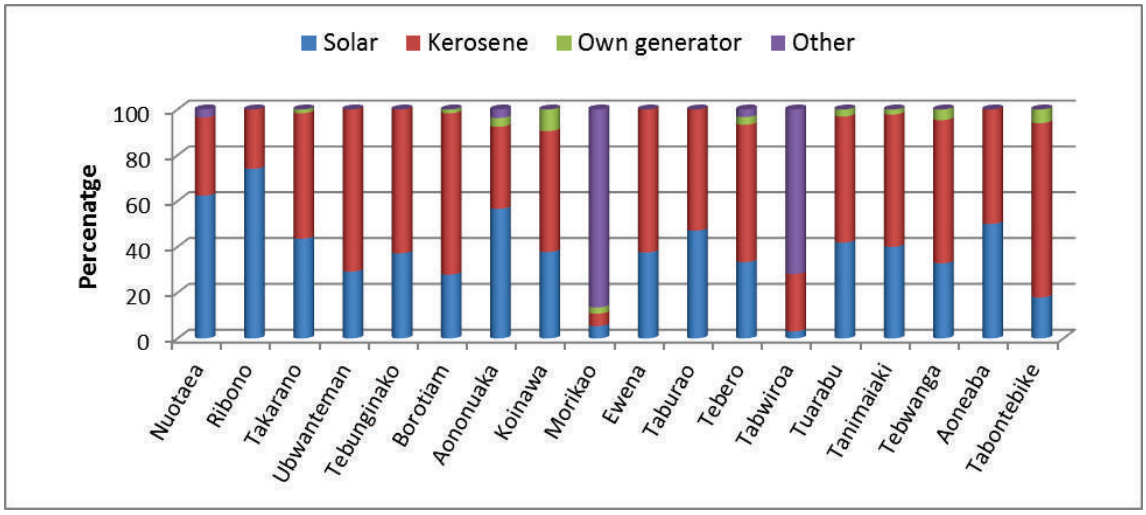

Figure 43: Percentage of households (by village) by source of energy for lighting , Abaiang Atoll.

Source: KNSO 2012

Over the past few years, the number of solar home systems for lighting, telecommunication and water pumps has increased across Abaiang. Today there are around 114 solar home systems, including those in schools such as Stephen Whitmee High School and St. Josephs and in *maneaba*s (according to EPU 2012).

With more than half of all households (52%) depending on kerosene for lighting, health risks increase because acute and chronic exposure to kerosene may result in irritability, restlessness, drowsiness, coma and possibly death (HPA 2006). In Tabontebike (76% of households), Ubwantemam (71%) and Borotiam (70%) the reliance on kerosene is highest, while the islets of Ribono (74%), Nuotaea (62%) and Aononuaka (57%) have a very percentage of solar panels for lightning (Fig. 43). Access to solar panels is not, however, evenly distributed across villages.

Sensitivity of energy infrastructure to climate change and disaster risks

If climate change impacts negatively on the productivity of coconut palms and trees it will, in the long term, reduce the availability of wood and coconut shells for firewood. Because kerosene, benzene and diesel are imported from Tarawa via boat, bad weather conditions can delay transportation and cause shortages in the supply. Solar home systems rely on sunshine hours. Batteries, solar panels and the photovoltaic system are exposed to salt spray and humidity, which can cause corrosion.

5.2.4 Education infrastructure

There are 10 primary schools, 1 junior secondary school and 2 senior secondary schools on Abaiang. The IVA assessment showed that there are no records of damage to school buildings from storms, erosion, fire or heavy rain. However, one primary school in Nuotea was reported to have been affected by inundation during king tides while one secondary school, located on the ocean side of the atoll, is threatened by erosion.

The government junior secondary school has one water tank, no freshwater and no sanitation facilities available. All of its 270 students have to defecate on the beach (school principal, key informant interview 2013). The open water well is used by resident teachers only, who boil the water.

All primary schools have thatched roofs and are made with bamboo. Most primary schools have access to fresh water from open water wells. Some school *maneaba*s have potential for water tanks (such as in Ribono), but a more detailed assessment would be required to gain a complete understanding of the rainwater harvesting and sanitation development potential in primary schools.

Stephen Whitmee Secondary School, St. Joseph Senior Secondary, and the Junior Secondary School (Ueen Abaiang, government) are built with concrete walls and corrugated iron roofs that have further potential for rainwater harvesting. Underneath its church, Stephen Whitmee has a rainwater cistern. Stephen Whitmee and St. Joseph Secondary schools reported that nearby villagers come on a regular basis to ask for fresh water.

Education infrastructure sensitivity

- All primary school buildings are built with local materials and thatched roofs, which are not suitable for rainwater harvesting.
- All primary schools rely on open well water, which is consumed by teachers and students without prior treatment (such as boiling).
- Reduced availability of building materials due to the effects of drought, sea level rise and warmer temperatures.

5.2.5 Health infrastructure

There is a lack of specialised knowledge to conduct health assessments and treat health problems at the national level. Health information and disease surveillance and response systems do not meet international standards. On Abaiang, there are 9 health clinics, each with 1 public health nurse and 14 nurse aides. They are supervised by one medical assistant.

Health clinic buildings are only a few years old, each having rainwater tanks to supply water for medical purposes, as well as a small solar panel. The water tanks are functioning, but at times are disconnected because villagers also require fresh water from the same source. The result is a risk of insufficient fresh water for medical purposes.

For severe diseases that require hospital treatment, patients must be taken to Tarawa because there is no medical doctor or hospital on Abaiang, nor is there an isolation ward for infectious diseases. The public health nurses at times lack transport and proper means of communication to reach and provide the required services for their patients.

Health infrastructure sensitivity

There is a reduction in fresh water availability during times of drought.

5.3 Human capabilities to support livelihood needs and sensitivity to climate change and disasters

The lack of appropriate formal and informal education and poor health is regarded as a key driver of vulnerability to climate change and disaster; therefore, this section aims to describe the skills, knowledge and health of Abaiang's people that enable them to utilise existing resources to meet their daily livelihood needs as well as to plan, implement and monitor resilient development actions. At the same time, the number of 'capable' people relative to accessible resources within a social unit also determines adaptive and risk reduction capacity and, therefore, demography and mobility are critical factors.

5.3.1 Productive population and dependency ratio

According to the 2010 national census, 39% of the population is below the age of 15. As shown in Figure 44, the island's population breakdown by age shows that: 28% are between 15 and 30, 16% are between 30 and 45, 11% are between 45 and 60, and 5% are over 60 (KNSO 2012). Such age distribution resembles that of other outer islands in Kiribati. What is worth noting is that:

- the economically active population is smaller than the dependent population (less than 15 and over 60). This may be a reflection of high birth rates and migration to South Tarawa for employment or education; and
- in the 5–9 and 15–19 age cohorts, the proportion of males is higher than that of girls (in the latter cohort by more than 1 percentage point), while in most other cohorts these are relatively even. The difference in the 15–19 age cohort could be explained by girls achieving higher levels of education at senior secondary schools on South Tarawa and other islands.

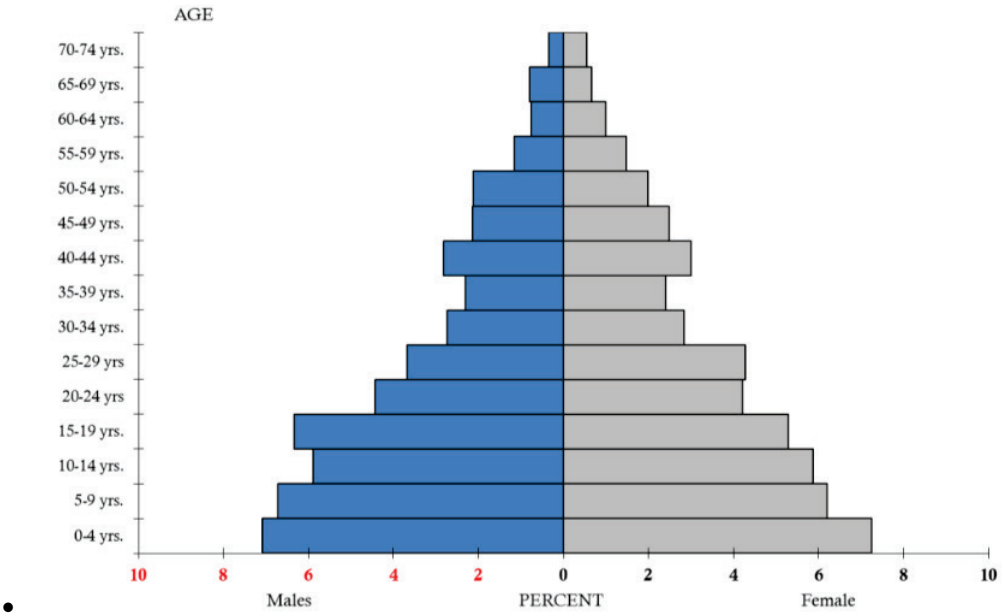

Figure 44: Abaiang's population by age and sex.

Source: OB, 2012

About 72% of the people on Abaiang are part of the labour force. This is higher than the average for the Gilbertese islands, where only 60% of the people are part of the labour force (Figs. 45 and 46). Only 7% of Abaiang's population indicated that they could be in the labour force but did not take on a job, while 21% indicated that they were not in the labour force and could not take on a job.

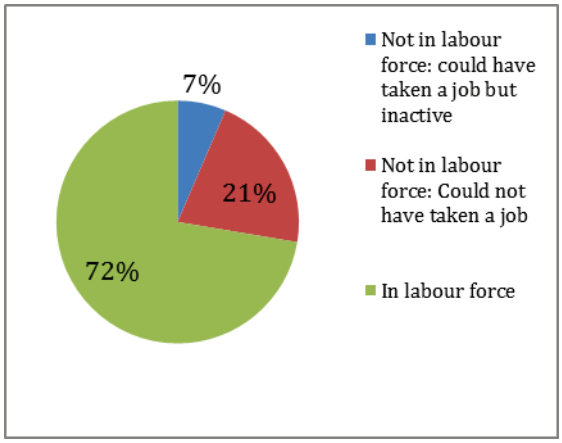

Figure 45: Percentage of population aged 15 and over on Abaiang by labour force status, 2010.

Source: KNSO 2012

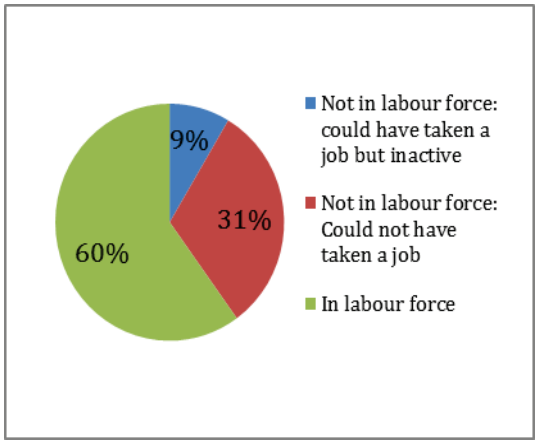

Figure 46: Percentage of population aged 15 and over in the Gilbert Islands by labour force status, 2010.

Source: KNSO 2012

As shown in Figures 47 and 48, 14% of Abaiang's population has access to formal work, which is much less than the Gilbertese population as a whole where 34% are engaged in formal work. On the other hand, a higher proportion of the labour force population on Abaiang (40%) are engaged in unpaid or volunteer work compared with the overall Gilbertese population where only 9% are engage in unpaid or volunteer work. Abaiang is similar to the rest of the Gilbertese population in terms of the proportion of the population engaged in market-oriented work (15% and 16%, respectively) and who are unemployed (22% and 30%, respectively).

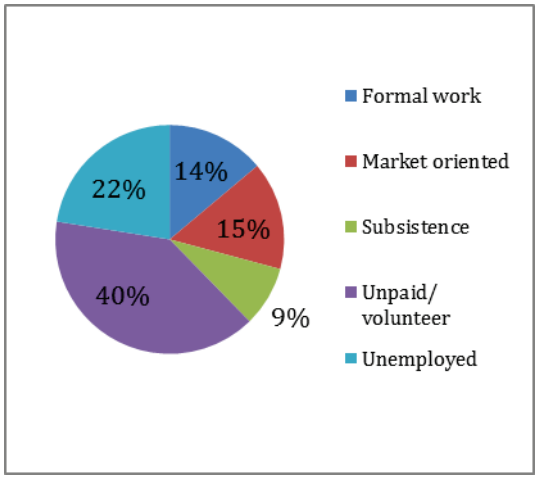

Figure 47: Percentage of the population on Abaiang aged 15 and over by type of labour force, 2010.

Source: KNSO 2012

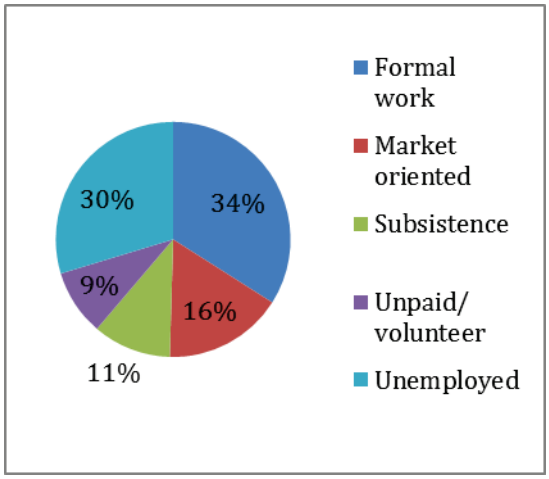

Figure 48: Proportion of the population in the Gilbert Islands aged 15 and over by type of labour force, 2010.

Source: KNSO 2012

Figure 49 shows that the main reason employment is not actively sought is due to domestic work (32%), education (24%), lack of interest in working (17%), age (16%), disabilities (4%), a belief that there is no work available (2%) and other reasons (5%). None of the respondents indicated transportation or weather conditions as a reason.

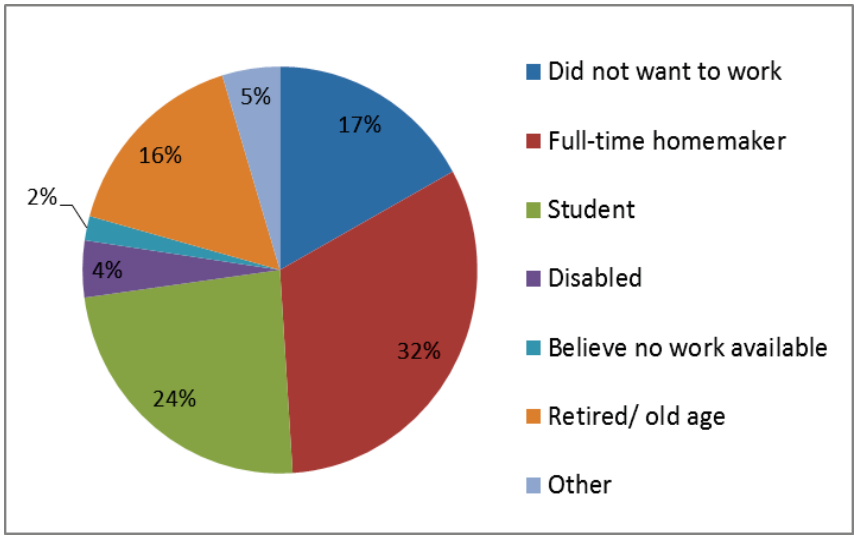

Figure 49: Proportion of the Abaiang population (aged 15 and over) and the reasons for not actively looking for work, 2010.

Source: KNSO 2012

5.3.3 Knowledge and skills (traditional and modern)

Men and women on Abaiang have a broad range of traditional and contemporary skills and competencies suited for living and thriving on the atoll. Observation during the IVA fieldwork and PRA exercises included people engaged in producing handicrafts and preparing medicine. Traditional knowledge of seasons, fish spawning runs and grounds, seafood harvesting methods and gear are still practiced and people still determine what fishing gear and methods to use by reading moon phases and the tides at various times of the year. Other traditional knowledge and practices observed included:

- knowledge of fisheries (techniques, seasons, names of marine organisms). For example, various clams and seashells such as arcshell were identified by women, and bonefish and spangled emperor (te morikoi) by men;
- cultivation of bwaibwai and copra, and toddy production (copra was identified in Tuarabu, Ribono, Koinawa and Takarano villages). Women in Takarano also engage in the production of coconut syrup;
- women use the pandanus tree for weaving and handicraft production, which are important ways to generate income (Tuarabu, Ubwanteman, women in Ribono, Koinawa and Takarano villages);
- house building; and women in Ribono engage in traditional healing practices.

About 85% of Abaiang household members speak English and 81% read and write English (a total of 425 household members, based on the IVA household survey in 2013). This result is, however, questionable because during appraisals and interviews only very few seemed confident to communicate in English. Nearly all (96%) of the 92 household respondents lacked any form of computer literacy. Only 1% knew how to access the Internet (advanced level). Those very few computer-literate household members were found in Ewena, Tabwiroa, Nuotaea and Tebunginako villages.

5.3.3.1 Formal education

This section looks at the level of education of Abaiang's population as a whole and at the village level, and examines the capacities of primary, junior secondary schools and senior secondary schools to determine adaptive capacities from an education perspective. (The safety and appropriateness of school infrastructure is discussed in Section 5.2.1).

On Abaiang there are ten primary schools, one government junior secondary school and two church-based senior high schools (St. Joseph and Stephen Whitmee). Eight primary schools are located on the mainland to accommodate students from twelve villages and two primary schools on the islets of Ribono and Nuotaea (Table 13). The junior secondary school is located between the villages of Koinawa and Aonobuaka, at the ocean side of Wakaam Primary School. Junior secondary school students from the two islets have to stay with relatives on the mainland. The two high schools, St. Josephs in Morikao and Stephen Whitmee in Tabuiroa, accommodate students from all over Kiribati.

Table 13: Primary school enrolment on Abaiang, 2011.

	No. of pupils			No. of teachers			
Name of school	**Females**	**Males**	**Total**	**Females**	**Males**	**Total**	**Villages catered for**
Tanimaiaki Satellite School	21	16	37	1	1	2	Takarano
Tebunginiman	19	7	26	1	1	2	
Taiwan Primary School	57	71	128	2	2	4	
Wakaam Primary School	104	108	212	5	2	7	Aonobuaka, Borootiam and Koinawa
Sunrise Primary School	67	65	132	4	1	5	Taburao, Ewena and Tebero
St. Paul	55	62	117	5	1	6	Tuarabu
Unity of Tateta Primary School	64	50	114	4	1	5	Tanimaiaki, Taneau and Tabontebike
Naibunaki Primary School	26	31	57	1	1	2	Ribono (islet)
Tearintarawa Primary School	51	52	103	2	2	4	Nuotaea (islet)
Ueen Nei Arauri – Satellite School	30	29	59	3	0	3	All on Abaiang. including islets

Source: OB, 2012

As shown in Figure 50, 985 pupils were enrolled in 10 primary schools, 370 in the junior secondary school and 611 in secondary schools on Abaiang in 2011.

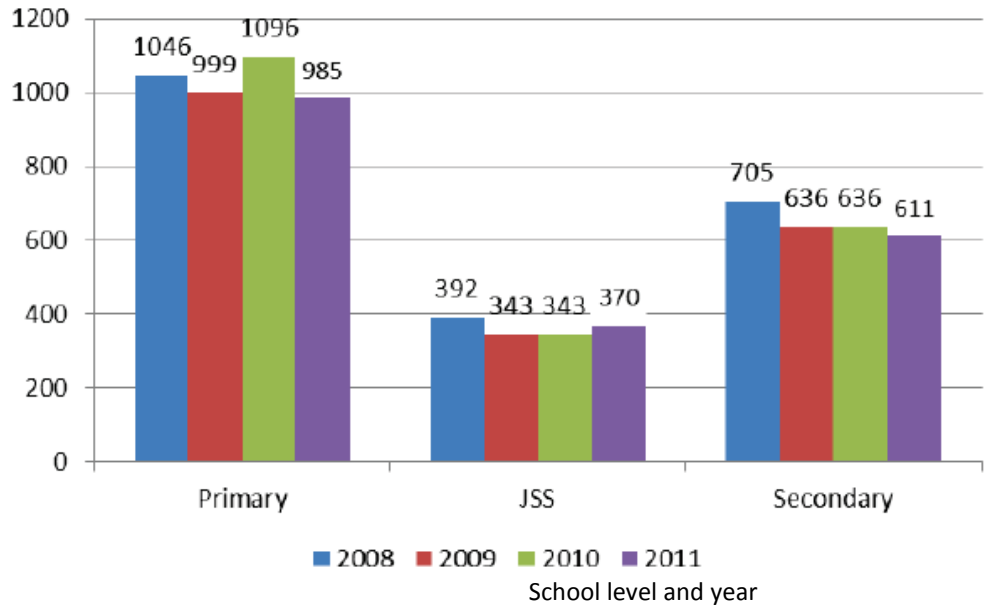

Figure 50: School enrolment on Abaiang, 2008–2011.

Source: OB, 2012

Across Kiribati, universal primary education is achieved although the net enrolment ratio has fallen from 92% to 84% for boys, and 93% to 87% for girls between 2008 and 2010. About 13% of primary school-aged children and 30% of junior secondary aged children did not attend school were out of school in 2009. However, 91% of children remained in primary school up to year 5 (GoK 2012).

The level of education among the school population is relatively low on Abaiang when compared with the national average. As shown in Figures 51 and 52, 19.1% of Abaiang's population had had no school education compared with 10% for all of Kiribati. One-third of Abaiang's population had completed primary school, only one-fifth of the population had completed junior secondary school, and one-fifth had completed senior secondary school, which is less than the national average (Figs. 51 and 52). The proportion of the population with any kind of tertiary degree (e.g. a diploma, bachelor's degree, master's degree or vocational degree) is between 0.1% and 1.4%, which is considered to be extremely low. This pattern is also observed at the national level.

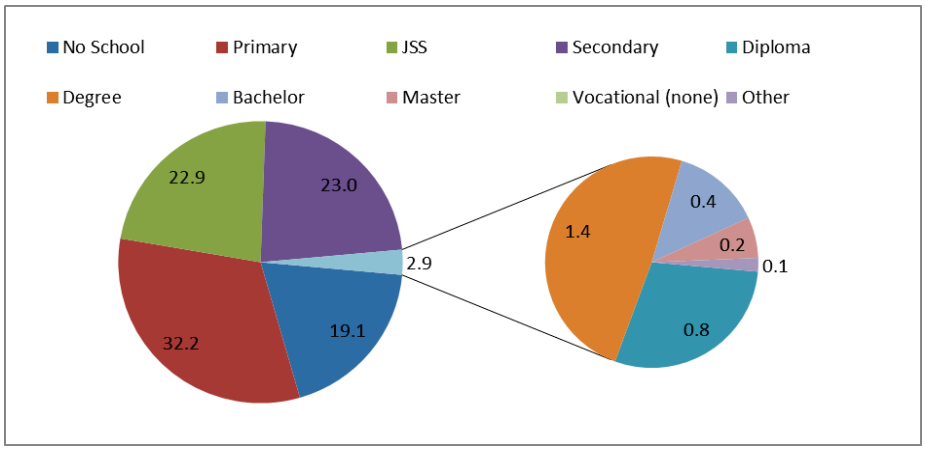

Figure 51: Proportion of the population on Abaiang by highest level of education.

Source: KNSO 2012.

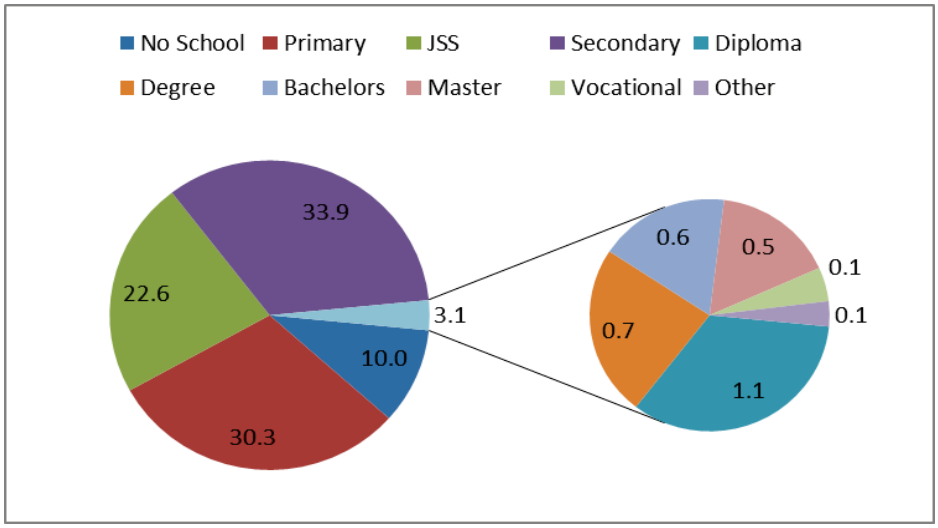

Figure 52: Proportion of the population in Kiribati by highest level of education.

Source: KNSO 2012

There are significant disparities in the levels of education between villages. As shown in Figure 53, almost 40% of the population in Ribono and Tebwanga has no school education. Between 35% and 25% of villagers in Nuotaea, Takarano, Aononuaka, Koinawa, Aoneaba and Tanimaiaki have not been to school at all (between 25% and 35%). In contrast, 69% of Tabwiroa's population has received a senior secondary education; this may be because St. Joseph Secondary School is located in this village. The next highest proportion of the population with a senior secondary education is Taburao at 37%, and this is the village where the mayor and Island Council are located.

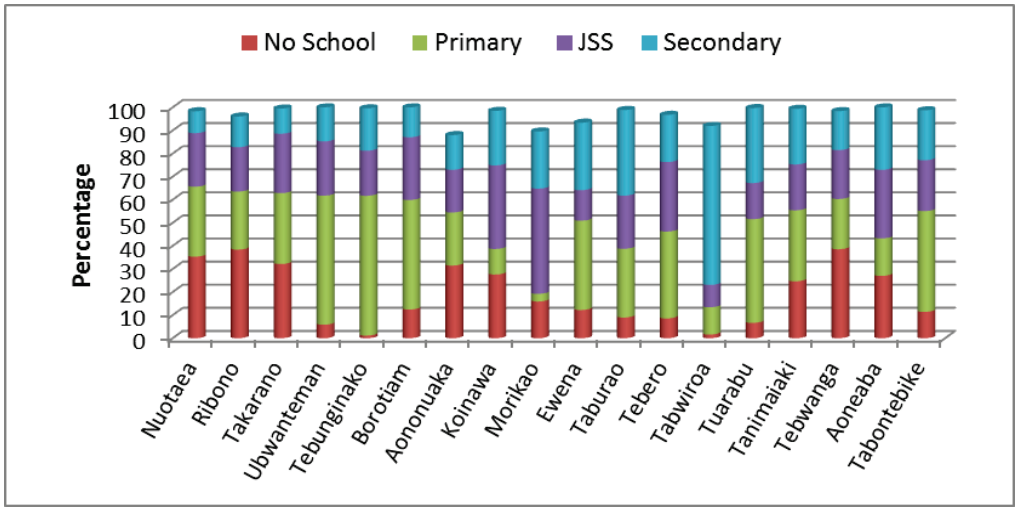

Figure 53: Percent population by highest level of school education and village.

Source: KNSO 2012

5.3.4 Population health

The physical and mental health of a population is a critical factor in determining adaptation capabilities. Sick people are less capable and have less time to commit to addressing livelihood needs as well as responding to climate and disaster risks and impacts. Changes in temperature and rainfall impact on the frequency and intensity of vector-, food- and water-borne diseases. Disasters can leave people with injuries, cause loss of life and, if not managed well, can lead to outbreaks of epidemics.

The most common diseases raised during PRA consultations in September 2013 included: 1) diarrhoea and stomach aches, 2) sore and pink eyes, 3) headaches, and 4) skin diseases. The prevalence of these diseases was confirmed by the local medical assistant during the key informant interview. In addition, the medical assistant and the Ministry of Health and Medical Services (MHMS) reported that skin diseases and diarrhoea were increasing as were non-communicable diseases (NCDs). As shown in Figure 54, official MHMS figures of communicable diseases in 2013 suggest that lung infection (38%) is the most prevalent communicable disease followed by intestinal worms (35%), anaemia (11%), tuberculosis (8%) and other diseases. The high occurrence of intestinal worms indicates that there are difficulties in maintaining the required standards in food hygiene.

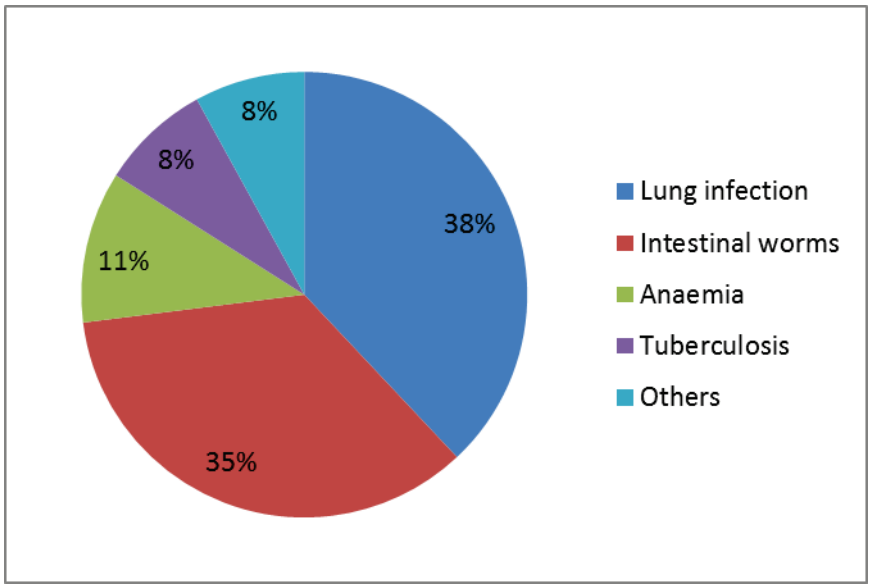

Figure 54: Prevalence of some major diseases on Abaiang Atoll.

Source: MHMS data, no date

Most alarmingly, in Takarano in August 2013, five children under the age of 5 years died from dehydration caused by diarrhoea and vomiting, which local health workers linked to contaminated well water (see also *E. coli* test results for Takarano in Table 11). In general, diarrhoea, headaches, and stomach aches are serious problems among young children. Abaiang had the highest number of diarrhoea cases in the outer islands of Kiribati in 2012 and 2013 as shown in Figure 55.

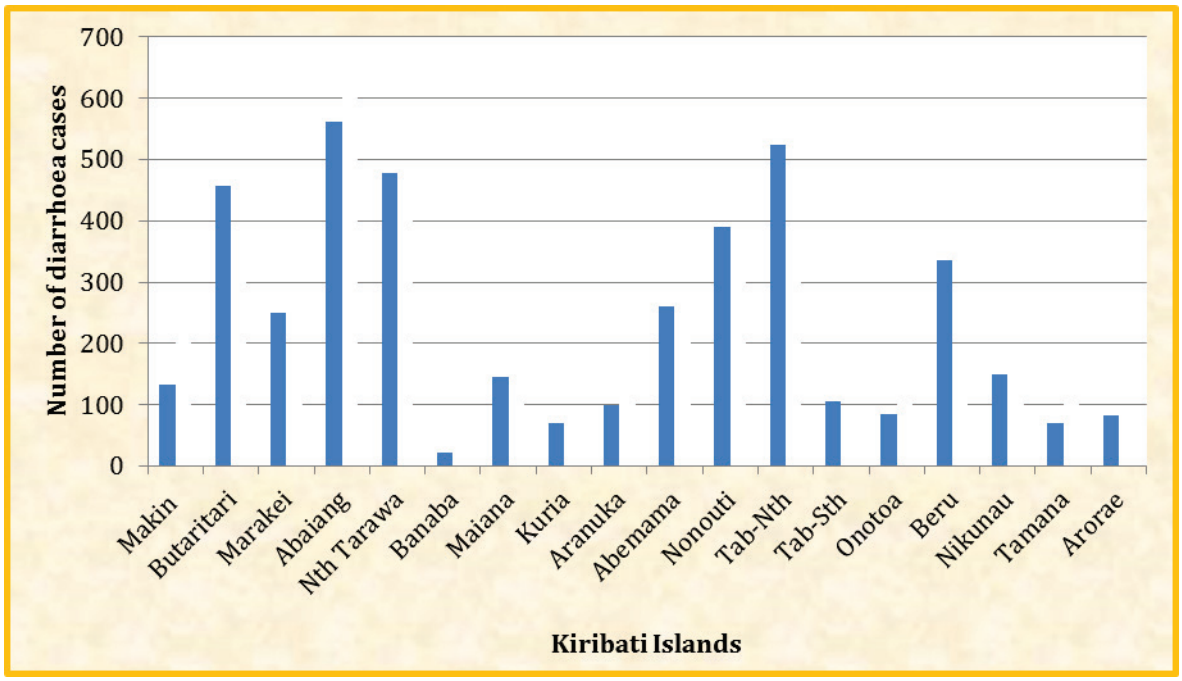

Figure 55: Cases of diarrhoea in Kiribati, 2012–2013.

Source: Tibwe 2013

Changes in lifestyle have led to poorer nutrition and less physical exercise, resulting in higher levels of non-communicable diseases. Figure 56 shows the prevalence of NCD risk factors: smoking tobacco is rated highest at 31% followed by kava drinking at 23%, overweight and obesity at 10%, high blood pressure at 12%, and a low diet of fruit and vegetables at 6%. Given that lung infections are recorded as the most common communicable disease, tobacco smoking is clearly the most significant health issue on Abaiang apart from diarrhoea.

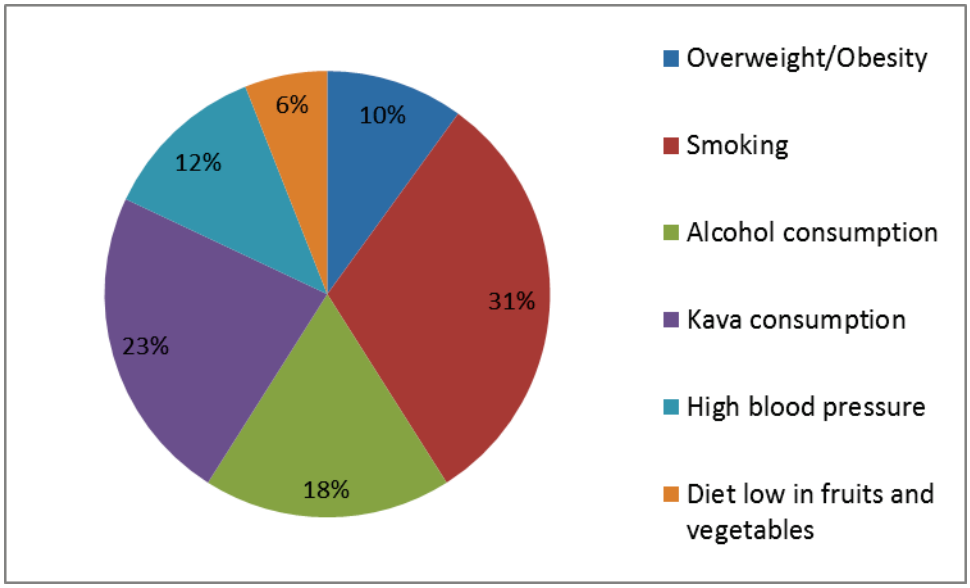

Figure 56: Prevalence of non-communicable disease risk factors on Abaiang.

Sensitivity of people to the effects of climate change and disasters

- Traditional knowledge is becoming lost because it cannot keep pace with the rapid changes in climatic patterns; for example, changes in the spawning season of various marine organisms as a result of changing ocean temperatures, and changes in crop productivity as a result of drought and soil salinity (reported by village representatives of Uwanteman, Koinawa, Takarano and Ribono). Traditional knowledge associated with palms and trees — such as cutting toddy and mat weaving — is at risk of such environmental change;
- School enrolment, attendance and education performance may be affected 1) by reduced access to adequate and healthy water and food when fresh water and crops are affected by sea level fluctuations, changing rainfall patterns, droughts and ocean acidification; and 2) increased need for children to help their families with food production due to increased need of labour. Several primary schools reported absences of students who had to help their families with fishing, gardening or other forms of food production (e.g. Nuotaea);
- There are increasing incidences of NCDs due to a combination of a decline in local land and marine food productivity, and increasing dependence on imported food, which has low nutritional value;
- There have been an increasing number of enteric infections (especially illnesses caused by salmonella, campylobacter and a wide range of enteroviruses) that are caused by rising temperatures (GoK 2014);
- There are also an increasing number of vector-borne diseases such as dengue fever due to warmer and wetter conditions (GoK 2014).

5.4 Financial capacity to support livelihood needs and sensitivity to climate change and disasters

Financial capital refers to money that can be accessed via available stocks (such as cash and bank savings, liquid assets such as livestock and jewellery, insurance and credit availability), regular inflows such as income earnings, pension, state transfers and remittance and income in kind. Financial resources that support adaptive and risk reduction capacity have the following combined features: improved prevention, preparedness and management of risks, microcredit ('smart' risk taking, e.g. to develop business or diversify sources of income), risk transfer (insurance), and risk reserves (savings).

Abaiang's local economy is largely semi-subsistent so cash flow is relatively limited and is channelled towards paying for livelihood needs. As shown in Figure 57, household income is mainly derived from wages (33%), sale of local commodities (26%), remittances (12%), own business (10%), land rent (10%) and seaman remittances (8%). Cash income is mainly from administration services and the sale of local commodities such as handicrafts, fisheries, copra, cocosap sugar, sea cucumbers, giant clams and seaweed.

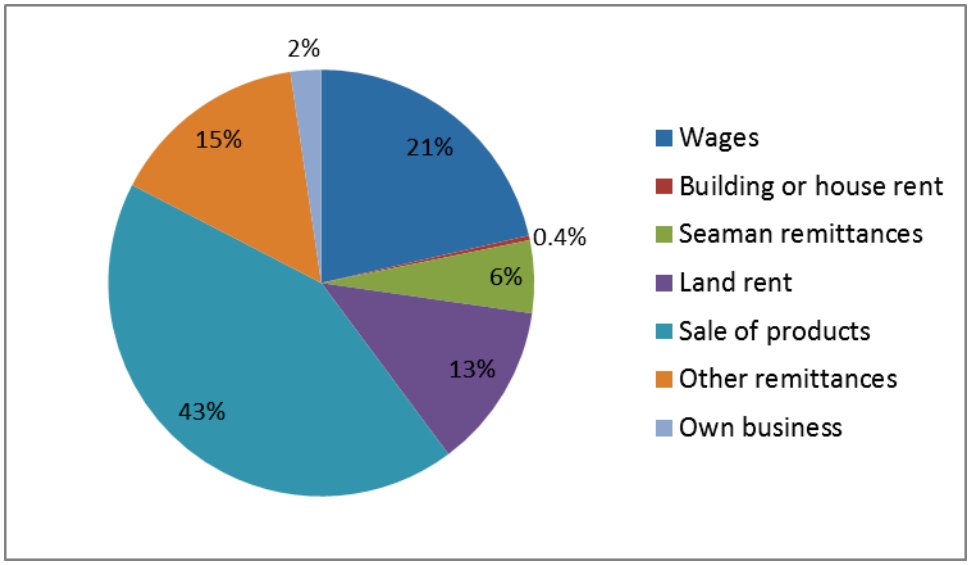

Figure 57: Household sources of income on Abaiang, 2010.

Source: KNSO 2012

Other key features of Abaiang's financial capacity are that there are no banking services on the island, and there are very limited employment opportunities. This lack of access to finance and markets is perhaps what drives the local population to migrate to Tarawa.

Sensitivity of the island atoll to climate change and disasters as a result of limited access to finance

- Reduced income due to a decline in productivity of natural resource-based commodities (e.g. copra, coconut oil and fisheries), which are in turn caused by the effects of sea level rise, increased air and sea temperatures, changing rainfall patterns, drought and ocean acidification

5.5 The institutional adaptive capacity of Abaiang

Sections 5.1 to 5.4 described the capacities and sensitivities (to climate change and disasters) of Abaiang's livelihood assets (natural, infrastructural, financial and human) that local communities have access to in terms of supporting their settlement, housing, water, food and income needs. This section focuses on the capacity of Abaiang's institutions in responding to the effects of climate change and disaster risks.

Institutional adaptive capacity refers to the informal mechanisms (such as values, norms, culture and customs) and formal rules (such as policies, laws and regulations) that shape the way people and groups respond to climate change and disaster risks and impacts, including the way accessible (natural, infrastructural, financial and human) resources are used to adapt. Institutions that are flexible, decentralised, democratic, participatory and based on sustainable development principles are regarded as more resilient. Local communities and leaders — with the appropriate support of national governments and external agencies — create, maintain or re-create such institutions. Thus, leadership, collective action, inclusive decision-making and 'learning-by-doing' are key elements of institutional adaptive capacity. This section assesses the institutional adaptive capacity of Abaing by examining the island's governance structure and networks; how people view the world; how decisions are made; and the ability of local leaders to mobilise the community.

5.5.1 Abaiang governance structure

The current governance of Abaiang is represented by three significant institutions and associations: the Island Council, the *Botaki ni Unimwane* (which is made up of village elders) and the *maneaba* system. The mayor of the Island Council is elected every four years and chairs a monthly council meeting. Furthermore, there is an Island Development Committee whose role is to manage and provide advice on development-related issues on the island and to screen major project proposals. Abaiang has three elected members of Parliament who represent the interests of the island.

The traditional governance system of the *Botaki ni Unimwane* and the *maneaba* government are still very influential. Each village is governed by the *unimawne* (village elder) and the elected councilor. The enforcement of bylaws for each village is carried out by an elected warden, and each village has an official Police Constable that is in charge of law and order.

The central government, through the Ministry of Internal Affairs has the overall management role of island governments. As such, the central government provides support through the provision of office space and employment of a mayor, deputy mayor, island clerk, treasurer and the island project officer (and sometimes a women interest worker) and assistant clerk. The Local Government Act of 1984 governs island decision-making throughout Kiribati.

In pre-colonial times, Abaiang — like the islands of northern and central Kiribati (Butaritari, and Abemama) — was ruled by *uea* (high chiefs). Reportedly, there were spates of war during the 1890s and throughout the 19th century as the *uea* (high chiefs) fought for dominance and precedence. This is distinct from the southern islands, where governance systems were represented by the *unimwane* (village elders) who represent the head of each *kainga* (extended family) and is often the premier decision-making body on the island (Hassall et al. 2011).

The governance systems in place at the island and village level are respected and acknowledged by the communities and central government. In recent decades, there has been a move to decentralise state administration in an effort to engage and empower people at the local or island level, as well as enable island governments to manage and account for their own development.

The Island Council is legally recognised through the Local Government Act, and is represented by a mayor and councillors who are elected by their villages or communities every four years. Administrative operation of the Island Council is led by an island clerk and assistant clerk. A range of line ministries employ extension officers (e.g. water, agriculture, education, and police officers) who report directly to their line ministries on Tarawa. These individuals engage closely with the Island Council through their representation in the Island Development Committee.

The Botaki ni Unimwane and the *maneaba* government also play a powerful role in decision-making on Abaiang. As guardians of Kiribati culture and custom, the *unimwane* (village elders) are represented by the Island Council as they have considerable influence over affairs of the island communities. However, despite being a highly respected traditional authority and given that the *unimwane* are considered the oldest and most experienced member of the community, it is interesting to note that the *unimwane*'s role and function is not enforced and articulated through legislation.

Under the *maneaba* system, various committees and groups are formed to provide advice and guidance to the Island Council. Decision-making by village elders and council members, official ceremonies and village meetings occurs in the *maneaba.*

The Island Development Committee's role is to manage and provide advice on development-related issues and to screen any major project proposals. The committee is chaired by the mayor, and its membership includes government and non-governmental groups, church, women and youth groups. The committee meets irregularly, based on request. Despite having an important role in supporting the implementation of development-related projects and programmes, until of late, the Island Development Committee has been functioning without terms of reference.

To garner support for development initiatives, it is vital to secure the support of key decision-making bodies, the Island Council and the *unimwane*.

At the village level, the *unimwane*, elected island councillors, and church leaders represent the interests of communities and villages on the Island Council and Island Development Committee. Each representative is also responsible for disseminating information and decisions back to the villages they represent. The local village wardens are key to the enforcement of bylaws.

Concerns and issues that involve the village must include the noted representatives. Church leaders play a key role in managing conflicts in the villages and most IVA household survey respondents believed that conflicts within the community were usually resolved adequately as shown in Figure 58.

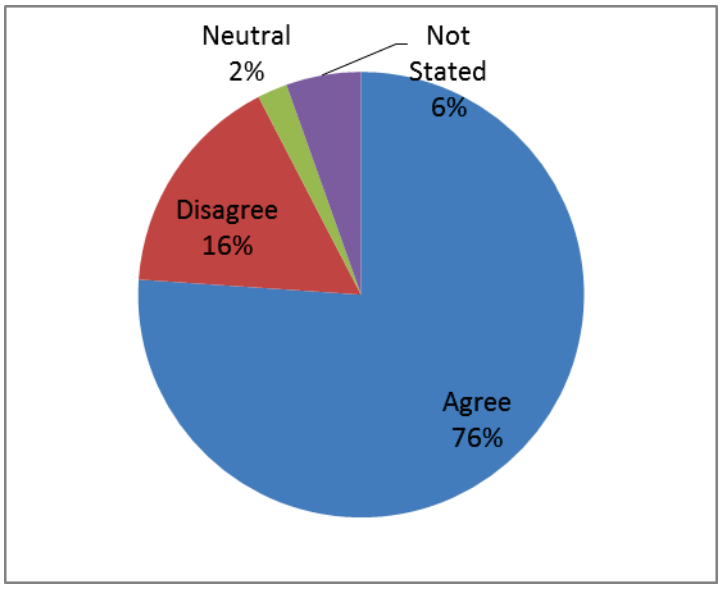

Figure 58: Household survey responses to the statement 'Conflicts within the community are usually resolved adequately'.

Households are generally supportive of current village governance arrangements as reflected in the findings from the IVA household survey results, which show that most households and communities value traditional values of collective action (Figs. 59 and 60). These findings support the notion that community 'buy-in' through community leaders or the *unimwane* is necessary to support initiatives that seek to facilitate resilient development thinking and practice.

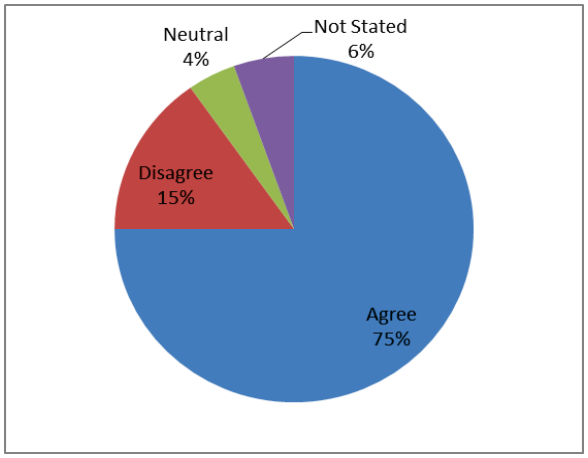

Figure 59: Household survey responses to the statement 'My household adheres to community traditional values of collective action (katein te aba)'.

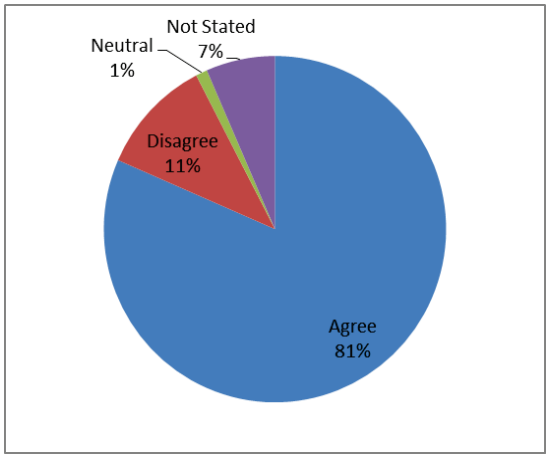

Figure 60: Household survey responses to the statement, 'My community values traditional practices of collective action and cooperation'.

5.5.2 Leadership and collective action

Community leadership and cooperation are key determinants of adaptive capacity as community ownership of resilient development investments is fundamental to ensuring effective and enduring outcomes. The IVA assessment team observed that although there was a high level awareness about climate change as a threat, the local institutional capacity for identifying, planning, implementing and monitoring adaptation measures was minimal. A similar observation was made of the island's general development planning, and the Island Council had yet to develop their strategic development plan at the time of the assessment. However, this general observation contrasts with the outcomes of the household survey, whereby 75% of respondents agreed that the community often plans for the future (Fig. 61).

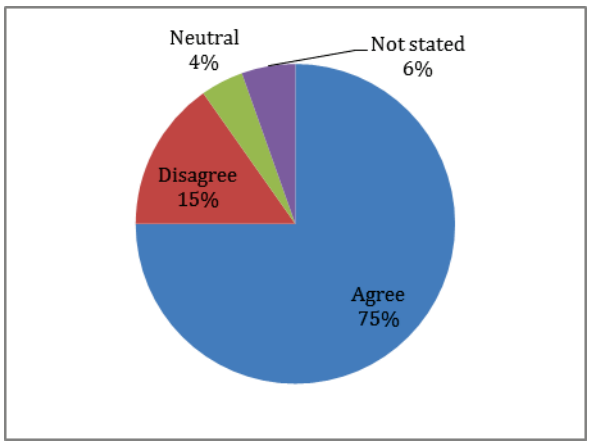

Figure 61: Household survey responses to the statement, 'The community often plans for the future'.

Community members consulted during the IVA household survey shared interesting perceptions about the future with a slight majority (55%) believing that they had no control over the future while most (84%) also believed that taking action now will prevent problems in the future (Figs. 62 and 63).

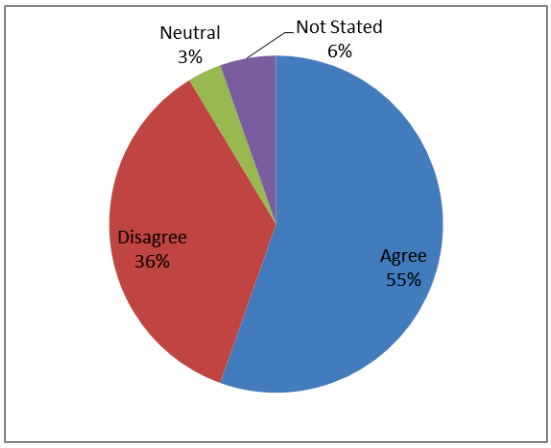

Figure 62: Household survey responses to the statement, 'We have no control over the future'.

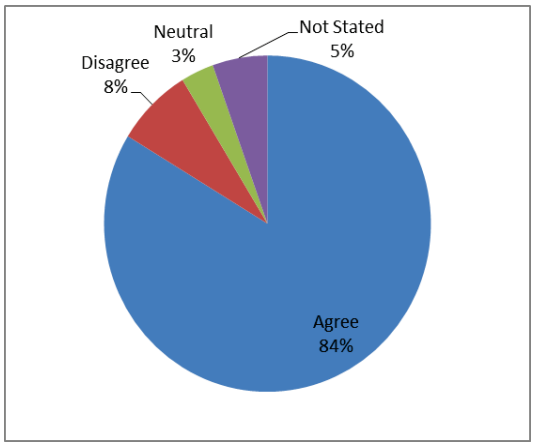

Figure 63: Household survey responses to the statement, 'Taking action now will prevent problems in the future'.

Additionally, while most IVA household respondents agreed that their households and communities adhered to and valued traditional practices (Figs. 59 and 60), they nonetheless responded positively to the view that new ways of solving problems are always accepted by the community (Fig. 64).

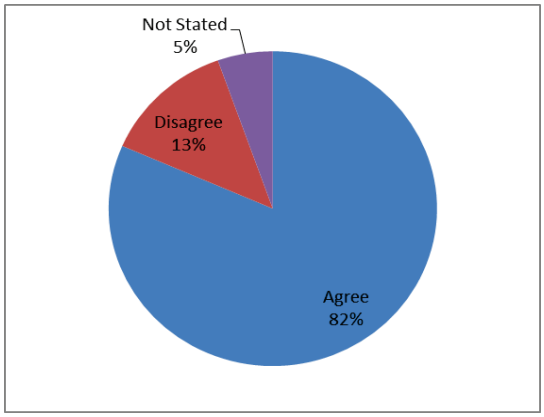

Figure 64: Household survey responses to the statement,
'New ways of solving problems are always accepted by the community'.

5.5.3 Inclusiveness in decision-making

The unique Kiribati culture is evident on Abaiang. Village level governance systems, led by male elders (*unimane*), closely manage community activities through meetings undertaken in the village meeting house (*mwaneaba*). This traditional decision-making process is now complemented by community activities and discussions that are organised through local church groups, and government initiatives that are managed by the Island Council. Limited access to external influences and media means that the traditional way of life continues to be practiced daily. Kiribati language is almost exclusively spoken, and traditional songs and dances are routinely performed. First-time visitors to the island are asked to visit Ribono before undertaking any activities; this is just one of the many traditional customs that are still in place. More than three-quarters of the island's population are Catholic, while most of the remaining population is Protestant (KNSO 2012). There are also a small number of followers of the Mormon, Bahai, Seventh-Day Adventist, Church of God, Assembly of God and Muslim faiths.

Women, youth and people with disabilities have limited access to traditional and modern governance systems of decision-making at the village and island level. While the Island Development Committee has a woman and youth representative it is a technical advisory committee rather than a decision-making body. Decisions are made by the Island Council, which is represented by councilors who are all men. Introducing female councilors or a mayor could also imply a tension of systems and values between traditional and contemporary governance arrangements. Nevertheless, most respondents to the IVA household questionnaire (over 70%) believed that women and youth actively participate in decision-making processes (Fig. 65).

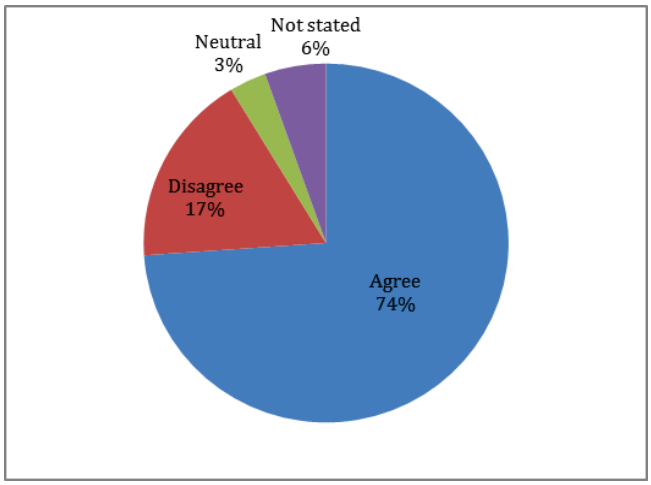

Figure 65: Household survey responses to the statement
'Women and youth participate actively in decision-making processes'.

The impacts of climate change and disaster risks differ between men and women, and an awareness of this is important for any adaptation and resilience building initiatives. Differences in the social and economic status between men and women are often shaped by cultural and societal values on rights, roles and decision-making power. In recognition of the importance of gender equality to the national development, the GoK has developed the 'Eliminating sexual and gender-based violence in Kiribati Policy and National Action Pan 2011–2021', and named 'Socio-protection and gender equity' as one of the two guiding principles of its 'Kiribati Development Plan (KDP)', which states that:

Government is mindful of the needs of different gender groups and levels of development pertaining to the different communities. Government programs and projects will be required to incorporate the development of an enabling environment for sustaining socio protection (gender empowerment with an emphasis on family, children, women's and men's rights (GoK 2012).

The Kiribati Joint Implementation Plan also emphasises that all vulnerable groups, including men and women, children, elderly and people with disabilities, must be supported in their efforts to adapt to a changing climate.

At the presentation and discussion of preliminary findings from the Abaiang IVA assessment and response action planning in November 2013, the women proposed the development of a plan and association for the welfare of women and youth, and their representation in the Island Council and the Island Development Committee. Both the Island Council and the Island Development Committee agreed to this suggestion and this proposal was incorporated into their action plan.

5.5.4 Managing networks

Community leaders and the *unimwane* play a key function in adaptive capacity such as initiating partnerships with external stakeholders (e.g. government and development partners), providing the link between outside partners and communities, disseminating information to communities, and mobilising community support for development-related projects and programmes. Only 12% of the 92 household survey respondents were confident of their local leader's ability to work effectively with other agencies. Most of the community members surveyed (59%) did not respond to the survey statement 'I am confident that local leaders can work well with other agencies', 7% disagreed and 22% were neutral (Fig. 66).

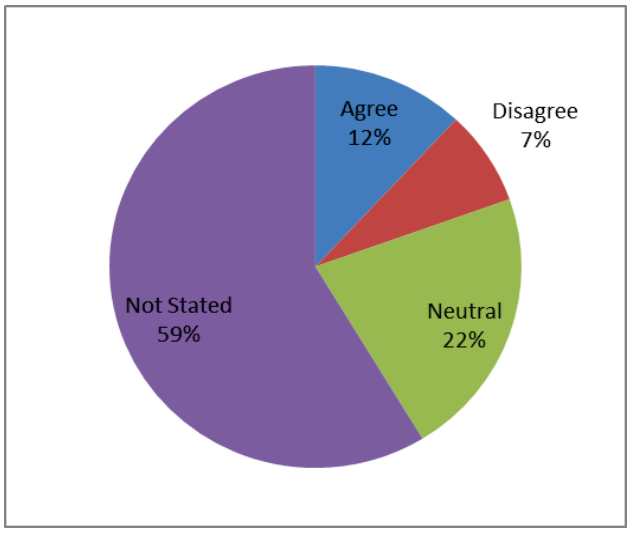

Figure 66: Community responses to the survey statement 'I am confident that local leaders can work well with other agencies'.

Local communities that were consulted during the PRA were asked to name the specific agencies and group that they thought were important to Abaiang, including governmental and non-governmental agencies as well as faith-based and donor organisations (Table 14).

Table 14: Agencies, groups and countries that were considered by communities to be important to Abaiang.

Association/Group/Agency/Country
Ministry of Education — through village schools and village school committees
Ministry of Environment, Lands and Agricultural Development — through the Agricultural Assistant
Ministry of Internal and Social Affairs — through the Social Worker Officer
Ministry of Internal and Social Affairs — through the Island Council
Ministry of Fisheries and Marine Resource Development — through the Fisheries Assistant
Reitan Ainen Kamatu — Kiribati Protestant Church Women's Association
Itoi Ni Gaina (Morning Star) — Roman Catholic Women's Association
Ministry of Public Works and Utilities
Office of the President
Telekom Services Kiribati Limited
Kiribati Protestant Church
Roman Catholic Church
Family groups
Solar energy company
Village elders
Ministry of Health and Medical Service — through village clinics
Kiribati Family Health Association
Village leaders
Men's groups
Village youth groups
Island Copra Organisation
Seventh-Day Adventist Church
Mormon Church
Bahai Church
Village groups
Sport groups (e.g. island football and volleyball teams)
Kava group
Kiribati Water and Sanitation for Outer Islands project
Religious groups
Kiribati Provident Fund
Development Bank of Kiribati
KiriEU
Taiwan
United States Agency for International Development
Japan
SPC/GIZ
Canada

5.5.4.1 Management of livelihood assets

Communities on Abaiang are highly depended on coastal fisheries for subsistence, especially as their main protein source. The PRA revealed that communities perceive the lack of proper resource management arrangements on the island as a major threat to the sustainability of fisheries and other natural resources. During the PRA, local communities were asked to identify institutional weaknesses in terms of maintaining and expanding skills and competencies to sustaining livelihoods and the following issues were raised:

- There is no disaster management or response plan in place. Communication between police constables and between Island Councillors is mostly limited to word of mouth.
- Traditional knowledge is in danger of becoming lost because it is not shared among people (reported by village representatives of Koinawa, Ubwanteman, Ribono and Koinawa).
- The exploitation of natural resources through fishing, handicraft production, building and construction is seen as a threat in Ubwanteman, Tuarabu and Koinawa.
- Men in Koinawa and Takarano believe that a lack of use of traditional skills has led to destructive fishing practices.

- Women in Ubwanteman, Tuarabu and Takarano have observed a decline in the number of pandanus trees, and see overuse of pandanus as one of the causes.
- In Koinawa, both men and women identified a lack of replanting trees.
- Infrastructure (e.g. water tanks and gutters, houses, boats and roads) is not maintained (identified as a weakness by village representatives in Ubwanteman, Tuarabu, Ribono, Koinawa and Takarano). Whether this is due to a lack of skills or a behavioural issue needs further clarification.
- Women in Koinawa mentioned community mismanagement of village bank funds, the use of black magic, and inappropriate consumption of kava and alcohol as threats to a proper functioning community.
- Women in Takarano suggested developing bylaws that apply to everyone in the community.
- Men in Ubwanteman suggested building a proper community meeting area (*manaeba*) to discuss issues.
- Women in Takarano identified a lack of motivation as a hindrance to development.
- Women in Ribono perceived fishing on reefs at night as being unsafe for men.
- The number of traditional healers is reported to be declining because the knowledge is usually only passed on to one trusted family member. If that family member is not available, the knowledge becomes lost.

5.6 Adaptation options

This section lists proposed adaptation options developed by both the IVA assessment team and local communities according to themes. The adaptation options were developed at the IVA results presentation and the participatory response planning workshop between community members, line ministries and partners.

5.6.1 Proposed adaptation options for marine and coastal ecosystems

- Foster the care of coastal fisheries resources and habitats by establishing protected areas and prohibiting fishing or harvesting activities in the lagoon and local habitats of importance.
- Strengthen the management of the island's fisheries resources through developing island bylaws with community support.
- Develop other livelihood and income generating alternatives to reduce pressure on marine and coastal ecosystems.
- Implement mangrove rehabilitation programmes with communities (these are ongoing in some villages already).
- Encourage communities, users and landowners to take ownership of managing and caring for their fisheries resources and the marine environment.
- Develop coastal plans that facilitate mangrove migration with sea level rise.

5.6.2 Proposed adaptation options for natural water resources

- Protect groundwater lenses from human and animal activities that contribute to contamination.
- Promote the use of improvised composting toilets such as that introduced by the Water Engineering Unit of the Ministry of Public Works and Utilities, under the Kiribati Water and Sanitation for Outer Islands project. Several households are already using their own resources to construct these facilities, which indicates that the skills for and interest in such projects exist. However, Abaiang is also going through an organic certification process that prohibits the use of compost from human waste.
- Additional education regarding the benefits of ecosystem-based approaches to resource management needs to be a part of all current and future adaptation programmes on Abaiang, and should be linked closely with the island's plans for organic certification.
    - For example, further community-based discussions are required to address the contamination threats of bwabai agriculture on the groundwater lens. Bwabai pits are most commonly dug in the centre of the atoll where the water lens is thickest. This is the same location that water supply projects often source or protect water. Coordinating projects under a joint approach can allow for bwabai agriculture projects (or other projects that may impact groundwater quality) to be undertaken away from water sector projects and vice versa. Without jointly managed cross-sectoral approaches, even these simple measures can be overlooked. Therefore, for ecosystem- based approaches to effectively help the people of Abaiang adapt to the adverse impacts of climate change, they must be prioritised by those responsible for project coordination and used in principle to guide the integration of projects across multiple sectors.

- The Whole-of-Island approach utilises cross-sectoral mechanisms such as the Kiribati National Expert Group working group, participatory planning processes for communities, and a joint coordination approach among international and regional development partners. It is these forums that allow an ecosystem-based approach to be undertaken through the integration of decision-making processes for cross-sectoral projects taking place in Abaiang's coastal, marine and terrestrial ecosystems.

5.6.3 Proposed adaptation options for land-based food resources

- Improve soil health by mixing soil with green and animal manure (including composting of plants) and using boiled water to improve soil health (soil disinfectant), planting on mounds and mulching.
- Promote appropriate water management practices; for example, through new irrigation methods such as biodiscs, wicking-bed and drip irrigation and increased shading of crops.
- Testing and evaluating adaptable crop varieties and livestock breeds.
- Promote more locally grown food, especially vegetables and fruits.
- Collaborate with the health sector to ensure local food with sufficient vitamins and minerals is grown.
- Collaborate with the fisheries sector to seek opportunities for processing and marketing locally grown produce on Tarawa. In agriculture, there is potential for value-added products such as breadfruit flour, and exporting fresh agricultural produce to Tarawa.
- Collaborate with the water sector to ensure that sufficient and adequate water for irrigation is available; for example, through harvesting rainwater and to reduce the risk of freshwater contamination by inappropriate waste management and other agricultural practices.
- Trial the use of plant-derived pesticides and Bacillus thuringiensis.
- Provide training on animal health as well as plant and livestock disease control,
- Promote giant swamp taro as a food reserve and return to the old practice of positioning the pits outside of the village.

5.6.4 Proposed adaptation options for housing

- A holistic scientific study and analysis of coastal change and erosion on Abaiang in order to identify areas that are eroding, and areas in which the amount of land is increasing due to accretion processes. Such a study would also consider future impacts of sea level rise (as did the SOPAC 2006 study).
- Developing a land-use plan to regulate future land development (including identified areas that are less likely to be affected by coastal erosion and inundations for relocation) and future development and natural coastal rehabilitation measures (e.g. coastal plantations).

5.6.5 Proposed adaptation options for transport

- Through funding by external donors, both Ribono and Nuotaea villages are expecting delivery of their own ferries.
- The Island Council is also seeking funds to rehabilitate the port at Tabontebike village for trade and easy access for fishing boats.

5.6.6 Proposed adaptation options for communications

- With the influx of various projects in Kiribati targeting communication infrastructure (e.g. Information, Communication and Technology - United Nations Development Programme Project, United States Agency for International Development Coastal Community Adaptation Project and others) there is a need to consider maintenance and operation costs for maintaining investments on enhancing communication on outer islands, including Abaiang. Availability of spare parts is also vital as often parts needs to be procured from Tarawa or overseas.
- Separate mobile towers could to be installed at the northern and southern part of Abaiang to cover remaining villages with the 2G network. Alternatively, the expansion of the 3G mobile network, launched on South Tarawa in 2013, could be extended to Abaiang.

5.6.7 Proposed adaptation options for energy

- EPU (2012) estimates that the number of solar home systems will continue to grow, with projects supported by the European Union and Taiwan. It is planned to rehabilitate seven solar systems at health clinics.

5.6.8 Proposed adaptation options for local skills development

Apart from income generating adaptation options already outlined in the context of fisheries, agriculture and income and education, the following adaptation options were identified during the participatory planning meeting in November 2013 that have the potential to increase the share of the active labour force:

- Deliver training on trade skills (carpentry, mechanical engineering, sewing, hospitality, business skills) to youth.
- Provide training in handicraft production and business skills, processing (e.g. virgin coconut oil, fish, pawpaw jams), growing and selling vegetables, and hospitality services for women based on existing skills (see also Section 3.2.4 on organic cocosap sugar).
- Provide assistance to youth to undertake vocational training with the Kiribati Institute of Technology or pursue academic courses at the University of the South Pacific.

5.6.9 Proposed adaptation options for health

During the participatory planning meeting in November 2013, the following adaptation options were identified:

- Produce awareness materials on rare communicable disease;
- Seek financial assistance for the construction of more sanitation facilities for individual households;
- Limit the dependency on imported food and encourage household vegetable gardens;
- Promote physical activity, including construction of sporting facilities and the provision of equipment;
- Provide transport and communication for the public health nurses;
- Seek financial assistance to ensure a steady water supply to health clinics (pipes, solar, pumps or desalination plant);
- Construct an isolation ward on the island; and
- Research the use and practice of traditional medicines.

5.6.10 Proposed adaptation options for traditional knowledge

- Preserve traditional knowledge, cultural values and practices.
- Develop community traditional medicine and healing techniques as an opportunity to enhance sustainability and to increase cash income.

5.6.11 Proposed adaptation options for formal education

- Ensure adequate provision of education materials.
- Provide teacher training on climate change with: a) the new picture-based education resource 'Learning about climate change the Pacific way'; b) extend the Sandwatch network from Tarawa to Abaiang.
- Improve sanitation facilities and programmes in schools.
- Install water tanks near all corrugated iron roofs.
- Promote gardening, composting and a better diet in schools.
- Provide low technology precipitation and temperature measuring devices to science and geography teachers for weather monitoring and education.
- Encourage teachers and students to monitor fish catch and food consumption at home to measure the effectiveness of adaptation measures and link them to syllabus learning outcomes.

5.6.12 Proposed adaptation options for livelihood commodities

All communities, as resource owners and users, should take ownership of managing and caring for their fisheries resources and the marine environment in order to identify and ensure effective implementation of sustainable management actions that generate food and income, and are adaptive to the impacts of climate change. These actions include:

- Foster the care of coastal fisheries resources and habitats. This can be through establishing protected areas that prohibit fishing or harvesting activities in the lagoon and important habitats around the island;

- Strengthen the management of Abaiang's fisheries resources by developing island bylaws with communities (including a regulation on fishing gear and mesh sizes of nets, banning the teororo fishing method; developing awareness programmes; and establishing marine protected areas);
- Strengthen the existing authority to better enforce bylaws (village wardens and Ministry of Fisheries and Marine Resources Development extension officers);
- Diversify fishing methods and operations; for example, through the deployment of nearshore fish aggregating devices and aquaculture development;
- Post-harvest value adding for fish products; for example, by smoking, marinating or brining, and assessing the market values of fisheries products, especially ark shell in Tarawa;
- Develop other livelihood and income generating alternatives to reduce pressure on fisheries resources; for example, the potential for bonefish tourism could be explored;
- Research on the impacts of climate change on coastal fisheries resources; and
- Develop community action plans to control crown-of-thorns starfish on reefs.

5.6.13 Proposed adaptation options for institutions

The existing governing institutions that combine a traditional and modern approach are evidently functional and provide an avenue that will further facilitate efforts to support communities on Abaiang to cope with climate change and disasters. Also, the church could play a key role given that nearly 73% of households agree that the church is instrumental in supporting community livelihoods needs. Additionally, the presence of an Island Development Committee could provide an additional link for engagement between line ministries and communities to facilitate initiatives and programmes that could also strengthen communities' resilience against climate variability, climate change and disasters.

However, there is scope to strengthen existing institutions to reduce the vulnerability of communities and village to climate variability and climate change and disasters. Such measures include, but are not limited to: committing resources (financial, human and technical) to strengthen existing institutions; building the capacity of communities and villages, the Island Council and Island Development Committee through relevant trainings; developing and documenting the terms of reference for the Island Development Committee and implementing projects and programmes that address the island's development priorities over the short, medium and long term.

Furthermore, marginalised groups such as women, youth and people living with disabilities are often the most vulnerable to climate change and disasters, and therefore must be involved in decision-making processes, particularly when it concerns their livelihoods.

5.7 Summary of the livelihood assets capacity of Abaiang, sensitivities to climate change and disasters, and proposed adaptation options

Table 15: Summary of livelihood assets, their capacity and sensitivity to climate change and disasters, and proposed adaptation options.

Livelihood assets	Current capacity and status	Local activities that influence risk	Climate and disaster sensitivity	Proposed adaptation options
Settlement, housing and locally sourced energy (firewood)	• Erosion and accretion occurring in various parts of the island with high coastal erosion risk perceptions identified in Ribono, Taburao, Nuotea and Tebunginako villages • Limited mangrove cover and growth	• Village location and expansion occurring towards vulnerable coastal unstable lands • Road construction is limiting landward migration of mangrove growth • Harvesting of natural sources of firewood and housebuilding	• Loss of village and household dwelling area from erosion due to sea level rise • Reduced mangrove growth due to sea level rise outpacing sediment surface elevations and limiting landward migration of mangrove growth	• Mangrove planting and coastal revegetation • Assess and identify appropriate areas most suited for settlement expansion, retreat or relocation. • Foster the care of coastal fisheries resources and habitats. This can be through establishing protected areas prohibiting fishing or harvesting activities in the lagoon and important habitats around the island. • Strengthen management of the island's fisheries resources by developing island bylaws with community support. • Develop other livelihood and income generating alternatives to reduce pressure on marine and coastal ecosystems. • Implement mangrove rehabilitation programmes with communities (these are ongoing in some villages already). • Encourage communities, users and landowners to take ownership of managing and caring for their fisheries resources and the marine environment. • Education and promotion of ecosystem-based approaches (EbA).

Livelihood assets	Current capacity and status	Local activities that influence risk	Climate and disaster sensitivity	Proposed adaptation options
Water	• Relatively good average annual rainfall although it varies significantly from year to year. • Groundwater estimated to have the volume capacity to support 27,660 people. • Poor groundwater quality in Takarano, Tebero, Tanimaiaki, Borotiam and Tabontebike villages.	• Over-pumping of water due to increasing and competing water demands (humans, crops and animals), which contributes to high salinity levels. • Current toilet practices in the open environment contaminate the freshwater lens. • Uncontrolled (unfenced) animals and livestock.	• Contamination of aquifers and wells from storm surge, debris and salt spray. • Salt-water intrusion due to sea level rise. • Water sources may be affected by changes in rainfall patterns and frequency; infiltration rates can be affected by temperature changes that influence soil moisture and plant water uptake. • Lack of water for recharge into freshwater lens is due to evapotranspiration.	• Establish and protect a groundwater reserve • Identify and control groundwater contamination sources ➢ promote the use of improved dry/composting toilet systems ➢ identify appropriate areas to cultivate bwaibwai and other similar crops that risk polluting groundwater source ➢ promoted Improves well-water bucket handing ➢ control or fence livestock away from water sources • Promote EbA approach at both WoI and village level

Livelihood assets	Current capacity and status	Local activities that influence risk	Climate and disaster sensitivity	Proposed adaptation options
Food	**Land-based** • Coconuts, breadfruit and pandanus are available for food. • Poor soil conditions. • Limited water availability for crops. • Narrow genetic base of food plants. • Limited and decreasing access to fruits and vegetables. • Food plants are highly susceptible to pests and diseases. • Limited choice for livestock production.	**Land-based** • Decline in localised pandanus, mangroves and coconuts caused by land clearing, overuse of plant materials and lack of re-planting. • Improper waste disposal. • Increase in the demand for timber due to an increase in the number of buildings/houses on the islets. • Banana and frangipani dieback was observed in Ubwanteman. • Rats are feeding on, and eventually destroying, coconut trees.	**Land-based** • Plant growth stifled by extended drought periods and brackish groundwater. • Unhealthy fruits prone to pests due to changes in fruiting seasons. • Decline in copra productivity due to reduced coconut size, numbers and shape (becoming oval shaped). • Loss of productive land due to coastal erosion. • Reduced soil fertility due to droughts. • Outbreaks of invasive species, pests and diseases may intensify with increasing temperatures and changing rainfall patterns. • Death of crops and livestock is likely with increasing soil salinisation as a result of sea level rise. • Reduced livestock productivity due to heat stress, increased susceptibility to diseases, periodic lack of freshwater, and increase in water-borne diseases.	**Land-based** • Improve soil health by mixing soil with green and animal manure (including composting of plants) and using boiled water to improve soil health (soil disinfectant), planting on mounds and mulching. • Promote new irrigation methods such as biodiscs, wicking-bed and drip irrigation and increased shading of crops. • Testing and evaluating adaptable crop varieties and livestock breeds. • Promote more locally grown food, especially vegetables and fruits. • Collaborate with the health sector to ensure local food that contains sufficient vitamins and minerals is grown. • In the agriculture sector, there is the potential for value-added products such as producing breadfruit flour and exporting fresh agricultural produce to Tarawa. • Collaborate with the water sector to ensure there is sufficient and adequate water for irrigation; for example, by harvesting rainwater and reducing the risk of freshwater contamination from inappropriate waste management and other agricultural practices. • Trial plant-derived pesticides and use *Bacillus thuringiensis.* • Provide training on animal health as well as plant and livestock disease control. • Promote giant swamp taro as a food reserve and return to the old practice of positioning the pits outside of the village.

Livelihood assets	Current capacity and status	Local activities that influence risk	Climate and disaster sensitivity	Proposed adaptation options
	Marine-based • There is a wide variety of marine habitats and rich biodiversity. • 2008 survey revealed a high abundance of fish and invertebrate species. • Some species such as ark shell (*te bun*), seashell, sharks (*te baibureburе*) and seagrass beds are now hard to find in the lagoon of Koinawa Village. • The number of turtles and common silver-biddy fish (*te ninimwai*) living in mangrove eco-systems are decreasing.	**Marine-based** • Overfishing of bonefish (*tekarii*) and spangled emperor is occurring. • Densities of the elongate clam (*Tridacna maxima*) and fluted clam (T. squamosa) are still sound. • All other giant clam species rare.. • There is a very low diversity of sea cucumber species. • Other shellfish (e.g. *Strombus luhuanus, 'te nouo')* are relatively common	**Marine-based** • The loss of live coral is estimated to be >25% by 2035 and >50% by 2050 due to rising sea surface temperatures, higher acidity of the sea, and more frequent coral bleaching due. • Coral reefs, crustaceans and molluscs are expected to have weaker or damaged skeletons and shells due increased ocean acidity. • The risk of fish and invertebrates being exposed to pests and diseases due to higher sea surface temperatures is expected to increase. • There are uncertainties surrounding shellfish populations because sea level rise will progressively convert large areas of intertidal lagoon habitat on Abaiang to subtidal areas. • Sedimentation of reefs will increase as a result of greater intertidal lagoon areas and coastal erosion. • loss of marine biodiversity and degradation of important habitats such as coral reefs and mangroves (including observed sedimentation and erosion of mangrove forest areas)	**Marine-based** • Establish marine protected areas and locally managed marine areas. • Develop marine management bylaws. • Develop alternative income sources to reduce pressure on marine and coastal ecosystems • Implement mangrove rehabilitation programmes with communities. • Encourage communities, users and land owners to take ownership of managing and taking care of their fisheries resources and the marine environment.

Livelihood assets	Current capacity and status	Local activities that influence risk	Climate and disaster sensitivity	Proposed adaptation options
Income	• Commercial resources include ark shell (te bun), giant clams (te were), all tridacna species (clams), te komera, sea cucumber and spider conch (te ang) and, to a lesser extent, seaworm (te ibo). • 50 seaweed farmers (100 tonnes of dried seaweed) • 624 hectares of island covered in coconut palms (used for copra and virgin coconut oil production)	(similar to 'food' resources above).	Generally similar to 'food resources' above but additionally: • reduced efficiency of culturing seaweed, giant clams and sea cucumbers as water temperatures increase and oceans acidify progressively; • reduced efficiency of coastal aquaculture operations due to higher water temperatures and ocean acidification; • increased incidence of ciguatera fish poisoning, shellfish contamination and algal blooms.	• Collaborate with the fisheries sector to seek opportunities for processing and marketing local produce locally and on Tarawa. • Diversify and value-add local commodity production.
Housing and public buildings	• 926 houses are 80–90% partially to fully thatched (flexible for retreat or relocation). • 86% of all houses are privately owned.	• Building houses in vulnerable areas	• Seawater inundations due to severe storms or king tides were considered a high risk for half of the households surveyed, especially those on the islets of Ribono and Nuotaea, but also the mainland villages of Tebunginako, Taburao, Borotiram and Koinawa. • Seawater inundations (from the ocean side) are also considered to be a high risk for the primary school in Nuotaea. • Private and public buildings in Taburao, Ribono and Nuotaea may experience damage through severe storms (although this risk is considered lower than for inundations). • Coastal erosion is a continuous threat on both the lagoon and ocean sides, particularly for the villages of of Nuotaea, Tebunginako, Ribono, Borotiam, Koinawa, Ewena and Taburao.	• A holistic scientific study and analysis of coastal change and erosion is needed for Abaiang in order to identify areas that are eroding and where the land area is increasing through accretion processes. Such a study should also consider future impacts of sea level rise (such as the SOPAC 2006, 'Analysis of coastal change and erosion of Tebunginako Village, Abaiang, Kiribati'). • A landuse plan should be developed to regulate future land development (including identified areas that are less likely to be affected by coastal erosion and inundations for relocation and future development and natural coastal rehabilitation measures such as coastal plantations).

Livelihood assets	Current capacity and status	Local activities that influence risk	Climate and disaster sensitivity	Proposed adaptation options
			• Generally, the risk of damage to houses and other infrastructure caused by strong winds is perceived as lower than sea water inundations. However, 32% of all interviewed households on Abaiang consider the risk of damage to be high, 23% as medium, and 45% as very small or non-existent. • Households in Taburao (80%), Ribono (67%) and Nuotaea (60%) perceive the risk of damage of buildings and infrastructure due to strong winds as high.	
Water and sanitation infrastructure	• 71% households use unprotected wells and 21% use protected wells. • 87% of well-users draw water directly with buckets; 13% have access to pumps. • 68% of households do not use any form of toilet.	• Poor sanitation and handling of well buckets. • Stray and uncontrolled animals. • Over-abstraction (unmanaged well abstraction rates).	• Strains on water storage capacity due to droughts. • Heavy rains and high winds (La Niña) block and damage water intakes, storage facilities and strain water-related infrastructure. • Contaminants from leaking septic tanks and other pollution sources are more 'mobile' due to sea level rise and high rainfall. • Storms and high rainfall events can damage infrastructure and contaminate water supplies.	• Improve water quality monitoring. • Protect wells with tamana pumps and improve waste management practices. • Increase water storage catchment capacity of communities, schools and churches by constructing water tanks and cisterns, and renovating school building to maximise catchment areas. • Institute a water, sanitation and hygiene communication awareness campaign. • Develop a drought management plan. • Improve access to appropriate and risk reducing sanitation. • Extend water reserve areas to maintain a reasonable standard of water for consumption.

Livelihood assets	Current capacity and status	Local activities that influence risk	Climate and disaster sensitivity	Proposed adaptation options
Economically enabling infrastructure	**Transport** • There is a road around the island close to the lagoon side. • There is weekly boat and air travel to Tarawa. • Motorcycles are the main first option for internal travel. • Most households have more than one transportation option for travelling internally.	• Roads are in poor condition because of the lack of maintenance	• Road damage due to storm surge and king tides	• Rehabilitate the port at Tabontebike Village to improve access to trade and fishing boats. • Improve transportation access for Ribono and Noutaea villages.
	Communication • Word of mouth is still the most common messaging media. • About one-third of households own a radio. • There is a mobile tower on island and close to half of households own a mobile phone.	• Lack of maintenance increases corrosion	• Increasing incidence of telecommunication problems may occur due to coastal erosion, severe storms and sea spray	• With the influx of various projects targeting communication infrastructure in Kiribati (e.g. ICT-UNDP Project, USAID C-CAP project and others), there is a need to consider maintenance and operation costs for maintaining communication on outer islands, including Abaiang. Availability of spare parts is also a concern because these typically need to be procured from Tarawa or overseas. • Separate mobile towers could to be installed at the northern and southern part of Abaiang to cover remaining villages with the 2G network. Alternatively, the expansion of the 3G mobile network, launched on South Tarawa in 2013, could be extended to Abaiang.
	Energy • Firewood and coconut fibre are the main sources of cooking fuel. • Kerosene is the main source of lighting (52%) followed by solar (39%).		• Sensitivity of coconut palms to climate change may negatively influence the availability of this energy source. • Bad weather increases the difficulty in accessing kerosene.	• EPU (2012) estimates that the number of solar home systems will continue to grow with projects supported by the European Union and Taiwan. There are plans to rehabilitate seven solar systems at health clinics.

Livelihood assets	Current capacity and status	Local activities that influence risk	Climate and disaster sensitivity	Proposed adaptation options
Education infrastructure	• 10 primary schools all have thatched roofs with bamboo structures; most have access to open wells. • One junior secondary school has a water tank, no well and no sanitation facilities. • There are two senior secondary schools.	• Water from wells is not boiled for drinking	• The primary school in Noutea experiences inundations and these may intensify	
Health infrastructure	• There are nine health clinics. • There is 1 public health nurse and 14 nurse aides and all are supervised by 1 medical assistant.	• Clinic has water tanks that are not reliably filled and share a well with the local community.		

Livelihood assets	Current capacity and status	Local activities that influence risk	Climate and disaster sensitivity	Proposed adaptation options
Household income	• Most households are semi-subsistent. • 33% of incomes are from wage earners • 26% of incomes are from the sale of local commodities (e.g. copra, fish). • About 10% of households own their own business. • About 10% of income is from land rent. • 8% of household incomes are from seafarers' remittances.		• Household income are less due to reduced productivity of natural resource-based commodities such as copra, coconut oil and fisheries due to the effects of sea level rise, increased sea and air temperatures, changing rainfall patterns, droughts and ocean acidification.	• Diversify fishing methods and operations; for example, through the deployment of nearshore fish aggregating devices, and through aquaculture development. • Post-harvest value-adding for fish produce; for example, by smoking, marinating or brining, and assessing market values of value-added products, especially arc shell in Tarawa. • Develop other livelihood and income generating alternatives to reduce pressure on fisheries resources; for example, the potential for bonefish tourism could be explored.
Banking and credit	• There is no bank on Abaiang.			
Productive population and dependency ratio	• 39% of Abaiang's population is below the age of 15. • 53% are in the productive age range of 16–60. • 72% of population regard themselves to be in the labour force.		• Traditional knowledge is becoming lost because it cannot keep pace with the rapid changes in climatic patterns; for example, changes in the spawning season of various marine organisms, and changes in crop productivity as a result of changing ocean temperatures, drought and soil salinity (reported by village representatives of Uwanteman, Koinawa, Takarano and Ribono). The knowledge associated with these palms and other trees — such as cutting toddy, handicraft production and mat weaving — is at risk.	• Deliver training on trade skills (carpentry, mechanical engineering, sewing, hospitality, business skills) to youth. • Provide training in handicraft production and business skills, processing (e.g. virgin coconut oil, fish, pawpaw jams), growing and selling vegetables, and hospitality services for women based on existing skills. • Provide assistance to youth to undertake vocational training with the Kiribati Institute of Technology or pursue academic courses at the University of the South Pacific.

Livelihood assets	Current capacity and status	Local activities that influence risk	Climate and disaster sensitivity	Proposed adaptation options
Knowledge and skills	• The net school enrolment rate has fallen from 92% to 84% for boys, and from 93% to 87% for girls between 2008 and 2010. • About 19% of Abaiang has had no school education. • One-third of the population has completed primary school, one-fifth has completed junior secondary school (all less than the national average). • Lung infection is the most prevalent communicable disease and smoking is the most prevalent non-communicable disease. • Other prevalent communicable diseases include: anaemia and tuberculosis.	• Prevalent non-communicable diseases (NCD) and NCD risk factors include smoking (33%), kava drinking (23%), alcohol consumption (18%), overweight and obesity, high blood pressure, diet low in fruits and vegetables	• School enrolment, attendance and education performance may be affected 1) by reduced access to adequate and healthy water and food when fresh water and crops are affected by sea level fluctuations, changing rainfall patterns, droughts and ocean acidification; and 2) increased need for children to help their families with food production due to increased need of labour. Several primary schools have reported absences of a few students who have had to help their families with fishing, gardening or other food production-related activities (e.g. in Nuotaea). • There are increasing incidences of non-communicable diseases due to a combination of a decline in local land and marine food productivity, and an increasing dependence on imported food, which is of low nutritional value. • There is an increase in enteric infections (especially illnesses caused by salmonella, campylobacter and a wide range of enteroviruses) due to rising temperatures. • There is an increase in vector-borne diseases such as dengue fever due to warmer and wetter conditions.	• Ensure the provision of already supplied education materials. • Provide teacher training on climate change with a) the new picture-based education resource, 'Learning about climate change the Pacific way'; and b) extend the Sandwatch Network from Tarawa to Abaiang. • Improve sanitation facilities and programmes. • Install water tanks near all corrugated iron roofs. • Promote gardening, composting and a better diet in schools. • Provide low technology precipitation and temperature measuring devices to science and geography teachers for weather monitoring and education. • Encourage teachers and students to monitor fish catches and food consumption at home to link to measuring effectiveness of adaptation measures and syllabus learning outcomes.
Population health	• Limited and decreasing access to fruits and vegetables			• Produce awareness materials on rare communicable diseases. • Seek financial assistance for the construction of more sanitation facilities at the household level. • Limit the dependency on imported food and encourage household vegetable gardens. • Promote physical activity, and construct a sporting facilities and provide equipment.

Livelihood assets	Current capacity and status	Local activities that influence risk	Climate and disaster sensitivity	Proposed adaptation options
				• Provide transport and communication for the public health nurses. • Seek financial assistance to ensure a steady supply of water to health clinics (pipes, solar, pumps or desalination plant). • Construct an isolation ward. • Research the use and practice of traditional medicines.
Abaiang governance structure	• Island Council (elected), *Botaki ni Unimwane* (village elders) and *maneaba* system. • Traditional governance still influential. • Island Development Committee.			
Decision-making	• Elected Island Council legally recognised but representatives of the *unimwane* are also influential in island decision-making. • *Maneaba* system provides advice and guidance to Island Council. • Island Development Committee advises on development- related activities.			• Develop a plan for women, youth and welfare.association • Encourage the representation of women in the Island Council and Island Development Committee.

Livelihood assets	Current capacity and status	Local activities that influence risk	Climate and disaster sensitivity	Proposed adaptation options
Managing networks	Island Council and *unimwane* manage relationships with external agents. Only 12% of households were confident in their leaders' ability to work effectively with external agents (59% did not respond to this question).			
Leadership and collective action	Development activities are mobilised by *unimwane* and church leaders. 75% of Abaiang communities agree to adhering to community traditional values.			
Management of livelihood assets	Abaing Island Council Strategic Development Plan now in place There is no disaster management response plan Schools are promoting: 1) gardening, 2) composting, 3) water, sanitation and health practices, and 4) coastal revegetation.		• Some villages feel other villages overharvest resources in lagoon areas that are considered to be theirs. • There is no legal recognised law at the village level for regulating the exploitation of marine resources.	

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