KIRIBATI GOVERNMENT

Second Communication under the United Nations Framework Convention on Climate Change

June 2013

Environment and Conservation Division, with assistance of Climate Change Study Team

Ministry of Environment, Lands and Agricultural Development

Preface

"... we must listen, take heed of what is happening in the most vulnerable states in the frontline, like Kiribati and act accordingly, act with urgency... "

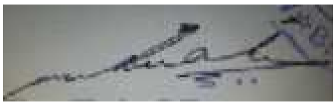
In 1999 through the initial communication report, Kiribati underscored the grave concerns faced by climate change. The Government of Kiribati is thankful for some initial reactions from the international community responding to these concerns with few adaptation projects. These efforts are not adequate in so far!

In this second report the same premises upon which Kiribati underlined the concerns in the initial communication report have not been changed but rather intensified and complex over time as observed in the last 10 years. The status of national circumstances, measures undertaken, including constraints toward meeting our obligation under the UNFCCC are all explicitly detailed in this report. This is also in recognition of the fact that Kiribati, as a Least Developed Country, can do very little to prevent the damages and impacts it is now facing. This also demonstrates our trust in the UNFCCC which is the only multilateral fora responsible for avoiding dangerous climate change impacts and enhances environmental integrity.

The Government and people of Kiribati have been and will continue to be mentally, physically worried and apprehensive by risks brought in by climate change, extreme events, slow onset events and sea level rise in the near and longer term future.

On that note, I would like to express my sincere appreciation to those who have contributed to this significant Second communication report by Kiribati to the UNFCCC, and to invite development partners particularly Developed Country Parties to consider the real issues highlighted in this report with optimism for their immediate support in the less distant future.

Tekeraoi!



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Minister of Environment, Lands and Agricultural Development.

Date: 27th June 2013

Acknowledgement

The successful completion of this report has been made possible through consistent participation and contributions of members of the National Climate Change Study Team from the early inception of this Second National Communication project in 2008 toward the end. The details of the team members can be viewed in the Annex of this report.

The content of the report owed credits to outcomes of several nationally and internationally driven projects and programs that have occurred from 2000. The undertakings produced some of the most up to date data and information that were employed to inform this report as well as practical measures to responding to climate change.

It would be a remiss not to mention consultancy based firms and organisations that have been contracted to fill in the information and capacity gaps relevant to specific components of the SNC report. This includes Pitt&Sherry from Australia for substantive work on Greenhouse Gas Inventory Calculation and Clim-systems from New Zealand for the substantial provision of, and training on, the vulnerability assessment tool.

The technical comments were received from National Communication Support Programme (NCSP) – UNDP, Climate Change Division of the Secretariat for Pacific Regional Environment Program (SPREP), Secretariat for Pacific Community (SPC), Pacific Australia Climate Change Science & Adaptation Planning Program (PACCSAP) and National Institute for Water and Atmospheric Research (NIWA). These comments have been extremely useful toward shaping the final structure of the report.

Last but not least, is to acknowledge other local consultants like Ben Namakin, local stakeholders, functional government's committees such as National Adaptation Steering Committee, Secretaries' level meeting; and finally Cabinet for appreciation and approval of this Kiribati's national communication report to the United National Convention of Climate Change herein.

Acronyms

ADB	Asian Development Bank
BNPL	Basic Need Poverty Line
COP	Conference of the Parties
CCU	Climate Change Unit
CCST	Climate Change Study Team
CRP	Climate Risk Profile
CSIRO	Australian Commonwealth Scientific and Industrial Research Organisation
CGCCM	Canada Global Climate Change Model
CCDMS	Climate Change Database Management System
CDM	Clean Development Mechanism
DSI	Drought Severity Index
DCC	Development Coordinating Committee
EbA	Ecosystem-Based Adaptation
ECD	Environment and Conservation Division
EDB	Equatorial Doldrums' Belt
ENSO	El Nino and Southern Oscillation Oscillation
EPU	Energy Planning Unit
FPL	Food Poverty Line
FAR	Fourth Assessment Report of the IPCC
FAO	Food and Agricultural Organisation
EIA	Environment Impact Assessment
GHG	Green House Gas
GDP	Global Domestic Product
GCM	Global Circulation Models
GEF	Global Environment Facility
GFOL	Goddard Fluid Dynamics Laboratory
HFC	Hydro-fluoro Carbons
IPCC	Inter-governmental Panel on Climate Change
IMR	Infant Mortality Rate
INC	Initial National Communication
ISME	International Society for Mangrove Ecosystems
ICZM	Integrated Coastal Zone Management
ITCZ	Inter Tropical Convergence Zone
JICA	Japan International Cooperation Agency
LE	Life Expectancy
LDC	Least Developed Country
KMS	Kiribati Meteorology Service
KPA	Key Policy Area

KAP	Kiribati Adaptation Program
KOIL	Kiribati Oil Company Limited
KBA	Key Biodiversity Area
KVAAM	Kiribati Vulnerability & Adaptation Assessment Methodology
KP	Kyoto Protocol
KirCAN	Kiribati Climate Action Network
KDP	Kiribati Development Plan
LDC	Least Developed Country
MELAD	Ministry of Environment, Lands and Agricultural Development
MCTTD	Ministry of Communication, Transport and Tourism Development
MPWU	Ministry of Public Works and Utilities
MLOS	Mean Level of the Sea
NGO	Non-Governmental Organisations
NIWA	National Institute for Water and Atmospheric research
NAPA	National Adaptation Program of Action
NZ	New Zealand
NIES	National Institute for Environmental Services
NDS	National Development Strategy
NCCHAP	National Climate Change and Health Action Plan
NASC	National Adaptation Steering Committee
NSO	National Statistics Office
OB	Office of Beretitenti (President)
PICCAP	Pacific Island Climate Change Adaptation Program
PCCSP	Pacific Climate Change Science Program
PAD	Project Appraisal Document
PIPA	Phoenix Islands Protected Area
PV	Photovoltaic
RERF	Kiribati Revenue and Equalisation Reserve Fund
SNC	Second National Communication
SRMU	Strategic Risk Management Unit
SOPAC	Applied Geo-science and Technology Division
SPREP	Secretariat for Pacific Environment Program
SPCZ	South Pacific Convergence Zone
SAPHE	Sanitation and Public Health and Environment Project
SPC	Secretariat for Pacific Community
SRES	Scientific Report for Emission Scenarios
TAR	Third Assessment Report
TFR	Total Fertility Rate
US	United States
UNFCCC	United Nations Framework Convention on Climate Change

UNDP	United Nations Development Bank
UNCBD	United Nations for Convention on Biological Diversity
UNESCO	United Nation Education and Scientific Commission Organisation
UNICEF	United Nation Children's Fund
USP	University of the South Pacific
V&A	Vulnerability and Adaptation Assessment
WB	World Bank
WEU	Water Engineering Unit
WMO	World Meteorological Organisation

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EXECUTIVE SUMMARY

The compilation of Kiribati's Second National Communication (SNC) to the United Nations Framework Convention on Climate Change (UNFCCC) adopts a participatory approach through contributions of members of the National Climate Change Study team (CCST). The process begins with designing the overall content of the report (building on the Initial Communication report), followed by allocation of responsibilities for data gathering pertaining to each information as relevant to chapters, and sub-sections contained in the structure of the report. The thematic working groups (on National Circumstances, Adaptation and Mitigation) were then formed in an effort to cluster the work of Climate Change Study Team on specific topics of the report. Each thematic working group proceeded with identification of available data and also those that are not available or somewhat difficult to collate. Data collected were gathered and weaved in consistency with the content of the report. Fragmented or absent data were augmented through engagement of international/regional and national consultants where applicable and produce input to such gaps. The overall coordination and steering of the process involving compiling SNC was the responsibility of the Project Management Unit and the Environment & Conservation Division, MELAD.

The SNC project's approach uplifts important elements of building capacity of members of CCST on climate change, increase knowledge on how climate change was directly linked to other institutions' roles and hence the need for more integration of climate change into relevant planning processes. Despite the success aspect of this approach, this does not mean that there are no constraints faced during the entire implementation of the project. The greatest challenge faced with involving national stakeholders was the sporadic availability of members, limited level of capacity and knowledge on climate change, unpredictable consistency in pursuing tasks as agreed tasks by thematic groups. These challenges were compounded by the members' own routine tasks and over-burden commitments within their own institutions.

Nevertheless, the report was completed according to what it was initially planned in terms of contents and structure. The draft went through several institutions including regional and international bodies, Secretaries and Cabinet for review and endorsement.

There are still missing data that require further assessments and research but due to inadequacy of resources and time with current project, these information were planned to form part of the subsequent Third National Communication.

The report has 5 mains chapters on National Circumstances, Island Biodiversity, Greenhouse Gas Inventory and Emission, Vulnerability and Adaptation and Other Matters. The executive summary presents key information from each chapter only.

The Republic of Kiribati as a sovereign state is committed to be mentally and physically prepared to the risks that climate change may bring. From 2000 to date, slow onset adverse impacts and extreme events were the driving forces for Kiribati to forge ahead with planning her response to climate change. The Kiribati Climate Change Adaptation Strategy includes institutionalising a nationally coordinated and participatory based adaptation approach and programs, in addition to securing bilateral and multilateral donor support to help meet the costs of the national climate change strategies.

Key technical, steering institutions and committee structures (Climate Change Study Team and the National Adaptation Steering Committee) were established and whose work have been integrated into the current national development planning process and make appropriate reporting and advice in a coherent manner. This is done so in the same spirit of building island resilience from the adverse impacts and extreme events of climate change and in parallel with achieving the common development goals of Kiribati.

Kiribati is a country that comprise of no more than coral atoll (lagoonal and non-lagoonal) and raised limestone islands but with a large ocean space (Economic Exclusive Zone). Except for Ocean island or Banaba (with more than 10m elevation), all islands of Kiribati are raised not more than 5m above mean sea level. The shorelines of the islands range from as short as 11.3km to 221km (refer to table 2). The width of liveable lands on each islands only range from 5.2km^2 to 321km^2. These geo-morphological features are not expected to increase substantially either in size or elevations in the future. This is an important aspect in addition to layers of demographic elements, environmental and climate change pressures. The soil was made up of largely calcareous materials in the form of coarse coral sand, gravels and typically quite variable organic matter contents. This presents a very poor fertility soil for agricultural productivity, and therefore confined to a limited variety of food crops. Such characteristics of small atoll islands, determine that freshwater resources are almost non-existent. The freshwater resource is known to exist as a thin layer of freshwater over seawater underground due to the high hydraulic conductivity soil of coral atolls. The existence of the freshwater lens is dependent on the discharge from rainfall only, and is the main source of portal water of rural communities in Kiribati.

The rate of sea level, waves and other oceanographic features of islands and how these function in the dynamic coastal system of each islands, are also equally fundamental in determining the national circumstances of Kiribati. However the following were noted, sea level rise has been increasing with a rate of between +2.1mm to +5.7mm per year. The range represents different pools where data were collected and are also results of differences in mean level of sea (MLOS) as datum or reference points. It was also noted that modelling waves in the context of enhanced understanding on the different types and definition of reefs will assist inform baseline knowledge in this area, and its significant relationship with the climate change and sea level rise.

Nevertheless, according to the current body of information on this particular geo-morphological subject, reef islands or atolls are still regarded as some of the most vulnerable and threatened coastal systems among reviewed systems, particularly in the face of climate change and sea level rise.

The climate of Kiribati has been described as a hot and humid tropical climate. However, there are marked differences in rainfall across the 3 main groups of islands of Kiribati (Gilbert, Line and Phoenix groups), and also within the groups. Temperature and winds were also uniquely differing with their own trends.

It is important to consider the traditional knowledge regarding the characterisation and prediction of weather and climate. This is the knowledge that appears to stress astronomical factors as principal drivers of the climate of Kiribati. With this knowledge, I-Kiribati identified two known seasons in Kiribati – “Te Aumeang” and “Te Aumaiaki”. Te Aumeang is characterized by stormy and rainy climate and weather for six months, from November to

April. For the rest of the months, from May to October, the climate and weather is normally calm and dry – Te Aumaiaki.

The climate of Kiribati is governed mainly by the movement of Inter-tropical Convergence Zone (ICTZ) and the equatorial doldrums' belt (EDB) which is present through-out the year in the western pacific. The South Pacific Convergence Zone (SPCZ) has an effect on the climate of the southernmost islands but to a lesser extent.

The Walker Circulation and associated El Nino Southern Oscillation (El Niño and La Niña) with their marked opposite conditions of flooding (excessive rainfall and severe weather events) and drought for different parts of the South Pacific and the wider tropical region of the globe are the predominating phenomena that determine or have direct relationship with the Kiribati's climate.

The temperature averages are best described as increasing for the past decades (last 30 to 40 years). Annual monthly mean temperature range from 27.8^{o}C – 28.4^{o}C, Annual monthly average of max temperature range from 31.1^{o}C – 31.2^{o}C and the Annual monthly average minimum temperature are 25.25^{o}C – 25.41^{o}C. The mean monthly sea temperatures for each of the years (1940 to date) are finally averaged to give what considered as the mean annual sea temperature which is 29.6^{0}C.

For observations and characterisation of rainfall in Kiribati, only 4 rainfall stations were able to retain more than 30 years datasets, and these are stations in Butaritari Island, Betio Island, Kanton Island and Kiritimati Island.

The trends vary a lot but they can be best summed up in annual averages and ranges for each island representing the entire Kiribati as follows; Annual average rainfall from 940 – 3160 (mm), Maximum ranges fluctuate from as high as 3473 to 4823 mm, and minimum ranges from as low as 177 to 1447mm. The analysis of drought duration for a 1% Annual Exceedance of Probabilities or Annual Return Interval of 100 years indicates that many islands in Kiribati can experience long and damaging drought events (more than 12months).

The most frequent wind speed is between 5-10knots and an increasing trend of 0.5knots per year was also observed for Kiribati. The mean cloud cover for stations in Kiribati is 5.56 to 5.86.

The population of Kiribati over the period spanned by censuses intervals indicates an increasing trend i.e. from 72,335 in 1990 to 92, 533 in 2005. The distribution of this increase over the 3 main groups of islands of Kiribati indicates that the Gilbert and Line & Phoenix group shares have increased.

The Total Fertility Rate "declined quite dramatically from about 4.5 during the 1990s to about 3.5 in 2005" (Kiribati Government. 2007. Kiribati 2005 Census, Volume 2: Analytical Report). Likewise, Infant Mortality Rate has declined to 52 at the 2005 Census compared to estimated value of 61 in the 1995 Census. And life expectancy at birth is 63.1 years in 2005 Census compared to 62.8 yrs in the 2000 Census.

Preliminary population data on the 2010 Census indicate urbanization at 48.4% of all population and rural population of 51.6%. If Kiritimati is taken as an urban area because the livelihoods and services there are quite similar to those on South Tarawa, then urbanization proportion of the population in the 2010 Census is 53.3%, exceeding the rural population proportion.

From the three census years intervals, the levels of education achieved by people of working age group and above may indicate that there is general increase in the number of people aged 15 years and over, who never attended formal schools during the period 1986-1990. This is because during 1995 Census, there were 2788 persons aged 15 years and over, who never attended school compared to 4781 of the same category in the 2005 Census. This increase would mostly be from persons born between 1986 and 1990 and who at the 2005 Census are aged between 15 and 20 and never attended school. This implies that there are increasingly more children not attending any schools and more adults not having opportunities to attend formal schools.

The records in the two census (1990 and 1995), show increases in the number of employees with the level of education above the secondary level in the rest of employment categories. Since 1995 there has been significant increase in the number of persons with post graduate degrees up to doctorate qualification.

Improvements in the Infant Mortality Rate (IMR), Life Expectancy (LE) at Birth and even the TFR (Total Fertility Rate) suggest that the general health of the population is improving if longevity of life means healthy life. This implies that state of health of the people shows improvement over the decade 1995-2005. The IMR (Infant Mortality Rate) has declined from 67 in 1990 to 52 in 2005.

Kiribati is still recognized as a Least Developed Country (LDC) in the United Nations categorization of countries on the basis of their wealth and stages of socio economic development. The need for external assistance will continue into the foreseeable future. It is also the precarious economic situation of Kiribati that makes the need of external assistance unavoidable. Government's recurrent revenue sources include from income tax and corporate tax, license fees paid by foreign fishing vessels, import duties, and drawdown from Revenue Equalization Reserve Fund.

The GDP per capita for Kiribati ranged from $969 in 2001 to $1,085 in 2009. Government's sector contribution to GDP shows an increasing trend, indicating more government's services have been established and are addressing areas that have received less attention in the past. Over the period 2001-2009, government's contributions to GDP have varied between 32% and 42% but with a positive trend. This suggests that Government's budgets will remain a significant contributor to Kiribati's GDP and its growth.

Unemployment rate is very high. The Kiribati Millennium Goals Report 2007 gives the rates of unemployment of 78.1% in 2000 and 66.5% in 2005 but notes that the rates are obscured in Census Reports since people who do not work for wages always regard themselves as self employed fishermen or farmers. The group that is highly dependent on natural resources and climate conditions.

This is where it brings into relevance the need for more government's services on areas such as environment protection and conservation as it also feeds into pillars of sustainable economic social and livelihood development.

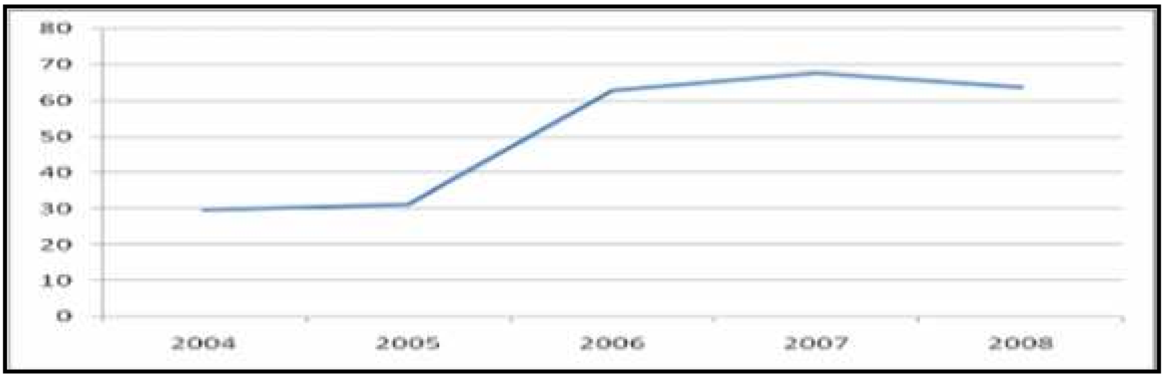
The natural state of biodiversity of Kiribati continues to face threats from several human and natural induced factors including climate change and sea level rise. Their abundance and services they harbour will be relied upon in the future for social livelihood and economic development activities, in addition to the resilience of Kiribati to the adverse effects of climate change.

The Government of Kiribati has and will continue to implement a number of conservation projects and initiatives which have linkages to climate change in terms of adaptation and mitigation measures. These projects are implemented by Ministry of Environment, Lands and Agricultural Development and also through its Environment and Conservation Division. Currently these ongoing projects and initiatives include: i) the Phoenix Islands Protected Area (PIPA), ii) Mangrove Rehabilitation Project which is implemented continuously in collaboration with an organization in Japan known as the International Society for Mangrove Ecosystems (ISME), iii) KAP II Mangrove Project, iv) the Ramsar Small Grant Project funded by the Ramsar Convention on Wetlands and vi) the Programme of Work on Protected Areas Project.

Given the socio-economic situation of Kiribati's where the dominant driving sector to economic growth is government's service(s) with very few small-scale industries; Kiribati emissions of greenhouse gases (GHGs) are insignificant when compared to emissions in the great majority of diversified economy countries.

The primary sector of emission for Kiribati includes Energy, Agriculture and Forestry. The Inventory compiled for this national communication which uses the IPCC 2006 Guidelines are for years from 2004 to 2008. The total emission trends for all sectors (for carbon dioxide and other GHGs) can be viewed in the graph below.

Kiribati total emission trends (in Gg) for periods 2004 – 2008



Source: Kiribati SNC Document, 2012

Data on wastes, agriculture livestock are not readily available for the compilation of methane and nitrous oxide emissions. This report also attempt to construct Inventory for these particular GHGs from such sectors but constrained by limited data available. However the Inventory indicates a decreasing trend and insignificant emissions ranging from 0.336754 to 0.647988 Gg for a composite of sectors such as agriculture livestock and waste.

Kiribati has no obligation under the UNFCCC to reduce its emissions of greenhouse gases. Nonetheless, the Government in its 2012 Policy Statement announced the aspiration to pursue the 2% reduction of GHGs by 2015. The base year and plans to achieve this target is still under discussion.

In any event, Kiribati recognises that efforts on emission reduction at the national level would also mean economic growth and additionally a good indicator of a clean and sustainable development. In demonstrating this recognition, Kiribati embarked on some small scale mitigation related activities at the country level. This includes setting up of the Kiribati Solar Energy Company which provides solar lightings on rural islands and market solar appliances, trial of bio-fuel, Solar PV Grid initiatives on urban islands. Whilst Kiribati recognises that fossil fuel underpins economic growth, she will continue to strive through its domestic policies to explore and implement other renewable sources of energy to alleviate substantial Government's high dependence, albeit high expenditures, on imported fossil fuel.

Because of the link between economic development and energy from fossil fuels, this communication report examines possible correlations between the values of GDP and those of the carbon dioxide emissions from fossil fuels. The correlations of carbon dioxide emissions from fossil fuels used separately under some of the categories in the inventory of emission, and the values of GDP contributions from the comparable categories of the economy was also examined.

From the analysis, it is noted that GDP at current prices or at constant prices are highly correlated with emissions of carbon dioxide from fossil fuels. However the correlations between the contributions to GDP of the different sectors and the corresponding emissions of carbon dioxide from the same labelled sectors vary because there is no consistency in the sectors as defined under the two separate considerations – national accounts and greenhouse gases inventory.

This denotes and further emphasizes the essential role of mitigation, not only, on domestic development but also spin-off effects to protect the environment and global benefits as well. This leads to the real need of directing future focus on in-depth mitigation analysis and how to better facilitate voluntary appropriate mitigation of climate change in the near future.

In the context of climate change, defining “Vulnerability” has been very pivotal to understanding measures and strategies to respond to the adverse impacts of climate change. The IPCC defined vulnerability as “the extent to which climate change may damage or harm a system”. It adds that vulnerability “depends not only on a system’s sensitivity, but also on its ability to adapt to new climatic conditions”. Kiribati agreed with that definition and continues to disclose elements of our vulnerability along the spectrum of that definition.

Since the last Initial communication report, there have been several climate modelling & downscaling efforts aimed at understanding the extent of possible future climates, including projected sea level rise for Kiribati. The details of these works including different scenarios from different credible work of several international institutions can be found in the Vulnerability and Adaptation section of this report.

Based on these scientific undertakings, there is consensus that i) both ambient and sea surface temperatures will increase in the coming future i.e. from 2025 up to 2100 with a range of $28^{o}C$ to $32^{o}C$; ii) precipitation will also increase on average but this is highly variable spatially and there should be caution on possibility of prolonged devastating drought events; iii) Sea level is also expected to rise in the future by several centimetres (range from 15cm to 70cm at different time scales). This confirms the notion that climate change in the future could dangerously damage or harm Kiribati's various systems.

As mentioned earlier, Kiribati is comprised mostly of coral atolls and therefore the environment systems that provide sustenance to living population are sensitive to any drastic or slow onset climatic conditions. Urban centres/settlements are among the many vulnerable sectors due to socio-economic activities and that climate change could further exacerbate the impacts.

Several sectors and systems have also been examined in past vulnerability assessments and consensually concluded that Kiribati has already been exposed to risks and impacts of climate change coupled with additional layers of stress already existed over these systems.

With the low adaptive capacity of island systems compounded by limited resources (spatially and financially) to deal with the adverse effects of climate change, this report finds consistency with His Excellency President Tong in his arguments stating that Kiribati and other low-lying island countries should be perceived within this phenomena as "Vulnerable countries in the frontline".

The projections of climate change and existing national fragile circumstances will only add up to compounded and probably unthinkable level of impacts which may be extremely difficult to neither cope with, nor reverse it in the longer term future.

The other advantage of V&A studies is that they will continue to assist to inform forward planning, allowing the identification of suitable adaptation options and develop adaptation planning strategies` – at any particular level of sector and scope which will be seen to have results on adaptive capacity, resilience and overall security of Kiribati in the longer term future.

Adaptation and Risk reduction was recognised by Kiribati as the only solution (with external support) to safeguarding critical systems and Kiribati's communities from what could emanate from the scale of our vulnerability, and risks by climate change. This notion was slowly happening and mainstreamed into sectoral and national planning priorities. Institutional arrangements, mainstreaming processes e.g. mainstreaming of our CCA and DRR efforts as being implemented by KAPIII, relevant policy instruments e.g. Climate Change Policy Framework, etc from various sectors are beginning to emerge and come into play. As this becomes to set its scene, coordination mechanism including climate change policy formulation, coordination, capacity mechanism framework and adequate capacity of sectors are essential elements that need to be in place and function properly as pre-requisites of this process of effective adaptation.

The process of compiling national communications efficiently requires capacity at sectoral levels for appropriate data generation and inputting to various components of the report. A robust and systematically updated data framework, including a working institutional setting that facilitate this reporting process and also translates the national communication into policy relevant information tailored to specific needs of national communications as well as sectoral operatives and priorities, will add value and inform the overall national approach to respond to climate change in the future.

Kiribati as one of the least developed countries does not have the resources to focus attention/actions on institutional strengthening needs. Evidently, there were already real issues that certainly need more attention/assistance and this is one of the core reasons why most of these institutional and capacity gaps were often sidelined or marginalized. These characterised the main areas of constraints and gaps in this whole process of preparing national communication.

Informed decision making requires accurate, consistent and timely provision of advices which should be based on factual, science-based and rigorous planning. Research capacities and capabilities in Kiribati that could alleviate this gap were chronically lacking at national level. Most of the research needs have been supplemented by international and regional organisations. Though these researches from these institutions are extremely critical to inform decision making at the national level, they could be very prolonged and untimely.

These gaps and constraints will continue to impede the process of preparing subsequent national communications, implementation of obligations under UNFCCC and overall national response to climate change, unless addressed.

The Kiribati SNC report ends with proposed project concepts that emerged and were identified during the preparation of this national communication report. These concepts could be translated into programmatic proposals with the view of seeking assistance to address some of the gaps and constraints identified in this report. This is an attempt to complement on-going national efforts and priorities that have been planned and thought out to also resolve the multifaceted challenges of responding to climate change.

1.0 INTRODUCTION

1.1 PURPOSE

Under Art 12.1 of the United Nations Framework Convention on Climate Change, each Party is required to communicate to the Conference of the Parties information on its implementation of the Convention. As a least developed low lying small island country, Kiribati would not have been able to meet this obligation without financial support from Annex 1 Parties. This support was received by Kiribati in April 2008, and has enabled the submission of this Second National Communication to the UNFCCC.

The scope of information and how they are structured in the SNC are based on the UNFCCC COP Decision 17/CP.8 “Guidelines for the preparation of the national communications from Parties not included in Annex I to the Convention”, and Kiribati Initial National Communication 1999.

1.2 PROCESS AND METHODOLOGY

The MELAD, through its Environment and Conservation Division (ECD), is the implementing Ministry for the SNC Project. The Climate Change Unit within the ECD, collaborating with other Ministries and stakeholders through Climate Change Study Team and networking, has been responsible for technical information contained in this SNC Report.

The Climate Change Unit started off with an initial strength of two employees but it receives the support it requires from the whole staff of the ECD as and when necessary. Two more individuals responsible for mitigation and adaptation were later recruited to the Unit. With that mode of operation, the CCU produced initial elements of information relevant for inclusion in the SNC while regularly referencing these to the CCST. The information were then collated to produce an initial draft text of the SNC that finally developed into the approved SNC.

The process and tasks undertaken for the SNC have engaged many individuals from other Government's line ministries, NGOs and the private sector. It is the Cabinet who approve on 31st May 2013 this final version of the SNC. However representatives from wider sections of the nation were involved from the formulation stage of the project document to its completion stage.

At the inception workshop for the preparation of the SNC project held in 2006, participants discussed broad areas of climate change issues that stakeholders consider to be included in the SNC report. These include i) energy and greenhouse gas inventories to understand Kiribati dependency on fossil fuels; ii) contribution to climate change and opportunities to mitigate climate change from the sector; iii) key climatic systems and their impacts on the economy to understand economic impacts of climate change; and iv) vulnerability and adaptation to be emphasized in order to heighten the need for global action to mitigate climate change and for Kiribati to be assisted in its adaptation. These issues are reflected in the approved SNC project document.

Based on the Initial National Communication, a draft outline of the SNC was adopted by the CCST. Major topics in the draft outline are greenhouse inventories and mitigation, vulnerability and adaptation, national circumstances. For each of these topics, a working group with core members from the CCST was established. The plan was for each of the thematic working groups to work through its topics from data collection, analysis, and finally to documenting information for inputting into the SNC Report. This plan was not as successful as originally anticipated.

The working groups were only able to provide to the CCU copies of some reports related to coastal vulnerability and adaptation, data on fuel consumptions, livestock, and on population. Climate data were readily made available to CCU by the Kiribati Meteorological Services (KMS). Thus leaving analytical work and the documenting of information to the CCU to work through, which it was doing whilst at the same time regularly referencing substantial outputs to CCST. This work also used information available since 2000 as part of national climate change related programs.

It was obvious that CCST involvement in the work on the SNC was less than what was expected. The reasons were that members of the CCST working groups have their own areas of work and priorities which left them no time to undertake analytical work and documenting of the information for the SNC. Moreover, high turnover of members who represent different ministries contributed significantly to the lack of continuity in pursuing the originally planned work of the Working Groups.

At the very start of the SNC project, CCU realized that some tasks would be very technical for working groups and CCU to be able to undertake adequately. A framework on vulnerability and adaptation that can set out what Kiribati wish to understand from any vulnerability and adaptation assessments is one of these tasks. The CCU and the CCST over several meetings have been able, however, to develop this type of framework as highlighted in the Vulnerability and Adaptation Chapter.

There are technical tasks that present technical teams cannot carry on such as GHG Inventory, so on. For these tasks, international experts were mobilized to conduct an in-country training workshop of week duration. Members of the CCST and other government's employees were able to participate. A training manual was produced, and moreover, a similar workshop training conducted by one of the trainees was organized for members of the CCST who did not attend the one conducted by the international expert. Nevertheless, the SNC Project faced difficulties in getting data on some of the remote islands of Kiribati such as Kiritimati. Based on information and knowledge gained in these trainings, the CCU has produced the greenhouse inventories that are included in this SNC. An alternative approach is to train members of the CCST and ECD so that whenever they travel to Kiritimati islands, they could conduct data collection for the GHG Inventory.

But the pace of work had not been up to speed that it was necessary for UNDP to arrange measures to fast track the project activities. Included was the acquisition of SIMCLIM tool and demonstrations of how it can be used.

1.3 LINKAGES OF SNC TO ENVIRONMENT ACT AND NATIONAL DEVELOPMENT PLAN

The SNC Project's key objective is to strengthen the technical and institutional capacity of Kiribati to prepare and submit its SNC Document to the UNFCCC. This project also serves at the same time as a capacity building project for Kiribati to understand how climate change and its impacts on national circumstances could evolve over time. It also heightens the logical connection of key climate change issues with the whole components of the environment.

This logical connection perhaps underpins Presidential allocations of climate change portfolio with other environmental issues to the Ministry of Environment, Land and Agriculture Development. "Environment", according to the Environment Amendment Act 2007 (which retains the definition in the original Environment Act 2000) defines "environment" as "natural and social and cultural systems and their constituent parts and the interaction of their constituent parts, including people, communities and economic, aesthetic, culture and social factors". This covers very broad areas of national issues.

All areas of national issues that got into the political agenda of government are reflected in ministerial portfolios; government (including colonial administration) has been instituted over a century; and until recently, it was thought that there was nothing left unattended to form new agenda on "environment". This has changed recently during the period from late 1980s to early 1990s, when the concept of sustainable development was developing at international level which made Kiribati to recognize the need for creating, a ministerial responsibility for environment for the first time. The three Rio Conventions were significant in bringing home the message that degradation in the global environment is real and require actions by all countries at the national and local levels.

The first legislation on the Environment was unanimously adopted in 1999 by Parliament, and came into force as the Environment Act 1999. Unanimous support for the conservation and protection of the environment came from the visibility of the deterioration of the urban environment. Parliamentarians welcomed the Environment Act and thought it was something that was long overdue.

The object of the Act at Section 3 (b) (iv) reflects international agenda on the protection of the global environment. Issues in the object include “to reduce risks to human health and to protect prevent the degradation of the environment by all practical means, including the following - (iv) to comply with and give effect to international and regional conventions and obligations relating to the environment”. The importance of this section in the object has been raised in the Environment Amendment Act 2007 to become Section 3 (e); it is no longer a sub paragraph in the section. Also in this amendment Act, climate change was integrated into the Environment Impact Assessment checklists and enacted in its regulations.

The activities of the ECD in pursuing Kiribati obligations under the three Rio Conventions – UNCBD, UNCCD, and UNFCCC – and other International Environment Agreements to which Kiribati is a party are consistent with the object of the Environment Act 1999. Nevertheless there is still more to be done in order for Kiribati to fully comply with its obligations under the Rio Conventions, not that this means ECD has been able to fully implement its Environment Act and Regulations. This is due to limited in-country capacity and resources available to ECD.

With the limited resources, Kiribati has been able to increase established positions within the ECD from one officer to about ten, within a period of about two decades for which environment issues have been recognized to form part of the national agenda. The number of project officers has also increased with the increasing number of activities related to implementing at the country level commitments under those Multi-lateral Environmental Agreements.

Although much of the obligations that are pursued are on preparation of plans and reporting, these reinforce the need to undertake focused actions on implementing the Environment Act and Regulations that have immediate benefits to the local environment. These include activities such as pollution control and waste management, development licensing system utilizing EIA procedures, inspection and monitoring of the enhancement of key ecosystems such as corals, mangroves and seagrasses.

As for the fact that climate change is an economic issue, the SNC needs to be consistent with national development objectives and strategies. During the period of between the Initial National Communication and this SNC, there have been three serial National Development Strategies, each of four year timeframe which is also the life time of the Government. Economic growth, vibrant economy, sustainable development, distribution of wealth, improved state of the environment, and people's needs are recurring themes with varying importance accorded to each relative to the others in the goals of National Development Strategies.

Normally, the preparation of National Development Strategies involves consultations among different line Ministries with the Ministry of finance and economic development as the leading institution. The NDS is fundamentally the planning document of the Government. It needs therefore to be consistent with "policy statements" of the present Government that has been presented to Parliament at its first sitting after the Government comes into power. Global and international issues bearing on economic development and environment protection, such as those of the "Millennium Development Goals" and "Agenda 21", have drawn the government's attention to some of the emerging issues e.g. environment, climate change. These documents play an important role in informing the formulation of the NDS.

Emerging issues include inadequate and substandard infrastructure in the urban area, high unemployment rate among young people, and increasing overuse and consequential degradation of the environment and natural resources. In addition, climate change is recognized in the NDS2004-2007 as potentially causing costly risks to economic growth as well as social adverse impacts. Understandably the climate change impacts on natural systems are first to be experienced by local communities, and because of these impacts on their natural systems, their livelihood and social organization would be affected in ways that will produce outcomes that are less than optimal.

NDS 2008-2011 goal is "Enhancing economic growth for sustainable development" that captures the thrust of Government's policy statement which is '*A* vibrant economy for the people of Kiribati'. Climate change is being integrated into the "Environment" Key Policy Area.

2.0 NATIONAL CIRCUMSTANCES

2.1 INTRODUCTION

The purpose of this chapter is to provide bio-physical and socio-economic information and characteristics that are vital for wider understanding on Kiribati's vulnerability to the adverse effects of climate change, its capacity and its options for adaptation, as well as its options for addressing its GHG emissions within the broader context of sustainable development.

It is acknowledged that the UNFCCC has been the driver for past and existing programmes related to climate change at the national, regional and international level. The chapter proceeded with explaining institutional arrangements at the national level that are involved in the preparation of the Second National Communication, including institutional settings for planning and managing climate change adaptation and mitigation. The underlying geographical and important morphology constructs of Kiribati that make it particularly vulnerable to climate change. The current and future climate outlook with important trends and elements are also explained. In the last section of this chapter, socio-economic circumstances is detailed with important association with Kiribati's vulnerabilities, capacity and capability; necessary to address adaptation and mitigation at the national level.

The chapter aims to provide updated information on each sub-section of the national circumstances since the submission of the Initial National Communication in 1999. Therefore based on the efforts vested in this project, new scientific information or outcomes of research that have recently produced since 1999 and are related to the sub-sections of national circumstances was captured and presented in this second national communication.

2.2 INSTITUTIONS FOR IMPLEMENTING THE UNFCCC

The Government of Kiribati established climate change institutions, committees, introduced the climate change adaptation policy and call for the whole of government's approach to tackling climate change. This is done so to effectively respond to the adverse effects of climate change and also complying with its obligations under the UNFCCC.

Presently, there are four leading Ministries that are involved deeply in the overall implementation of climate change activities (Abeta 2011). These include i)Strategic Risk Management Unit of the Office of Te Beretitenti, ii) Environment and Conservation Division of MELAD, iii) Kiribati Meteorology Service of MCTTD[1] and iv) Energy Engineering Unit of MPWU[2]. The functions assigned to each of the leading government's agencies that relates to climate change thematic areas is summarised below. The participation of other sectors in climate change is expected to grow in the near future.

Table 1: Roles of key institutions in the National Communication process

Leading Agency	**2012 Directed Ministerial functions by President (powers under section 45 and 47 of the Constitution)**	**Climate Change thematic responsibility**
Office of the Beretitenti – OB	• Ministerial coordination • Cabinet taskforce chairmanship • National crisis • Disaster • Climate change adaptation Policy coordination	• Policy Development & Coordination • Mainstreaming • Adaptation • Climate Financing
Ministry of Environment, Lands and Agricultural Development – MELAD	• Climate Change and Sea level rise • Environment Adaptation programs • Monitoring State of Environment and CC impacts	• Capacity Building • Knowledge management • Adaptation • Awareness and Communication • International (UNFCCC/KP) negotiations

[1] MCTTD – Ministry of Communication, Transport and Tourism Development

[2] MPWU – Ministry of Public Works and Utilities

		• Focal point for international and regional climate change agencies (SPREP, AOSIS. etc) • Climate Financing • Overview of climate change issues, maintaining climate change information data and information
Ministry of Communication, Transport and Tourism Development – MCTTD	• Meteorological services	• Capacity Building • Knowledge management • Research & Systematic observation
Ministry of Public Works and Utilities - MPWU	• Energy Management (and other alternative sources of energy including Solar Energy Company)	• Mitigation • Technology Needs Assessment

However, the overall effective implementation of responsibilities under the UNFCCC including preparation of the Second National Communication Report was undertaken by the Environment and Conservation Division of the Ministry of Environment, Lands and Agriculture Development.

At the national level, Secretary to the MELAD was the designated Focal point for the UNFCCC; hence all communications regarding implementation of the UNFCCC COP decisions and routine operational messaging from the UNFCCC Secretariats went through the Focal point (FP) for authorization of any action.

The Climate Change Study Team, one of the key committees for climate change in Kiribati was a body originally established to undertake operations and activities of the UNFCCC and Focal Point. Being multi-disciplinary inclusive of NGOs and other inter-governmental and non-governmental organizations; it serves as a port of channel and working team for the implementation of the UNFCCC. Over time as Climate change caught the attention of policy makers, the same team was later destined to provide technical advice to the newly established oversight committee on adaptation called – National Adaptation Steering Committee.

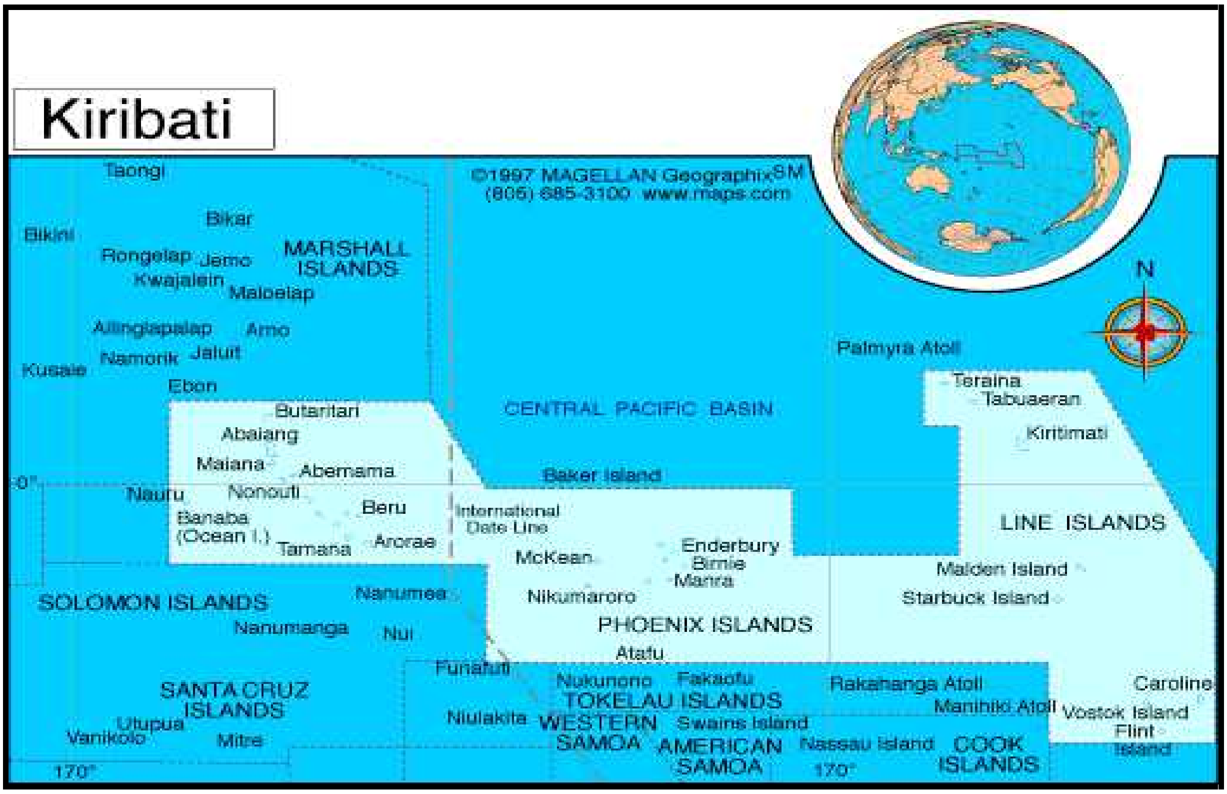
However the MELAD continued to maintain its role on coordinating matters related to negotiations and decisions follow ups from the UNFCCC. This participation was usually constrained by lack of sufficient capacity and knowledge on the background and substance of the negotiation's hot issues and how those relates to the local context, inconsistency in participation and lack of interest to participate. In the post negotiation sessions, being a relatively small work force, appetites for follow-up actions were often absent due to numerous official tasks that burden negotiators to commit to such actions. This could be addressed by creating either permanent or project-based positions to shoulder these commitments.

In terms of the SNC preparation, the CCST with its thematic working groups focusing on specific components was still used to deliver the tasks. Although, recognising that some undertakings were implemented by international experts due to inadequacy of knowledge and/or lack of time. The financial resources provided to support the process assisted Kiribati to undertake focussed assignments and capacity building activities relevant to climate change to be successfully completed.

2.3 GEOGRAPHY

Kiribati is a small island country in the central Pacific, comprised of 33main islands span in three main groups of islands, Gilbert, Line and Phoenix Islands. From the 33 islands, only one island, (Gilbert Group) is a raised limestone and the other 32 are low-lying coral atoll islands. There are a total of 12 uninhabited islands; most of them are from the Phoenix and Line group. The whole area of the Phoenix Group (of just more than 400,000 km^2 and comprised of 8 atoll islands) was declared by Government of Kiribati as the Phoenix Island Protected Area and named as a UNESCO World Heritage site in 2010.

Figure 1: Map of Kiribati



Source: Google Maps and Photos

Atolls termed from the Maldivian word "*atolu*" represent a generally ring-shaped structure. These are characterised by an annular reef around a central lagoon, while there are also isolated table reefs in geological settings where only one island is found on the smaller reef or lagoon is residual feature (Nicholls 2007). The extents of atoll islands vary in size and shape either along the entire rim or may be restricted to one or more breaks of the rim margins.

There were several theories and studies performed in the past over the formation of coral atoll islands. This was best understood by Charles Darwin's (Darwin, 1842 as quoted in Woodroofe, 2007) initial and revised opinion on coral atoll formation. Darwin's first viewed atoll formation as a result of gradual subsidence of volcanic land eruptions underwater, but dependent on the time horizon (which may be prolonged in some cases) of the subsistence of the foundations on which the atolls were formed, together with the possible upward growth of the reef constructing corals. The detail of these studies were also captured and detailed in the Initial National Communication.

These geological studies have been instrumental in explicating the geo-morphological origins and features of atoll islands relative to issues referred like sea level rise and their vulnerability to potential environmental stressors e.g. climate change. This specific aspect of information on geology of atoll islands is fundamentally important to understand, as Kiribati closely monitor the trends of changing climate and the risks they poses on these atoll systems in the future.

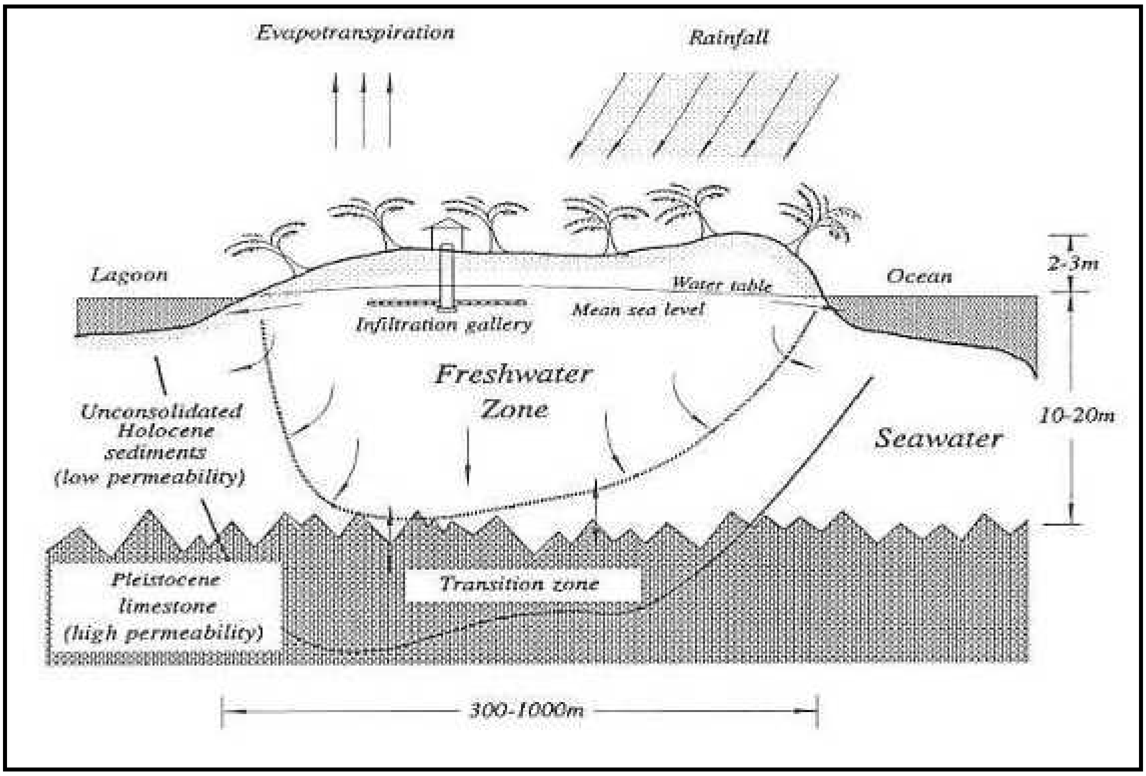
According to the current body of information on this topic, reef islands or atolls are still regarded as some of the most threatened coastal systems among many reviewed systems, in the face of sea level rise. The extent of their capacity and their vulnerability in the face of climate change will be revealed in subsequent national communications.

The atolls are generally elongated in a north-south orientation, with the eastern side facing the predominant easterly winds. Several passages separate islands in most of the atolls, and these have allowed exchange of seawater on the two opposite sides of the atoll to take place.

Intertidal reef platforms with varying widths (150 –200 m.) exist around table reefs and at atolls with lagoons on the side facing the prevailing winds. Intertidal mud platform extends seaward from the lagoonal beach to the lowest low water mark beyond which the platform slopes to the seabed.

The ocean side of the atolls are slightly higher than the lagoon sides. Variation in heights of the land surface across the atoll is quite small, but stretches of berms at the edge of the atoll on the ocean sides are quite visible in parts of the atoll (Webb 2005). The land surface is probably within 1 meter and 4 meters above the reef platforms and the lagoonal mud platforms.

Figure 2. Cross-section of typical coral atoll island



Source: Falkland, 2004

Figure 3. Aerial view of low-lying coral atoll - South Tarawa

Source: Google maps and photos

The table below describes the land area, type of island, lagoon area, length of shorelines and the elevations.

Table 2. Description of island geographical features

Island	Land area (km^2)	Lagoon area (km^2)	Length of Shorelines (Km)	Elevations (estimates) (m)	Coordinates
Makin	6.7	0.3	30.7	< 5	3^0 23'00"N 173^0 00' 00"E
Butaritari	11.7	191.7	104.83	< 5	3^0 10' 04"N 172^0 49' 33"E
Marakei	10	19.6	69.0	< 5	02^0 01' 0" N 173^0 17'0"E
Abaiang	28.0	232.5	111.21	< 5	01^0 51' 0" N 172^0 58'0"E
Tarawa	31	343.6		< 5	1^0 25' 0"N 173^0 02' 0" E
Maiana	27	98.4	68.6	< 5	1^0 50' 0" N 173^0 01'0" E
Kuria	12.7	NA	26.82	< 5	0^0 55' 0" N 173^0 0'0" E
Aranuka	15.5	19.4	50.81	< 5	0^0 11' 0" N

					173^0 36’0” E
Abemama	23.0	132.4	103.6	< 5	0^0 24’ 0” N 173^0 52’0” W
Nonouti	25	370.4	155.9	< 5	0^0 40’ 00” S 174^0 21’ 0” E
Tabiteuea	38	365.2	215.74	< 5	01^0 20’ 0” S 174^0 50’ 0” E
Onotoa	13.5	54.5	73.5	< 5	01^0 52’ 0” S 175^0 34’ 0” E
Beru	21	38.90	54.5	< 5	1^0 20’ 0” S 172^0 ’0” E
Nikunau	18	(Enclosed Lake)	31.25	< 5	01^0 22’0”S 176^0 28’ 0”E
Tamana	5.2	Non lagoonal island	11.3	< 5	2^0 30’ 0” S 175^0 59’ 0”E
Arorae	26	Non lagoonal island	19.5	< 5	2^0 38’ 0” S 176^0 49’0” E
Banaba	6.5	Non lagoonal island	16.7	< 5	0^0 51’ 34”S 169^0 32’ 13” E
Kanton	9.1	50	NA	< 5	2^0 50’ 0” S 171^0 40’0”W
Teraina	7.4	(Enclosed lake)	33.3	< 5	4^0 43’ 0” N 160^0 24’ 0” W
Kiritimati	321	324	147	< 5	1^0 53’ 0” N 157^0 24’ 0”W
Tabuaeran	33.7	110	221	< 5	3^0 52’ 0” N 159^0 22’ 0” W

Source: Kiribati Second National Communication, 2012. Note that not many in-depth studies on elevations

Kiribati soil is among the poorest soil in the world. It is classified as Entisol meaning the soil is very young. The major limitations to the productivity of Kiribati soils are highly related to their poor physical and chemical characteristics.

The soils are made up largely of calcareous materials in the form of coarse coral sand and gravels and typically with quite variable organic matter content (Trewren, 1984). The general profile of the atoll soil is thin layers of organic accumulation overlying a calcareous substratum of the parent materials which are themselves having a geologically young formation. Because of this, the particles constituting the soil remain coarse, and their holding capacity for water is poor, compounding the problem associated with increased temperature and vapour-transpiration.

Shallow depth of soil, sandiness of the soil texture, low organic matter content and very high soil pH are the major factors contributing to low or poor soil productivity. The high calcium content of the soil caused some important trace elements such as iron (Fe), Manganese (Mn), Copper (Cu), and Zinc (Zn) to be lock and not made available to plant.

Consequently, the availability of some major nutrient elements like Nitrogen (N), potassium (K), phosphorus (P) and Magnesium are also influenced by the soil pH and organic matter content (Bar, 1992, Morrison, 1986, Finlay, 1987, and Beenna, 1994).

Ground water quality and quantity and as well as the activity of the micro-organisms are critically important factors to agricultural activities including crop and livestock production.

The nature of Kiribati soil restricted the type of food crops and other flora that can thrive and adapt. Some of the traditional food crops include coconut (Cocosnucifera), pandanus (Pandanustectorius), breadfruit (Artocarpusaltilis), babai (Cyrtospermachamissonis) and te bero (Ficus) are well adapted to the conditions of atoll environments (Thaman, 1992). There are also other specialized flora adapted well to the alkaline soil and are also part of the natural vegetation (Morrison, 1990).

Noting that the composition of Kiribati soil is predominantly carbonate sediments, it is significant also to reveal important sediment producers as it underpins the future existence of islands. Parent materials from which the soil is derived are corals, coralline algae and foraminifera which produce tonnes of million carbonate annually since first formation of these islands (Milliman, 1974 – in (Biribo 2008)). These continue to provide sediments to the land at the edges. However of most important is the sustainability of the supply of these carbonate based sediment in the longer term. The rate of carbonate sediment production from living sources is subject to environment conditions such as bio-turbation, bio-erosion and changes in winds, waves and weather conditions due to climate change (Biribo unpublished). Despite those natural processes that in some instances act as stressors, human-induced factors such as land-based and marine pollution, destructive fishing practices, and coastal man-made structures e.g. seawalls, reclamations also have the potential to alter the sediment production and movements particularly on populated islands.

Related to human induced impacts on our physical resources, the demand of aggregates for building materials, landscaping has resulted in over-mining these protective natural carbonate aggregates on coastal areas of populated islands. The consequences of such activities are the exacerbation of coastal erosion cases on such fragile coastal systems of Kiribati atoll islands.

A survey by Pelekoti (2009) reported that about 4,716.4m3 of aggregate material are extracted from the beach annually for household use only; to meet raw construction materials for various usages. The Government's usage is additional to that amount. This means a high rate of extraction which relates directly to increase in coastal vulnerability of these populated islands to degradation of limited land space and to adverse effects of climate change and sea level rise.

It is fundamental to understand the existing circumstances of oceanographic conditions and how this may be influenced by future climate change.

Recognising that there is limited data on this area, this section will provide information on sea level, astronomical tides, currents, storm surges and waves. These are important parameters that interact with the island natural systems and are essential to emerging areas on climate change such as Blue carbon, so on.

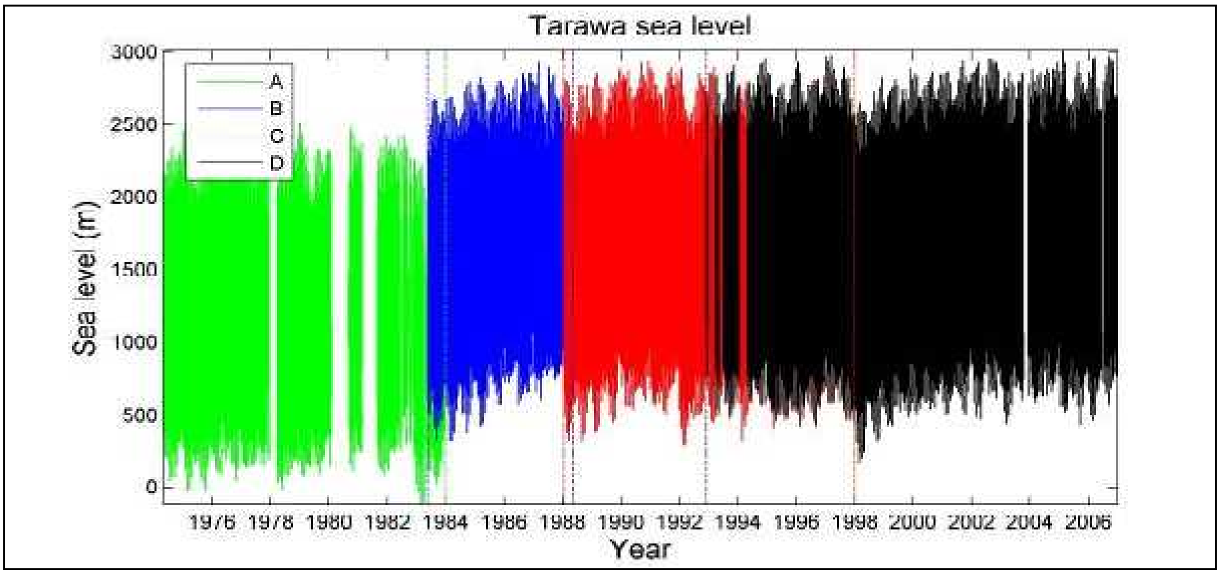
The record for sea level began in 1974 but the tide gauges in South Tarawa had been moved (to several locations including one also established in Kiritimati Islands at different time series) several times between two locations that are separated by few kilometres. The recent permanent modern tide gauge, funded by Aus-AID, was installed toward end 1992 and fully operational in 1993. The datum for each of the tide gauges were different, however this was taken into account when plotting the adjusted sea level for Tarawa – Kiribati from 1974 – 2007 (33.25 year record relative to SEAFRAME gauge Zero). This work was made possible by work of NIWA as part of the Kiribati Adaptation Project.

Table 3: Record of sea level from different gauges showing datum shifts

Name	Location	Start date	Finish date	Datum shift (mm)
Tarawa A	Betio	31 May 1974	31 Dec 1983	+419
Tarawa B	Bairiki	17 May 1983	10 May 1988	+23
Tarawa C	Betio	20 Jan 1988	31 Dec 1997	+23
SEAFRAME (D)	Betio	27 Mar 1993	31 Aug 2007	0

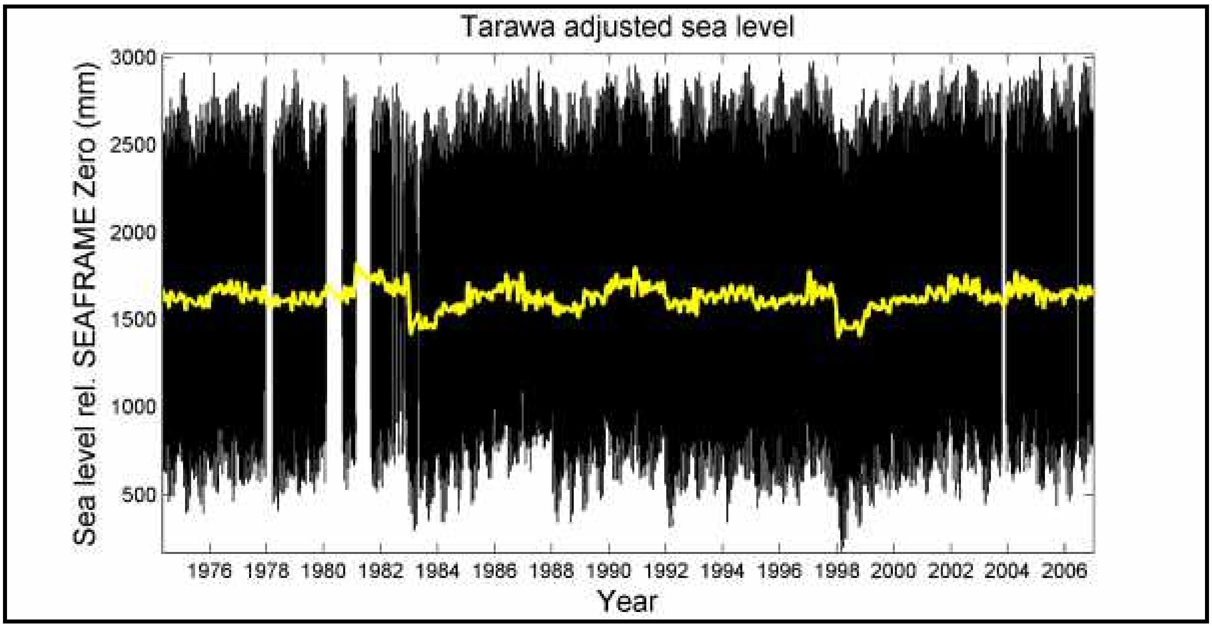
Source: Ramsay, et al, 2008

Figure 4: Sea level time series from different tidal gauges



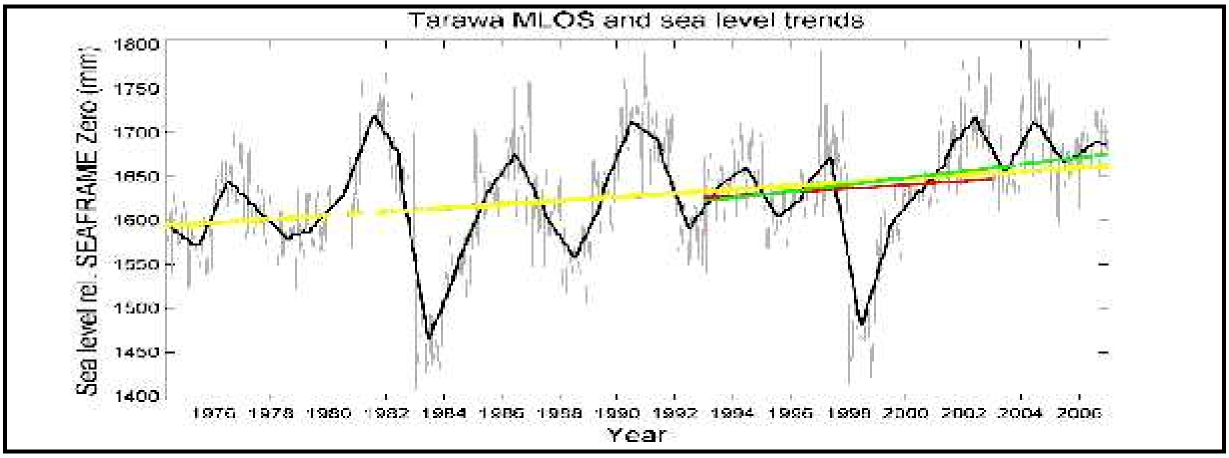
Source: Ramsay, et al, 2008

Figure 5: Adjusted sea level using Sea-frame as reference datum



Source: Ramsay, et al, 2008

Figure 6: Sea level with analysis of trends of different time series



Source: Ramsay, et al, 2008

Linear rates of sea-level rise since 1974 to present (yellow line), 1993 to 2003 (red line) and 1993 to 2007 (green line). The grey line is the Mean Level of the Sea (MLOS) as measured at the SEAFRAME and earlier sea level gauges, and the black line the annual average MLOS.

Table 4: Sea level rise of different time series

Start date	Finish date	Duration (years)	Sea level rise (mm/year)
May 1974	Jan 2007	32.7	+2.1
Jan 1993	Jan 2003	10	+2.1
Jan 2003	Jan 2007	4	+5.7

Source: Ramsay, et al, 2008

Rates of sea level rise for different timeframes based on an analysis of available recorded sea-level data at Betio, Tarawa.

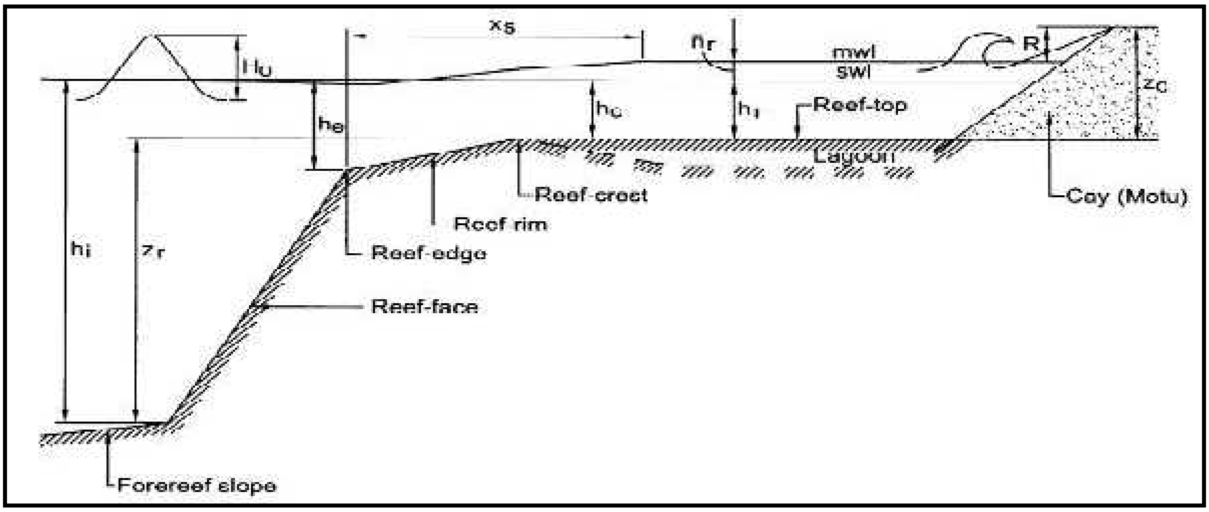
The different trends above are not significantly greater than the global trend of annual mean sea level rise, but they indicate an accelerated rate of increase in the mean sea level. It is also known that the mean sea levels are also affected by ENSO, and moreover it is realized that that sea level records and the linear trends presented here are for one island (Tarawa) only. Nonetheless, it is assumed (coral atolls behave the same to sea level rise) that these trends would not be greatly differ from what could be derived on the other islands within the Gilbert group, provided data availability at those islands. Collating the trends of these recorded and corrected data over time is greatly fundamental to validating information from any assessments of global or regional impact of climate change/sea level, and cannot be over-stressed.

There is unknown evidence of measurements of wave conditions in Kiribati to permit analysis of circumstances and their implications on natural and human systems on the islands of Kiribati.

Waves are important oceanographic features of the island system. They transport sediments, particles, help shape the islands and importantly waves can damage the island coastlines and vital ecosystems. The work done by NIWA was the first of its kind to produce wave statistics using the NOAA/NCEP WavewatchIIIhindcast dataset for the period February 1997 to November 2007 to determine offshore (deep-water) wave conditions around each atoll.

In addition, it is also important to stress that in a typical atoll with fringing reefs, the dynamics of waves from their formation to their end journey and the consequences they may induce are fundamentally important. The work of NIWA attempted to understand wave set-up and wave height translation over fringing ocean reefs of Kiribati islands using existing parameters such as sea level, wind speed and gusts and air pressures. These elements of the wave dynamics is a complex process and relatively poorly understood subject. Gourlay (Gourlay 1999) definition of reefs is instrumental in enhancing understanding on this aspect, particularly in modelling wave's impacts on shorelines and natural systems of low-lying atolls with climate change.

Figure 7: Gourlay definition of coast used for modelling waves impacts on atolls



Source: Ramsay, et al, 2008

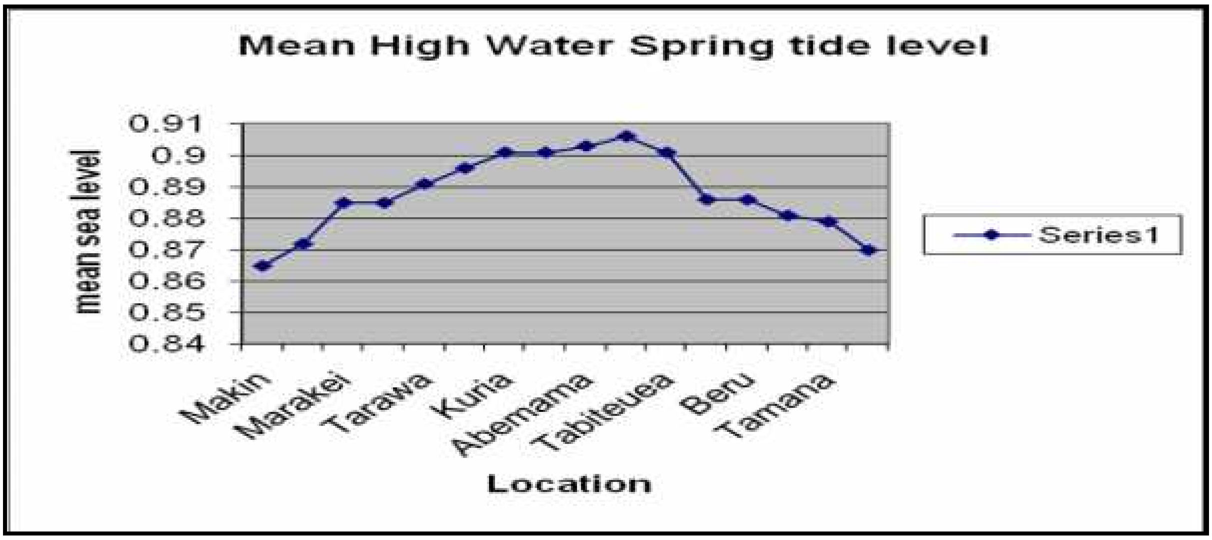
Storm surge are usually generated in distant locations either in lagoon or ocean water and is characterised by an increase in the water levels due to low barometric pressures and set-up due to strong winds. In open Deep Ocean, storm surges are dominated by atmospheric pressure effects while, in shallow lagoonal waters atmospheric pressures together with wind set up greatly influence storm surge formation.

Astronomical tides are characterised by the in and out ebb flow of sea level. Kiribati experienced semi-diurnal tides with two high tides and two low tides, however high tides was also experienced as a combined result of lunar and solar tides that occurred during full moon. Tides are critical oceanographic feature of the island systems and are particularly relevant to prediction of sea level rise and impacts of extreme storm surges. The tide levels are permanent through-out the year and can be easily predicted accurately beforehand.

Islands which are closer to equator should have more increase tide levels compared to other islands spreading to the north and south. This is a result of their positioning which favour more gravitational pulls of both moon and sun. Refer to figure 8 below for validation of this.

This implies that islands (e.g. Abemama, etc as in figure 8 below) with higher lunar and solar tides are more prone to risks from storm surges, sea level rise and other climate related impacts.

Figure 8: Spatial tides changes of few islands in Kiribati during spring season



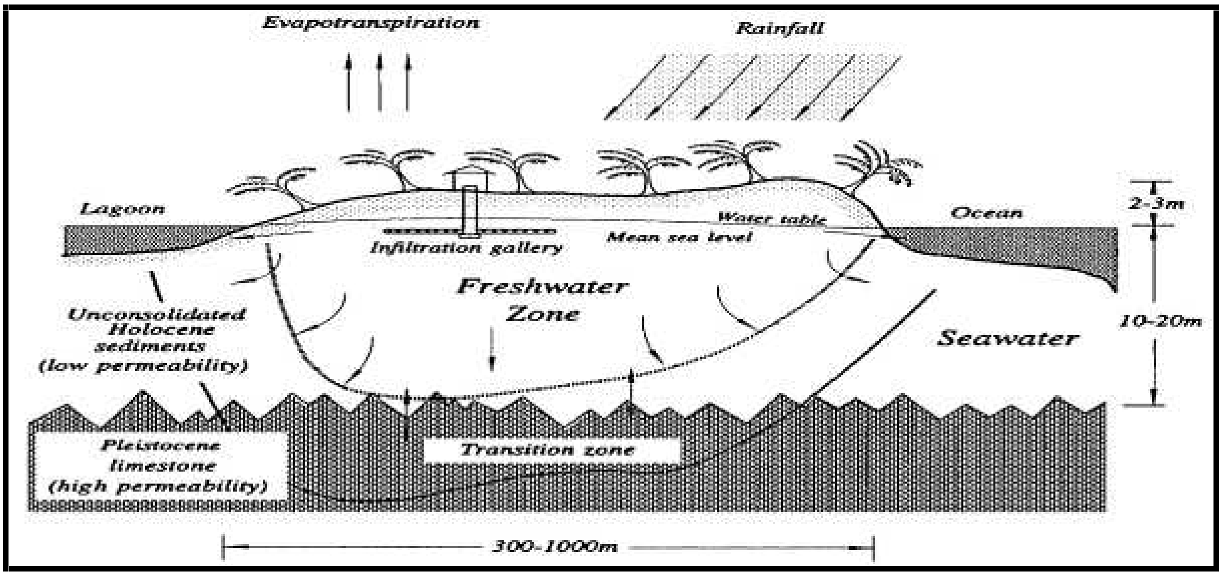
Source: Kiribati Second National Communication, 2012

Many small atoll islands of Kiribati, especially those in the north, have relative high rainfalls but still encounter critical water problems particularly in the urban islands. The freshwater sources of these small islands are constrained by limited land space, geology of atolls, socio-economic pressures and land-based pollution sources. The social ethical agency of communities, conflicts over use of lands, response and resource limitations including climatic related risk factors such as droughts and sea level inundation that contributes to the aggravating water problems on these small atoll islands.

The fact that (Hosoi 1995), atoll islands were a result of gradual carbonate reef deposits that sits on the edges of a submerged volcanic cone occurred during the last Holocene period presents the circumstances of these islands' land area composition as a result of coral algal modifications (Hosoi 1995).

These geomorphologic features of the islands characterises the freshwater resources as non-existent and further compounded by a great hydraulic conductivities of coral sands of the order of 10-100 m d^{-1} (Ian White 2007). Therefore fresh groundwater resources exist as thin freshwater layers floating over seawater (see figure 9 below)

Figure 9: Cross-section of an atoll showing freshwater lens



Source: Falkland, 2004

The quantity of these groundwater freshwater lens are dependent on rainfall to recharge their content, therefore during extended drought events, freshwater lens becomes thin and mixed with seawater leading to brackish water. This is one of the main sources of portable and drinking water (accessed by wells) for residents on almost all islands in Kiribati.

Due to restricted land areas, there are only three main sources of water i.e. i) government's managed ground water reserve on South Tarawa (Bonriki) – infiltration water galleries ii) groundwater wells (private and communal) and iii) rainwater catchments (water tanks, containers, water catchments).

2.4 CLIMATE

As noted from the section above on the geography of Kiribati, the three groups of islands are in the Central Pacific, widely spread out within few degrees North and South of the Equator and longitudes East and West of the International Dateline. The climate of this particular region of the Earth surface has been described as dry maritime type.

However, there are marked differences in rainfall across the groups, and within the groups. Temperature and winds are also slightly different. Long term records on consistent basis are available for Betio Weather Station in South Tarawa, and it is largely from these records that describe the climate of Kiribati.

Firstly controlling factors of the Kiribati climate was discussed. Traditional knowledge and information appear to stress astronomical factors as principal drivers of the climate of Kiribati. However, it was not the stars that maintain their positions, but that the Earth with Kiribati remains fixed in its position in space while the stars revolve. The Sun travels northward and southward, along an upper arc and along a lower arc relative to Kiribati, that is as observed from Kiribati. And this apparent movement of the Sun is associated with the movements of more distant stars, two of which are identified with two known seasons in Kiribati – "Te Aumeang" and "Te Aumaiaki". Te Aumeang is characterized by stormy and rainy climate and weather and last for six months, from around November to April. For the rest of the months, that is May to October, the climate and weather is characterized as calm and dry. Variations or changes from these seasonal weather patterns, which may be of days or weeks durations are claimed to be predictable from observations of heavenly bodies including the moon.

Implicit in the traditional knowledge of weather and climate is the sense of the relative position of Kiribati in the globe against the background of stars. And Kiribati is spread within the equatorial belt. Wind directions are from the easterly quadrants. Our traditional weather seasons "Te Aumeang" and "Te Aumaiaki" convey the sense of the directions of the winds, from the north and from the south respectively (Teuatabo 2011). But Hadley cells are more accurate in describing drivers of wind directions.

Kiribati climate is indeed part of the global climate systems. The Walker Circulation and associated El Niño and La Niña with their marked opposite conditions of flooding and drought for different parts of the South Pacific and the wider tropical region of the globe are predominating phenomena that determine Kiribati climate. These phenomena have also marked conditions on the temperature and movement (east to west) of the waters of the Central Pacific Ocean, and on wind direction. The patterns of the Walker Circulation are so synchronized with those of the El Niño/La Niña phases, that they are being referred to as one phenomenon – the ENSO (El Niño Southern Oscillation) for which the SOI has been developed to indicate the level of their distinctive states. Negative values of the SOI are pro-El Niño with a corresponding mode of the Walker Circulation. Positive values are pro-La Niña with opposite mode of the Walker Circulation. El Niño is known to occur every 5 to 7 years.

ENSO is known to affect known weather systems in the Pacific and monsoons in the Indian Ocean. It is also through ENSO effects on these systems (or correlation in the shifts of the positions) that determine the climate variability of Kiribati. A little to the north of Kiribati stretches the Inter Tropical Convergent Zone which is a region of lower pressure and cloud cover. Farther to the south is the South Pacific Convergent Zone which is orientated in a NW-SE alignment. During El Niño, these systems tend to move towards the Equator and therefore get closer to Kiribati which then experience heavy rainfall.

Monsoon winds in the Indian Ocean may also have influence on variability of winds directions and speed in Kiribati. Perhaps on low magnitude but longer period frequency, Pacific Decadal Oscillation may influence as well the climate of Kiribati, moderating or exacerbating the immediate influence of the ENSO.

Upper winds regimes are not known but at stratosphere strong westerly are known to prevail with occasional short waves generated. Kiribati is cyclone-free, but when and where cyclones or hurricanes happen to pass close from the north or south, Kiribati gets strong winds reaching gale forces and even storm forces.

The primary cause of the global climate (and Kiribati climate part of this) is from solar energy that has been absorbed in the climate systems. IPCC Reports (M.L. Parry 2007) have warned world leaders that enhanced greenhouse effect is leading the world to catastrophic climate change. However, how enhanced greenhouse effects interact with the climate systems and phenomena to signal and cause a climate change regime of Kiribati remain unknown.

However, there are records of climate variables that are discussed in the latter sections of the report. The records were made available by the Kiribati Meteorological Services Department to ECD and both authorities worked collaboratively to produce information on these sections.

TEMPERATURE

Betio Weather Station is located on the island of Betio in South Tarawa. A trend of 0.004^0C per year during the period 1947 to 2007 has been observed, compared to global temperature linear trend of 0.74^0C for the whole period 1906-2000 (IPCC, 2008, Climate Change 2007, Synthesis Report). The length of the period is 95 yrs which implies a trend on yearly basis of 0.008^0C. The report recalled the comparative trends of between Kiribati and global respectively for the same length of 40 years that were nearly conterminous. Kiribati temperature trend was a factor of ten lower than the global trend. This information provide the SNC team reasons to think that the global temperature has risen faster than Kiribati temperature but further that the latter is catching up.

As for the mean conditions of the temperature, the SNC team compare these during two periods 1970-2000 and 1976 to 2006, each period with duration of 30 years in order to be consistent with the WMO recommended length of the period for defining the climate.

Table 5 : Temperature averages

Temperature averages	**1970-2000**	**1976 - 2006**
Annual monthly mean temperature	27.8^0C	28.4^0C
Annual monthly average of max temperature	31.1^0 C	31.2^0 C
Annual monthly average of minimum temperature	25.25^0C	25.41^0C

Source: Data extracted from Kiribati Meteorological Service office

The range of temperatures for Kiribati that are normally quoted (e.g. in the Kiribati Country Report to the Conference of the Parties to the Convention on Biodiversity 2007, Kiribati Initial National Communication 1999, Kiribati National Adaptation Program of Action 2007) is between 26^0C and 32^0C. This range was also sourced in the State of the Environment Report (Wilson, 1994). From the information presented in Table 5 above, it appears now that there is new minimum temperature of 25^0C. This implies that the temperature range i.e. the variability of the temperature of Kiribati has also been increased.

The Table 5 gives the mean conditions. But as noted in Kiribati Country Report on Biodiversity 2007, temperature extremes of 37^{0}C and 22^{0}C have been recorded. The SNC team now considers the highest values in the monthly temperatures for each year; for the period 1977-2007. Monthly data are complete for all the years, except 1977 for which there are no data for the first four months, and 1992 for which there are no data for the whole year. These highest values of maximum monthly temperatures in each year, one value for each of the years, show a positive trend of 0.021^{0}C per year. The SNC team follow the same process for the lowest values of minimum monthly temperatures for each of the years over the same period. Records for the whole of 1992 are in this case available. The trend in this case is 0.025^{0}C per year. This suggests that the respective values of the maximum and minimum temperatures during each of the months in each of the years over those periods 1977-2007 have tended to converge.

The SNC team also recognizes a slight intra-annual variation (seasonal) of temperatures. From records of mean monthly temperatures over the period 1947-2007, the highest average value is 28.5^{0}C for the month of November. The lowest average is 27.9^{0}C of the month's temperature for May. It is also evident that the September, October, November, and December are the four hottest months.

The Kiribati Initial National Communication 1999 notes that during May to June the South Equatorial Current and the Counter Equatorial Current are weak (McLean,1989) which may suggest that these ocean currents do also influence the temperature regime that Kiribati experience.

The SNC team assessed the situation of the sea surface temperature (SST). The data are records of water temperatures on hourly basis obtained from records of a SEAFRAME located at Betio wharf. The records are from 1993 to 2004, a short period with gaps in the records. For each of the years, each month with hours as sub-units has or has no values of temperatures. The SNC team find the average of these values and take this average to be the value of temperature for that month in that year. The monthly values of temperature, January to December, in each of the years are averaged and this is the mean monthly sea temperature for that year. The mean monthly sea temperatures for each of the years are finally averaged to give what considered as the mean annual sea temperature and it is arrives at **29.6^{0}C**.

In a country report prepared by the SEAFRAME Management authority (AUSAID, June 2004) the minimum sea temperature noted is 22.4^0C and the maximum 32.9^0C. These compare to the lost minimum air temperature of 20^0C which occur in December 1981 and the highest maximum of 34.1^0C which occur in September 2003. The two ranges are 10.5^0C and 14.1^0C respectively, and the SNC team understand that sea surface temperature is taken few centimetres below the actual surface of the sea. The difference between the two ranges confirms that land temperature is more variable than sea temperature, but does not suggest strong influence of the latter on the former.

The SNC team's own analysis of available records confirmed the negative correlated relationship between sea temperature and air temperature. The quoted maximum of 32.9^0C differs only slightly from a maximum of 32.6^0C that was noted from records of hourly temperature from the SEAFRAME at Betio from 1993 to 2004. From the same record the SNC team notes a minimum temperature of 26.2^0C. These values give a range of 6.4^0C which, compared to the range (10.5^0C) given in the above paragraph, imply less variability of sea temperature compared to greater variability of land temperature. This suggests more convincingly that sea temperature may not have significant influence on land temperature.

From the same data, the highest monthly mean (over all the years) of 30^0C occurred in September while the lowest mean of 28.9^0C in February. And except for February mean water temperature, all the other months mean water temperatures are above 29^0C.

The lowest annual mean sea temperatures (over the twelve months) is 28.69^0C which occurred during 1999, with next higher mean sea temperatures recorded for 1998 and for 2000. The inverse correlation between sea temperature and rainfall is clearly demonstrated by rainfall records of 621mm, 639mm, and 903mm respectively for these three years (1998, 1999 and 2000) for which national emergency condition of drought was declared in Kiribati.

RAINFALL

Rainfall is highly variable and is largely affected by the ENSO. During El Niño, heavy rainfall is experienced in Kiribati, while La Niña is associated with drought. Inverse correlation between the SOI and the amounts of rainfall is well established. This is discussed in later sections of the report. For this SNC report, the team examine the pattern of variability and distribution of the rainfall.

Rainfall data for the periods 1947 to 2004 are available from Butaritari and Betio stations in the Gilbert Group, from Kanton in Phoenix Group, and from Kiritimati in the Line Group. There are some gaps in few monthly records. Monthly records are summed for each year over the whole period, 1947-2004. Annual averages, maxima and minima in the annual totals for each of the stations are shown in the Table below.

Table 6: Average, maxima, minima of annual rainfall in mm for period 1947-2004

Stations	Average	Max	Min
Butaritari	3160	**4823** (1990)	1447 (1950)
Betio	2029	4356 (1992)	397 (1950)
Kanton	940	3473 (1987)	198 (1954)
Kiritimati	947	3635 (1997)	177 (1954)

Source: Data extracted from Kiribati Meteorological Service office

Butaritari is the second island from the north, not far from the most northerly island of Makin, in the Gilbert Group. Tarawa, where Betio station is located, is south of Butaritari and record less rainfall. Islands further south are drier and their annual rainfalls are close to those of Kanton and Kiritimati.

Table 6 above also shows spatial distribution of rainfall which is quite consistent with what Kiribati people have known. But it is further observed from the Table that minima rainfall was experienced in the 1950s while most of the maxima occurred more recently during the 1990s; this could not have been known from Kiribati people experience.

The SNC team assesses linear trends of annual mean rainfall over the same period 1947-2004, though the team recognized that annual rainfall is highly variable. They are shown in Table 7 below.

Table 7: Trends of rainfall on different stations for period 1947-2004

Stations	**Trends in 1947-2004**	**Trends in various periods provided by KMS**
Butaritari	-2.3 mm per year	0.166 mm/yr (1931-2007)
Betio	2.1 mm/yr	1.048 mm/yr (1926-2007)
Kanton	19.2 mm/yr	0.942 mm/yr (1937-2007)
Kiritimati	12.8 mm/yr	0.651 mm/yr (1921-2007)

Source: Data extracted from Kiribati Meteorological Service office

Butaritari in the northern Gilbert where amount of precipitation is normally high may have experienced slight increase of annual precipitation. Kanton in the Phoenix Group and Kiritimati in the Line Group which normally have small amounts of precipitation in a year may have in this long period experienced noticeable increase of annual precipitation. Betio in Tarawa may share the same experience.

More rainfall can also be more intense. This leads to floodin***g*** that are health-risks through run-off that affect ground dug wells, and settlement areas. Heavy rainfall, flooding and run-off have been regularly (at least twice a year) experienced, but there has been no indicator of the level of rain intensity to associate with the occurrence of flooding. However, recently NIWA (2008) produced analysis of intensity of rainfall based on records from several islands and for different periods. This report provide information on the four islands, and adjust and combine information from various Tables in NIWA Report (2008) for exceedance probability of 50% as shown in the Table 8 below.

Table 8: Extreme rainfall values with reference to day durations for 50% exceedance probability

Station/Island	Period	Durations and extreme rainfall values in mm		
		1 day	**2 days**	**3 days**
Butaritari	1971-1999	132.9	163.2	186.2
Betio in South Tarawa	1948-2000	109.3	137.4	153.0
Kanton	1948-2000	81.8	101.3	115.9
Kiritimati	1952-2000	71.1	94.4	108.0

Source: Data extracted from Kiribati Meteorological Service office

The Table 8 above shows also the spatial distribution of rainfall, and the differences of rainfall distribution at the days' durations. Moreover, since flooding from heavy rainfall that have caused discomfort for people living on Butaritari, Tarawa, and Kiritimati have been experienced with exceedance probabilities of 50% and over, attached to the extreme values, indicates that this report take these extreme values as indicators for flooding and discomfort. Flooding from heavy rainfall is another concern to communities in Kiribati.

However, a more serious concern about rainfall variability is ***drought***. This is because of its serious impacts on ground water lens which is the main source of potable water for Kiribati people. For most people it is the only source. But it is not only the scarcity of water or its increasing salinity being noted, Kiribati people also associate drought with; diminishing agricultural and fisheries productivities as the experiences and indicators of "drought".

Previously there is no clear definition of "drought" in Kiribati, however in 2011, drought definition for South Tarawa was adopted and this informs the development of the Drought Response Plan for South Tarawa which also builds on the "Decile" method. But clearly Drought was generally perceived as the period when there is little rainfall with consequences on water, and agricultural productivity. This period can vary between months to years, and the severity of drought depends on the length of the period and how well people are prepared for it.

In the past and recent period, drought conditions have been experienced. Anecdotal sources talked of droughts after the World War II (1940s) when some island governments issued ration of rice for the people's food, but for water they just had to live with underground saline water. More recently in 1999, the Government of Kiribati declared state of emergency for the whole of Kiribati on account of drought felt throughout, but in particular for water supplies for urban Tarawa. Indeed ***"drought"*** conditions of varying durations have been experienced from time to time.

While drought is real to people who experience it, findings of past scientific objective investigations on drought have been inadequate to account the sufferings of people who have experienced the drought impacts. This is also to mention that there is few scientifically impact assessments that have been undertaken in Kiribati to understand the level of drought impacts on the society.

There was the case of the drought experienced during 1998-2000, when it was scientifically assessed that the ground water lens from which water was pumped to supply the urban population of South Tarawa still had huge amount of water with tolerable salinity level. Nonetheless, fresh water lenses were halved as reported in Falkland, 2003, "Kiribati SAPHE Project: Mid-Term Review. Review of groundwater resources management for Tarawa".

Based on rainfall records, and several tools of analysis, the amounts of rainfall in 1998-2000 would be considered as drought conditions. These analysis tools include Decile Method (DM), Critical Risk Profile (CRP), and Drought Severity Index (DSI). But there is inadequate local capacity to fully understand them and use them to analyse data. It is known that drought depend on rainfall temporal distribution at a particular island; the appropriate time interval that can be set within which to define drought conditions depends on the purpose for which rainfall has been useful for the needs of people. The Decile Method was the first to be introduced, it is also the simplest of the three and there is better understanding of it.

The CRP and the DSI were more recently brought to our notice and still take time to enable these to be used as tools. CRP uses maximum and minimum of rainfall for each year during the period and establishes ranking to work out the return period and exceedance probability.

It would be possible to work cumulative sums and to work out percentage of the lowest cumulative sum and likewise up to the highest which will be 100%. The DSI is too complex for our understanding but the Coastal calculator provided by NIWA would appear to suggest information that are extracted and set out in the Table 9 below.

Table 9: Annual Return Interval for rainfall

Annual Return Interval, that is, Annual Return Period							
	2	**5**	**10**	**20**	**50**	**75**	**100**
	Corresponding Exceedance Probability						
	0.5	**0.2**	**0.1**	**0.05**	**0.02**	**0.013333**	**0.01**
Islands	**Duration in months**						
Butaritari	4.9453	10.73	14.504	19.722	27.475	31.262	32.919
Betio in South Tarawa	4.4029	11.707	19.085	24.366	29.702	31.408	32.407
Kanton	5.6258	9.7291	12.849	15.555	25.981	27.679	28.496
Kiritimati	5.5177	10.116	13.572	15.773	17.806	18.517	18.948

Source: Data extracted from Kiribati Meteorological Service office

The DSI having turned to value of the onset of drought, then it will be expected to continue for at least 4 months for Butaritari with a likelihood of 50%. With the same interpretation, Betio, Kanton, and Kiritimati drought continues for 4.4 months, 5.6 months, and 5.5 months respectively with the same probability that they were to be exceeded of 50%.

NIWA 2008 concludes that, "the analysis for Kiribati shows the joint recurrence interval increases with drought duration and intensity, and events with the largest average recurrence interval (i.e., rarest events) coincide with the very severe and long-lasting droughts**."** This feature is demonstrated in the table 9 above. This simply means that probability of having drought events in Kiribati is highly variable but severe and long-lasting droughts could still occur but on a rare occasion.

How to apply these tools were not fully understood but nonetheless the SNC team still uses them to the best of their knowledge in analysing rainfall data from Betio Station. This could lead to different and inconsistent results with reference to the tools themselves or to the reality of felt droughts by the people. The notion of drought as one that brings dire consequences on the life of the people need not be obscured by complex analytical tools. The SNC team are particularly conscious of this in the case of using the DSI following the description in a technical report “Kiribati Adaptation Programme. Phase II: Information for Climate Risk Management, High intensity rainfall”, 2008, by NIWA. Nonetheless, the SNC team made efforts to incorporate it with the Decile and CRP tools to enable this work to determine droughts occurrences from rainfall data for Betio Station. Values of the Southern Oscillation Index are also used to decide drought months. The results are presented in the Table 10 below.

Table 10: Drought severity

Year	Total drought months	Year	Total drought months
1947	6 (Jul-Dec)	1973	8 (May-Dec)
1948	3 (Jul, Oct, and Nov)	1974	10 (Jan-Oct)
1949	4 (Sep- Dec)	1975	12 (Jan-Dec)
1950	12	1976	6 (Jan-Apr; Oct-Nov)
1951	2 (Jan-Feb)	1978	8 (May-Sep)
1952	3 (May-Jul)	1981	8 (Jul – Dec)
1954	9 (Apr-Dec0	1982	3 (Jan-Mar)
1955	12	1983	1 (Dec)
1956	12	1984	2 (Jan-Feb)
1957	1 (Jan)	1985	6 (Feb, Apr,May,Aug,Sep, Dec)
1958	3 (June-Aug)	1986	2 (Mar, Jun)
1959	4 (Sep-Dec)	1989	9 (Jan-Jul, Sep- Oct)
1960	8 (May-Dec)	1990	1 (Jul)

1961	7 (June-Dec)	1992	1 (Sep)
1962	12 (Jan-Dec)	1995	4 (Jul - Sep and Nov)
1963	5 (Jan-May)	1996	12
1964	9 (Apr-Dec)	1998	8 (May-Dec)
1967	6 (Feb-Mar; Jun-Sept).	1999	12
1968	5 (May-Aug; Dec)	2000	12
1970	7 (Jun-Dec)	2001	3 (Jan-Mar)
1971	12 (Jan-Dec)	2004	1 (Mar)
1972	3 (Jan-Mar)	2005	1 (Jul)

Source: Data extracted from Kiribati Meteorological Service office

The Table 10 shows that in Kiribati drought conditions can normally be expected in any month whichever tools and however, they may be used. “Given that droughts are frequent in Tarawa, that many households have galvanised iron roofs (particularly in urban South Tarawa), and the public water supply is intermittent, the percentage of households with working rainwater harvesting systems is low” - GWP Consultants (2010) observed in their Report “SOUTH TARAWA, RAINWATER HARVESTING ASSESSMENT For GOVERNMENT OF KIRIBATI”.

It is noted also that the years without or with very few identified drought months are when El Niño occurred, and it is possible that the occurrences have been more frequent while droughts nonetheless continue to prevail.

WIND

Data from the SEAFRAME tide gauge are used in describing wind conditions.

The table below shows monthly wind directions and frequencies for the period 1993-2003.

Table 11: Monthly frequently of wind directions

	N	NE	E	SE	S	SW	W	NW	N,NW,NE	S,SW,WE	DIFFERENCE IN FREQUENCIES OF NORTHERLY AND SOUTHERLY WINDS
Jan	4	26	48	11	2	0	2	4	34	13	21
Feb	1	28	59	9	0	0	0	1	30	9	21
Mar	0	26	58	8	2	0	2	2	28	10	18
Apr	1	23	58	7	2	3	4	2	26	12	14
May	3	18	52	14	4	4	2	4	25	22	3
Jun	0	14	46	20	6	5	5	3	17	31	-14
Jul	3	16	40	20	8	5	4	3	22	33	-11
Aug	2	9	39	20	6	9	3	7	18	35	-17
Sept	3	12	37	21	7	8	8	5	20	36	-16
Oct	1	8	39	19	3	9	15	4	13	31	-18
Nov	1	12	38	19	5	6	9	8	21	30	-9
Dec	4	23	40	11	3	4	7	8	35	18	17

Source: Data extracted from Kiribati Meteorological Service office

The Table 11 shows also the prevailing directions of the winds that would be expected to correspond respectively to the two weather seasons of Te Aumeang and Te Aumaiaki. But the traditional weather season month of April when Te Aumaiaki starts may now have shifted to June, and the season ends now in November. It is now recognized however that the data are incomplete and that the period covered may be inadequate.

Wind Speed

Table 12: Wind Speed frequency

Speed frequency							
Months	<5 (km/hr)	5-10 (km/hr)	10-20 (km/hr)	20-30 (km/hr)	30-40 (km/hr)	40-50 (km/hr)	>50 (km/hr)
Jan	6	13	36	37	5	0	0
Feb	3	5	36	48	6	0	0
Mar	4	9	33	46	6	0	0
Apr	6	12	40	39	3	0	0
May	12	17	44	27	1	0	0
Jun	13	20	42	23	1	0	0
Jul	17	27	36	18	1	0	0
Aug	16	22	37	26	1	0	0
Sept	14	22	40	23	2	0	0
Oct	7	15	40	32	4	0	0
Nov	12	20	39	25	2	0	0
Dec	13	17	36	31	3	0	0
TOTAL Frequency	123	199	459	375	35	0	0

Source: Data extracted from Kiribati Meteorological Service office

The most frequent speed is between 10-20 km/hr which is equivalent to about 5-10 knots, and the next higher speed of 10-15 knots are the next frequent. Wind speeds of between 15 – 20 knots are infrequent and these are more generally from the westerly directions, but strong gusts from the easterly directions have also been experienced.

This is analysed for each of the years (1992-2004) gust speeds and wind speeds. Strong gusts reaching 50.3 knots or about 100 km/hr have been reported as in Paterson Brentton (1992) citing JICA (1985). Maximum gusts for each year of the data from the SEAFRAME at Betio are shown in the Table below.

Table 13: Annual maximum gusts, 1992-2009

Year	**Max gusts in m/sec**	**Max in knots (1.85 km/hr)**
1992	6.7	13.02
1993	17.6	39.65
1994	20.4	39.65
1995	22.4	43.54
1996	19.8	38.49
1997	24	46.65
1998	16.6	32,27
1999	20.6	40.04
2000	19.8	38.48
2001	33.1	64.34
2002	23.0	44.71
2003	18.3	35.57
2004	20.8	40.43
2005	22.6	43.93
2006	21	40.82
2007	20.3	39.46
2008	18	34.98
2009	21.5	41.79

Source: Data extracted from Kiribati Meteorological Service office

The Table 13 above shows that strongest gust of 64 knots was observed in 2001, higher than 50.3 knots noted by Bretton (1992). A clear increasing trend of 0.5knots per year is also observed in the table above, but again the data may not be of adequate length and quality to establish a more persistent value.

CLOUD COVER

Solar radiation data are provided in a Draft State of the Environment Report 2003-2005. The units of solar radiation are given in kw/h per sq m. The report takes 1kw/h to be equal to 3.6MJ. Solar radiation incident on Tarawa or on Kiritimati is taken as proxy for the intensity of sunlight and therefore cloudiness. Solar radiation during cloudy day is expected to be lower than the clear day. It is also dependent on the geographical position of the stations on globe latitudes.

Table 14: Cloud cover for islands

Island	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	Mean
Tarawa	5.75	5.94	5.94	5.58	5.5	5.36	5.30	5.77	6.75	6.25	6.5	5.55	5.86
Xmas	5.19	5.47	5.67	5.58	5.45	5.2	5.42	6.03	5.98	5.57	5.12	5.56	5.56

Source: Data extracted from Kiribati Meteorological Service office

Solar radiation is higher for Tarawa than for Kiritimati, which may be due to the different in minutes of latitudes of their positions. The difference appear to be more marked for the months from September to March which is the period when the apparent movement of the sun is overhead at south of the equator.

On the other hand, it is within that period when the traditional “Te Aumeang” dominates the weather and more rain is expected for Tarawa which seemingly has been observed. Lower solar radiation would be expected, if measured below cloud levels, but from the data above this has not been so since the data were from satellite cloud maps. Perhaps the period covered in the data on solar radiation is very short.

2.5 SOCIO-ECONOMIC CIRCUMSTANCES

2.5.1 DEMOGRAPHIC SITUATION

During the 2000 Census the total population of Kiribati was 84,494 and during the 2005 Census was 92,533 giving annual growth rate of 1.8 per cent. This compares with the earlier 1995-2000 intercensal growth rate of 1.7 per cent.

Broad age structure in the two censuses, 2000 and 2005 Census is shown in the Table below.

Table 15: Age structure at the census 2000 and 2005

Census yrs	**Age groups (%)**				
	0-5	6-14	15-17	18-49	50+
2000	0.17	0.23	0.07	0.42	0.11
2005	0.14	0.22	0.07	0.44	0.11

Source: Kiribati National Statistic Office

The Total Fertility Rate (TFR) "declined quite dramatically from about 4.5 during the 1990s to about 3.5 in 2005" (Kiribati Government. 2007. Kiribati 2005 Census, Volume 2: Analytical Report). Likewise, Infant Mortality Rate (IMR) has declined to 52 at the 2005 Census compared to estimated value of 61 in the 1995 Census. And life expectancy (LE) at birth is 63.1 years in 2005 Census compared to 62.8 yrs in the 2000 Census.

These trends in population growth rates, TFR, IMR, and LE seem to move toward a desired social and economic situation. However, social and economic situations are characterized by other variables also which will be discussed in the other sections.

Now this section discusses the distribution of Kiribati population. The Gilbert and Line Groups are permanently populated i.e. urbanized with fixed infrastructures and settlements, while the Phoenix Group has not been so since the early 1960s when its inhabitants, originally settled there in the 1930s from overcrowded Gilbert Islands, were again uprooted but this time to another Pacific island country –Solomon. Kanton is the only island of the

Phoenix Group that has few people; they are government's officials and families living there as caretakers.

In the Table below its show population distribution and trends between two regions – the Gilbert group, and Line and Phoenix groups combined. The distributions relate to four latest censuses- 1990, 1995, 2000, and 2005.

Table 16: Population distribution by main regions and census

Kiribati Group	**1990**	**1995**	**2000**	**2005**	**TREND**
Gilbert:					
Population	67,508	71,757	78,158	83,683	5,492 persons/per census intervals
Line and Phoenix:					
Population	4,827	5,901	6,336	8,850	1,250 persons/per census interval
Kiribati All population	72,335	77,658	84,494	92,533	6,743 person/per census interval

Source: Data extracted from the Kiribati National Statistics Office

While all population totals have been increasing over the period spanned by the censuses, it is evident from the Table 16 that the both share of Gilbert and Line & Phoenix Islands has increased at an alarming rate per census intervals.

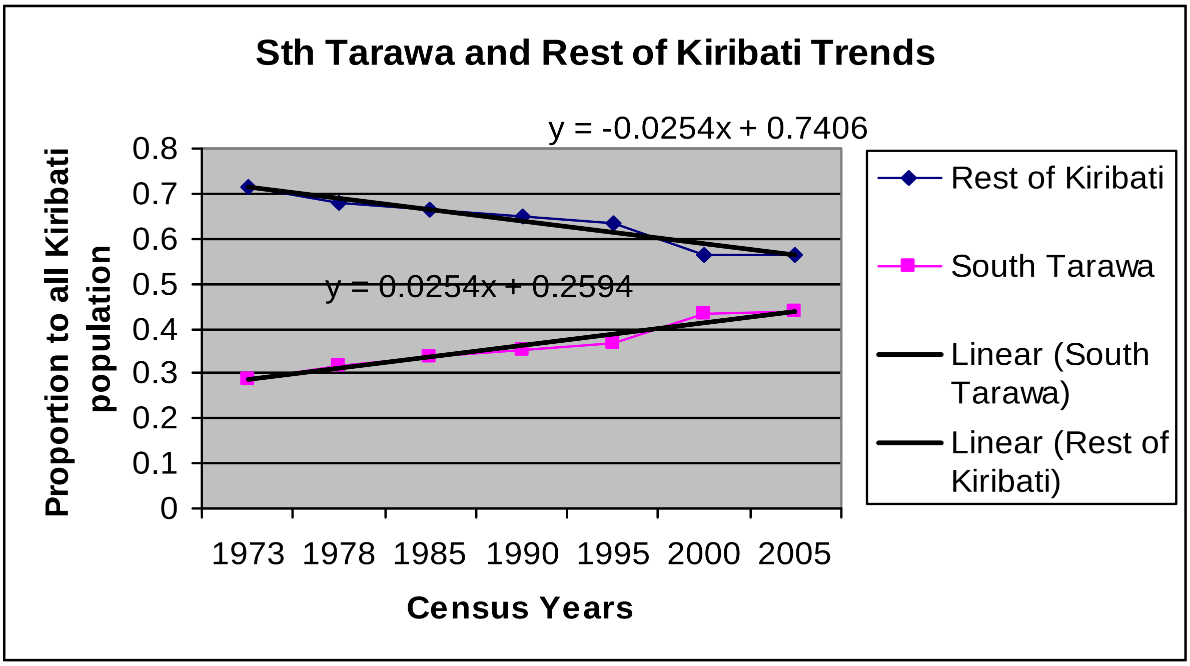
Initially this is the result of a resettlement policy and schemes that were started in the mid 1980s and later as a consequence of new income earning opportunities opening up on the Line group.

Urbanization is also very noticeable in the census data from 1973 to 2005. South Tarawa which is the only urban area shows an increasing trend. Its population has shown an increase of about 4,300 people compared with the previous census, while the second highest increase is about 800 which is the increase in Kiritimati population. Islands close to South Tarawa as in the situations of North Tarawa and Abaiang, and islands close to Kiritimati as in the situation of Tabuaeran, have shown much higher increases (trend) of their population than those observed for other islands. It is significant that the four most southerly islands in the Gilbert all experience a decreasing trend of population, which is also the situation of the population of Banaba. All the rest of the islands have increasing population but not as high as the urban centres.

However, their population proportions to the total Kiribati population show decreasing trend, implying the increasing dominance of the populations of Line island groups and the three islands in the Gilbert group, that is South Tarawa, North Tarawa and Abaiang.

In the 2005 census the urban population, which is the population of South Tarawa, where 43.6% of all Kiribati population is located, and also reflects that this proportion could increase further in the future. In figure 17 below the trend of urbanization is shown. Preliminary population data on the 2010 Census indicate urbanization at 48.4% of all population and rural population of 51.6%. If Kiritimati is taken as an urban area because the livelihoods and services there are quite similar to those on South Tarawa, then urbanization proportion of the population in the 2010 Census is 53.3%, exceeding therefore rural population proportion. High urban population should not however be taken to imply that the importance of subsistence livelihood based on natural resources is becoming less significant relative to increasing importance of lifestyle based largely on monetary economy. In urban areas, a high proportion of the population still depends on available natural resources that are over harvested. Rural outer islands would still be populated whether or not decentralization is a conscientious policy of government (given population growth rates).

Figure 17: Population trends of urban and rural areas of Kiribati



Source: Data extracted from National Statistics Office for Kiribati SNC, 2012

EDUCATION AND SKILLS

The level of formal education attained by any person of the working age of 15 years and above is generally commensurate with the level of skill in a trade or profession that the person holds. From the three census years, the levels of education achieved by people of working age group and above are shown in Table19 below. This may indicate that there is general increase in the number of people aged 15 years and over, who never attended formal schools during the period 1986-1990. . This is because during 1995 Census, there were 2788 persons aged 15 years and over, who never attended school compared to 4781 of the same category in the 2005 Census. This increase would mostly be from persons born between 1986 and 1990 and who at the 2005 Census are aged between 15 and 20 and never attended school.

This implies that there are increasingly more children not attending any schools and more adults not having opportunities to attend formal schools. It is noted here that Kiribati 2007 “Millennium Development Goals” assert another interesting perspective, that primary level enrolment rate from 1990s to early 2000s was over 100% because of repetitive rates.

Table 18: Number of adults who never attended formal schools

Census	All population	Pop of 15yrs and over who never attend formal schools
1995	77,658	2,788
2000	84,494	2,759
2005	92,533	4,781

Source: Kiribati National Statistics Office

This does not however mean that the general level of educational qualification of employees in various occupation categories is declining. The Table 19 below shows the changes levels of education of employees during two recent censuses 2000 and 2005.

Table 19: Education levels of the workforce at two recent censuses 2000 and 2005

Occupation category	Census yr	Level of education achieved							
		None	Prim	Secondary	Certificate	Diploma	Degree	Post grad degree	PhD
Agric and Fisheries	2000	1	38	64	0	3	1	1	0
	2005	92	488	253	4	1	0	0	0
Legislators and Snr Officials	2000	7	39	305	6	18	37	12	1
	2005	2	146	316	34	38	68	44	2
Professionals	2000	7	109	848	12	30	38	8	0
	2005	21	254	1654	261	133	138	17	2
Technicians and Associate Professionals	2000	11	151	653	2	6	4	1	0
	2005	14	259	772	74	37	16	11	0
Clerks	2000	0	60	766	4	5	3	3	0
	2005	21	215	1438	91	19	21	4	1
Service workers	2000	46	454	584	0	2	2	0	0
	2005	108	945	1165	24	9	3	3	0
Trade workers	2000	31	294	273	0	1	0	1	0
	2005	49	460	480	27	11	3	0	1
Plant and	2000	22	225	184	0	0	3	0	0

Machine operators									
	2005	55	567	780	33	4	1	0	0
Elementary Occupation	2000	24	252	232	2	2	1	0	0
	2005	40	424	306	11	1	0	0	0

Source: Information extracted from Kiribati 2000 and 2005 census reports for SNC Document 2012

With the exception of "Agriculture and Fisheries" category, comparative records in the two census show increases in the number of employees with levels of education above the secondary level in the rest of the employment categories. Agriculture and Fisheries is an odd category because all unemployed I Kiribati can claim to be in that category. This may be explained by the wide differences in the numbers given under this category for the censuses 1995, 2000, and 2005.

Since 1995 there has been significant increase in the number of persons with post graduate degrees up to doctorate qualification. But the number of persons receiving no formal education is increasing faster. This suggests that the gap between the numbers who receive higher education and those who do not have any education has increased. Between secondary education and primary education there appears to be decreasing emphasis on the latter while the former receive increasing emphasis.

Secondary education is one of the areas to which Churches have traditionally made significant contributions. This contribution continues and is more extensive as additional secondary schools run by churches are opened up. But also some of the schools have been closed, reopened, or never so again. This explains in part why the ratios of all persons achieving secondary education to all persons achieving primary education are much less than what would be expected from greater emphasis placed on secondary education.

HEALTH

Improvements in the Infant Mortality Rate (LMR), Life Expectancy (LE) at Birth and even the TFR suggest that the general health of the population is improving if longevity of life means healthy life.

Table 20. Pattern of three statistics on health

Pattern of Health	1990/1995	1995/2000	2000/2005
IMR	67	43	52
LE	59.7	62.7	61
TFR	4.5	4.3	3.5

Source: Kiribati Health Statistics, 2012

Many factors could have contributed to these improved health indicators. The state of the natural environment upon which life depends might have been improved and healthier. Better access to improved health facilities, more informed people on how to look after their health - all may have been contributing factors. In addition, under-reporting may have been occurred in the past as compared to many people now reporting to clinics thus providing more realistic information at ground level.

The state of health of the people shows improvement over the decade 1995-2005, according to the three statistics. Often it is taken as a reflection of improved level of economic development and social progress. But it does not tell the full story. Long term illnesses such as TB are not disappearing but appear to be persistent and may have affected high proportion of people. “Kiribati 2007 Millennium Development Goals” report asserts that between 1990 and 2006 indicated that TB prevalence rate have increased from 392 (per 100,000) to 403; - the highest in the Western Pacific.

Diseases such as respiratory track diseases, diarrheal, and skin diseases are among common causes of illnesses and deaths. Other diseases such as dengue fever, firalarisis, diabetes complexities, eye diseases, and HIV/AIDS are more recently acquired by Kiribati population.

Health statistics also need to be correlated with conditions of a changing climate.

2.5.2 ECONOMIC SITUATION

Kiribati is recognized as a Least Developed Country (LDC) in the United Nations categorization of countries on the basis of their wealth and stages of socio economic development. The UNFCCC acknowledge that special considerations for funding and transfer of technologies should be given to LDC needs.

Accordingly, Kiribati deserves assistance from UNFCCC processes and international funds that are established, so as for Kiribati to be able to meet the challenges of climate change. These challenges include the impacts of sea level rise, increasing frequency and severity of storms and storm surges on crucial islands ecological resources such as coastal areas, ground water lens, traditional agricultural plantations and systems. Assistance to Kiribati has been forthcoming since 1990, with significant increases during the recent decade.

There is a need to investigate the level of assistance that Kiribati had received either directly from the UNFCCC process or indirect through bilateral arrangements. This external assistance must also be fully understood in terms of which sectors and categories they have been vested into e.g. technical assistance, capacity building, and investments. These are important baseline climate finance information that is fundamental to inform Kiribati on notion of climate finance as should “new and additional” to aid funding. These are current issues that need to be ascertained in the subsequent Third National Communication.

There is no doubt that the need for external assistance will continue into the foreseeable future (Kiribati had preliminary assessed it financial needs with respect to climate change and was quite substantial). This is supported by anticipated increase in the severity of the impacts of sea level rise and storms on the coastal zone where development and settlement infrastructures concentrate. Ground water lenses are most vulnerable as well. And ecosystems and biodiversity need protecting from slow onsets, and creeping or unexpected impacts of climate change.

Due to its poor economic situation the need for external assistance seems to be unavoidable in Kiribati. Main sources of Government’s recurrent revenue come from income tax and corporate tax, license fees paid by foreign fishing vessels, import duties, and drawdown from

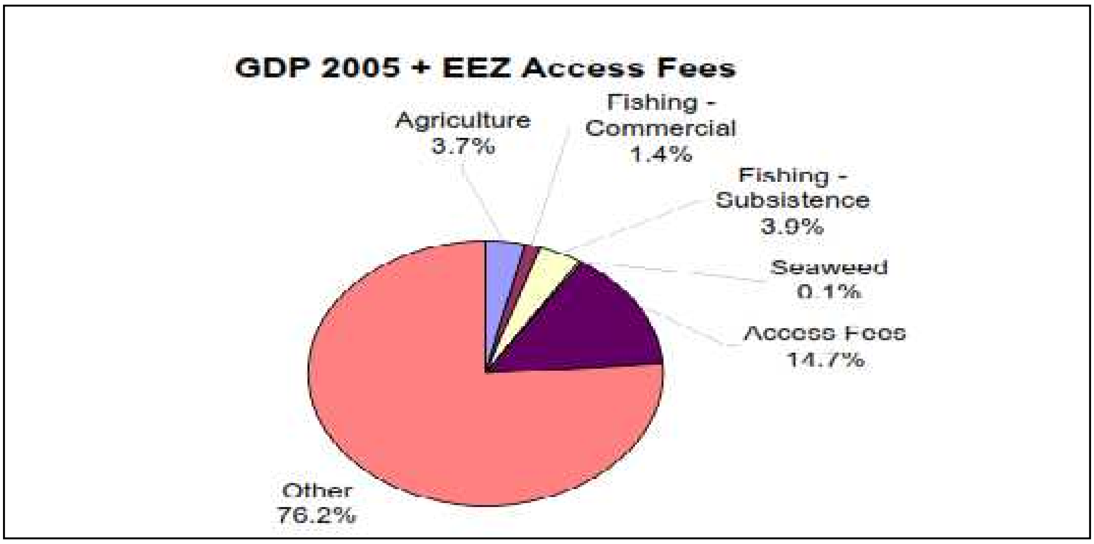
Revenue Equalization Reserve Fund (RERF). The RERF is one of Kiribati's foreign investments set up from sales/tax of phosphate mining in Banaba. The purpose of RERF is to cover shortfall on revenue during the post phosphate period. The amounts of drawdown varied from year to year. However, in most recent years the amounts have been significant to meet in part, new or increased amounts of public expenditures dealing with various issues. The figure 10 below highlights the main fabrics of the economy of Kiribati with the category "other" as mainly Government and some private services. The detail of GDP by various industries in Kiribati is shown in the table below.

Table 21: Kiribati GDP by Industry for 2011 ($A'000) – revised June 2012

Industry	**2011e**
Agriculture & Fishing	43,009
Mining and Quarrying	45
Manufacturing	9,461
Electricity, Gas & Water Supply	1,700
Construction	2,250
Wholesale & Retail trade	12,539
Hotel & Restaurants	1,069
Transport and Storage	9,431
Communications	5,004
Financial Intermediation	8,623
Real Estate (housing business)	18,295
Business Services (3)	1,618
Government sector	47,494
Other Community, Social & Personal Services	2,914
Less imputed bank service charges	(7,000)
GDP at factor cost	**156,453**
Plus taxes on products	20,082
less subsidies	(8,583)
Nominal GDP at market prices	**167,952**
Nominal GDP growth rate	***2.4%***
Population	***103,197***
Nominal GDP per capita	***1,627***

Source: Kiribati National Statistic Office

Figure 10. Contributions to the national economy of some key sectors in 2005



Source: Hay and Onorio, 2006

At present, there is however no intention by Government to use local resources such as drawdown from the RERF for any climate change activities. However, given the severity of these climate change associated impacts – the Government may have committed significant amount of local resources (through normal budgeting and other funds already). This notion of externally financing of the climate change impacts was reflected in its Climate Change Policy 2005 whereby, it states that "climate change needs will be met as far as possible by external funds". On the other hand, Kiribati makes in kind contributions to support project based activities on climate change such as SNC or Kiribati Adaptation Project but these contributions are not clearly identified, valued, and allocated. There is also need to include project funds in government's multiyear (3yrs) budget and in annual operational planning and budgets of relevant ministries that implement the project activities.

If Kiribati needs to be able to address climate change, in particular adaptation, and if the need are to be met from multinational financial mechanisms then there is the need to emerge a workable arrangement for cooperation in the implementation of project based activities, between international implementing agencies and Kiribati. Kiribati is going through this process in its association with the WB as the Implementing Agency for KAP.

Any mal-adaptation or misplaced focused area selected for adaptation will have adverse repercussions in Kiribati's economy. Hence, it is critically important that these climate change projects are nationally driven but not dictated by development partners. Large portions of adaptation funds may end up in the production of complex reports which may never be used, or in excessive management services for the funds, while on the other hand a much needed physical work could be starved of funds. Any adaptation need that can be identified now but which is not addressed immediately will at some later time be so critical as to demand urgent action at a much higher costs. It may also turn out that the impacts of climate change that originally generate such adaptation need have been so aggravated, widespread, severer, and irreversible that there is no longer any adaptation option to consider - may be too expensive or difficult to secure funding. In such situation, it is a fact that climate change is not only an environmental issue but also an economic issue which needs to be highlighted and addressed.

Kiribati is a LDC. The level of formal education and skill of the general population is low; economic development opportunities are limited, and the national economy is open and subject to global economic fluctuations. Since 2002, GDP per capita have remained rather constant and annual growth rates do not suggest any sustained long term positive trend. This could be a reflection of the state of the global economy. The table below shows the rather unhealthy socio economic circumstances over the last decade.

Table 22: Socio-economic indicators for 2001-2009

Socio econ indicators	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**
GDP at Market Prices (in $AUD thousands)	83346	95135	101399	95733	97456	100290	105599	105943	107975
Agric and Fisheries contribution ($AUD in thousands)	2107	5622	9082	8684	6807	8389	10571	9480	9292
Govt sector $AUD (in thousands)	28679	31144	34620	35579	37726	42467	42371	44424	42220
Population	86044	87622	89229	90866	92533	94231	95959	97720	99512
GDP per capita	969	1086	1136	1054	1053	1064	1100	1084	1085
growth rate of GDP	3.0	14.1	6.6	-5.6	1.8	2.9	5.3	0.3	1.9

Source: National Statistics Office, 2010. Kiribati National Accounts. The Production Account and GDP.

Government's sector contribution to GDP also shows an increasing trend, indicating more government's services addressing areas that in the past have received less attention. Among such areas are environment protection and conservation. Another significant feature observed in the Table is the drop in GDP from the level in 2003 to what it is in 2004. It has been suggested in "Kiribati 2007 Millennium Development Goals" that this is due to increase in oil prices from US$20 a barrel in 2001 to US$70 a barrel in 2005, and to high fluctuation in the price of copra and seaweed. These costs tend to increase the costs of intermediate inputs to final domestic products, and moreover increase the imbalance of trade.

Government's recurrent budget is based generally on five years budget of two years backward, and two years forward, of the current year. There is also a requirement that Ministries prepare their current year Operational Plans which they regularly monitored and upon which performances are assessed. Government's expenditures, in particular wages and salaries, are factors in GDP. Over the period 2001-2009, government's contributions to GDP have varied between 32% and 42% but with positive trend. This suggests that Government's budgets will remain significant contributor to GDP and its growth.

But how well has GDP filtered down and distributed throughout the regions and households, NSO and UNDP analysis of data from the "2006 Household Income and Expenditure Survey" report shows that expenditure of the household in the Line and Phoenix Group is higher than that of the household in South Tarawa. As expected, households on the rest of Gilbert, that is, in the rural areas, have the lowest expenditure. These imply that household incomes are different for the three main regions.

The analysis is specifically on poverty levels and characterization. The SNC team extracted some important information and show them in the Table below. They are based on expenditure patterns of the lowest thirty percentile of ranked levels of expenditure. If there are households whose incomes per week are below the FPL for the area in which they live, then these households would be categorized as absolutely poor. From the second column it can be clearly noted that it is more expensive in South Tarawa than in the Line and Phoenix

Group or rural Gilbert to be able to live above the FPL, and moreover that there would be less subsistence food products to count towards meeting the FPL in South Tarawa than in the Line and Phoenix Group or rural Gilbert group.

Table 23: Poverty

	Food Poverty Line (FPL) for Household per wk	**Percentage of FPL met from subsistence**	**Basic Needs Poverty Line (BNPL) for Household per wk**	**Ratio of non-food to food expenditures**
South Tarawa	$104.42	33%	$230.57	50/50
Line and Phoenix	$84.39	60%	$156.53	40/60
Rural Gilbert	$48.32	43%	$83.81	47/53

Source: Data extracted from National Statistics Office

For any households to adopt a below FPL existence which they need to move out of it, their best strategy would be living in rural Gilbert. In the Line and Phoenix Group the household would be able to meet a higher percentage of their food expenditure from subsistence food products but the total food expenditure would be higher as well than at rural Gilbert. There would be households in South Tarawa, in Line and Phoenix Group, or in rural areas who for many reasons are living below the FPLs as being here defined.

But on Gini's Coefficient as measures of income distribution and inequality, South Tarawa and the Line and Phoenix Group have nearly equal coefficients of 0.35 and 0.34 respectively which are said to be comparable with the Pacific countries index. Rural Gilbert has index of 0.42 which indicate a more unequal distribution of income among the rural population.

Unemployment rate is very high. The Millennium Goals Report 2007 gives the rates of unemployment of 78.1% in 2000 and 66.5% in 2005 but notes that the rates are obscured in Census Reports since people who do not work for wages always regard themselves as self employed fishermen or farmers.

However, agricultural and fisheries resources are limited and variable. Unemployed persons who claimed self employment in those activities could not be taken seriously.

Copra has been the only income source from agricultural farming. Copra production of the Gilbert Group during the period 1990 to 2003 shows a declining trend, while the Line Group for the same period shows an increasing trend. It is also interesting to observe that four years cumulative annual totals of rainfall and of copra production are highly correlated. This may show that coconut productivity has a cycle of four years, or alternatively the cycle of peoples' efforts to harvest copra is four years.

2.5.3 INTERNATIONAL ASSISTANCE TO KIRIBATI's EFFORTS ON CC

Kiribati Initial National Communication submitted to the COP in 2000 was one of the outputs of the Pacific Islands Climate Change Assistance Programme to which Kiribati participated. The PICCAP was executed through SPREP and funds were from GEF.

Before the PICCAP was the US Country Study Programme which was the first climate change project, starting in 1995. The project activities were on enabling activities involving vulnerability studies which gradually extended to cover identification of adaptation measures.

After PICCAP, funding for LDCs was set up in a decision of the COP under the name of National Adaptation Plan of Action. Kiribati participated in the NAPA and working with UNDP completed its NAPA document and submitted it to the COP. Concurrently with the preparation of the NAPA, Kiribati welcomed also WB initiative to start a Kiribati Adaptation Project with co-finance from Government of Japan. The initial phase of KAP under the WB was the preparation of Adaptation Project Implementation Plan for the second phase, and studies that were considered necessary for this preparation.

The second phase of KAP, that is KAP II, is completed in 2011 with many technical reports that were produced on the coastal vulnerability relative to sea level scenarios, droughts information, and water planning documents, designs of coastal protection, construction of some coastal protection structures, rainwater harvesting and construction of a community infiltration gallery in North Tarawa, and other improvement works on South Tarawa water supply. Phase III of the KAP is being designed. The intention is to concentrate on addressing coastal risks, and water supply that are associated with climate change.

Funds for these projects are from bilateral sources as was the case of the US Country Study Program, or from Multi-lateral source, including donor agencies like Aus-AID and NZAID that contributes to financing KAPII, and through GEF as in the case of the NAPA and KAP. Kiribati experience with implementing agencies suggest that this need to evolve to better understanding and responsiveness to the real need to protect natural systems from degradation impacts of climate change, and to ensure the long term sustainability of human systems.

3.0 ISLAND BIODIVERSITY

The natural state of biodiversity in Kiribati is affected by climate change as when the various living organisms constituting an ecosystem are stressed by the increasing levels in physical aspects of their ambient environment. For examples the health, diversity, and abundance of species of corals, and fish stocks could decrease when the temperature and acidity of the ocean increase. Mangrove ecosystems now being monitored would enable assessment in due course of how they are thriving under current conditions associated with progressing climate change. The climatic conditions include, increasing temperature, rising sea level rise, more frequent storm surges, and possibly increase in annual precipitation are more frequent and experienced in Kiribati.

Other coastal ecosystems that are found along the beach and close to the shoreline would be subjected to climate change conditions particularly from sea level rise and storm surges which generally lead to observed eroding of beach and shoreline. Coastal vegetation including coconut trees and pandanus trees are uprooted through coastal erosion, or damaged by sea water over wash.

There are also existing threats that are induced as direct results of socio-economic activities e.g. marine export demands, channels and causeways, among others.

Biodiversity as represented by different species of organisms provide materials required for the livelihood of the people. Different species supplying particular needs of the people would have different tolerant levels to climate change physical factors such as temperature and sea level increases for example. This characteristic of biodiversity will provide opportunities to develop ways to enhance the tolerance of ecosystems to climate change impacts.

Coconut and pandanus trees are basic perennial crops for food and cash. They grow well throughout Kiribati, and are sources of materials for traditionally housing constructions, and for many amenities in the traditional livelihood of the people. However, in the case of pandanus trees, some important species have eroded or lost due to the change in consumption pattern and preference of I-Kiribati.

Coconut tree' and Pandanus' fruits

"Babi" are important food crops which are cultivated in fresh water dug up pits. Depending on the thickness of fresh water, it has been observed that saline water below the fresh water lens had at times intruded to the fresh water layer, spread out and damaged the plantation in the pit.

Babai swamp crops

Breadfruit trees are important tree and seasonal food crops that are normally grown with the village areas in a traditional agro forestry system. Other fruit crops like pawpaw, pumpkin, fig tree and banana can be incorporated within the system as well. They are normally grown within the village areas and there are varieties of these with some that require for their environment, more moist soil and more raining days. Pawpaw, pumpkin, local fruits are among food plants and tree crops.

Breadfruit crops

These plants and trees as part of ecosystems are also impacted by exotic pests such as taro beetle in South Tarawa that attack “babai”, and “banana”, occasional mealy bug that attack breadfruit, pawpaw and the Pacific and Ship rats (*Rattus exulans* and *Rattus rattus*) that attack coconut trees. How these pests cope with climate change would determine the indirect impacts of climate change on the ecosystems with the plants and trees.

Pawpaw and Banana trees

The composition and structure of ecosystems could also change with climate change. Disappearing small islands show that coconut trees and other tree crops are dying out, as small non-food bush plants and weeds are springing up from the shrinking hedges of the islands.

Other documented primary threats to biodiversity aside of climate change are habitat alteration caused by unplanned or poorly planned development (especially causeway construction), over harvesting of resources (over-fishing, gleaning, harvesting of mangroves), waste and pollution, modern agricultural methods and the spread of invasive species.

Examples of the first two threats include the disappearance of Garfish (*Rynchorhamphus georgi*) in Kuria after the closure of the passageway between the two main islets on the island; and the depletion of in Makin after the construction of a causeway across an inlet passage. Sharks and sea cucumbers are overfished in most islands for commercial trade. Coconut trees, breadfruits and pandanus are reported as the common overharvested terrestrial flora (Programme of Work on Protected Areas Phase I Report).

The coral reefs of Kiribati and much of the Pacific face a number of well-documented local and global threats. Despite the dependence of the people of Kiribati on coral reef resources, for food and income, and the protection that the outer reefs provide from coastal erosion, the significance of corals and coral reefs of the Gilbert Islands of Kiribati have not been realized, hence the subject of much research or public attention.

Coral reefs and reef fish

Preliminary data (Donner, 2007) analysis and previous research suggests the coral reefs of Kiribati are already being affected by the growing human population through increasing sewage and increased demand on reef resources.

The Fourth Assessment report of the IPCCC suggests that climate change may pose an existential threat to many reef-building corals worldwide and lead to widespread degradation of coral reefs ecosystems. More frequent coral bleaching events (coral bleaching events occurred in 2007), especially when combined with local disturbances like fishing, pollution or sedimentation, are expected to keep coral, fish and invertebrate species richness low. The rise in oceanic carbon dioxide concentrations also poses a threat; it is an important area of research to quantify the magnitude of their impacts on corals and reef ecosystems. Long-term degradation of reef ecosystems, from either cause, could have serious consequences for the marine resources that sustain the economy and the people of Kiribati.

The Government of Kiribati has and continues to implement a number of conservation projects and initiatives which have linkages to climate change in terms of adaptation and mitigation measures. These projects are implemented by Ministry of Environment, Lands and Agricultural Development through its Environment and Conservation Division.

Mangrove replanting in Kiribati

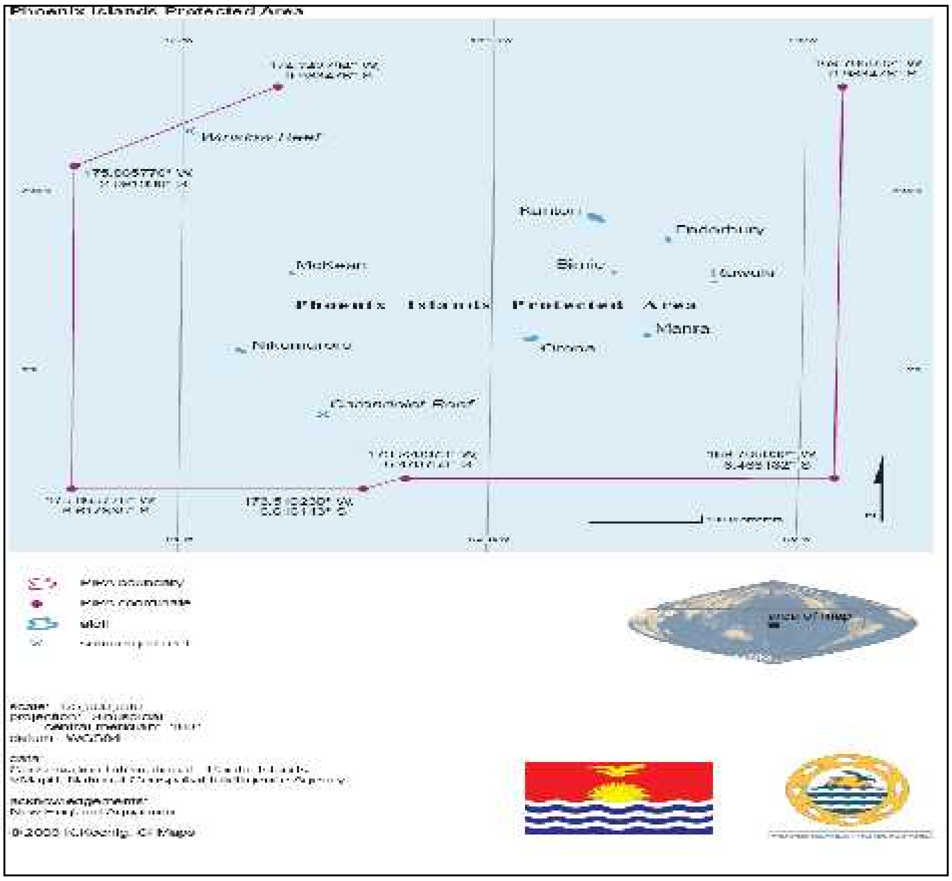
These currently ongoing projects and initiatives include: i) the Phoenix Islands Protected Area (PIPA), ii) Mangrove Rehabilitation Project which is implemented continuously in collaboration with an organization in Japan known as the International Society for Mangrove Ecosystems (ISME), iii) KAP II Mangrove Project, iv) the Ramsar Small Grant Project funded by the Ramsar Convention on Wetlands and vi) the Programme of Work on Protected Areas Project – funded by UNDP. PIPA is an exceptional case from these four projects in terms of scale and profile but its linkages to climate change adaptation and mitigation are in parallel with the rest of the aforementioned projects.

With the exception of PIPA, all projects promote the rehabilitation and protection of mangroves in order to: i) mitigate the impacts of storm surges and coastal erosions which are exacerbated through Climate Change, ii) act as buffers to land-based pollution and nutrient run-off which could be detrimental to the marine life and coral reef ecosystems, and iii) contribute to the natural carbon sink. Additionally, the latter two projects promote the establishment of marine and terrestrial conservation areas and this objective directly links to

Climate Change adaptation by providing measures that help strengthen the ecosystem resilience to climatic impacts.

The boundary of PIPA with significant potential opportunities in conservation and ecosystem-based adaptation, refer to figure 12 in the next page.

Figure 11 : Phoenix Island Protected Area



Source: PIPA website

Kiribati executes its smaller scale projects through community-based and ecosystem-based approaches as deemed most relevant approaches in an atoll and poor-resourced environment. A community-based approach allows and promotes communal participation and support and performs in a way that the sovereign rights of the communities over their natural resources are not jeopardized, whilst the ecosystem-based approach promotes enhancing the resilience of natural ecosystems to help the ecosystems and communities adapt to climate change.

Besides the KAP II Mangrove Projects, the rest are currently ongoing and there is plan to continue and expand and build work on the PIPA, the Programme of Work on Protected Areas, Ramsar Small Grant Project and the KAP II Mangrove Planting and Re-planting Project which will continue to receive support from KAP III due to successful implementation during KAP II.

4.0 GREENHOUSE GAS INVENTORY AND MITIGATION

4.1 DATA, METHODOLOGY AND MANUAL

Kiribati emissions of greenhouse gases are insignificant relative to global country-based average emissions. However, in the local context they are important as they measure Kiribati economy dependency on fossil fuels which has been increasing. Given the insignificant level, this project indicated a slight increase in the emission compared to the 1st National Communication. Information on local emissions would also be part of the data to determine opportunities in technology acquisition and development for mitigating climate change and promoting sustainable development in Kiribati. This importance needs to be understood in Kiribati.

Any methodology for assessing emissions requires activity data. Fossil fuels used in energy dependent purposes of sectors of the economy are all imported. Kiribati Oil Company Limited (KOIL) is the main importer of major oil types and the distributor to various retailers and major users such as public suppliers of electricity, shipping services, and civil aviation. Some businesses import bottled Liquefied Petroleum Gas (LPG) but data on these are not available.

Other categories of greenhouse gas emissions are agriculture livestock. Data for these are obtained from the reports of national population censuses. Data on wastes are not readily available to use in the compilation of greenhouse gas emissions.

Data for the purpose of compiling national inventory of greenhouse gases need to be improved. With this recognition, nonetheless inventory of greenhouse gases is compiled with in mind a commitment to improve on data collection and management.

The methodology used is based on IPCC 2006 Guidelines and an international consultant was mobilized to offer hands- on training on the methodology. The outputs of the training include the compilation of the inventory for the years 2004, and 2005. Based on the knowledge gained in the training, it has been possible to work through the IPCC 2006 Guidelines to compile the inventory of greenhouse gases from the use of fossil fuels, and livestock for the years 2004, 2005, 2006, 2007 and 2008.

Conversion factors and emission factors that are required to turn raw activity data into emissions are de facto values given in the IPCC 2006 Guidelines and those that are provided in the training. The units may have been different but they are of equivalent values.

The SNC team have been able to describe steps adopted to compile the inventory and these descriptions constitute the manuals for this purpose.

4.2 GHG INVENTORY, EMISSIONS AND TRENDS

Our inventory is based on two sectors only: Energy, and Agriculture and Forestry. Energy is the key sector for emissions, and Agriculture and Forestry which include Fisheries which are also a high source of emissions

All imported fossil fuels are used in the Energy sector under the various purposes of public electricity, transport, and other sectors. Transport category includes subcategory of road transport, marine navigation, and civil aviation. Other sectors include the subcategory of residential and agriculture/forestry/fishing uses of fossil fuels.

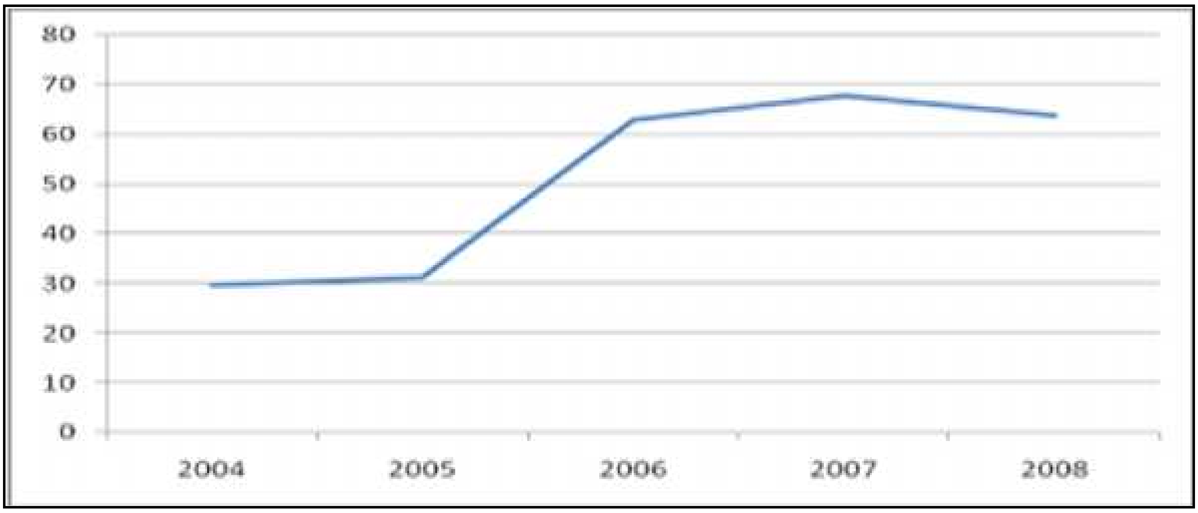
The main gas emitted in the burning of fossil fuels to provide various forms of energy is carbon dioxide, and the emission of this gas was only calculated from 2004 to 2008. The results are given in Table 24 below.

Table 24: Carbon Dioxide emissions by regions, sectors and by years

Emission of carbon dioxide from fossil fuels by sector sources, 2004-2008 (Gg).					
Sector sources	2004	2005	2006	2007	2008
Gilbert					
1 Energy Industries	11.8958	13.0234	17.446167	17.7675	17.1013
2 Transport	13.8756	14.3533	28.53352	29.5932	28.5114
3 Other Sectors	3.8871	3.8528	8.9107	10.6144	10.2387
Kiritimati					
1 Energy Industries			2.7189549	3.1863	2.7966
2 Transport			2.7428	2.9975	2.7047
3 Other Sectors			2.4298	3.5584	2.4311
All Kiribati					
1 Energy Industries	11.8958	13.0234	20.1651	20.9538	19.8980
2 Transport	13.8756	14.3533	31.2763	32.5908	31.2162
3 Other Sectors	3.8871	3.8528	11.3406	14.1729	12.6698
Total carbon dioxide emission	29.6587	31.2296	62.7821	67.7175	63.7841

Source: Kiribati SNC Document, 2012

Figure 12. Kiribati total emission trends (in Giga gram - Gg) for periods 2004 – 2008



Source: Kiribati SNC Document, 2012

Data used in the inventory need improvement. Based on these, the summary of the emissions on carbon dioxide shown in the Table 24 and figure 13 above suggests that there has been a sharp increase in emissions from their level in 2005 to their level in 2006. This may reflect change in assumptions and again the poor recording of fuel data.

Data related to other sector activities are not better managed. The SNC team assembled data on Agriculture and Forest Sector but limited to availability of data for livestock from population census 2005; the livestock consists of only two animal categories – swine and poultry.

There are two gases that are expected to be emitted from the livestock through enteric fermentation and manure according to their management. The two gases are methane and nitrous oxide. Methane is emitted through enteric fermentation of the pigs, and through the wastes of these animals and of poultry and depending too on how these wastes are managed. Nitrous oxide is emitted direct from their wastes.

The starting and critical data are the annual average number of animals of each type – swine and poultry. These are obtained from the 2005 Census of Population Volume 1 from which data obtained on the average number of pigs and of chicken per household. Preliminary data from the 2010 Census include on the number of households. By interpolating between the numbers of households in 2005 and 2010, the numbers of households in the intervening years are obtained. Applying the average number of animals per households obtained from the 2005 Census to the intervening years households, the corresponding annual average number of animals are obtained.

For three years - 2006, 2007, and 2008 – estimated emissions from the livestock are summarized in the table below.

Table 25: Emission from livestock

Emissions from livestock			
Years	**2006**	**2007**	**2008**
Number of Swine	46,955	49347	51738
Methane enteric (Gg)	0.046955	0.049347	0.040323
Methane Waste (Gg)	0.070433	0.074021	0.060485
Nitrous oxide Waste (Gg)	0.59029	0.620362	0.322584
Number of chickens	55,759	58599	61439
Methane waste (Gg)	0.001115	0.001172	0.000945
Nitrous oxide Waste (Gg)	0.026286	0.027625	0.01417
Total Methane (Gg)	0.118503	0.124539	0.101752
Total Nitrous oxide (Gg)	0.616576	0.647988	0.336754

Source: Kiribati SNC Document, 2012

4.3 MITIGATION

It is understood that being a least developed country, Kiribati (as an LDC and SIDS) has no obligation under the UNFCCC to reduce its emissions of greenhouse gases. However, any reduction of emissions at the same time that economic growth is achieved will be good indicator of clean and sustainable development. Opportunities to be able to do this are being explored for they will be good mitigation options.

Economic development requires resources and one critical resource is energy which is provided largely from fossil fuels. There is the production of public electricity, the use of energy in agriculture and fisheries sector, in residential areas, and use of energy in transport. Because of this link between economic development and energy from fossil fuels, the SNC team examine possible correlations between the values of GDP and those of the carbon dioxide emissions from fossil fuels. The SNC team also examine correlations of carbon dioxide emissions from fossil fuels used separately under some of the categories in the inventory of emission, and the values of GDP contributions from the comparable categories of the economy. The table 26 below shows the values of the correlations.

Table 26: GDP and EMISSIONS correlation analysis

Variables	2004	2005	2006	2007	2008	Colum for Correlation coefficient
Nominal GDPs in A$000's						
Nominal GDP at market price	95,733	97,456	100,290	105,599	105,943	
Electricity, Gas &Water Supply (GDP current, formal sector only)	1530	666	461	262	1822	
Transport and Storage (GDP contribution)	6794	7830	6522	9095	9207	
Agric and Fishing (GDP contribution)	8684	6807	8389	10571	9480	
GDP at const price 2006 and in A$000's						
GDP	142502	142930	145644	146237	144631	
Electricity	419	433	461	486	462	
Transport	5340	6714	6522	6146	5917	
Agric and Fishing	34156	32218	34771	34829	35443	

Emissions as second variables for correlation assessment						
Carbon dioxide emissions (Gg)	29.659	31.2296	62.7821	67.718	63.7841	
Electricity (emission Gg)	11.896	13.0234	20.1651	20.954	19.898	
Transport (emission Gg)	13.876	14.3533	31.2763	32.591	31.2162	
Agric and Fishing (Gg)	4.68	5.01	5.726	5.624	5.436	
Correlations						**Corr Coeff**
Nominal GDP and Carbon dioxide emissions						0.8944975
Const price GDP and carbon dioxide emissions						0.9520141
Nominal electricity GDP contribution and carbon dioxide emissions						-0.2984168
Const price electricity contribution and carbon dioxide emissions						0.948363
Nominal transport contribution to GDP and carbon dioxide emissions						0.4469409
Const price transport contribution and carbon dioxide emissions						0.1837173
Nominal agric/fisheries GDP contribution and corresponding carbon dioxide emissions						0.4659015
Constant price agric/fisheries GDP contribution and corresponding carbon dioxide emissions						0.5589362
Energy intensity Emission/GDPs (nominal)	0.0003	0.00032	0.00063	0.0006	0.0006	
Energy intensity Emission/GDPs (constant price 2006)	0.0002	0.00022	0.00043	0.0005	0.00044	

Source: Kiribati Second National Communication, 2012

It is noted that GDP at current prices or at constant prices are highly correlated with emissions of carbon dioxide from fossil fuels. However the correlations between the contributions to GDP of the different sectors and the corresponding emissions of carbon dioxide from the same labelled sectors vary because there is no consistency in the sectors as defined under the two separate considerations – national accounts and greenhouse gases inventory.

The SNC Project also evaluated energy intensity which was defined as the carbon dioxide emissions associated with a dollar of GDP. The last rows show these values. There appears to be two lots of years with equitable values of energy intensity; the first lot corresponds to 2004 and 2005, the second lot includes 2006, 2007, and 2008. This jump from the values in the first two years to the values in the later three years may be due to the different qualities of the data in the two periods rather than the jump in the actual energy intensity.

It is also most likely that there was an increase in the energy intensity. This increase implies that a dollar increase in the GDP would require higher amount of emissions of carbon dioxide. This in turn implies inefficiency in the economy.

The extent of mitigation analysis on how different sectors would improve their overall mitigation in terms of the existing policies, taxes frameworks, and other social economic incentives and enabling instruments; to allow nationally appropriate mitigation options to flow and progress more effectively was not covered in this project. This will be the new area of focus in the subsequent third national communication.

However, in general there is much room to explore opportunities to be able to reduce emissions of carbon dioxide from the various technologies. Presently, Kiribati does not have any plan or policy in place to reduce emissions in accordance with decisions or provisions of the UNFCCC. Nonetheless, the Government in its 2012 Policy Statement announced the aspiration to pursue the 2% reduction of GHGs by 2015. The base year and plans to achieve this target is still under discussion. Therefore the Government is indeed interested to explore renewable energy measures and support measures towards this aspiration. The Government has formulated the Kiribati Energy Policy (KIEP) and it Implementation Plan to pursue this aspiration on fuel energy sources only, with the aim of reducing emissions through alternative energy sources highlighted in the policy.

According to Wade, etc (2004); given that almost all of the GHG emissions occur on the urban islands of Kiribati, any reduction in GHG emissions will largely be through energy efficiency improvements or the use of grid connected renewable energy systems. The largest potential renewable energy source that could be viable for Kiribati includes conversion from diesel fuel to bio-fuels on coconut oil. Other sources are biogas generation from community pig pens and wind power for power generation. These options have the potential to save fuel and reduce emissions but require high social and financial investments to make it viable.

Other renewable energy sources such as Ocean Thermal Energy Conversion (OTEC), Wave and Tidal energy are considered impractical according to the Wade's 2004 assessment.

5.0 VULNERABILITY AND ADAPTATION

5.1 NATIONAL FRAMEWORKS FOR VULNERABILITY AND ADAPTATION ASSESSMENT

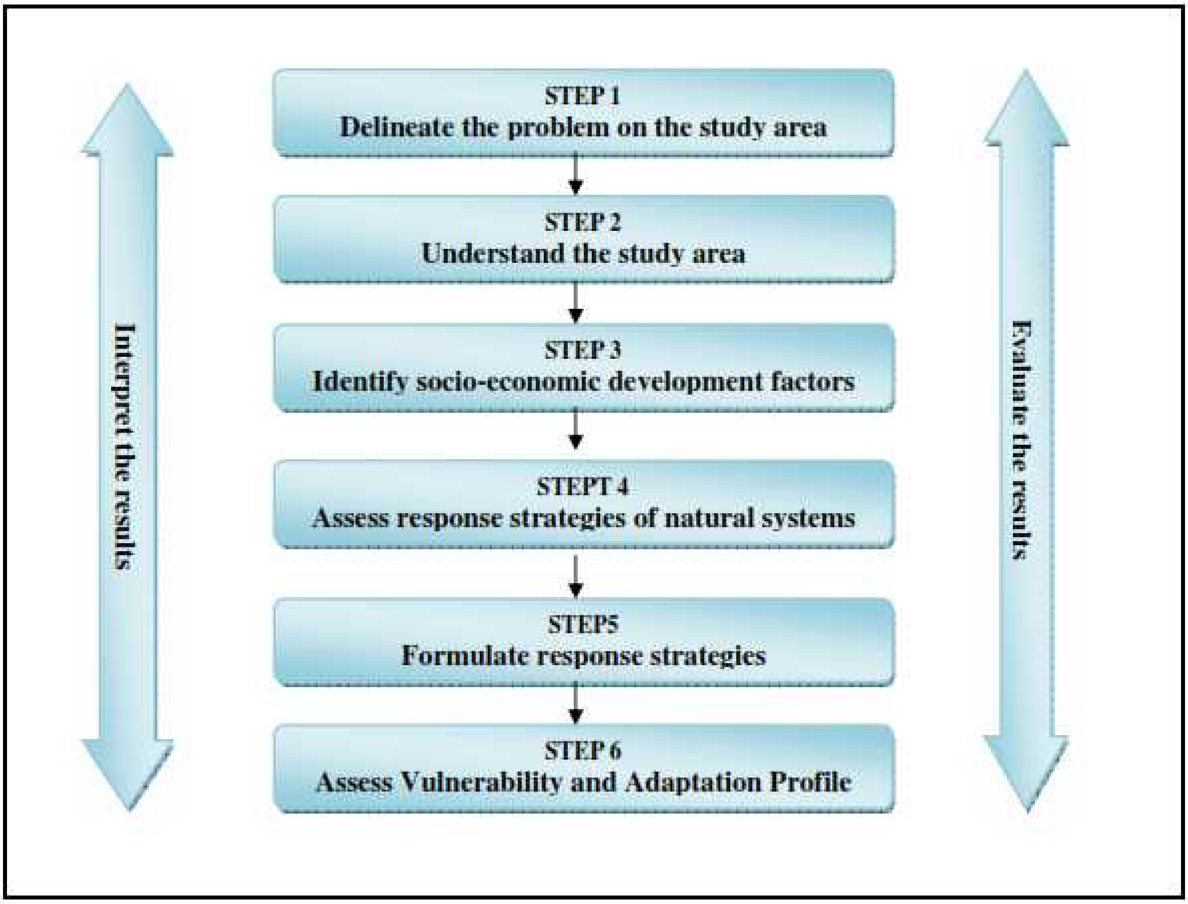
The Fourth Assessment Report of the Intergovernmental Panel on Climate Change affirmed that climate change is unequivocal as it was and still is the result of anthropogenic interventions. Although the cause of Climate change is largely blamed on developed countries, Kiribati will and must bear the consequences particularly as the adverse effects gradually increase in frequency and intensity in the near future.

Since the Initial National Communication report in 1999, several studies and assessments have been undertaken by various international institutions on various vulnerable sectors relevant to climate change in Kiribati. These studies are important undertakings to highlight key vulnerabilities in Kiribati which require adaptive actions. However, due to a cross-cutting nature of climate change and increase interest of international academic and research institutions' interest on Kiribati vulnerability to climate change, local stakeholders and recipients sectors have experienced proliferation of climate change information from these professional Vulnerability and Adaptation (V&A) assessments. With limited understanding and capacity to complement and influence these assessment, local sectors dealt with these international academic/research institutions independently. The information and outcomes of these studies in most cases were complex and difficult to absorb and understand.

As part of the Second National Communication project, and trying to better use the V&A assessments, the Kiribati V&A Assessment Methodology (KVAAM) was prepared as a tool to assess studies and assessment reports that have already been prepared. This tool will also assist in determining whether, from much of the information already available in reports on the vulnerability of Kiribati to climate change, additional information is needed to undertake more studies. The KVAAM will guide any commissioned studies as to types of information that are to be researched and produced, and would be also instrumental in understanding synergies from different reports which may be used for informed decision-making and adaptation.

The KVAAM is an open and flexible approach that adapt methods from various sources, however it is advisable that climate change scenarios are clearly stated (IPCC V&A methodology, Australia/NZ Risk Assessment Method, etc). It is a framework of guidance for national stakeholders primarily aimed to facilitate their reviewing and understanding of V&A studies/reports. The steps and concepts are explained in the chart below.

Figure 13: Kiribati Vulnerability & Adaptation Assessment Methodology flow chart



Source: Kiribati Second National Communication, 2012

This framework was developed to be used as a manual for all Government's stakeholders particularly those who are members of the National Climate Change Study Team. The Climate Change Unit of the Environment and Conservation is the key responsible agency mandated to advocate and integrate this method into work programs of key sectors of Government.

Although, the framework was placed to build national capacity on V&A, it is recognized that technical capacity building on climate change science, modelling, in-depth understanding on models used in studies and others are necessary to increase competencies of local sectors to understand and contribute in any V&A assessments. This is considered one of the technical capacity building needs for members of CCST on this particular subject.

5.2 V&A STUDIES IN KIRIBATI SINCE THE INITIAL NATIONAL COMMUNICATIONS

Since the submission of the Initial National Communication in 1999, there had been observed growing interests by academic and international organisations on Kiribati future vulnerabilities to the adverse impacts of climate change. This was evidenced by the number of Vulnerability and risk assessment conducted on specific sectors in Kiribati. These studies form part of a critical body of information that inform not only the Government of Kiribati in terms of their adaptation approaches but also the regional and international communities. These vulnerability studies generate useful baseline information and also triggers adaptation programs and projects formulated as a result of the findings of such studies. The details of these vulnerability studies and other climate change assessment studies on specific sectors were summarised below.

Table 27. Matrix of V&A studies and their details undertaken in Kiribati

Study reference	**Coverage of studies**		
	Scope of assessment and geographical location	**Degree of impact(s)**	**Implication**
Chiaoxing He's study (He 2001)	Assess vulnerabilities of Bairiki and Bikenibeu to sea level rise. Emphasis of the study is the overtopping and flooding impact on the sites under three sea level scenarios of 0.3m, 0.5m and 0.95m during a 14-year storm event interval. Evaluate tides, water levels data	Flooding and overtopping event for the two sites under different scenarios Bikenibeu 0.3m – 53% 0.5m – 71% 0.95m – 100% Bairiki 0.3m – 17% 0.5m – 35%	Quantitative assessment of sea level rise on important villages of South Tarawa. Provide an understanding on the level of impact of sea level rise on the coasts of the villages under climate change.

	Relate the functions of coral reefs, human population and other anthropological stress like land-based pollution, mining and so on.	0.95m – 100% Recession is still unknown due to characteristics of various complex systems and how they respond to sea level rise.	
World Bank Vulnerability study (Bank 2000)	Assess vulnerabilities of the economy, coastal zone, water, public health, and agriculture in terms of the costs of the damages	7-12 Million worth of damage to the coastal areas 1-3 Million worth of damage to the water resources significant damages to health issues and agriculture 210-430 Million worth of damages in instant events of storm extremes	Provide projected costs of damages that could be posed by climate change. Several sectors were included in the assessment.
Coral reefs assessments by Ed Lovell and Dr Simon (E 2000), (Donner 2007)	assess the state of coral benthic ecosystem around South Tarawa and another outer island, Abaiang	Corals are mostly health except some sites on South Tarawa which are degraded due to associated with sewerage outfalls and influence of sediment smothering as a result of causeway construction Low coral cover in most shallow waters at South Tarawa	The response of coral reefs to climate change was an important indicator of change and effect. This study does not talk much about association of observed degraded corals with global warming. An understanding on this monitoring of coral reef is documented in this report.

Challenges in freshwater management in low coral atolls (White, 2007)	Assess the all sources of freshwater in the context of low coral atolls and the impacts of natural hazards including climate change	Recognised that drought, storms and sea level rise and inundation impact the thickness and quality of groundwater lenses and rainwater tanks. This was generalised to all sources of water.	Acknowledged that climate change and sea level rise is one of the greatest threats to the freshwater sources of low-coral atolls and small islands. Indicate that future efforts need to take the climate variability
Robert Kay's Coastal Risk Assessment pilot study (Kay 2008)	Assess the risks of coastal areas of Bikenibeu and Temwaiku villages of South Tarawa, from erosion and flooding under different CC scenarios using data from the IPCC AR4 data, for timeframe of 2030 and 2070.	Generates erosion and inundation maps at a village scale for Bikenibeu and Temwaiku under a combination of different maps and timeframe in the future. Zones to be eroded and inundated under different CC scenarios in 2030 and 2070. Aerial view of infrastructures to be affected under different CC scenarios in the future identified.	Map the risks, vulnerabilities and coping strategies through these assessments and programs. Several element of adaptation are produced in these works and are important information for this research as well.
Social vulnerability assessments (Mackenzie 2004), (C Hogan 2008)	Gather social perception on the risks observed in the outer islands of Kiribati. This is done through national stakeholders'	Generate the range of environmental risks whether they are associated or not associated with climate change. Mackenzie' (2004)	Social perception on changes seen on the environment. Provide a social and cultural perspective into the risks associated with climate change on the

	consultation and facilitated through participatory discussion.	indicated that most people observed the risks as bad, which implies that the impacts are already happening.	coastal zone.

Based on the above table, it is evident that a number of V&A studies with distinct scopes and objectives in Kiribati had been undertaken and consensually demonstrate that Kiribati has already been exposed to risks and impacts of climate change. The projections of climate and sea level rise together with existing undesirable national socio-economic circumstances will only add up to compounded and probably unthinkable level of impacts which may be extremely difficult to cope and reverse them. The other positives of V&A studies was that they will continue to assist and inform forward and constructive adaptation actions and adaptation planning – at any particular level of sector. The results are expected to enhance adaptive capacity, resilience and overall security of Kiribati in the near and longer term future.

5.3 EXISTING CLIMATE CHANGE AND SEA LEVEL RISE SCENARIOS

During the formulation of the Kiribati Climate Change Policy Statement and Strategy in 2004, the MAGGIC SCENGEN was used by the World Bank consultants and local climate change experts, members of Climate Change Study Team to derive climate change and sea level rise scenarios. The intention of generating these scenarios was to reference these projections in this policy to guide future planning thinking framed within the Policy. These climate change scenarios are presented in the table below.

Table 28. Kiribati Approved Climate Change Scenarios in 2005

Climate change indicator. ***Year***	**2025**	**2050**	**2100**
Mean sea level rise (centimetres) relative to the level in year 2000	**+6 cm** (+3 to +10)	**+14 cm** (+6 to +26)	**+39 cm** (+12 to +83)
Change in annual mean air temperature (degrees Centigrade) relative to year 2000	**+0.4 îC** (+0.3 to+0.5)	**+1.0 îC** (+0.8 to+1.4)	**+2.3 îC** (+1.3 to +3.5)
Change in annual mean rainfall relative to year 2000	**+3%** (+1% to+7%)	**+7%** (+2% to+17%)	**+15%** (+4% to +46%)

Source: Climate Change Adaptation Strategy 2005

In 2006, Climate Risk Profiling was prepared by Professor John Hay with inputs from Climate Change Study team. This method considers a given geographical unit which involves an evaluation of current likelihoods of all relevant climate related risks, based on observed and other data. The future changes in risk are estimated using the outputs of GCMs which are Hadley Centre (United Kingdom), Australian Commonwealth Scientific and Industrial Research Organisation (CSIRO), Japan’s National Institute for Environmental Science (NIES), the Canadian Climate Centre GCM (CGCM) and the Goddard Fluid Dynamics Laboratory (GFDL).

Best estimates of future risk levels are based on an average of the estimates using a multi model and emission scenario ensemble. The range in uncertainty is determined using a model and emission scenario combination that produces, in turn, the maximum and minimum rate of change in future risk levels.

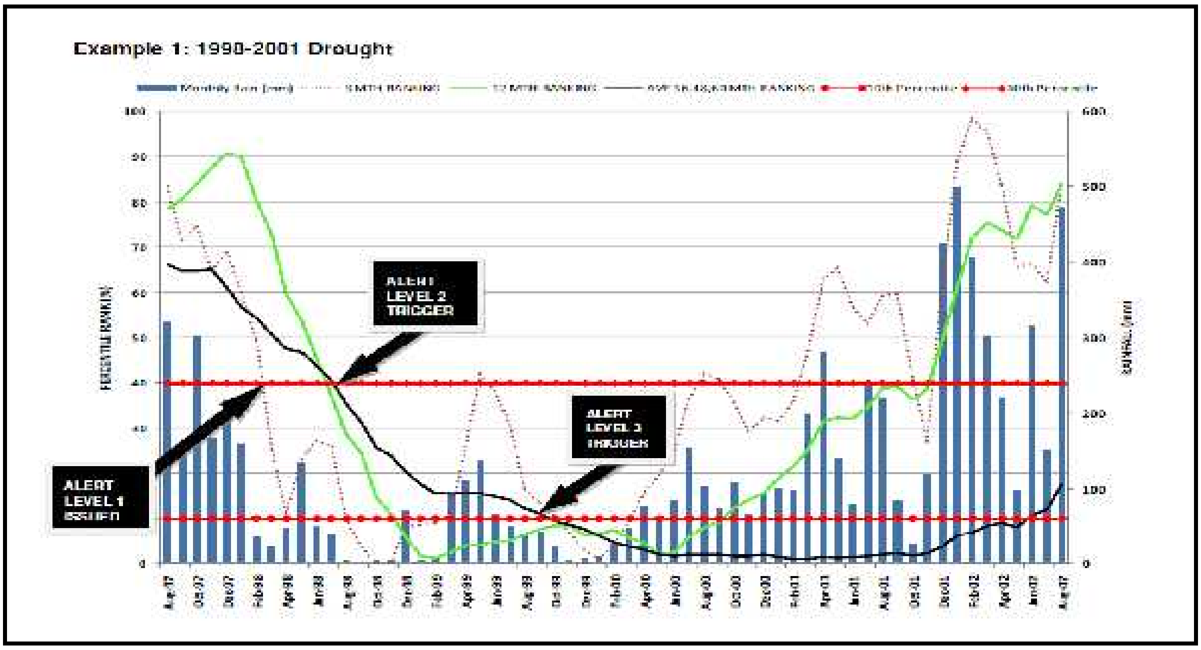
According to this report, (Hay 2006), best estimates of long term, systematic changes in the average climate for Kiribati indicate that by 2050 sea level is likely to have increased by 37 cm, rainfall by over 20%, extreme wind gusts by 7% and maximum temperatures by almost 1.0 C. No significant long term trends are evident in the observed daily, monthly, annual or maximum daily rainfall.

The foregoing analyses convey two key messages: (i) increased occurrences of extreme high sea levels, air temperatures and winds are highly likely in the coming decades; and (ii) there is less certainty regarding changes in the frequency of intense precipitation events (daily or hourly), but there are indications that the frequency of these events will also increase in the future.

In 2008 the Kiribati Adaptation Program Phase II contracted New Zealand's National Institute for Water and Atmospheric (NIWA) to develop climate risk information for Kiribati. This work produced the Coastal and Drought Calculator tools. These are the tools that used local data, global data, and outputs of GCMs to estimate projections, calculate return periods of any climate factor on various sites on islands of Kiribati. These tools are imperative towards generating specific on-site climate risk information for drought and impacts of climate change on coastal areas. It also confirms that Kiribati is vulnerable to the extreme events including droughts.

In addition, a drought response action plan was prepared by the Government of Kiribati through its Ministry of Public Works & Utilities in 2011 and submitted for Cabinet consideration in early 2012. The document outlines the methodology for determining the level or severity of drought condition for South Tarawa, Kiribati. The methodology provides a definition of drought, in the context of South Tarawa water resources and identifies a procedure for alerting the required government and non-government stakeholders and community of the drought status. The diagram below summarises the drought methodology adopted for South Tarawa.

Figure 14. Drought record in Kiribati from 1998 – 2001



Source: Water Engineering Unit, MPWU Kiribati, 2012

Currently, a hydro geological assessment is being undertaken through the Kiribati Water and Sanitation Project (KIRIWATSAN) on 16 outer islands of Kiribati. This will inform development of methodology for defining drought on the outer islands of Kiribati, which will be quite different to the urban area on South Tarawa.

Through the NIWA-KAPII work in 2008, consultation was attempted among members of CCST and other stakeholders to agree on definition for timeframes and emission scenarios. The outcome of this consultation is explained in the table below;

Table 29. Local definition on climate change time frame planning

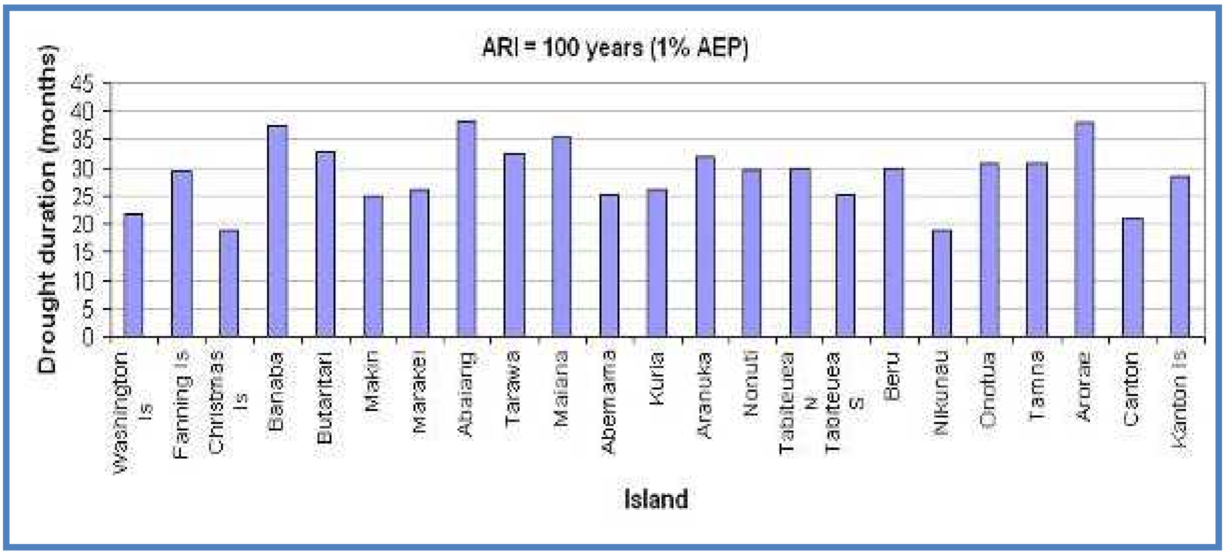
Timeframes horizon	Interpretation into planning
2012 – 2035	Grandchildren (*Te tibu*)
2036 – 2060	Great grandchildren (*Tibu toru*)
2061 - 2085	Great-great grandchildren (*Tibu mwamwanu*)

B2 is the low scenario, A2 as Intermediate scenario and A1FI as the high scenario.

Some of the scenarios produced for droughts and sea level rise is explained in the figures below.

The data used to construct this graph was taken from Kiribati Meteorological office. This is only the duration of a 1% chance drought and reflects that most islands can experience long and damaging drought events.

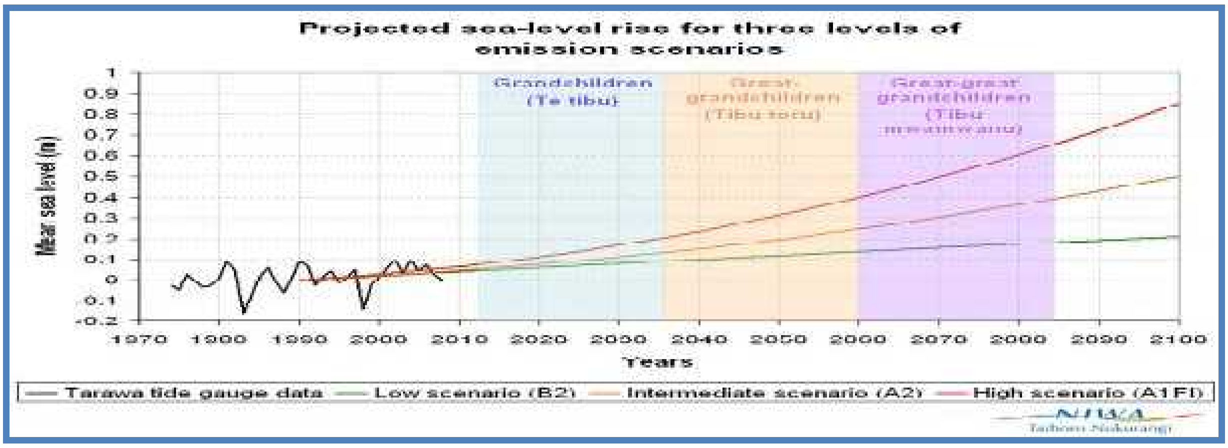
Figure 15. Trends for a 100 year return period events for Drought



Source: Ramsay, et al, 2008

This (NIWA) work also developed the modelling tool that can be used to generate projections of particular climate parameter such as sea level rise for Kiribati as shown in the graph below.

Figure 16. Sea level rise projections



Source: Ramsay, et al, 2008

The Sim-Clim model customized for Kiribati was developed in 2011 as part of the Second National Communication Project. This model enables generation of global and local climate change scenarios for various sites of Kiribati. For localized climate change scenarios, an ensemble of 21 Global Climate Models (GCM) outputs and the options of SRES were available in the tool for scenarios generation.

The table below (table 30) presents the climate change scenarios site specific to the Gilbert Islands taken from the outputs of the customized Kiribati Sim-Clim model. The baseline data used for the high emission and high sensitivity is the 1990. For temperature and Precipitation, ensembles of the outputs of 21 GCMs were employed. For Sea level rise, ensembles of 13 GCM were used. The fact that islands of Kiribati is sinking (by tectonic movements) by 4mm/year was also considered in the generation of the scenarios.

Table 30. Climate Change projections

Parameter and Year (all relative to 1990 baseline)	**2025**	**2050**	**2075**	**2100**
Temperature (mean in ^{0}C)	28.5 - 29	29 – 30.3	29.7 – 32	30 – 33
Precipitation (mean in mm)	2171 - 2322	2338 - 2714	2540 - 3252	2683 -3702
Sea lever rise (mean in cm)	15 – 18.5	26 – 40.5	38 – 70	50.6 - 107

Source: Sim-Clim model for Kiribati

In addition, this model is able to undertake extreme value analysis of temperature, precipitation, sea level and wind. This is where the local observed data were used. The analysis allows one to use hourly, daily or monthly data to generate extreme events' trends and return period curves. This can be projected for any particular emission scenario and any future timeframe.

The other feature of the tool is the direct synchronisation of the data with any sector for direct assessments of the impacts of the any climate change indicator to that particular sector and/or information directly related to informing vulnerabilities. However this is area of work is currently being developed specific to Kiribati. The Water tank impact model is available for use in the model, while the other sectors need more local data and time for modelling building.

The Pacific Climate Change Science Program, the Australian initiative assisted the Pacific Island Countries to develop projections of future climate scenarios of Kiribati. Their methods used the risk assessment framework to separate climate variables results from outputs of different Global Climate Models (GCM). This method adopt three emission scenarios B1 – Low emission, A1B – medium emission and A2 – High emission and a timeframes of 2030, 2055 and 2090.

This web-based method called the Pacific Climate Future tool allows one to generate the different categories of future climates of a particular variable based on how the outputs of GCMs were sitting in the framework of risks. Examples of categories of future climate includes, Most likely, Least Change, Hottest and Wettest, Hottest and Driest, High Impact Climate, so on. The table below illustrate the climate change scenarios as projected using this tool for Kiribati.

Table 31. Climate Change projection using Pacific Climate Futures Tool

Climate variable and emission scenario	**Time Frame**		
	2030	**2055**	**2090**
Temp (change relative to the average of period 1989 – 1999 Kiribati recorded data) in degree Celsius (^{o}C)			
Low emission	0.2 – 1.2	0.6 – 1.9	1.0 – 2.4
Medium	0.2 – 1.4	0.9 – 2.3	1.6 – 3.5
High	0.3 – 1.3	1.0 – 2.2	2.2 – 3.8
Sea level rise (change relative to the average of period 1980 – 1999) in cm			
Low	4 - 13	9 – 25	16 – 45
Medium	5 – 14	10 – 29	19 – 57
High	5 - 14	10 – 28	20 - 58

Source: Pacific Climate Futures tool

Almost all of the GCMs projected an increase in average annual and seasonal rainfall but not all the models show consistent results. The sea level rise projection does not take into account the glaciers and green land ice melting.

Kiribati's Government and people have perceived the adverse changes to the natural systems in their environment. From available climate data recorded, it affirmed social's feeling that temperature has indeed increased from the past decades or more.

The population are also aware of climate change, with Government being more informed than the latter on complex issues associated with climate change. The populace know they are experiencing adverse impacts of climate change, and need to have had embarked on soft and hard adaptation options since years back.

On the other hand Kiribati's Government recognizes that implementing the UNFCCC, including reporting to the COP on how Kiribati is implementing the relevant provisions and decisions of the Convention would aggregate to solving this global challenge. These obligations under the UNFCCC are internationally expected to be supported by evolving and sound science and it is therefore necessary even for Kiribati to meet (contribute to) this requirement.

Accordingly there are opportunities for internationally recognized climate scientists to enhance the quality of knowledge and information about climate change scenarios specific to Kiribati. The CCST recalled that when the Initial National Communication was prepared, this type of information was very limited. In fact, none was available at the time, and so this gap was expressed in the INC itself. Now there are several tools available to generate such information as noted above. Ideally, the CCST proposed that firstly it is important to understand them, know how to use them, and then have confidence in their outputs obtained for its applications.

The tools highlight the need for in-country capacity building to be able to appreciate the range of modelling capabilities and complexities, but which can provide most likely specific climate change scenarios, climate extremes scenarios, and their impacts on natural systems and human systems.

All of the tools provide scientific basis for the convincing knowledge together with the experiences from the Kiribati people that their islands are already critically vulnerable and will continue to be threatened due to the adverse climate change and sea level rise impacts.

5.4 EXISTING SOCIO-ECONOMIC SCENARIOS

Population future scenarios

Annual growth rates over the years, from 1978 to 2010, varied between 2.6% during the intercensal years 1978 to 1985 and 1.43% for the years 1990 to 1995. The growth rate for the most recent intercensal years 2005 to 2010 is 2.2%. And several projections of the actual population size have been made. The SNC team note two projections which outlined in the table below.

Table 31. Projections of Population of Kiribati

Year	Sited in CRP by Hays	National Statistics Office ('000)	Real
2010	106,000	90.1-102.8	103,055.
2015	112,000	106.0-115.0 (110.5)	…
2020	119,000	113.0-127.8 (120.3)	…
2025	127,000	119.4-140.4 (129.8)	…

With these scenarios the SNC team recalled concerns about overpopulating Kiribati was expressed in the 1970s and now 40 years later this concern must be fully acknowledged.

Urban Tarawa is said to be overcrowded, with increasing pressure on natural resources and public utilities that are provided by Government. Some people are not serviced with public water and electricity, and there is evidence of increasing number of people who may subsist below minimum health food requirements, not as matter of choice on their parts but rather forced to it also by impacts of the high concentration of population in South Tarawa. Children are most vulnerable to being undernourished, and infant mortality rate is high.

Decreasing trends of TFR and IMR would not continue to levels that could limit population growth. LE would not improve significantly over the next decades because increase in national productivity would be far exceeded by pressure and needs of the growing population.

Urban Tarawa population continues to increase. In the latest census 2010, the proportion of the Urban Tarawa population to the total Kiribati population is 48.7%. It is possible for this to increase further in the future. From the trends of the urban and rural population proportions respectively at census years, it is possible that by the next two censuses, that is, by 2020, half of the Kiribati population today could be in Urban Tarawa. The other half would be in rural Gilbert and in the Line Group; this implies that there will be higher population density in Urban Kiribati compared to rural Kiribati.

Between Urban Tarawa and Kiritimati, the latter known as secondary growth centre, the rates of population increase in the former has been four times faster than that of the latter. This fact and that of population proportions in the Line Islands group being more increasing in rate than that of rural Gilbert group may suggest that more people will move to the Line Islands and that more development can be accommodated at Kiritimati in particular. Over 90% of the population during previous censuses lives in the Gilbert group but a decreasing trend is now observed. It is expected that this high percentage will decrease below 90% at some future dates.

Between censuses, there are no consistent patterns of the populations of rural islands as proportions to all Kiribati population. Population proportions of any island during two successive censuses may show an increase but during other successive censuses can show a decrease. This may indicate that at census years people can easily relocate themselves between urban Tarawa and outer islands.

Education and skills scenarios

Availability of formal education at various levels must have increased from baseline of high literacy rate among adults, and of more lately the claim to have been able to provide primary education for all children. Nevertheless, Table 19 indicated an increased number of adults who never attended formal schools" which translate that this number has increased in the 2005 census from what they were at during census years 2000 and 1995. It is unrealistic to be optimistic that all children would be able to receive formal education at primary level; there were those who would not. There will always be costs to parents to enable their children to attend primary education.

The Government has given priority to primary education, and extended this to cover junior secondary education levels. But there will always be limit to Kiribati capability to provide

those levels of education for all, whilst population continues to increase. The number of children who would never have attended formal education would increase in future years.
The importance of tertiary and post tertiary levels of education is not overlooked by Government. Increasing number of privileged nationals has achieved qualifications from colleges and universities outside of the country. They are taking up professional and administrative jobs in the country, but more recently they are now competing for available jobs.

More people and of greater proportion of the total population would never have formal primary education than those attaining tertiary and above tertiary levels of education. The gap is the difference in the proportions between that which relate to number of people who never have had formal education and that which relate to the number of people with tertiary and post tertiary levels of education. The trend of this gap is expected to expand.

However, the increase in this gap allows Kiribati to set and achieve economic development goals, benefit from technological advancement, from good practices of government, and from aspects of globalization. Generally these nationals become agents of change from the simple subsistence to a globalised way of life. And all processes of globalization such as trade, communication, and overseas employments, facilitate the socio-economic changes that are taking place in Kiribati.

Traditional social values and norms are now being challenged by new alternatives. Egalitarian values that underpin social relations and traditional activities are being challenged by the differences in economic wealth as the new basis for social relations and for activities that go beyond traditional scope.

Reciprocity and communal solidarity begin to lose their traditional values as guidelines for relationships including through reciprocated and cooperative activities. Monetary gains and profits prevail as alternative guidelines.

In the future, Kiribati traditional social structure and values will change to “modern” form. The emphasis is on a more harmonious structure and values with those of the region and the globe. Education and national wealth; and how these are distributed across the population will set the course of development, welfare, social structure and governance for Kiribati people. Traditions would erode as people aspire for modern life.

Economic development scenarios

The process of development will always continue. This developmental process will equate with the existence of Kiribati as a nation and state. Kiribati will remain a LDC for many years, and dependent on bilateral and multinational assistance for development.

As noted above, population will continue to increase. Kiribati natural resources are expected to be overexploited and decreased in abundance and quality, due also to adverse impacts of climate change and socio-economic demands.

"Rich" and "poor" will be well recognized as characterization of people within the whole Kiribati population. There is high tendency that poverty and associated poor health indicators will be more acute and characteristic of the majority of the population. Living standards for the majority will fall, exploitation of resources including human labour would be stretched to extremes and more prominent in urban areas, and private ownership of properties will be less respected.

With reduced abundance and quality of natural resources, labour productivity would accordingly be reduced. This meant for subsistence livelihood that extra efforts were to be exerted for the same level of productivity presently obtained with lesser labour input. Subsistence livelihood would be more impoverished.

Unless substantial adaptation and sustainable development are implemented seriously in the near future, these economic development scenarios will be less acute.

5.5 CONSOLIDATING CLIMATE CHANGE AND SEA LEVEL RISE SCENARIOS BASED ON EXISTING CLIMATE MODELLING WORK

Mean Temperature

An elderly woman on Butaritari according to a report by Dr. McKenzie has observed that the "Sun has come down on her island". The island is less direct under the sun as it is located in the most northerly part of the Gilbert group; most of the other islands are more directly facing the sun. This sense of increasing temperature is no doubt shared by many Kiribati people.

In the Initial National Communication, it is reported that temperature is slightly increasing. In the SNC it notes that there is clear indication that temperature has increased. However, our concern is what impacts the future scenarios of temperature may bring to Kiribati.

The CCAS produced in 2005 has temperature scenarios. Subsequently there have been several studies and tools which contain information relevant for determining temperature baseline and future scenarios.
After synthesizing information on temperature scenarios, all relevant information are shown together in the table below.

Beside temperature scenarios of the CCAS, those of the SIMCLIM, PCCSP, and NIWA respectively are shown in different ways in the table 32 below. SIMCLIM scenarios copied straight from this report are actual values (not changes from baseline values), PCCSP scenarios copied from the PCCSP Country Report are changes from baseline, and NIWA scenarios are also changes. They are similar in that the scenarios are in ranges of temperatures with upper and lower bounds. All these scenarios show increases.

The baseline year for SIMCLIM is 1990, and for the PCCSP and NIWA it is 1980-1999 which is represented by 1990 temperature. The SNC team therefore use 1990 temperature in the SIMCLIM tool as the baseline. Over the Gilberts, 1990 temperature varies between 28.13^{0}C and 28.3^{o}C. The table below shows all relevant information in determining temperature scenarios.

Table 32 . Projection outputs from various climate tools

Tools/Reference	**Climate variable**	**Base year**	**Projected years**						
			2025	**2030**	**2050**	**2055**	**2075**	**2090**	**2100**
MAGICC SCENGEN/CCAS	Change in mean air temp	2000	0.4^{0}C(0.3 to 0.5)		1.0^{0}C(0.8 to 1.4)				2.3 (1.3 to 3.5)
SIMCLIM	Temp mean (Gilbert)	n/a	28.5^{0}C to 29^{0}C		29.0^{0}C to 30.3^{0}C		29.7^{0}C to 32^{0}C		30^{0}C - 33^{0}C
(Refer Kiribati SNC report)			28.5	28.6	29	29.14	29.7	29.9	30
			29	29.3	30.3	30.6	32	32.02	33
PCCSP	Temp-Low (B1)	1990 (1980-1999)		0.2-1.2^{0}C		0.7-1.9^{0}C		1.0-2.4^{0}C	
(Refer Volume 2. Country	Temp Medium (A1B)	1990 (1980-1999)		0.2-1.4^{0}C		0.9-2.3^{0}C		1.7-3.5^{0}C	
Report)	Temp High (A2)	1990 (1980-1999)		0.3-1.3^{0}C		1.0-2.2^{0}C		2.2-3.8^{0}C	
			0.1	0.2	0.6	0.7	0.87	1	1.08
			1.39	1.4	1.42	2.2	3.1	3.8	4.2
Use SIMCLIM 1990 mean temp as baseline		28.13 LOW	28.23	28.33	28.73	28.83	29	29.13	29.21
		28.35 HIGH	29.74	29.75	29.77	30.55	31.45	32.15	32.55
NIWA	Temperature	1980-1999	**2025**	**2030**	**2050**	**2055**	**2075**	**2090**	**2100**
(Refer Doug Ramsay NIWA.		Low	0.1		0.6			1.2	
March 2008. Climate Change		Middle	0.7		1.5			2.6	
Scenarios. PPT presentation)		High	1.9		3.1			5.6	

This SNC report gives SIMCLIM- based mean temperature for Gilbert for the scenario years of 2025, 2050, 2075, and 2100. The other scenarios years in the same table are 2030, 2055, and 2090. For these years the SNC team obtain mean temperature values by interpolation.

Volume 2 Country Report of the Climate Change in the Pacific: Scientific Assessment and New Research by the PCCSP show temperature scenarios for the years 2030, 2055, and 2090. For the other scenarios years namely 2025, 2050, 2075, and 2100 the SNC team obtain their corresponding temperature change values by interpolation or by extrapolation whichever is more appropriate. These are added to the baseline temperatures of 1990 (these baseline values are obtained from the SIMCLIM) to obtain mean temperature scenarios.

Presentations by Ramsay on NIWA scenarios of temperature, changes in temperature from the base year period 1980 to 1999 are shown in the table above. Again the 1990 temperature range in the Gilbert group as per adopted by SIMCLIM was representative of the baseline 1980-1999. In the same way as worked out for temperature values under the PCCSP tool, temperature values for the scenarios years under the NIWA information was done.

Upper bounds of the PCCSP and SIMCLIM are more comparable with each other, than both against the upper bounds of NIWA which are clearly higher. Comparing lower bounds, it is NIWA and PCCSP that are more comparable with both clearly lower than SIMCLIM lower bounds. The ranges for upper and lower bounds within each tool, shows that they are more comparable for PCCSP and SIMCLIM, whilst NIWA has the widest range.

Scenarios for mean temperature

Although people have felt increasing temperature as noted above, our analysis of mean temperature indicate that warming is much lower than global average. This information was reported in the INC and re-asserts it in the SNC report but that it is catching up to the global increase of temperature. For this reason Kiribati would not use upper bounds of temperature that are shown in the NIWA scenarios. Those of the PCCSP and SIMCLIM are used to determine upper bounds in the temperature scenarios.

For the lower bounds this report did not use those of the SIMCLIM because they are higher than NIWA and PCCSP projections, therefore exclude the lower bounds of NIWA and PCCSP that are more comparable with each other. The latter are therefore used to determine the lower bounds of temperature scenarios.

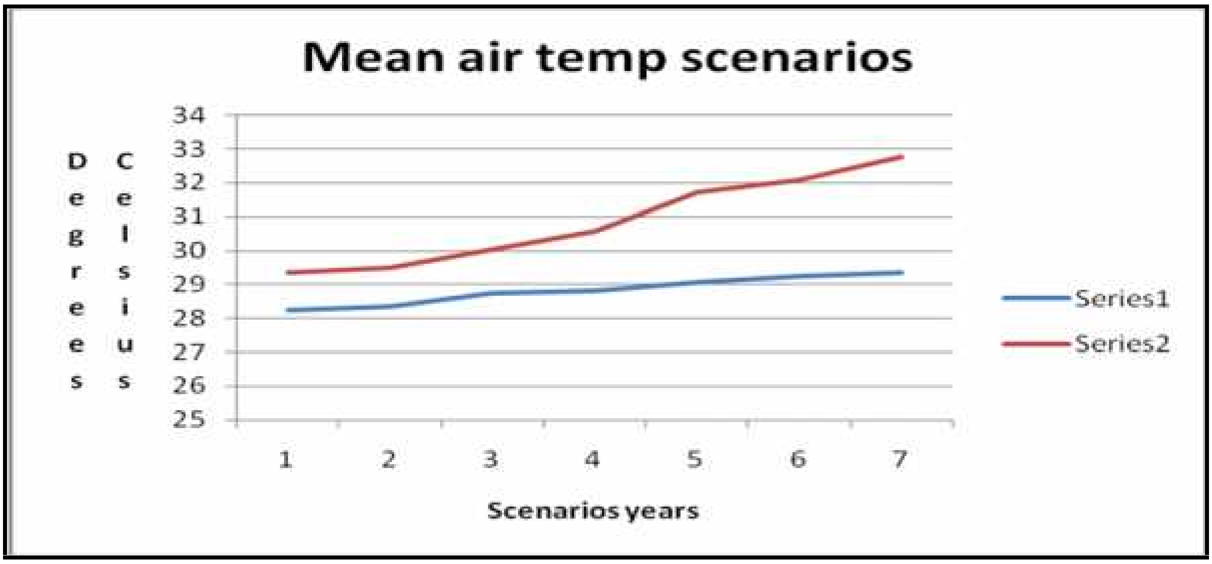
The simplest way to establish the upper and lower bounds is to take the averages of the PCCSP and SIMCLIM for the upper bounds, and of NIWA and SIMCLIM for the lower bounds. This is shown in the table below.

Table 33. Results of interpolating projection outputs from various climate tools

VARIABLES	TOOLS	2025	2030	2050	2055	2075	2090	2100
temp upper bounds	PCCSP	29.74	29.75	29.77	30.55	31.45	32.15	32.55
	SIMCLIM	29	29.3	30.3	30.6	32	32.02	33
Averages		**29.37**	**29.525**	**30.035**	**30.575**	**31.725**	**32.085**	**32.775**
temp lower bounds	PCCSP	28.23	28.33	28.73	28.83	29	29.13	29.21
	NIWA	28.23	28.33	28.73	28.805	29.105	29.33	29.48
Averages		**28.23**	**28.33**	**28.73**	**28.8175**	**29.0525**	**29.23**	**29.345**

Graphical representation is shown below

Figure 17. Air temperature scenarios



Series 1 represents air temperature lower bounds; Series 2 represents air temperature upper bounds.

In summary, scenarios for mean temperature for different timeframes are represented in the table below.

Table 34. Summary of Temperature Scenarios

2025	2030	2050	2055	2075	2090	2100
28.2-29.4	**28.3-29.5**	**28.7-30.0**	**28.8-30.6**	**29.0-31.7**	**29.2-32.1**	**29.3-32.8**

Rainfall

Rainfall is highly variable and unlike air temperature there is no clear pattern globally as to whether it has been increasing. While the long term trend may indicate slight increase, within the more recent period since 1980 the trend is decreasing (PCCSP Fact sheet). But most studies, in particular those related to water resources, would suggest that Kiribati rainfall has been increasing. Scenarios of rainfall that are adopted in the CCAS are from global climate models in the MAGICC that show increases; few models in the MAGICC that show decreases of rainfall for Kiribati were left out.

While rainfall is projected to increase, at the same time drought is expected to be as regular as it has been. Seasonal rainfall pattern may not change significantly. Work under KAP II provides information on the risks of drought events that could still occur. PCCSP with various global models project decreases and increases of rainfall from base year. On the other hand, SIMCLIM, using various global climate models, projects only increases of rainfall for Kiribati. Synthesizing information on rainfall scenarios from various efforts is of paramount important for the complete understanding of Kiribati.

The SNC report collated scenarios of rainfall for Gilbert from various sources and is shown in the Table 35 below.

For PCCSP Future Climate the SNC project team have simply adopted the scenarios that are given for Gilbert in the PCCSP 2011 report, "Climate Change in the Pacific: Scientific Assessment and New Research. Volume 2: Country Reports". The given rainfall scenarios are for the years 2030, 2055, and 2090. For the other years, the given rainfall values are interpolated or extrapolated as appropriate the years in question. Sim-Clim scenarios are extracted from the tools with KI Gilbert selected as the site. The SNC team also extracted scenarios of global changes in rainfall.

Table 35. Results of interpolating rainfall projection outputs from various tools

Tools/Reference	Climate variable	Base year and scenarios	Projected years						
			2025	2030	2050	2055	2075	2090	2100
CCAS. MAGICC	Change in rainfall	2000	3% (1 to 7%)		7% (2% to 17%)				15% (4% to 46%)
PCCSP	Change in annual mean rainfall(Gilbert)	1980-1999: B1	-9.8 to 36	-11 to 39%(14)	-15.8 to 53.4	-17 to 57%(20)	13.6 to 59.3	-11 to 61% (25)	-9.3 to 62.1%
(source: vol 2 report)		1980-2000: A1B	-22 to 42.6	-20 to 44% (12)	-12 to 53%	-10 to 56% (23)	-16.3 to 83.8	-21 to 95% (37)	-24.1 to 106.1
PCCSP Climate Change in the Pacific		1980-2001: A2	-14.6 to 22.2	-14 to 28% (7)	-11.6 to 51.20%	-11 to 57% (23)	-22.4 to 90.1	-31 to 115% (42)	-36.7 to 131.6
SIMCLIM	Change in annual mean rainfall	1990: B1	5.89% - 8.93%	6.78-10.28	10.45-15.83%	11.34-17.18%	14.65 - 22.19%	16.16-16.72%	16.79-25.44%
		1990: A1B	6.34-9.61%	7.77 to 11.77	14.11-21.38%	15.72-23.81%	21.52-32.60%	24.65-37.34%	26.44 to 40.05%
		1990: A2	6.07 - 9.20%	7.23 to 10.96%	13.31 - 20.16%	15.09 - 22.86%	23.13-35.04%	29.56-44.78%	34.03 to 51.55%
NIWA	N/A	N/A							

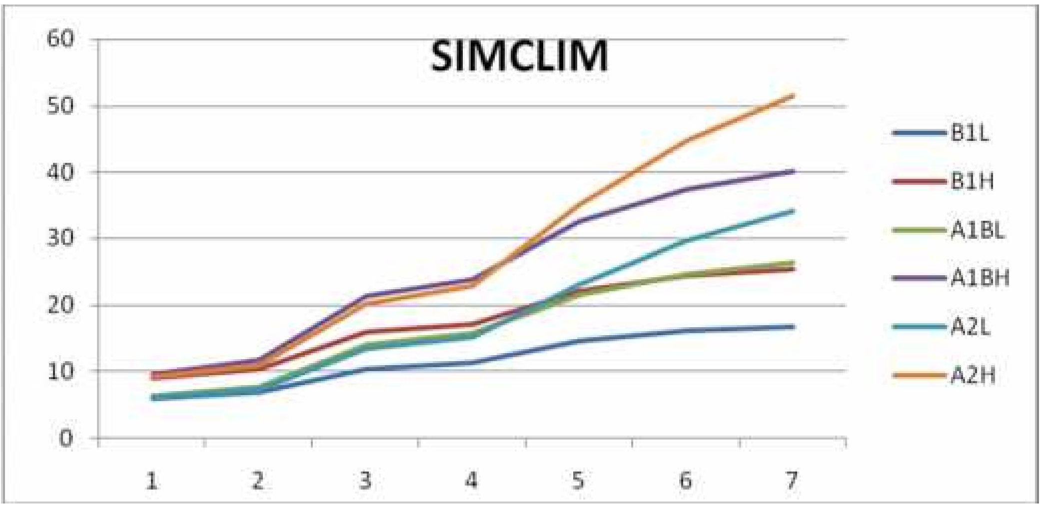
The SNC team first compare the changes in rainfall as projected by the different tools (SIMCLIM and PCCSP) using the same emission scenarios. Variations of the changes across Gilbert give the range in their changes. PCCSP projects much higher ranges than SIMCLIM does.

Moreover, PCCSP projects for all the scenarios (B1, A1B, and A2) lower bounds that are negative whilst SIMCLIM projects lower bounds that are all positive. In this SNC report, it was noted that rainfall for Butaritari for the period 1947-2004 would appear to show a decreasing trend of -2.3 mm/yr; this may support PCCSP projection of lowest values of change in rainfall as being of negative trend. The highest bounds of changes for each of the scenarios are much higher in the PCCSP projections than in the SIMCLIM.

SIMCLIM gives also global changes in rainfall. Changes in rainfall for Gilbert are contained within the range of global rainfall changes, and noted above the changes for Gilbert are all positive according to SIMCLIM. But the CCST note too that negative trends for lowest bounds should be expected according to PCCSP.

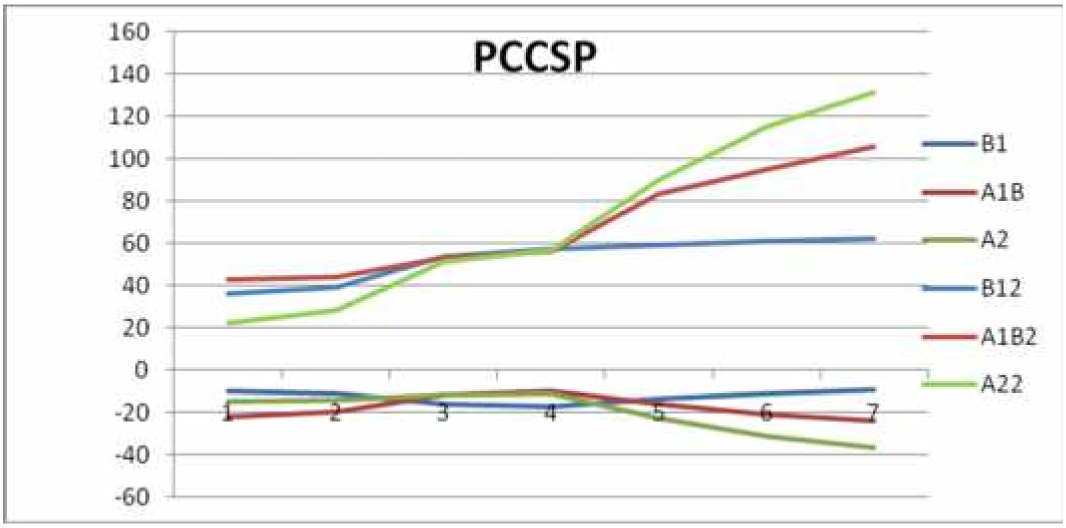
The SNC team then compare the changes in rainfall according the different emission scenarios using the same tool. By using SIMCLIM, the highest bounds in the ranges of rainfall changes under A2 and A1B are comparable up to mid century, and thereafter to end of the century the A2 highest bounds exceed all others. Highest bounds for B2 are the lowest among those of A2 and A1B. The lowest bounds for B2 are all below those of A2 and AIB.
This pattern is shown in the graph below.

Figure 18. Rainfall projection outputs for different SRES – Sim-Clim tool



Likewise the SNC team compare differences of the scenarios' resulting ranges in rainfall changes using the PCCSP. The SNC team recalled that the selection of B1, AIB, and A2 among other scenarios, in the PCCSP Future Climate tool was based on there being respectively producing least change, medium, and greatest change in climate change – A1FI was considered as unrealistic. The pattern of the changes in rainfall is shown in the graph below.

Figure 19. Rainfall projections for different SRES - PCCSP



From the above it is seen that it would be during the second half of the century when the three scenarios should have their predetermined relative effects on the climate noticed.

Gilbert rainfall scenarios.

The SIMCLIM appears to be neater to adopt from it rainfall scenarios. PCCSP appears so diverging in values, which are very variable as the CCST have noticed for rainfall distribution. But to emphasise that it is this variability that the SNC team should not want to lose it in our scenarios.

To determine scenarios the SNC team used the A2 upper bounds in the ranges of change in rainfall as projected using the SIMCLIM as the upper bounds in the Gilbert scenarios. But the values are from the trend equation. The trend is 7% per scenario interval year. For the lower bounds the Kiribati SNC team use the trend of B1 as projected using the PCCSP. The trend is -5% per scenario interval year.

The Kiribati SNC team adopt as the base year 2000. Scenario interval year means for the scenario year 2025, the period of 25 years. For the scenario year 2025, the scenario interval year means 5 years and so on. This is based on the graph. Then for the various scenario years, this report uses the trends to determine the scenario changes in rainfall. These are shown in the table below. The CCAS rainfall scenarios are also shown.

The upper bounds in the two scenarios are comparable but the lower bounds are diverging. However the SNC team reason (Butaritari trend) to include the possibility of decreasing rainfall. This is consistent with the concern about drought which is to continue.

Table 36. Rainfall scenarios for Kiribati Second National Communication report

Base year and scenarios	**Projected years**						
	2025	**2030**	**2050**	**2055**	**2075**	**2090**	**2100**
2000, CCAS	**3% (1 to 7%)**		**7% (2% to 17%)**				**15% (4% to 46%)**
2000, SUGGESTED as per this SNC Report	-5% to 7%	-10% to 14%	-15% to 21%	-20% to 28%	-25% to 35%	-30% to 42%	-35% to 49%

Sea level rise

Of different but connected impacts of climate change, sea level rise attracts significant level of response from Kiribati people. Within a relatively brief period, it was considered to be a threat not in the near future but in distant future. And monitoring of the sea level was needed and so was established through Australian Assistance program in the Pacific islands.

Now it is felt that it is time to raise issues that the Kiribati SNC team highly suggest should start preparing for the extreme threat that sea level rise (extreme sea levels projections) is causing. People will be displaced, and opportunities for external migration should be quietly explored. In the meantime, let it be granted that people are already incurring losses and damages to their properties. For the country, the meagre natural resources are more frequently facing severe damaging impacts of extreme weather conditions.

The future of Kiribati in the world with climate change was described, few decades back, to be bleak with possible submergence some decades later. After four decades hence, Kiribati has not disappeared but certainly sea level has risen over the decades.

What are plausible levels of rising sea that can be expected in the future years? Kiribati needs sea level scenarios.

At the time of KAP 1 and NAPA, scenarios were established and these become part of the Climate Change Adaptation Strategy adopted in 2005. The scenarios were compiled from information elicited from the MAGICC tool.

During the years of KAP11 and SNC (2007 to date) more sources of information on scenarios are available. They are from scientific institutes and programmes, namely Clim-system which develop “SIMCLIM”, Pacific Climate Change Science Programme (PCCSP) which develop “Climate future” tool, and New Zealand Institute of Water and Atmosphere which develop “Coastal Calculator”.

The SNC team attempted to synthesize information from those various tools. The synthesis is the scenario the Kiribati SNC team wish to recommend.

On the section “Vulnerability and Adaptation”, sea level scenarios from PCCSP and SIMCLIM tools are given among temperatures and precipitation scenarios as shown in the table below.

Table 37. Sea level rise and temperature scenarios recommended by this SNC report

		Base yr	**2025**	**2030**	**2050**	**2055**	**2075**	**2090**
SIMCLIM	Temp mean	n/a	28.5^{0}C to 29^{0}C		29.0 to 30.3		29.7 to 32	
	Precipitation	n/a	2171 - 2322mm		2338 - 2714mm		2540 - 3252mm	
	Sea Level	***1990***	***15cm-18.5cm***		***26cm-40.5cm***		***38cm-70cm***	
PCCSP	Temp-Low	1989-1999		0.2-1.2^{0}C		0.6-1.9^{0}C		1.0-2.4^{0}C
	Temp Medium	1989-1999		0.2-1.4^{0}C		0.9-2.3^{0}C		1.6-3.5^{0}C
	Temp High	1989-1999		0.3-1.3^{0}C		1.0-2.2^{0}C		2.2-3.8^{0}C
	Sea Level, Low	1980-1999		***4-13cm***		***9-25cm***		***16-45cm***
	Sea Level, medium	1980-1999		***5-14cm***		***10-29cm***		***19-57cm***
	Sea Level, high	1980-1999		***5-14cm***		***10-28cm***		***20-58cm***

Table 38. Sea Level rise projections from different tools recommended by SNC report

Sites and climate-related variable	Scenarios	Tools/Sources	2025	2030[i]	2050	2055[i]	2075	2090[i]	2100
Betio or Tarawa sea level	B1	SIMCLIM	6.34-10.71cm	7.23-12.84cm	10.76-22.40cm	11.61-25.00cm	14.96-35.94cm	17.33-44.42cm	18.85-50.04cm
		PCCSP	3-10.6cm	4-13cm	8-22.6cm	9-25cm	13-36.4	16-45cm	18-50.7cm
		NIWA	6-9cm	7-11cm	10-19cm	11-21cm	15-30cm	17-36cm	19-40cm
	AIB	SIMCLIM	6.09-11.81cm	7.03-14.36cm	10.88-26.36cm	11.89-29.76cm	15.95-44.69cm	19.07-57.03cm	21.19-65.67cm
		PCCSP	2-11cm	5-14cm	9-26cm	10-29cm	15.1-45cm	19-57cm	21.6-65cm
		NIWA	7-10cm	7-12cm	12-22cm	13-25cm	17-36cm	20-45cm	22-51cm
	A2	SIMCLIM	6.15-9.23cm	7.07-11.48cm	11.02-22.94cm	12.09-26.44cm	16.74-43.16cm	20.71-58.61cm	23.63-70.38cm
		PCCSP	4.2-13.2	5-14cm	9-17.2cm	10-28cm	15.71-45.1cm	20-58cm	28.6-66.6cm
		NIWA	6-10cm	7-11cm	11-20cm	12-23cm	17-35cm	22-47cm	24-55cm
	i. Years for which PCCSP Vol 2 Country Reports give values of sea level.								
	Interpolation from these values give values for the other years								
Global	B1	SIMCLIM	6.30-9.62cm	7.19-11.42cm	10.70-19.30cm	11.55-21.38cm	14.88-29.83cm	17.24-36.02cm	18.74-39.92cm
	A1B	SIMCLIM	6.61-10.58cm	7.60-12.69cm	11.63-22.28cm	12.66-24.91cm	16.81-36.13cm	19.95-45.0cm	22.05-51.0cm
	A2	SIMCLIM	6.43-9.41cm	7.40-11.31cm	11.52-20.42cm	12.63-23.10cm	17.44-35.57cm	21.53-46.85cm	24.53-55.35cm
	B1	IPCC 4thAR						0.18-0.38m (2090-2099)	
	A1B	IPCC 4thAR						0.21-0.48m	
	A2	IPCC 4thAR						0.23-0.51m	

Conclusion

The scenarios in more distant future have wider range than in nearer future years. This implies increasing level of uncertainties with increasing length of the future time frame. Nonetheless for the SNC team and Kiribati, this is the best available scientific information, and futher that in planning the SNC team thought that Kiribati should be prepared for the worse case scenario.

Scenarios for Extreme Events

This section define extreme environmental events as occurrences of environmental variables far exceeding or far below their normal magnitudes over comparable time intervals, and moreover impact adversely on the livelihood and health of the community and people. Selection of the length of time intervals is important for it should be reasonable for the type of impacts considered. For example, in impacts of droughts time intervals of few months is reasonable whereas for flooding few hour time intervals may be more reasonable.

The type of variables to be used need also to be reasonable for the impacts considered. Running totals of rainfall for each of three months duration (3 months interval) may be more reasonable from which to assess drought than totals of consecutive three months rainfall.

Related to climate change, the environmental variables that can be relevant include sea level, height of storm surges, wave heights, wind speed and direction, amounts of rainfall in a period, and temperature. Values far exceeding or far below their normal magnitudes in any of these variables are usually associated with their adverse impacts on the livelihood and health of the people. For this reason, it is important to collect and understand information about extreme events.

Various technical studies and tools have been produced on extremes. These include Climate Risk Profiles produced by Prof J. Hay, NIWA 2008 works, PCCSP and SIMCLIM. The SNC team made attempts to bring out useful information from these sources and to suggest, based on what the SNC team can comprehend from those works, the risks to Kiribati from extreme events. Underlying assumptions in the studies of extreme events

The concern is climate and weather extreme events. The desire is to understand the likelihood of their occurrences, the return periods, their severity and the consequences for the people affected.

The likelihood of the occurrence of any extreme value, say of the variable –rainfall, should be based on its relative frequency in the time series of all values of the variable over some length of duration in the past. But there are also theoretical probabilities functions that certain variables tend to follow.

When data is available, it should be possible to construct relative frequency curves for the variable and these curves are approximate to theoretical probability density functions where these exist. In some cases, the variable has single values or range of values where each value occurs but once. One way to analyse this is to draw up a cumulative curve based on the values arranged in descending order as is done in the CRP. This gives the probabilities of exceedance of particular values.

CRP use duration of a day rainfall, NIWA use durations of 10 minutes to 72hrs. These durations could be considered as partitioning the calendar year; for each duration there is a value of the variable of interest, and from all duration-values there is one extreme value which the SNC team target. It is a maximum or a minimum and this is taken as a value for the year in which they occur.

For maxima, if there are n years each of which has been partitioned by much smaller durations, then it should be possible to apply the CRP tool to the maxima (or minima) of the values of the variables pertaining to the durations. CRP step 1 is to arrange the extreme values from the highest to the lowest. Step 2, rank them – give the highest rank 1 and so on. Step 3, the number of years plus one all divided by the rank of the maximum or minimum is the return period of that extreme value. Step 4; define the exceedance probability of the maximum as the reciprocal of the return period.

The report intends to compare the CRP with NIWA. NIWA Table from their report is abridged as below. It is for the period 1971-1994.

Table 39. Tarawa rainfall depth-duration-frequency based on 1971-1994 records (NIWA)

ARI Average Return Interval	**AEP** Annual Exceedance Probability	**10 min**	**1 hr**	**24 hr**	**72 hr**

(yrs)	(%)	(mm)	(mm)	(mm)	(mm)
2	50	19.1	49.6	115.9	163.4
5	20	24.8	63.3	175.4	220.7
10	10	28.5	72.4	206.6	258.7
20	5	32.1	81.1	236.5	295.1
50	2	36.7	92.4	275.3	342.2
75	1.3	38.7	97.3	292.3	362.8
100	1	40.1	100.8	304.3	377.5

The period covered is 24 yrs and if CRP is applied, it will have a maximum return period of 25 yrs, not 100 yrs, for the duration of 10 min. Thus in the table above, 40.1mm rainfall in a duration of 10 min would be an event of 1 in 100 yrs, but if this SNC report use the CRP it would be a 1 in 25 yrs. Yet, it is the CRP that is simpler to follow but it appears the real test of these results from CRP or from NIWA would be to consider the raw data and then use cumulative frequency curves for assessing the probabilities and return periods of any particular value in the variable of interest.

It is noted that flooding has occasionally occurred, but there is no definition so far that could link this experience with the amount of rainfall for a set duration of time. Therefore it could be noted from the table above as flooding occurrences and therefore regard the ARI of 2 yrs related to rainfall at the various durations of time as referring to flooding. Thus the SNC team would imply that flooding with return period of two years would be experienced for rainfall of 19.1 mm in duration of 10 minutes, and so on.

Droughts

More understanding about flooding is undoubtedly desired. Drought remains a subjective phenomenon. It is a shortage of potable water due to shortage of rainfall experienced by the people throughout the island due to below normal rainfall.

Low rainfall over long enough periods will also set in drought conditions. Drought of some durations have always occurred in Kiribati, and along any atolls in Kiribati there are areas at which ground water lens is very thin and very vulnerable to drought.

For analysis of rainfall to understand drought, various definitions and tools were noted. White and Falkland in one of their reports on Kiribati water resources mentioned and explained “decile method”. This method is noted in the Kiribati Climate Change National Implementing Strategy.

NIWA in their highly technical report on drought which they prepare for KAP II explain “drought severity index” which is based on comparing the median of previous three months with the median of current month. For each month, median value should be known; medians of three months should also be known. The anomaly of rainfall for the current month is the current rainfall less the median which if it is negative, then it is compared with the median of the previous three months (taken together) and if it is also negative then the drought is considered to set in. The DSI (drought susceptibility index) is just the anomaly value, taken as positive (i.e. modulus). The lower the value of the DSI, the lesser is the drought severity; conversely, the higher the DSI, the more is the drought severity.

DSI applied to record of rainfall at any island gives ranges of DSI, durations that the particular range of values has persisted, and their frequencies within the period covered in the record. The table 40 below is extracted from NIWA report (2008) and gives the analysis for Tarawa.

Table 40. DSI from data and modelled drought events

Rainfall record period 1950-1999				
	As Observed		As modelled miub-echoz	
DSI	No. of Events	Duration (months)	No. of Events	Duration (months)
0-4.9	9	3.7	6	3.3
5-9.9	5	4.6	6	3.7
10-14.9	3	5.7	5	6.8
15-19.9	7	7	3	7.7
20-24.9	0	0	3	9
25-29.9	2	10.5	2	7.5
30-34.9	0	0	1	11
35-39.9	4	10.8	3	11.3
40-44.9	1	11	2	14
45-49.9	0	0	0	0
50-54.9	0	0	0	0
55-59.9	1	19	3	14.7
60-64.9	0	0	1	13
65-69.9	1	16	1	14
70-74.9	1	21	1	16
75-79.9	1	18	0	0
80-84.9	1	24	1	18
85-89.9	1	22	0	0
90-99.9	0	0	0	0
>100	2	30.5	0	0
	39		38	
θ	0.78		0.76	

From table 40 above it is understood that the less severe a drought is, the shorter the duration is, but the more frequent it occurs. Conversely, the more severe a drought is, the longer is the duration, but the less frequent it occurs.

The information above is better reflected in a table with Average Return Interval (ARI), and Annual Exceedance Probability (AEP) which definitions are consistent with those that may be understood from the CRP tools. Information from NIWA (2008) report on drought is re-produced below to provide an example of such table.

Table 41. Droughts at each of the Kiribati islands

Table 4 of NIWA. Present day rainfall (1950-1999). Drought in months with characteristics of ARI and parameter θ (Number of drought events per year)									
ARI/AEP									
	Site	**θ**	**2**	**5**	**10**	**20**	**50**	**75**	**100**
			50%	**20%**	**10%**	**5%**	**2%**	**1.30%**	**1%**
	Banaba	0.63	3	13	18	22	32	36	37
	Makin	0.94	5	12	16	20	23	24	25
	Butaritari	0.9	5	11	15	24	27	31	33
	Marakei	0.77	4	12	17	20	24	25	26
	Abaiang	0.68	3	11	17	25	35	37	38
	Tarawa	0.75	4	12	19	24	30	31	32
	Maiana	0.68	5	12	16	24	32	34	35
	Kuria	0.86	5	11	16	21	24	25	26
	Aranuka	0.81	4	11	16	23	30	31	32
	Abemama	0.85	6	11	14	16	22	24	25
	Nonouti	0.81	5	11	15	18	27	29	30
	Tabiteuea North	0.83	4	10	15	23	28	29	30
	Tabiteuea S	0.83	5	11	16	20	24	25	25
	Onotoa	0.78	5	11	15	22	28	30	31
	Beru	0.68	4	12	18	23	27	29	30
	Nikunau	1	6	11	14	16	18	19	19
	Tamana	0.74	5	13	17	22	29	30	31
	Arorae	0.68	3	12	17	20	28	36	38
	Tabuaeran	1.05	6	10	13	18	20	21	22
	Teraina (Fanning)	0.91	5	11	15	19	24	27	29
	Kiritimati	1.02	6	10	14	16	18	19	19
	Canton	0.93	5	10	13	15	19	20	21

From the table above, it is can be observed again that the longer the drought duration equates to the longer the ARI. As for the parameter θ (mean number of droughts per year), NIWA explained that it is related to the ARI/AEP, and the SNC team note that the drought events are defined in terms of median rainfall *on particular sites* so that this parameter could not be used meaningfully to compare drought occurrences among the islands. For example the value of θ for Butaritari is 0.9 while for Onotoa it is 0.78 but the SNC team know generally from accumulated anecdotal data that Onotoa is much drier than Butaritari; so any I-Kiribati would expect Onotoa to have higher value of θ. These may be variations in data and approaches that are important to distinguish and make sense out of them.

For Kiribati as a whole, drought of four to five months can be expected every two years while drought of longer duration between 10 months and 16 months can be expected with probability of between 20% and 5%, which could occur in any year. Contrary to what is generally thought to be the case, it appears from the table above that where rainfall for an island is higher compared to another, drought of the same duration would have higher probability to start in any year at the former than in the latter.

Beside the parameter θ, ARI/AEP which are also introduced in the CRP, other concepts to characterize droughts include "severity", "magnitude", and "intensity". The sense of "severity" is suggested in the measure of the DSI and, with the duration of the drought under the persistence value of DSI, lead on to the measure of "magnitude".

"Intensity" is defined as the magnitude of drought divided by the duration; it is easily understood in the case of "rainfall" intensity. These are useful for theoretical analysis of droughts, but for practical purposes the SNC team need in Kiribati first to adopt a definition of drought. Would it be DSI, or a Decile? The Decile method would be the simplest and manageable.

However as mentioned previously, Kiribati had officially adopted a methodology for defining drought for water sector which also used the "decile method".

Rainfall intensity (storms) and on droughts

NIWA explained in their report that global temperature scenarios are based on emission scenarios and global climate models. Low, medium, and high temperature scenarios are from emission scenarios B1, A1B, and A1Fl respectively; the emission scenarios were used in 18 global climate models which simulate better temperature pattern in the Pacific. The SNC team recall that PCCSP considered A1Fl as most unlikely and use A2 scenarios as the highest or likely emission scenario.

Temperature scenarios at 180 longitudes and 0 latitude (coordinates within Kiribati region) for an emission scenario are representative of temperatures at all Kiribati islands, but they (temperature scenarios) are different for each climate models.

The table (table 42) below is extracted from NIWA (2008) report. It gives temperature change scenarios relative to temperature in the period 1980-1999.

Table 42. Temperature change scenarios

Scenario Period	Low	Middle	High
2025 (2015 -2034)	0.1	0.7	1.9
2050 (2040-2059)	0.6	1.5	3.1
2090 (2080-2099)	1.2	2.6	5.6

These temperature change scenarios affect rainfall. It is so assumed that for a temperature change of 1^0C there is 7% increase in water in the atmosphere. The assumption is used for rainfall change during 10 minutes duration. NIWA (2008) report's own work produces percentage changes on 24hr rainfall with various return periods. Percentage changes per one degree temperature increase for durations in between (10 minutes and 24hrs) and longer than 24 hrs are obtained by interpolation and extrapolation. These percentage changes are shown in the table below.

Table 43. Percentage changes of rainfall depths per temperature increase

Percentage changes of rainfall											
	ARI	**AEP**	**10min**	**20min**	**30min**	**60min**	**2hr**	**6hr**	**24hr**	**48hr**	**72hr**
	2	50%	7	6.7	6.3	5.9	5.4	4.6	3.8	3.3	3.1
	5	20	7	6.7	6.5	6.2	5.9	5.3	4.7	4.4	4.2
	10	10	7	6.8	6.7	6.5	6.3	6	5.5	5.3	5.2
	20	5	7	7	6.8	6.7	6.7	6.5	6.3	6.2	6.1
	50	2	7	7	7	7	7	7	7	7	7
	75	1.3	7	7	7	7	7	7	7	7	7
	100	1	7	7	7	7	7	7	7	7	7

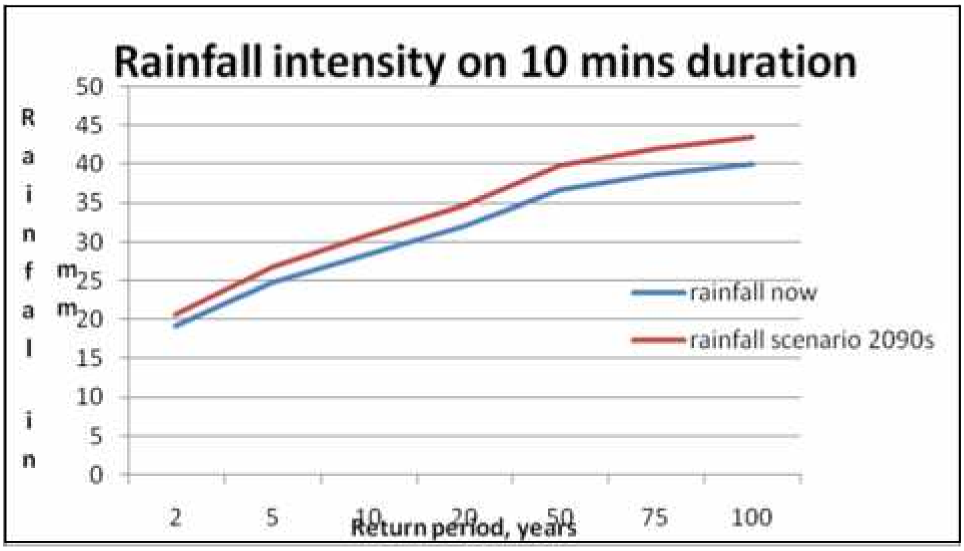
The two tables above (42 and 43) are applied to historical data of rainfall to obtain scenarios of rainfall for storms and flooding.

Table 44. Tarawa historical data scenario for 2090 on rainfall intensity

Historical data 1971-1994					**Low rainfall scenarios for 2090s**			
ARI	**10 min**	**1 hr**	**24 hr**	**72 hr**	**10 min**	**1 hr**	**24 hr**	**72 hr**
(yrs)	**(mm)**	**(mm)**	**(mm)**	**(mm)**	**(mm)**	**(mm)**	**(mm)**	**(mm)**
2	19.1	49.6	115.9	163.4	20.7044	53.1117	121.185	169.4785
5	24.8	63.3	175.4	220.7	26.8832	68.0095	185.293	231.8233
10	28.5	72.4	206.6	258.7	30.894	78.0472	220.236	274.8429
20	32.1	81.1	236.5	295.1	34.7964	87.6204	254.379	316.7013
50	36.7	92.4	275.3	342.2	39.7828	100.162	298.425	370.9448
75	38.7	97.3	292.3	362.8	41.9508	105.473	316.853	393.2752
100	40.1	100.8	304.3	377.5	43.4684	109.267	329.861	409.21

The first column under "Low rainfall scenarios for 2090s" is similar to the NIWA relevant table; the last three columns are higher than NIWA table. Nonetheless, it is clear from the above that the intensity of rainfall will be expected to increase. At a level of intensity and duration that now cause flooding with a determined return period, the same level during future years under the influence of climate change will be more frequent. This is demonstrated in the graph below.

Figure 20. Rainfall intensity on 10mins duration



As already noted, there have been many droughts as defined by DSI obtained from monthly data during the periods 1950 to 1999. Modelling work produces the number of droughts in the same period that reasonably match the actual; one particular global climate model that produces the best fit is miub-echog. The SNC team take it that model such as this one can produce rainfall at month duration in future years up to 2100. Three models are used by NIWA namely miub_echog, mri_cgcm232, and ncar_ccsm30. These are monthly rainfall scenarios; it should again be possible to determine DSI on monthly rainfall for any number of years.

The number of years is normally 30 yrs period; the notional scenario years are middle years of the 30 year period, and these are 2025 (2010-2039), 2050 (2035-2064), and 2090 (2071-2100). Based on miub_echog, NIWA develops a scenario of drought durations and frequencies for Tarawa. These are shown in the table below.

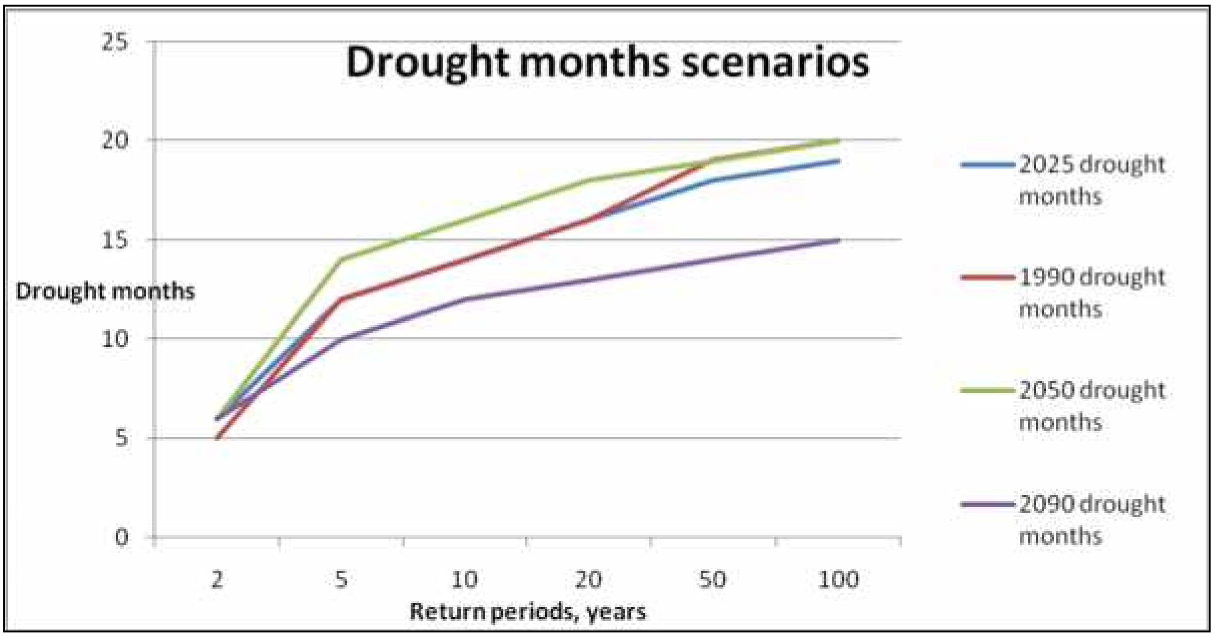
Table 45. Tarawa expected drought durations for various years (NIWA)

ARI (yrs)/AEP (%)								
			2	**5**	**10**	**20**	**50**	**100**
Period	**Drought parameter**	**N_{events}**	**50%**	**20%**	**10%**	**5%**	**2%**	**1%**
1990	0.76	38	5	12	14	16	19	20

2025	0.933	28	6	12	14	16	18	19
2050	0.7	21	6	14	16	18	19	20
2090	1	30	6	10	12	13	14	15

Drought parameter is the number of droughts per year, assessed from a total number of droughts in the 30 year scenario period with centres at 2025, 2050, and 2090. DSI is used to pick out drought months that are the number of droughts in a year. It should be possible to arrange droughts in order of their durations and frequencies. CRP method or cumulative frequency analysis can be used to construct the return period component of the table above. Consistent with these methods, graphic representation of the relevant portion of the table above is shown below.

Figure 21. Drought months' scenarios for Tarawa



Extreme events that the SNC team have examined here relate to rainfall. They are determined firstly by the amount of rainfall in short durations but which cause flooding, and rainfall in longer durations but which cause drought conditions. The former implies also storms.

Analytical tools to characterize rainfall appear to be available; CRP, NIWA including DSI, and Cumulative frequency. The SNC team also notes "decile method" for drought, and there is the Future climate change tool of the PCCSP, and the SIMCLIM. The team tried to extract from SIMCLIM and Future climate change tools information that are relevant to understanding ‘flooding’ and ‘drought’. But the team feels that in- country capacity needs to be developed to understand fully these tools, and to apply them to substantiate quantitatively a nation- wide sense about flooding, storms, droughts and other important climate related events.

However understanding of these tools does not obviate the need to decide what values of variables that are used or derived in the tools that must be adopted to constitute “flooding” and “drought”. Nevertheless these tools are understood to guide important decisions to be made on appropriate responses to the adverse impacts and events of climate change.

5.6 VULNERABILITIES AND IMPACTS OF CLIMATE CHANGE ON KEY ISLAND COMPONENTS IN KIRIBATI

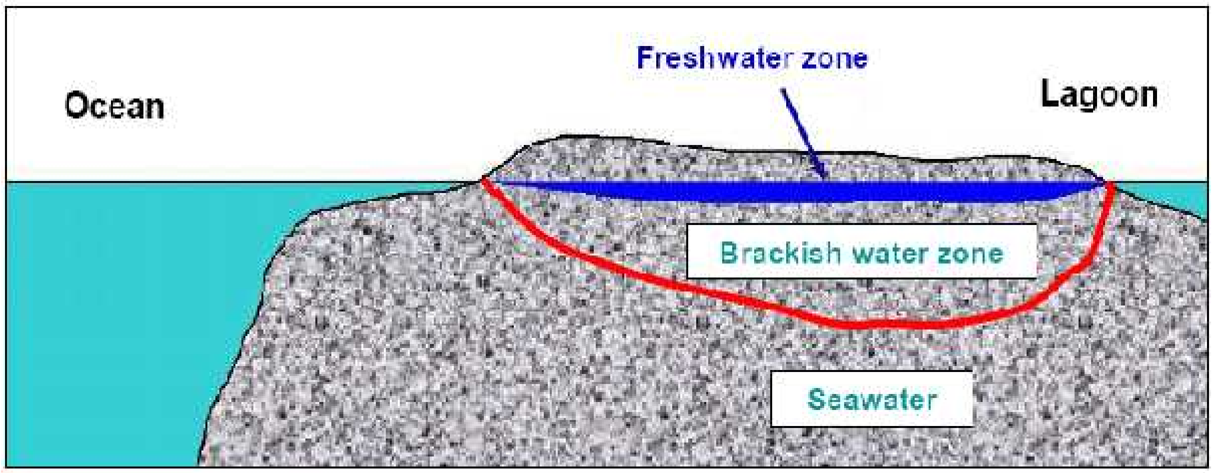
Kiribati comprised of mostly coral atolls with the exception of only 1 raised limestone island, Banaba. According to the 2005 census the majority of I-Kiribati resided on coral atolls and therefore they have depended on the existing complex ecosystems of these coral atolls. The socio-economic demands of Kiribati such as coastal aggregates mining on fragile coastal environment, population growth with issue over limited land space and natural resources for livelihood and infrastructure developments will exacerbate the vulnerability of Kiribati. These existing socio-economic forces on the environments of these coral atolls combined with climate variability and climate change effects are additional burdens that does not only continue to threaten these sources of livelihoods but will eventually despair the people's cognition of being safe and able to survive in these islands.

This section covers the current state of important components of atoll islands and their vulnerability to the projected adverse effects of climate change. These critical components include Water lens, Coastal Zone, Agricultural systems, Marine ecosystems, Biodiversity and Livelihood and Health.

Water lens

The groundwater lenses of Kiribati are fragile and sensitive to inputs from rainfall recharge, eva-transpiration, discharge to the sea, tidal mixing with underlying seawater in the aquifer and pumping or extraction due to consumption.

Figure 22. Coral atoll showing freshwater lens

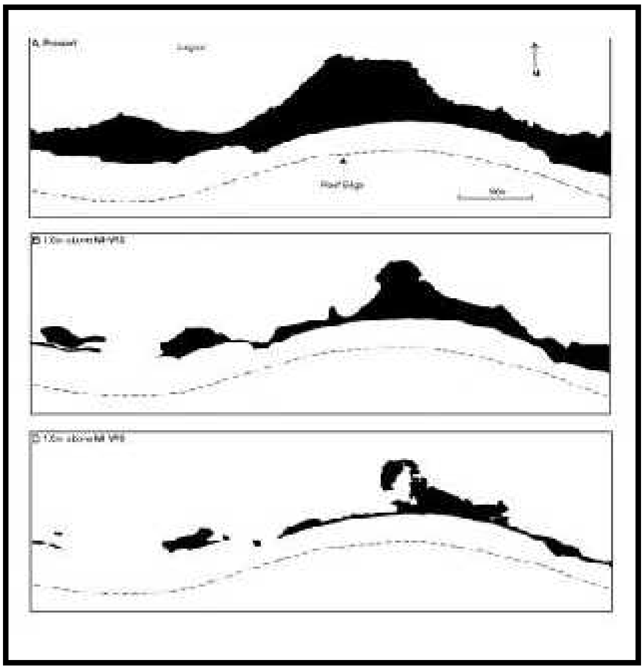


Source: Falkland, 2004

According to the 2005 Census, the predominant source of drinking water in Kiribati is sourced from local household wells – or groundwater lens.

The projections for temperature and sea level rise in almost every climate modelling groups show increasing trends. This means that there are high expectations for climate change to compromise the water lens – important surviving good for the people. However, rainfall seemed to predict an increasing trend as well but the current GCMs outputs do not seem to show consistent results due to knowledge gaps on uncertainties. On the outer islands, anecdotal evidence shows consistent cases of saline water quality in every village as compared to the past experience. The study of World Bank (2000) projected loss of land due to sea level rise for different time periods and using worse case scenarios. The result of this assessment are the projected impacts as reported in the figure 24 below which represent how climate change could eventually loose lands in coral atoll island of Tarawa (capital island of Kiribati) and their important components such as water lens.

Figure 23. Scenarios for inundation of lands of Bikenibeu village - Tarawa Island due to sea level rise



Bikenibeu Village of Tarawa in 2000

Bikenibeu Village in 2100

Bikenibeu village in 2100 with storm surge

Source: World Bank, 2000

There was clear and definitive evidence already on the scale of the water lens vulnerability to climate change. The focus on this particular component should be on enhancing adaptive capacity for resilience of island communities rather than understanding or quantifying whether water lens is vulnerable to climate change or not. Current adaptation programs are underway, among others, to install alternative rainwater harvesting facilities and identification of unused water lenses on outer-islands for protection and proper management.

Coastal zone

In Kiribati, coastal zone is where most of the socio-economic activities took place, with wide range of structures at ocean and lagoon side including residential and community settlements within. In essence, most of the lands were regarded costal or fall within the coastal zone.

Figure 24. Houses in a low lying coastal zone in Kiribati

Source: Environment and Conservation Division photo galleries

Coral atolls are generally small, low and flat, with elevation of few metres. Islands are those landforms located on coral atolls. These islands are highly vulnerable to elevated sea levels caused by extreme events and global climate change. Such vulnerability has been observed in specific low-lying coastal areas of many islands of Kiribati during accelerated spring tides.

The bio-physical nature of the coastal zone of each island represents a typical soft coast environment which is highly dynamic and sensitive to human and natural induced change (e.g. severe erosion) over a great temporal horizon.

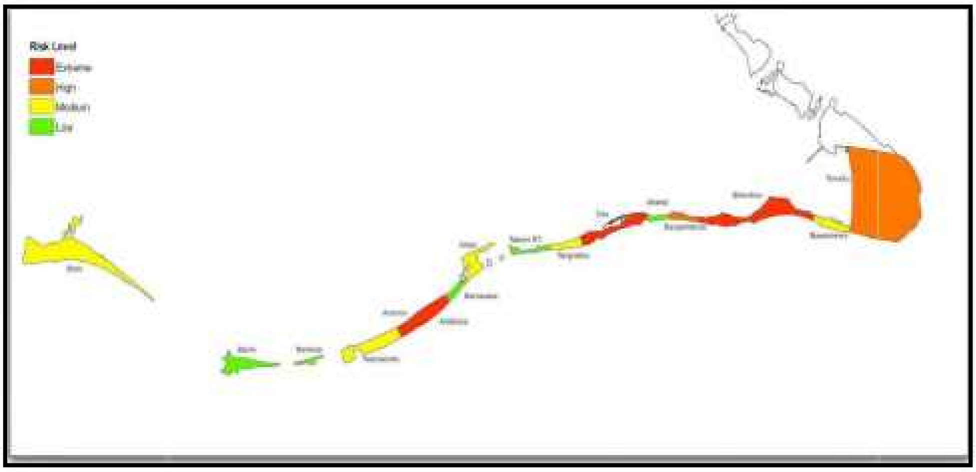
The projection of change in mean sea-level for Tarawa, capital island of Kiribati at the year 2070 using rate of change generated from the Coastal Calculator tool, under the A1FI scenarios for mean high water springs, was a rise of change from 2.09m to 2.61m, and a rise from 2.61 m to 3.1m during storm events. The areas of 'impact' were also managed to be generated using contours data and with the assistance of GIS technology (Kay, 2009). This reflects the extent of the vulnerability of coastal zone with respect to sea level as shown in figures below.

Figure 25. Inundation land maps, showing land situated below sea level, 2070 A1FI + 1 in 10 yr storm events

Source: Kay, 2009

The risk assessment of village level of the island of South Tarawa informed by scientific-based projection of change of sea level as shown on maps above, including field visits and community consultations suggest that the islands are exposed to a range of climate change risks as in figure below.

Figure 26. Risk levels per Village of Tarawa Island



Source: Kay, 2009

In addition, the Pacific Climate Change Science program predicted sea surface temperature and ocean acidification to continue to increase (PCCSP 2012 report). This implies that the constituents of the coastal zone within the coastal marine zone are likely to be affected due to alteration in the temperature and acidification.

There is high degree of confidence that the coastal zone of almost every island in Kiribati is subject to climate change risks in the near future. One real example was a case in the village of Tebunginako, Abaiang (one of the outer-islands of Kiribati). Several studies by SOPAC and other national institutions (e.g. MFMRD, MELAD, OB) have been undertaken on this village. Due to sea level and inundation impacts on the former site of this village, permanent migration of their entire village further to the Lee-ward side was affirmed with significant social and financial implications. There are probably many similar cases in other outer-islands but proper scientific documentation and investigation was relatively poor due to their isolation and lack of resources.

Agricultural systems

Agriculture was an important sector of the subsistence particularly in the outer-islands of Kiribati where sustenance were depended from fisheries and agricultural crops and livestock. The majority of the population resided on the rural islands of Kiribati depended on agricultural food crops from coconut breadfruit, pawpaw trees, babai, and other crops.

Figure 27. Agricultural activities in the islands of Kiribati

Source: Agriculture presentations

Agricultural systems and production in Kiribati is likely to be undermined by future climate change due to the effects of erosion, increased contamination of groundwater, storm surges, heat stress and droughts.

Projected increase intensity and frequency of rainfall as indicated by most models, and prolonged dry spells may impact the soil fertility. The soil of most Kiribati islands is infertile and highly dependent of the climate to nourish it nutrients. In addition, the effects of climate change on critical infrastructure such as roads and food storage facilities may also undermine upset the effective supply and distribution of food and materials required for farmers and eventually affect subsistence and commercial agriculture. Agriculture systems are dependent on other things such as water, among other things.

Fisheries and Marine systems

Fisheries play a crucial role in ensuring sustainable food and supplementary of protein nutrients to people of Kiribati, their means of livelihood and source of revenue for economic growth and employment. Kiribati has the second largest Exclusive Economic Zone in the Pacific, with scattered islands in the central Pacific. Therefore it has a rich coastal and offshore (ocean) marine resources.

Most people in rural areas who cannot afford fishing nets and boats rely on seashells and lagoon mudflats marine resources as source of food. Those with fishing boat can run small-scale commercial fisheries. There are some milk-fish ponds in the capital Tarawa and in rural areas.

Figure 28. Fisheries activities and tuna resources in Kiribati

Source: SPC website

The decrease in the productivity of coastal fisheries in the future was projected by the Coupled Model Inter-Comparison project outputs (using A2). In addition, most studies projected that air temperature and sea surface temperature, as well as ocean acidification will continue to increase. These two critical changes, could lead to the collapse of the entire reef ecosystems, thus limiting or eliminating access to a critical food source. The high air temperature will increase the rate of evaporation from small ponds. It is also important to note that, there is also tendency that Tuna resources could be more abundant in the face of climate change in the region of Kiribati waters. This is due to the projection that the future climate of Kiribati could be a more frequent El Nino type of climate.

An El Nino climate means more warm pool waters in the central pacific which brings with it fortunes of Tuna (especially Skipjack tuna). This becomes a positive impact of climate change on the fisheries sector. The coastal fisheries will be impacted much.

Island Biodiversity

According to the 2005 Millennium Ecosystem Assessment report, it was estimated that by end of this century, climate change will be the pre-dominant thrust for the mass biodiversity loss. The IPCC also asserts that about 20 to 30 percent of species that have assessed are likely to be at increasingly high risk of extinction as global mean temperature manifests itself to its highest that could exceed pre-industrial levels by 2 to 3 degree Celsius.

Within the scope of the definition of biological diversity or biodiversity which literally referred to as,....“variability among living organisms from all sources including, *inter alia*, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part; this includes diversity within species, between species and of ecosystems”.... (Kiribati NBSAP, 2006); the Biodiversity of Kiribati therefore includes all terrestrial and marine ecosystems, all plant and animal species and varieties found in these ecosystems and the traditional knowledge, uses and beliefs and local language that people have, in relation to these ecosystems and species.

Kiribati, in comparison to other small island countries, has the lowest level of biodiversity with very few endemic species. Biodiversity has and will continue to, play an important role on sustaining the communities’ livelihoods; cultural identity and socio-economic well-being of Kiribati (refer to Kiribati reports to CBD for more information on biodiversity index, etc). Since biodiversity has been integral to peoples’ lives in Kiribati, it is also equally important that they are protected and managed in a sustainable manner so that resources do not compromise the notion of sustainable development.

Climate change is among the threats of biodiversity and was predicted to be more detrimental to its health and abundance particularly in small islands like atolls, Kiribati.

This section builds on the findings of past vulnerability assessment reports that have been conducted in several parts of Kiribati, reiterating the extreme vulnerability of biodiversity and elements that are associated with it.

The climate change parameters that have potentially impacted on the elements and compartments of biodiversity include sea level rise, air and sea surface temperature and drought severity. Rain downpour is to some extent plays an important role to enhancing biodiversity abundance. However, in urban islands it is also believed that rain downpour was an ingrained factor to land-based pollution which in turn pollutes coastal marine biodiversity.

It is clear from the past trends and projections that these climate parameters have increased variability. These patterns have contributed to the downgrade of Kiribati's limited biodiversity.

Alternatively, rain downpour has impacts on the avi-fauna population. During the El Nino season towards the end of 2009 to early March 2010, five nesting colonies in the Southeast end of Kiritimati Island Peninsula along with number of nesting grounds at the Central area lagoon area of the same island – a popular habitat occupied by shearwater, noddies and terns were badly affected by flooding from the prolonged period of heavy rainfall.

Vulnerability studies specific on biodiversity was limited simply because biodiversity was too broad. Further research is required on this to establish some of reliable data and mechanisms to use health of biodiversity as an indicator of the level of climate change impacts. However many sector vulnerability studies have confirmed biodiversity will be severally affected in the face of climate change. According to the World Bank report, it is clearly stated that a large proportion of land in South Tarawa will be lost due to inundation as a result of climate change (refer to fig 24). This could be imitated to be similar situation to the rest of islands in Kiribati or even worse depending on many geo-related features.

However, on many islands saltwater salinity have been reported to have been increased resulting in contamination of their "giant taro" plantations and other crops. Increase force of storm surges coupled with sea level increase has accelerated risks of inundation in many of the outer-islands. This was repeatedly reported by several outer-islanders in national consultations.

Figure 29. Island crops polluted by sea water intrusion

Source: State of Environment Report and EIA reports

The ethno-biodiversity knowledge that has been retained by I-Kiribati could also be undermined by the upsurging impacts of climate change. This rich knowledge was vital to the maintenance of biodiversity. The recent social assessment on climate change by KAP introduced several statements that culminate how people in the community are being observant to the climate change impacts. Some of the statements include, "Sun is getting closer to my island home" – which literally means that normal air temperature had increased from the past normal or average. This prevents more time for people in the rural community to execute their own normal routine which is primarily engineered by their ethno-biodiversity knowledge. Lesser time for practicing this knowledge due to disruptions posed by climate change will slowly dissipate the retention of such knowledge.

Persistent high heat air temperature will also directly impact the healthy growth of several plant species in the islands of Kiribati. This may well contributes to the decline of many species as predicted by the Millennium Ecosystem Assessment report.

There have been reported incidences of coral bleaching in several islands of Kiribati (e.g. in Abaiang, Tarawa, Tabiteuea in late 2004) according to Donner report (Donner 2008). While no direct actions can be taken by the Kiribati's Government to stop a coral bleaching event from occurring, monitoring the change or lack of change in the coral community over time will help determine level of threats and therefore assist in devising strategies to manage coral reef resources or adapt to changes in coral reef resources. These incidents represent level of vulnerability of our key constituents to our biodiversity which may prone to such changes.

In addition, lesser is known about the threat from dissolution of carbon dioxide in the ocean which alters the composition of calcium in the ocean which be damaging in the future to marine calcifying organisms. The recent PCCSP report projected the level of ocean acidification to continue to increase. This subject requires more in-depth understanding from the scientific and local practitioners' community. These would greatly affect the principal source of sustenance of rural communities in Kiribati.

Figure 30. Coral reefs bleaching in Phoenix Islands - Kiribati

Source: PIPA website

The biodiversity of Kiribati contains essential components that are highly vulnerable to many threats including, the adverse impacts of climate change. It is believed that biodiversity when managed and conserved could play an important role to the resilience of the islands to climate change effects and continue to nourish the community with the life-contained services it provides.

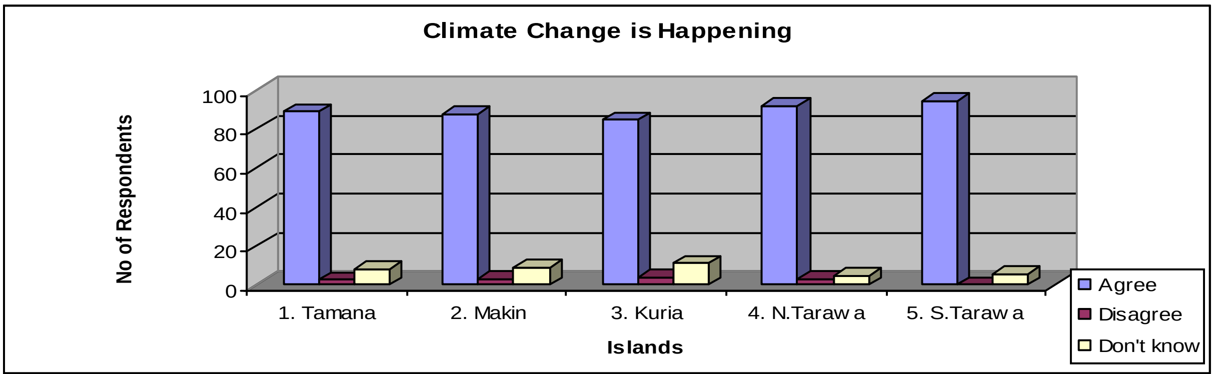
Livelihood and Health

According to Mackenzie (2003); he asserted that people have felt more vulnerable than ever to changes that have occurred in their environment in the last 5 to 30 years. The communities in most of the rural islands have attributed these changes mainly to global warming and climate change. This was clear from the community-based survey carried out in 4 islands that there is a perceived sense of powerlessness on the part of the people in relation to these changes and increasing vulnerabilities resulting from them. This was partly due to the fact that, in so far as most of the key changes are concerned, they have been unprecedented both in terms of their nature and scale of severity and intensity, so that the usual or traditional coping mechanisms have been rendered ineffective in most cases. This report stated that coastal erosion, fish abundance, intensive temperature and rising sea level.

In 2008, the status quo of climate change in rural communities of Kiribati was investigated through a survey commissioned by the Kiribati Adaptation Project. This survey provides, among others things, major findings about the existing level of baseline knowledge and awareness of climate change in Kiribati.

According to this survey, respondents' state of knowledge believed that the predominant possible future effects of climate change will include *hotter environment (70%), less rain (57%), sea level rise (52%), increased erosion (44%), saltwater into lens and wells 23% and fish stocks decline 12%.* In addition, the majority of the respondents agreed that these climate change effects have been happening (see fig below).

Figure 31. Baseline survey results on social perception on climate change



Source: KAP II, 2007

This analysis confirms social assertion of the vulnerabilities and possible impacts of climate change. This implies that climate change is already interferes with the dynamics of communities livelihood in Kiribati. Also reflecting on the survey, it has gauged that climate change will not only affects the source of livelihood of the communities but will in turn affect the children and grandchildren.

The current state of climate and the projections are all likely to support the notion that climate change will affect communities particularly children and grandchildren. Some of these effects as summarised by Burton, D, et al (2011) can be seen below.

Table 46. Impact of different climate change variables and their degree of their projections on the children and communities - Kiribati

Climate change variable/s	Comments	Kiribati Context	Potential Impact	Adaptation measures
Increased sea surface temperatures and increased ocean acidification	Impact on coral reef (e.g. bleaching), changes to fish migration, fish breeding patterns, carbon ion concentrations etc leading to potential decrease in some fish stocks (Hoegh-Guldberg 2011)	- Fish are a staple food in Kiribati - Fish stocks in Tarawa Lagoon are already dwindling from over fishing and pollution (Beets 2000)	- Reduced availability of protein and impacts on food nutrition - for children protein is an essential requirement for growth and development (WHO 2002)	- Diversify agricultural-food and protein based sources through training, incentivising farmers - Promote healthy and balanced diet to children
Increased ocean temperatures	Temperature can cause coral bleaching of coral reef (Hoegh-Guldberg 2011)	- Ciguatera is an existing issue in Kiribati (Lehane and Lewis 2000)	- Correlation between climate change and Increased occurrence of ciguatera (fish poisoning) (Hales, Weinstein et al. 1999)	- Ban fishing in ciguatera spotted areas

Climate change variable/s	Comments	Kiribati Context	Potential Impact	Adaptation measures
Increased average warming, increased El Nino-Like Events	Changes to geographic spread and breeding rates of vector carrying species (Githeko 2009) More frequent El Nino – like conditions are predicted (USGCRP 2011)	- Kiribati currently experiences dengue fever but not malaria	- Associated health challenges such as malaria and dengue fever (McMichael, Woodruff et al. 2003)	- Promote cleanliness and hygiene during heavy rainfall seasons
Drought, extreme weather, sea level rise	Decreased local land-based food productivity from increased salinity, crop wilting, invasive species	- 4.9% of people are currently below the food poverty line	- Potential for increased exposure to malnutrition - Increased reliance on western foods – bringing associate issues such as obesity, diabetes etc - Decreased rural incomes and increased cost of living in urban areas	- Diversify agricultural-food and protein based sources through training, incentivising farmers - Promote healthy and balanced diet to children
Increased average temperatures	Correlation between increased average temperatures and diarrheal (i.e. (Kolstad & Johansson 2011)	- 5.7% increase (1.9% to 9%) in diarrheal related hospitalisations by 2050 (based on Climsystems modelling - 1.9°C increase in average daily temperature)[3]	- Possible increase of diarrheal hospitalisations of 1%-5% (3% mean) per 1°C (Kolstad and Johansson 2011)	- Promote cleanliness and hygiene during heavy rainfall

[3] These results are based on an assumption that the correlation of temperature change stated in Kolstad and Johannson 2011 can be replicated for Kiribati and Vanuatu. As the results have not considered any other variables (e.g. development pressures, health etc) they are indicative only.

Climate change variable/s	Comments	Kiribati Context	Potential Impact	Adaptation measures
Drought and reduced average rainfall, sea level rise	Decreased availability of potable water	- In Kiribati the population projections is between 46% and 96% by 2030 meaning existing water resources will be severely stressed (White 2011) - Climsystems modelling for this project sees average rainfall change between -5% and +75%	- Potable water is a crucial support of health and well being	- Expand rainwater catchments programs - Promote community managed water infiltration galleries
Extreme precipitation, sea level rise, wave action	Increased runoff and spread of sewerage	- Anecdotal evidence obtained by researchers suggests that sea waves distribute sewage in Tarawa, Kiribati - As many people in Kiribati use the beach and lagoon for defecating strong wave action push faecal matter onto the land and into the wells	- Combination of drying and extreme rainfall can spread sewage (Jofre, Blanch et al. 2010) - Strong wave action can distribute polluted sea water onto land and destroy existing infrastructure	- Design and implement disaster reduction measures/programs
Extreme weather (e.g. Cyclones)	Physical harm from flying debris and storm surge. Increase in cyclone intensity	- Anecdotal evidence obtained during interviews suggests that children are often kept out of school after extreme events	- Cyclones have not been known to occur in Kiribati – there are no publications which examine the potential emergence	- Design and implement disaster reduction measures/programs

Climate change variable/s	Comments	Kiribati Context	Potential Impact	Adaptation measures
	Damage to schools, transport routes, houses	to help the family / community clean up - Psychological impacts post disaster (Doherty and Clayton 2011) - Increase risk for sexual abuse post disaster (Fritze, Blashki et al. 2008) - Potential for reduced access to school - Potential for damage to close schools	under climate change	
Extreme Temperature	More frequent extreme temperatures		Diminished productivity and other impacts related to learning in a hotter environment (Sheffield and Landrigan 2011)	- Promote climate smart crops and climate resilient building codes and practices.

Source: adapted from UNESCO report on Children and Climate Change, 2011

Kiribati with most of its communities do not have sufficient space to avoid risks, projected increased sea level rise will have direct and indirect consequences on their livelihood. Some of the examples of such communities in Kiribati include, Betio – densely populated islet and Tebunginako, Abaiang – community had had to relocate due to coastal erosion over past few decades (Reed, 2011). - REED, B. (2011) Climate Change And Faith Collide In Kiribati. National Public Radio, available from http://www.npr.org/2011/02/16/133650679/climate-change-and-faith-collide-in-kiribati?ft=3&f=133681251

Reiterating impacts under coastal zone, mapping of sea level rise impacts (out to 2100) has been undertaken for parts of Tarawa, although the resolution does not clearly show hospitals and schools in the publication (Elrick, Kay et al. 2009). The impact mapping undertaken by Elrick et al. (2009) identifies that under an IPCC high scenario (A1FI) the villages in South Tarawa with high and extreme risks include Antenon, Antebuka, Eita, Bangantebure, Bikenibeu and Temaiku (although the study also recommended the need for better elevation data). High end sea level rise projections will challenge the very existence of the country.

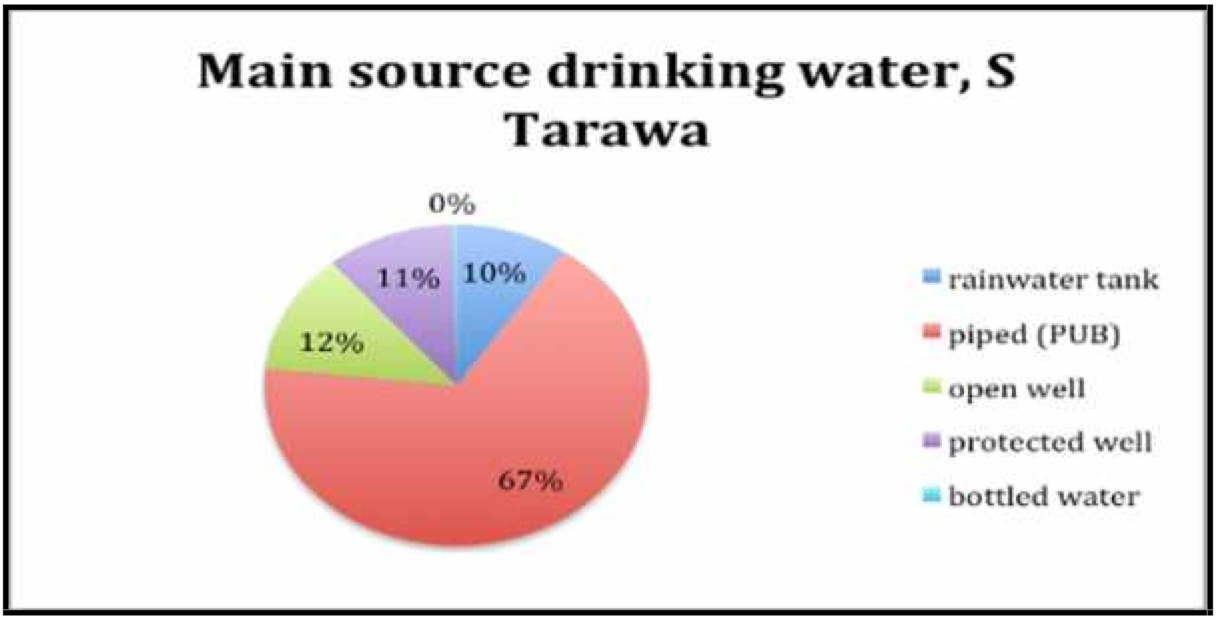
The change in the state of society's livelihood due to climate change will also incur the gradual change in the public health. There is a strong correlation between these changing climate patterns and health trends.

According to NCCHAP (2011), it stated that night-time temperatures are projected to increase more markedly than day-time temperatures. This change will have direct effects on health (for instance, outdoor workers will be exposed more frequently to extreme heat). Increased force of floods and storms will increase risk of injuries. The changes will also favour many disease-causing micro-organisms (for instance, those responsible for food poisoning).

Heavy downpour of rain and extreme waves' action would make it more likely for bacterial and chemical contaminants to be washed into reservoirs for drinking water. The forecast climate conditions (increased temperatures and heavier rainfall) will boost mosquito breeding and increase the potential for transmission of diseases such as dengue fever. Note that these statements are all framed here in terms of probabilities. Whether or not the potential for harm is actually translated into outbreaks of disease will depend on factors other than climate change, such as the presence of mosquito breeding sites close to homes, protection of drinking water sources, levels of food hygiene, crowding, and housing quality. This means climate change could harm or exacerbate existing health risks that have been due to domestic infrastructures' inconveniences. Some of these include the lack of proper toilet facility for population of Kiribati and good and reliable portable water sources (refer to figures 33 and 34).

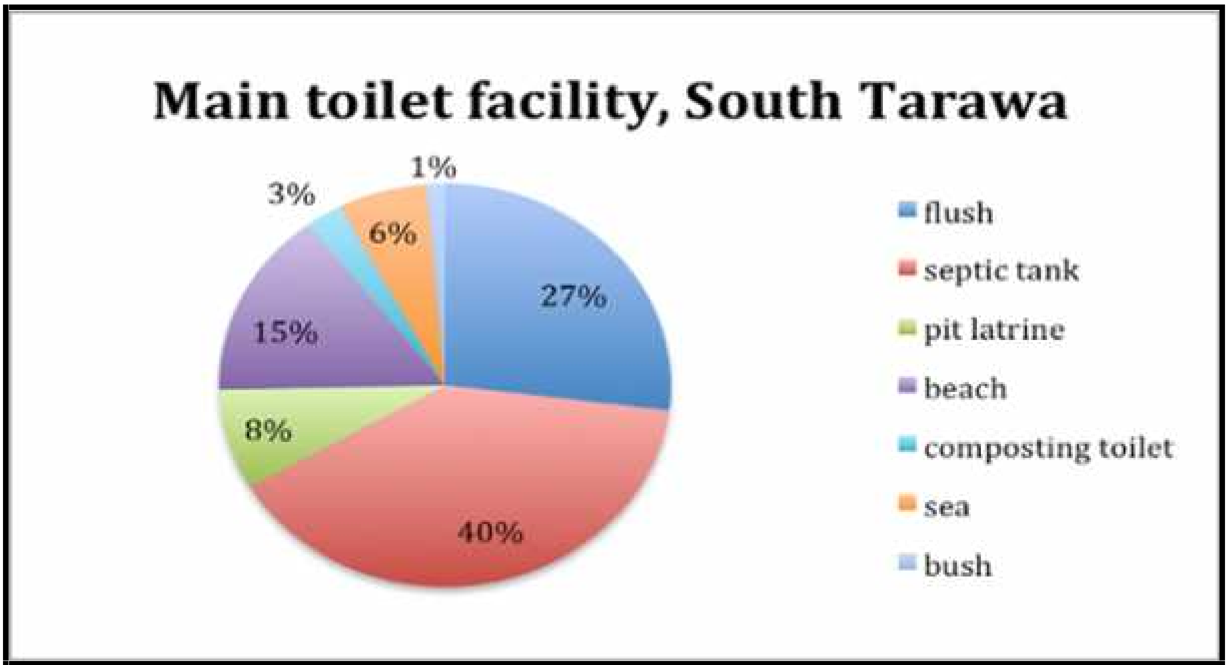
There are several intertwined reasons for the absence of these infrastructures and systems.

Figure 32. Population distribution on sources of portal water sources in Tarawa – Kiribati



Source: Kiribati Climate Change and Health Action Plan 2011.

Figure 33. Toilet facilities in Tarawa Island, Kiribati and population distribution over them



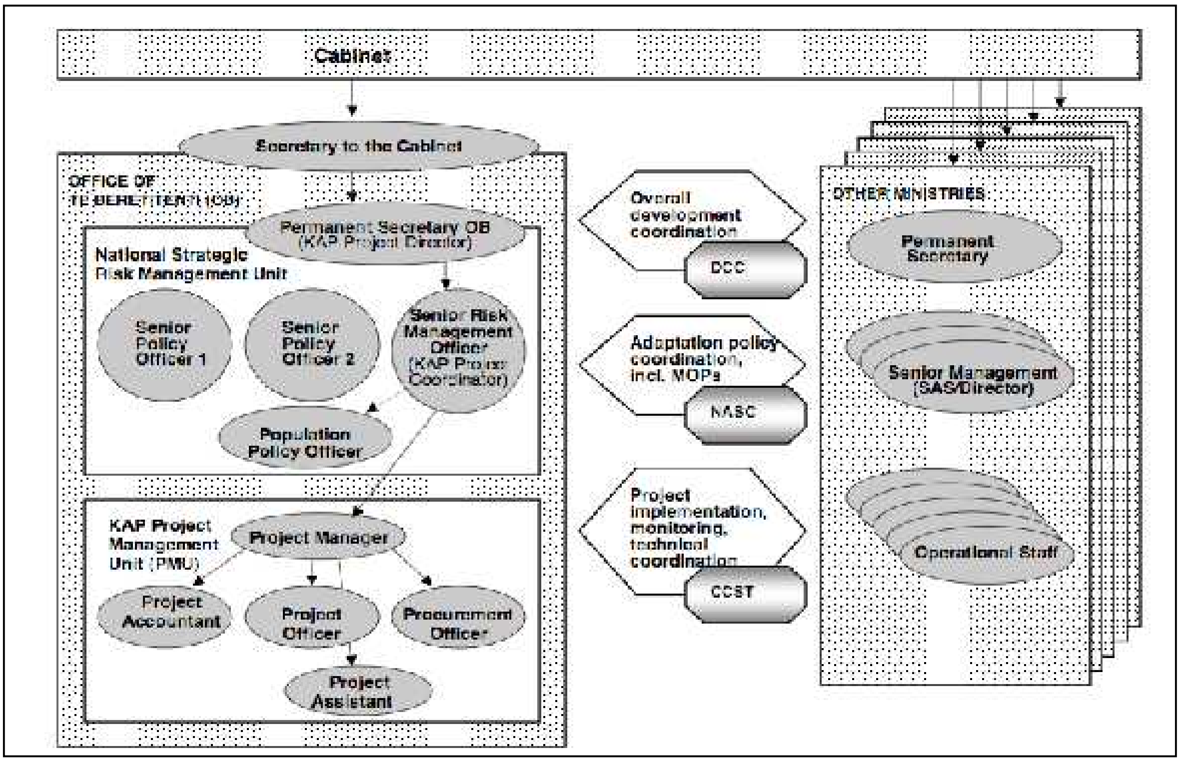
Source: Kiribati Climate Change and Health Action Plan 2011.

5.7 ADAPTATION OPTIONS AND MAINSTREAMING CLIMATE CHANGE ADAPTATION INTO NATIONAL DEVELOPMENT

The concept of adaptation was first introduced in Kiribati through preparation of National Adaptation Program of Action project and coincided with the execution of the Kiribati Adaptation program in 2004. This was relatively the time when adaptation as a subject and as a process was still not clearly understood by many key sectors.

In view of the felt impacts reported and documented as referred to above and coincidence of implementing these two similar Climate Change Adaptation - CCA projects; the Government was able to craft the nation's institutional approach to adaptation. This give rise to the establishments of committees and how these functioned within the existing Government's overall administrational configuration – climate change governance. This can be depicted in the figure 35 below.

Figure 34. Climate change institutional settings in Kiribati



Source: Project Appraisal Document of KAP II, 2007

The *National Adaptation Steering Committee* (NASC), which was established during KAP-I, is responsible for promoting and monitoring coordination among project activities across the implementing agencies, including the utilization and sharing of technical expertise. The NASC is chaired by the Secretary of the OB, and includes higher level officials from all key Ministries, as well as representatives of the Kiribati Council of Churches, the Kiribati Association of NGOs (KANGO), the national women's organization, All Women of Kiribati (AMAK), and the Kiribati Chamber of Commerce. The NASC will continue to provide overall policy analysis, quality control and advice to the Government of Kiribati on matters related to climate risk management, covering both NAPA and KAP-II issues and activities.

The *Climate Change Study Team* (CCST), established as a committee for Kiribati Initial Communication Project, which was later implemented NAPA preparation along with KAP I, contains technical officers from all key departments affected by climate risks. The CCST will continue to provide expert analysis and technical advice to the Government of Kiribati on climate-related matters, as well as coordinate scientific activities relevant to the planning and execution of the NAPA preparation Project and KAP-III Project implementation.

These two committee engineered by two different institutions, Strategic Policy and Risk Management Unit, Office of Te Beretitenti and the Climate Change Unit – Environment and Conservation under the Ministry of Environment, Lands and Agricultural Development will be guided by the overall Policy framework of the Government on climate change, and with support of line Ministries and sectors.

The existing committees of more specific responsibilities are expected to provide complementary role to the overarching committee reference above. However, coordination and direction of overall Policies should not be compromised given any situation, which are equally extremely important. This is where the role of the NASC and the Office of Te Beretitenti would eventually come into play.

The roles of different committees and how they are being supported by each administration is fundamental to achieving overall adaptation or increasing resilience of the country. There is also further thinking to link the role of these committees with disaster committee. However this is still in discussion.

The Government of Kiribati with assistance of international organisation and development partners had invested some efforts into developing relevant climate change policies. The following is the table containing hierarchy of established policies that are relevant to climate change in Kiribati.

Table 47. Climate change policies relevant to implementation of UNFCCC and addressing climate change impacts in Kiribati

Policy and year its established	Overall intent and main components	Scope (national strategic, overarching, sectoral, etc)
1. National Framework for Climate Change and Climate Change Adaptation 2013	Over-arching themes: 1. The impacts of climate change are brought upon us as the direct result of action of others around the world and as we stand in the frontlines of these impacts, those responsible must accept a fair share of the burden that climate change and the associated impacts placed on us. 2. We must continue to advocate strongly for an international legally binding mechanism for the established and maintained flow of new and additional funds to address all our adaptation needs. 3. Given 1 and the Extreme vulnerability of our economy, we need to think beyond adaptation. New and innovative initiatives on the ultimate and unthinkable – consequences of climate change, need to be actively pursued now and dialogue with our development partners on how this is to be approached should start immediately.	National and overarching on climate change (mitigation) and climate change adaptation

	The following are main headings of the Policy framework that need strengthening their capability to be able to meet the challenge of climate change: 1. Mitigation 2. Integration of Climate Change and Climate Change Adaptation into national planning and institutional capacity 3. Population and resettlement 4. Governance and services 5. Survivability and self-reliance	
2. Climate Change Adaptation Policy and Strategy, 2004	This Government's policy aims in respect of climate change includes: (a) Kiribati should be mentally, physically and financially well prepared to deal with whatever climatic trends and events the future may hold; (b) this should be achieved through a co-ordinated, consultation-based adaptation programme carried out by official and private agencies; and (c) The financial costs attributable to the national adaptation programme should be met as far as possible by external assistance. This Policy Strategy outline how the above aims would be implemented through strengthening the following 8 policy headings: *1.* Integration of CCA into national planning and institutional capacity *2.* Use of external financial and technical	National Policy on Climate Change Adaptation

	assistance *3.* Population and resettlement *4.* Governance and services *5.* Freshwater resources and supply systems *6.* Coastal structures, land uses and agricultural practices *7.* Marine resources *8.* Survivability and self-reliance.	
3. National Water Resources Policy and its Implementation Plan, 2008	The intent of the policy are: 1.Provide safe, socially equitable, financially and environmentally sustainable water supplies to enhance the welfare and livelihood of I-Kiribati 2.Protect and conserve freshwater sources for public water supplies 3.Deliver freshwater efficiently and effectively This Policy frame its objectives into different timeframes, short to medium term (3 years) policy objectives and longer term policy objectives.	Sectoral on Water in but National in scope
4. National CC and Health Action Plan, 2011	Health recognises that climate change is a new kind of environmental health problem and therefore sees the relevance of integrating climate change into their activities. This lead to Action Plan which focussed on: 1. Describe the specific health risks posed by climate change in Kiribati, and 2. To outline strategies that may be implemented to anticipate and avoid most serious impacts of climate change on health.	Sectoral on Health but National in scope

	The main priority areas of this Action Plan are: 1. Water safety and water-borne disease 2. Food safety and food-borne disease 3. Vector-borne disease Other indirect priority areas include disease surveillance, nutrition, environmental health and mental health.	
5. Kiribati Integrated Environment Policy, 2013	The National Integrated Environment Policy also recognised that climate change is one of the threats to the environment. Therefore climate change was one of its core policy issues. The vision of this policy: "The people of Kiribati continue to enjoy a safe and health natural environment that is resilient to the impacts of climate change and supports livelihoods and sustainable development"	Sectoral on Environment but National in scope

The National Framework for Climate Change and Climate Change Adaptation attempts to subsume the Climate Change Adaptation Policy and Strategy. This intention to reconcile policy goals into one single document and direction rather than various independent strategic policy documents with possible different directions.

There is strong anticipation that in the coming years as climate change unfolds with extreme and adverse impacts; other sectors will eventually come on board with their organisational intent on how to implement their activities with respect to climate change. These policies and their strategies are highlighted here as Government's efforts to describe these priorities with the intention that these are recognised and supported from Annex I Country Parties because these impacts are the result of their externalities. Most importantly, these policies aim to secure a resilient (social, environmental and economic) Kiribati from the impacts of climate change guided by the overarching National Framework on Climate Change.

Kiribati considers climate change adaptation seriously and most of its adaptation activities were project-based activities. However, the Government of Kiribati understood it very well that despite the fact that while Kiribati strive hard to attract external assistance to support our adaptation needs, significant amount of annual budgeted resources have already been assimilated and projected to increase in the future to protect our shorelines, install water catchments and to name a few.

The domestic pressures was already burdening the existing environment, social and economic trajectories of future Kiribati, while noting that climate change had already add slow and immediate onsets of climate change adverse impacts.

This implies that significant amount of efforts and interventions are required now to build resilience of atoll systems, social and economic stability in the coming years.

Kiribati had implemented a number of adaptation measures and also assessed their effectiveness with a view to recommend better approaches, measures and areas for adaptation in the future. The table (table 48) below summarises the list of adaptation measures (both soft and hard) that have been implemented through different initiatives. This table 48 does not include other interventions by line Ministries of the Government which were also graded as adaptation measures but were not supported as incremental costs occurred due to climate change.

Kiribati believed that next phase of adaptation will involve implementation of the National Adaptation Program of Action and other relevant climate policies and action plans that have been or will be developed in the future by various departments. Some of the emerging and immediate adaptation options that are likely to dominate future adaptation agendas in Kiribati may range from food security, ecosystem approach to adaptation, sustainable local governments' involvement in climate change adaptation, integrated coastal and water management adaptation, to name a few. However, these areas need to be re-prioritised and implemented in a coordinated manner so as to avoid duplication, best use of limited resources and improve synergies and lessons learned for a resilient socio-economic and physical environment of Kiribati.

Table 48. Compendium of adaptation efforts implemented in Kiribati.

Adaptation option	Objectives	Sector/Triggers
Installing Groundwater monitoring boreholes	Monitor the quantity and quality of groundwater where boreholes are located	**WATER**/Poor water quality and quantity
Improve Water leakage detection capacity	To reduce and replace some sections of pipelines where leakages are found to occur – thus ensure the sustainability of supply of freshwater to the densely populated Betio and South Tarawa	**WATE**R/More drought and less water and ,more wasted water, population concentration with high demands of water
Increase options for Rainwater Harvesting	Clean Drinking water, Increase Rainwater Harvesting reservoir (Best case practices). Increase in potable rainwater availability	**WATER**/Rainfall variability leading to more frequent/worse droughts; Poor /inadequate water supply infrastructure; Depletion of groundwater reserves (pollution from human activities, sea-level rise contamination); Potable freshwater shortages (Outer Islands)
Water Services Rehabilitation	Groundwater abstraction from other water gallery reserves; Rehabilitate water infrastructure.	**WATER**/Rainfall variability leading to more frequent/worse droughts; Poor /inadequate water supply infrastructure; Depletion of groundwater reserves (pollution from human activities, sea-level rise contamination); Potable freshwater shortages (Outer Islands)
Install rain gauge in outer-islands	Install rainfall monitoring stations on each inhabited island; Improve ability to predict (extreme) weather; Conduct more accurate water resource assessments	**WATER**/Rainfall is an important determinant of weather pattern
Water supply infiltration gallery on rural islands	Increase groundwater abstraction and distribution to selected community/village in rural islands	**WATER**/Potable freshwater shortages on outer islands
Engineered Seawall	Improving the protection of public assets (KAP II - Component 2) eroded on coastal low-lying areas	**COASTAL**/Increase Storm surges; Coastal erosion
Ecosystem Monitoring	Ecological gap assessment to identify Key Biodiversity Areas (KBA) Identification and monitoring of ecosystems	**BIODIVERSITY**/National consultations and household surveys; Destructive human activities; Unsustainable over-exploitation of natural resources

Mangrove re-planting	Protection of coastlines from seawater intrusion and inundation Protect and manage biodiversity	**BIODIVERSITY**/Seawater intrusion; Inundation; Loss of biodiversity
Coral Reef Monitoring	Monitoring Coral Reef to assess coral bleaching due to increased sea surface temperature rise	**FISHERIES**/Coral reef is the best indicator of sea temperature rise, and that this important for the local people depend heavily on marine resources
Phoenix Islands Protected Area (PIPA)	Maintenance of natural beauty of PIPA Maintenance of natural ecosystem Promote PIPA as a sustainable tourist attraction	**FISHERIES & BIODIVERSITY**/Pipas ecosystem remains in its natural state (untouched)
Climate adaptation baseline study	Assessment of awareness and attitudes to climate change	**INFORMATION and KNOWLEDGE**/Information lacking about peoples' baseline understanding of the issue
Community participation	Quality and effectiveness of current public consultations assessment	**COMMUNITY**/ Information lacking about successful and unsuccessful processes Training on community participation processes
Information accessibility	Develop a common language, climate risk information, best agricultural practices through Centre of Excellence, assessment tools for Government	**INFORMATION & KNOWELEDGE**/ The use of English terms with villagers in outer islands Need for further training to Government's officials Need for one message across Ministries
Climate Change Adaptation Awareness	Help our local people understand the impact of Climate Change and Adaptation	**INFORMATION & KNOWLEDGE**/ The fact that Kiribati people lacking the luxury of speaking freely on climate change and their needs People lack the understanding of adaptation and how important it is

The table 48 above suggests that some effective adaptation options have been implemented in an effort to build resilience of some of the critical systems/sectors and invigorate other areas particularly information and knowledge. It is obvious that adaptation is a huge burden, expensive exercise and will continue to be part of everyday or normal routines of the country.

It is expected to see emergence of new sectors and areas for adaptation (which were not also sufficiently covered in the list thus far) as the need arises in the future. These will include health, local governments (sub-national) and cities, food security, human resource development including up-skilling programs, tourism, gender based adaptation, ecosystem based adaptation.

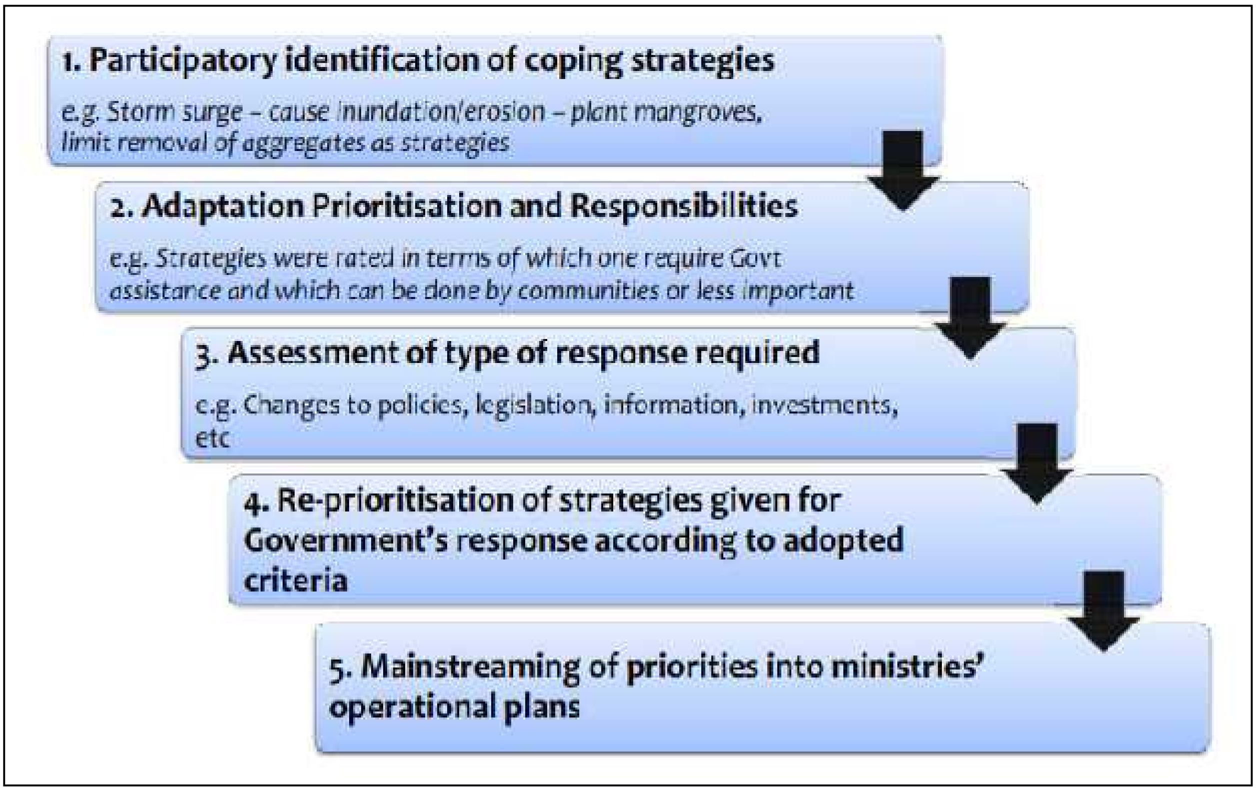
To make adaptation become part of everyday life, mainstreaming comes into play as been advocated and progressed also in Kiribati through adaptation programs recently in 2004 until these days.

Therefore, Mainstreaming climate change adaptation into national development processes becomes an important element of effective adaptation as it ensures that climate change adaptation was given more prominence at the national level. It is also significant that climate change as an urgent issue is mainstreaming into the national planning frameworks to gain "whole of nation" participation in its various implementation phases. This mainstreaming process requires a clear and elaborate system of communication and reporting information and other outputs. In Kiribati, the system was set up to act in parallel with the reporting mechanisms of the National Sustainable Development Strategy or what commonly known as the Kiribati Development Plan. In Kiribati, the mainstreaming process was understood and conceptualized to be working in the logical steps as described in the flow chart (figure 36) below.

Although the mainstreaming process is a new concept, it has been practiced at it early stage in Kiribati and is expected to be a continuous and reiterative process that will involve eventually all sectors/institutions/communities in Kiribati.

There is much to do and understand further how this process is actually working. This implies that proper data and reporting mechanisms need to be in place to support the monitoring and evaluation process of ensuring that climate change efforts are being mainstreamed adequately into national planning and by which resources.

Figure 35. Mainstreaming process in Kiribati



Source: Adapted from World Bank 2006 report

This whole system of mainstreaming climate change adaptation and how its results were fully understood and relevant to adapting to the impacts of climate change, was chronically lacking due to capacity constraints and other challenges from concerned sectors. Effective adaptation require a good framework for mainstreaming and it is evident at this stage that mainstreaming still require capacity and structural developments to realize what is really meant for achieving mainstreaming climate change adaptation into national response capabilities and overall development systems.

6.0 CAPACITY BUILDING AND TRAINING

The status quo of institutional capacity, training and research in Kiribati was chronically lacking. The biggest challenge towards achieving an improved cognitive, research and training sector is funding, and the source to generate funding is economy – which was relatively weak as indicated in Kiribati being categorised among the Least Developed Countries. Like other developing countries, the Government of Kiribati priority aspiration is to build economic wealth which could then later assist other pillars of development e.g. social and environment pillars. Therefore, training, capacity building and research were commonly viewed among other sectors or services that do not generate revenue but rather funnel out the resources.

Capacity building, training and research needs of the Government were often supported by development partners and internationally recognised organisation, e.g. UN based organisation, international and regional banks, regional agencies and to name a few.

Since the Initial National Communication report, there is increased acceptance of the relevance of having capacity building, training and research to be amalgamated in the workings and activities of the Government. This was seen as an opportunity to improve decision making and overall state of innovation and creativity which can have positive benefits to the developmental agenda and the community as a whole. Though this was more effectively managed at the personnel level; the systemic, institutional and research areas were still independently vested within each individual organisation to handle.

Nevertheless, through an enabling environment project on national capacity self assessment for the three Rio Conventions; the component of this project for one of the Conventions – UNFCCC becomes very relevant to addressing the needs to understanding capacity needs on climate change at the national level. As identified by this report, some of the overall capacity development outputs anticipated to address capacity constraints in Kiribati with respect to implementing obligations under the UNFCCC or relatively benefiting the national capacity needs for undertaking climate change activities on the ground, includes;

1. Improved understanding of climate change across sectors of the population (such as work force, communities, etc)
2. Enhanced capacity at all levels to undertake V&A assessments, prioritize and implement adaptation actions
3. Enhance capacity to undertake research, conduct systematic observations in areas of meteorology, ecosystem and hydrology.

The details on the capacity development actions on each of the three outputs above can be extracted from the Kiribati NCSA 2011 Report. Again the NCSA report is not an exhaustive means to report on the capacity needs of Kiribati with respect to climate change. There are other aspects of climate change which deals with infrastructures, economic planning and social well-being which are not necessarily reflected in this enabling environment capacity assessment project.

Opportunities for training were observed to have been increased since the last decade on climate change. These opportunities need to be extended to other sectors and policy makers. The Government’s entity for training public civil servants need to work closely with other government’s organisations in designing and coordinating training needs and opportunities geared for an anticipated climate change response required in the future.

The research is critical to inform the process of decision making and more over to accurately monitor and advice on state of climate change and the responses that community need to be aware of, from time to time. In the past, this need have been largely facilitated or supported by academia, regional organisations and other well-resourced international organisations. With this normalcy, Government‘s decisions at national level may have been strongly associated with international advice in many cases. This could be seen positive or negative, as in certain incidences the urgency of needing those required technical advice instantly (whether it is climate change or any other issue) may not always readily available. This leads to the proposition to consider establishing a national institution with research capability on pressing and emerging issues. Other more in-depth and sophisticated issues which require similar weight of research’s attention could be dealt with by international organisations with proper research expertise on such matter.

7.0 RESEARCH, DATA AND SYSTEMATIC OBERVATION

As previously stressed in section 6.0, research capacities and capabilities in Kiribati are chronically limited at the national level. Nevertheless, these needs have been greatly substantiated and supported with programs, project-based activities and initiatives of regional and international institutions with more research/analytical capabilities and resources. With the urgency and prominence of climate change issues in the context of future developments and survivability of Kiribati, immediate and responsive informed planning and decision making is required. Therefore considering the strengthening of national research capacities and frameworks may address this issue. To what extent this may be feasible, require future assessment and deployment of investments to this cause.

Data/information are necessary to not only complementing efficient technical assistance from regional and international entities but would also aid in addressing some of the critical issues which require on-the-ground focussed undertakings that require timely response for decision making and more importantly implementation of Kiribati's obligations under the UNFCCC.

Informed decision making requires accurate and consistent-based advices which should be based on factual, science-based and rigorous planning. One of the main ingredients to achieving this is data and information. Two national websites (**www.climate.gov.ki** and **www.environment.gov.ki**) were developed during since 2009 and contains both data and information on climate change. Unfortunately, limited quantitative scientifically proven data has been one of the many challenges of Kiribati. This problem applies to almost every key institutions with relatively poor institutional frameworks and capacity to gather data, archive data systematically, tailor data to performance indicators and more over analyse data to generate relevant information. Most of the institutions have data structures but often ad-hoc, poorly managed and fragmented. This leads to the proposition of reiterating a request to developed country Parties with advanced data knowledge and resources to support Kiribati as clearly highlighted in the provisions of Article 5 of the UNFCCC.

The Kiribati National Meteorological Service had developed the 2009 National Strategic Policy with the intent to set it strategic policy goals and directions through improvements and strengthening of various specific areas. The Policy recognised it very well that these strategic policy objectives will still be impossible with the provision of financial support from international donor communities. Some of the areas proposed under this strategic policy include institutional capacity building, maintenance and upgrading of stations and data infrastructure of the KMS, to name a few. These specific needs on data and systematic observation can be found in the Strategic Policy document of the Kiribati Meteorological Service.

8.0 CONSTRAINTS AND GAPS

8.1 STATUS OF CONTRAINTS AND GAPS

Kiribati national circumstances focusing on the states of its environment, social and cultural, and economic development aspects are pooled and considered together against the backdrop of global climate change. The challenge of climate change that Kiribati is facing, suggestive of gaps between what it is assured of and what is considered to be timely, adequate, and appropriate action will be appreciated. Sector policies and institutional issues to marshal efforts to meet the challenge are also factors that contribute to the gaps.

From those considerations, Kiribati continues increasingly to be vulnerable to climate change and its impacts. The national sense of Kiribati's current and future vulnerability to climate change has weakened (among key Government's officials) confidence in the UNFCCC processes to be able to timely mitigate climate change. This is apparently due to the slow pace and lack of ambition in reaching decisions (at the UNFCCC level) which are expected to curb emission of greenhouse gas emissions (GHGs) and the required financial support to address impacts felt now by Parties to the UNFCCC. The important gap was therefore embedded on the question of not knowing whether or not; the UNFCCC processes will be able to prevent dangerous anthropogenic interference to the climate system.

Key environment aspects such as low lying, narrow coral islands, calcareous and poor agriculture soil, and precarious ground water lens as the main source of water, droughts, and storm surges inundating villages are well recognized. However, this knowledge and experience is considered in the UNFCCC process as insufficient to define vulnerability, to design adaptation measures, and to proceed to seek external assistance.

Vulnerability and adaptation assessments and studies are still demanded as pre-requirements to physical structural adaptation. The demand of rigorous science on the vulnerability and adaptation options assessment is unfair to the realities about Kiribati; on the other hand it provides opportunities for international consultants to contribute to the planning of adaptation options. In turn this implies there is gap in the available national human resource to provide the required scientific information or to sufficiently understand such information as may be provided by international consultants.

The gaps exist between information provided by international consultants and the national capability to understand them, between any justifications for conducting vulnerability studies and the experienced incidences of vulnerability of the national circumstances, and between national capability and the need that this too should be able to provide scientific information on the vulnerability of Kiribati to climate change.

Moreover the requirement of rigorous science which usually only confirms experienced aspects of Kiribati vulnerability to climate change will only lead to delayed planning and implementation of appropriate adaptation actions. There is therefore a gap between the time that the rigorous science has or can be provided, and when appropriate adaptation actions based on the rigorous science may start. Furthermore, the scattered nature of the islands of Kiribati means the range for which to understand the nature of vulnerability in a rigorous scientific framework would be very large that there would never be an end to be able to justify more and more scientific assessment of Kiribati vulnerability to climate change.

Associated with the need of rigorous scientific information are data and approved tools and models. Data usually lack good geographical and temporal coverage. The quality of the data is also questionable except data that are systematically collected as part of well established monitoring procedures such as for the weather and sea levels by the Kiribati Meteorological Services. Computer based tools to understand future climate change and impacts on various sectors could be expensive, highly complex, but must be used. Other useful tools for integrated vulnerability and adaptation assessments would also be useful. Kiribati national capability to make use any of these tools has not been assessed, but it is most certain that these are areas where serious gaps are expected.

National capacity to plan adaptation activities and to access available international assistance or climate change finance is limited. This is further complicated by the difficult requirements or conditions of external assistance usually require “middle men” type arrangements (e.g. Implementing Agencies) for the execution of the activities. At times, these create more layers of processes and gaps between priorities or how to implement activities that middle organisations decide and those that national authorities would prefer.

Institutional arrangements to enhance holistic national approach to address climate change through effective leadership, consultation among key officials, and coordination have much need of improvement. In addition, it is also noted that externally funded projects on climate change tend to also have influence over the national priorities and how things should be improved within the existing processes of Government. This is an opportunity to take advantage of.

8.2 CONSTRAINTS AND GAPS RELEVENAT TO IMPLEMENTING UNFCCC

Themes are taken from the UNFCCC Articles. And key themes are the objective, principles, adaptation, preparation of GHG inventories, mitigation, reporting, research and systematic observation, education, training and public awareness, international negotiations under the UNFCCC processes, and financial mechanism.

Parties to the UNFCCC are concerned that human activities have been substantially increasing the atmospheric concentrations of greenhouse gases, leading to enhanced warming of the Earth's surface and atmosphere, and affecting natural ecosystems and humankind. Most recently, IPCC FAR (2007) affirms that the warming of the climate system is unequivocal, and this is most likely due to emissions of anthropogenic greenhouse gases. The ultimate objective of stabilizing atmospheric concentration of greenhouse gases at a safe level for ecosystems to be able to adapt naturally and economic development to proceed in a sustainable manner (Art.2 of the UNFCCC) presents therefore a big challenge.

Various parties have proposed different concentration levels: one group proposed 350 ppm (Parts Per Million) while another group proposed 450 ppm, and then there were proposed levels of temperature increases of 1.5^0C, and 2.0^0C. These are gaps when compared together, concluded the fact that these have implications for Kiribati survival. Thus the gaps between the different concentration levels and between temperature levels, and between these and what may turn out to be realistic for the objectives, considered on global scale and for

Kiribati geographical scale are important considerations to Kiribati. Current assessments are that these gaps are ominous for the future survival of Kiribati because any value within the gaps would make climate change and sea level impacts far in excess of the adaptive capacity of Kiribati. Moreover, scientific guidance on concentration or emission levels that will cause dangerous interference with the climate system will never be provided explicitly and so the gap in any agreed concentration level and 350 ppm would be determined solely by prevailing political and economic forces in the negotiations.

Among the principles that were adapted to guide actions to address climate change are sustainable development principles and common but differentiated responsibilities. The fact that the latter has been too often referred to may suggest that many parties hold that this principle override concern about the sustainability of the global environment for future generations. In other words, there cannot be progress on agreed global mitigation unless the Parties consider that their individual set mitigation targets conform to their individual understanding of their share in, and how is to be shared the "differentiated responsibilities". Individual countries place their interest above the global interest even if part of the global would be destroyed.

The precautionary principle has been acknowledged, but also that economic development is necessary to be able to address climate change. If climate change is occurring because of past and current economic development, then it is also acknowledged that the latter contains opportunities to be able to address climate change. The facts on the gap between the intent in the precautionary principle and any actions that are accordingly stopped or reduced, after having recognized the problem of global warming, is from the profiles of global emissions which is nonetheless increasing. Therefore, global actions are departing greatly from the precautionary principle.

Adaptation is visibly required in natural systems in Kiribati as already noted. Coastal ecosystems and water resources are affected by rising sea levels, increasing storm surges, and extremes of rainfall – flooding and droughts. The UNFCCC accord favourable considerations for international assistance to various characteristics of countries such as for being small islands, low lying coastal, least developed among the developing countries – and these properly describe Kiribati circumstances. Perhaps encouraged by these considerations and the attractiveness of justice, Kiribati has considered that external assistance should be sought for all its adaptation needs, and at the same time that it is recognized that local resources are very limited for the national needs were there being no climate change. External assistance that have been secured for adaptation has been inadequate to address adequate adaptation throughout the atolls, and Kiribati has no option but to use its local resources to meet part of the costs of damage experienced by communities from extreme weather conditions including storm surges.

An important element of information that Parties should communicate to the COP is their national inventories of greenhouse gas emissions. These gases include carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O) and it is emission of these gases only that this report is now reporting. Other gases are hydro-fluorocarbons (HFCs), perfluorocarbons (PFCs), and sulphur hexafluoride (SF_6). In this exercise, Kiribati activities data are from the energy sector, and agriculture. In the energy sector, these data consists of imports and consumptions of three major fossil fuel types – diesel, petrol (benzene), and kerosene. Activity data of different purposes in the use of energy such as for public electricity, transport, navigation, and residential are estimated rather than being based on available disaggregated data for these different purposes. In the agriculture sector, activities data are the number of livestock, that is, pigs and chicken, and include estimated data on fuels used for fishing outboard motors. The inventory presented is compiled with the knowledge that there were significant gaps in the processes and procedural steps that were circumvented through estimations. These highlight the inadequate data collection and management systems in the entities that are involved. Improvement for the sake of the compilation of the inventories of emissions of greenhouse gases would not be critical since national emissions are insignificant compared to global emissions but very important for informing policy options that promote cleaner and sustainable development.

National system for compilation of inventory of greenhouse gases need therefore to be improved and widely appreciated among relevant sectors. Currently mitigation option through more use of renewable energy such as the use of photovoltaic cells for lighting, cooling medical supplies in rural areas is being pursued. Kiribati Copra Mill is producing bio-fuel and promoting its use. However there are no programmes devoted to specific options for mitigation involving technology acquisition and diffusion. But technology is present in all sectors and human activities and as already noted, the economy may be increasingly less efficient; emissions per dollar GDPs appear to have been increasing.

There is limited research capacity that nationals could undertake on topics relevant to climate change. It may be helpful to work closely with the University of the South Pacific (USP) and suggest topics that require in-depth research for them to incorporate in their future academic research programs. Their involvements in any such research undertaken by international scientists were often minimal that the research programs the Government approved could be enlisted in their programs and their results could be useful information to feed the current research deficient status at the national level. However, ministries and divisions may have data that they collect on the aspects of national affairs and circumstances for which they are responsible and may have carried out analysis for their use and some for public information. But until most recently, there have been very little opportunities for sharing information and research among ministries.

More qualified nationals now recognize the relevance of climate change to their particular areas of interest. Kiribati Meteorological Service personnel are very aware about global warming as they continue monitoring the weather and occasionally analyse climate data. Officials of the Fisheries and the Environment Divisions in undertaking coral monitoring do so with awareness of climate change and potential effects on coral health. But there is still a big gap between the desired level of integrating climate change into sector policy and planning and actions.

In the education sector, it is felt desirable for schools to teach topics that are specific on climate change. However, it is not easy to come up with such topics because climate change being multidisciplinary would have been implicit in normal subjects covered in schools. Nonetheless, effort is being made to construct a course that aims to focus on science and issues about climate change. This seems to be a huge challenge due to resources. The GIZ, UNICEF and SPC are currently assisting this area in the Curriculum Development and Resource Division in Kiribati. Public awareness raising on climate change is conducted in the form of workshops, visits to communities and schools, displays and disseminations of prepared posters and pamphlets. Current radio programs are also contributing from NGOs and other sectors so it is important to capitalize also on those efforts.

They are usually included as components of climate change projects. But the critical gap for Kiribati is to be determined by agreements in the negotiation on continuing mitigation actions after the first commitment period under the Kyoto Protocol, and agreements on financial support for adaptation and how timely Kiribati is able to secure and use effectively such financial support. Gaps highlight the need for capacity building particularly on adaptation, and reporting to COP.

8.3 CONSTRAINTS AND GAPS RELEVANT TO ARTICLE 6 OF UNFCCC

In Kiribati, articulation and implementation of commitments under Article 6 falls mostly under the Environment and Conservation Division through its Media and Public Awareness Unit. However, seeing that campaigns and awareness raising at national and international have become a cross-sectoral interest, this role was seen to be shared by other government's entities and projects e.g. Office of Te Beretitenti, KAP, USP, civil society and others. However the greatest underpinning gap is the lack of effective implementation of Article 6 due to insufficient assessment on the needs to leverage support and also the lack of realistic and well consultative action plan on implementing commitments under Article 6 of the UNFCCC.

Within the respective capabilities of concerned government's organisation presumably responsible for Article 6, it is evident that such commitment was unable to be implemented also due to the following constraints.

Table 49. National challenges on respective Article 6 obligations

Article 6 commitments	Challenges
Development & implementation of educational and public awareness programs on climate change and its impacts	Limited skilled human resources and tools, limited and unreliability means of communication at national level, insufficient funds to visit remote islands for campaigns
Public access to information on climate change	Limited information and database professionals, limited bandwidth for internet connectivity, lack of human resource for climate change information maintenance and development

Public participation in addressing climate change and its impacts and developing adequate responses	High costs to visit and engage large community from remote islands
Training of scientific, technical and managerial personnel	Lack of highly qualified professionals and limited and over-worked qualified professionals to do training of stakeholders, limited number of research institutions

The root source of problems mentioned in the table above is the insufficient resources and opportunities to support or meet the challenges highlighted in the table above. The implementation of these need to be carefully captured in the National Action Plan to implement Article 6 and also Article 5 which were not assessed in depth as part of this SNC project due to insufficient resources.

9.0 PROPOSED PROJECT CONCEPTS

1. Kiribati Climate Change Database Management System and Sectoral data strengthening

National reporting as a UNFCCC obligation covers a compilation of greenhouse gas inventories, description of the national circumstances, vulnerability and adaptation assessments, and national mitigation measures. For these different purposes and applications, specific data are required. Types of data have to be identified, located throughout governments and private sectors, collected and organized systematically at one central location within the Climate Change section of the ECD, and regularly updated. These institutions therefore need support to construct data relevant to climate change responses (e.g. asset inventory for loss and damages, so on) and NC reporting accordingly. The CCDMS would also provide data for SOE required under the Environment (Amendment) Act 2007.

2. National Adaptation Programme of Action and Support to other National Climate change Priorities

Food security is becoming a serious concern including ecosystem-based services. Health adaptation, Traditional agricultural systems, ecosystem-based adaptation measures, also exploring blue carbon concept, building social adaptive capacity based adaptation programs including educational reforms, up-skilling initiatives are some of the new areas for adaptation.

There is already some thinking at the national level to advance adaptation efforts beyond Kiribati shores. These are outlined in the related climate change policies of Kiribati such as National Framework for CC and CCA, Kiribati Integrated Environment Policy, and the upcoming Kiribati Joint Implementation Plan for CC and DRM.

Environmental sustainability is the foundation of resilience building and therefore requires support in order to play their vital role. Existing environment protection and management systems must be fully supported to envision their goals which are aligned to emission reductions and adaptation.

3. Morphological development of reef islands over different time scales to support appropriate coastal management plans

Low-lying reef islands formed on the rim of atolls in Kiribati appear threatened by the impacts of anticipated sea-level rise. There is general agreement that the responses of reef islands to sea-level rise are largely negative. To have a better understanding of how these reef island will cope with future sea-level rise requires an understanding of their past behaviour at different time scales. In turn, the development of appropriate coastal management plans will depend largely on the assessment of the past morphological changes of reef islands. In order to capture the past behaviour of reef islands at different time scales will involve the following three studies a) examination of the morphological evolution of reef islands morphological evolution of reef islands, b) investigation of the topography of reef islands to water levels using detailed topographic information and, c) historical shoreline changes

4. Kiribati Adaptation Project focussing on protecting key infrastructures

Low lying reef islands of the atolls, extending seaward from the top of the beach to the sloping beach to the intertidal reef platform are subject to erosion and inundation from high sea level and storm surges. Roads, water pipes, electrical cables, buildings in South Tarawa are being exposed to high risks from coastal erosion and inundation that can be attributed to sea level rise and storm surges associated with climate change.

Ground water lens in South Tarawa is highly vulnerable from erosion, saltwater intrusion, and inundation. With increasing urbanization in terms of the increase in population and economic development activities, the shortage of ground water resources would be highlighted when so many people would be affected.

KAP should continue to provide assistance to Kiribati to be able to protect its public assets from the risks of climate change impacts, maintain urban services in particular water supplies to the increasing population of South Tarawa, and to improve water supplies and chronic coastal erosion issues at outer islands for local communities that are most in need.

5. Raising public understanding of technical information about the environment

Efforts need is required to identify near parallel ideas that exist within the Kiribati language to those key ideas and concepts that are found in relevant technical reports and information.

Support programs focussing on behavioural change is required more in the future to inform and educate the public on this important issue.

Support is also needed for the establishment of core working group, with local professionals to work separately and as a group, to review and expand any available "bilingual vocabulary" about the environment, in particular where words and ideas are about climate change.

6. Analyzing scientific information that has been produced on the vulnerability of, and adaptation options for Kiribati.

Various tools and methodologies have been used to characterize the vulnerability of and to come up with adaptation options for Kiribati. These include the several reports since 2000, and tools and methodologies that are acquired or produced through KAP or SNC or other initiatives. These include the works of NIWA, SIMCLIM, and PCCSP. There is a need for a capacity building program for local stakeholders to understand the relevance, and application of these tools within their respective sectors. There is also a need to build local capacity to be able to optimise the use of these vulnerability tools with establishing baseline information and data for quantification of the impacts, losses and damages associated with climate change.

7. Support to CDM and overall Nationally appropriate mitigation framework and actions

Financing opportunities that could lead to better promotion, deployment and implementation of applicable clean and renewable energy technologies in Kiribati. The establishment of a formal institution to manage CDM and NAMAs require support.

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ANNEX 1. List of the Kiribati Climate Change Study Team and other local stakeholders who have contributed to the SNC Document

Members of the SNC Project Team (CCST) from 2008 to 2012

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