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2º Ciclo de Estudos em Riscos, Cidades e Ordenamento do Território

Drought and its social, environmental and economic negative impact in Kiribati with a specific case study of South Tarawa.

2014

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Classificação: Ciclo de estudos:

Dissertação/relatório/Projeto/IPP:

Declaration of Originality

I, Baraniko Namanoku, hereby declare to the best of my knowledge that the information given in this dissertation are true and correct and all the materials used in the text are fully acknowledged.

I believe that this mini-thesis is the first of its kind for Kiribati and the Pacific Island Countries and sincerely pray and hope that it will promote further scholarship and guidelines for students within the region who want to venture to probe on drought implications in their respective countries including Kiribati.

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Baraniko. Namanoku.

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Declaration by Supervisor

I certify that the information, data and analyses contained in this dissertation are the original works of Baraniko Namanoku, except where duly acknowledged.

.....

Professor Ana Sousa Monteiro

First and foremost, I would like to dedicate this to the “Almighty God” for giving me the pillar of strength, guidance and wisdom to complete this dissertation.

Thank you “Jehovah God”.

This is also dedicated to my beloved wife Akoia and three children Christina, Lusiana and Namanoku including to all my families in Fiji, Kiribati and abroad for their never-ending support, encouragement and prayer during my 2 years studied at Porto University in Portugal.

Acknowledgement

It is my deepest gratitude goes first to the my sponsor the European Union for the wonderful support and allowances rendered to me during the two years course at Porto University in Portugal.

Also my sincere appreciation goes to my entire Professors from the different disciplines who had been lecturing me in the Master programme (Hazards, Cities and Spatial Planning) at Porto University for their wonderful support and friendship during my one course programme as a post graduate student (Ana Monteiro, Carlos Bateira, Alberto Gomes, Carmen Ferreira, Laura Soares, Helder Marques, Teresa Marques and Mário Fernandes. Additionally, I will never forget also all my colleagues in our programme and Assistant Lecturers for their true friendship, support and jokes during the two year programme. Kam bati n rabwa (Muito obrigado).

My gratefulness also goes to the Climate, Health and Environment Research Group (CHERG) members such as Mário Almeida, Sara Velho, Luís Fonseca and Carlos Sousa for their assistance, advice and friendship while mingling with them. It is a pleasure to be part of this Research Group under the leadership of Professor Ana Monteiro. Additionally, I will never overlook the input of my Supervisor Professor Ana Monteiro and Co-Supervisor Professor Victor Prior, Dr Eberhard Weber from the Geography Department and Dr Sarah Hemstock from PACE-SD, USP for their constructive feedbacks and advise on the draft including Camari Waqanivalu Koto for advising and proofreading my questionnaires.

I am also thankful to all the staff at the Mobility International Office at Reitoria including at the Faculty of Arts, Letras for their continuous support and friendship during the two years studies.

Moreover, I am indebted to all my informants from Kiribati and the people who are assisting in answering the questionnaires including staff from the different institutions such as:-

- ✓ Ribeta Abeta, Former Climate Change Officer from the Environment Unit (MELAD)
- ✓ Ruiti Aretaake, Director of FSPK
- ✓ Maryanee Utiree, Assistant Health Statistician (MHMS)
- ✓ Raikaon Tumoa, Acting Director for Fisheries Division (MFMRD)

- ✓ Tianeti Bweena, Acting Director for Agriculture Division (MELAD)
- ✓ Andrew Teem and Michael Foon, Policy Officers - DRM (Office of President)
- ✓ Aritita Tekaieti, Senior Economic Statistician (KNSO)
- ✓ Mamarau Ringkan Kairirieta, Climate Change Adaptation Coordinator
- ✓ Dr Arthur Webb, Deputy Director-Ocean & Islands Programme Coastal Processes Adviser, SOPAC.
- ✓ Kataebaeti Bataua, GIS and RS Specialist, SOPAC.
- ✓ Librarian at USP, SOPAC and Faculty of Arts, Letras (University of Porto).
- ✓ Tebikau Noran, Director of Environment Health (MHMS)
- ✓ Ueneta Toorua, Climate Officer (KMS)
- ✓ Itienang Timona, Water Engineering Manager PUB (MPWU)
- ✓ Uenaate Willie, Acting Senior Water Engineer (MPWU)

Also I am grateful to my former and current Pacific Islanders Community members in Porto for their friendship and words of encouragement during the writing of this dissertation.

Finally, my sincere gratitude directs to members of the jury during the final defence of this dissertation.

Last but not the least, my special appreciation goes to my Supervisor Ana Sousa Monteiro for her guidance, experiences, feedbacks, input, advices and support during the writing of this dissertation.

Once again, this dissertation is also dedicated to you all including those I forget to mention.

Muito Obrigado / Kam bwati n rabwa/ Vinaka Vakalevu.

Te Mauri¹, Te Raoi² ao Te Tabomoa³

¹ Good Health

² Peace

³ Prosperity

Abstract

Drought is a multi-variable factor and therefore there is no common or universal definition to describe it. In Kiribati, it is known as “te mwautakataka” and become an important issue due to climate change and climate variability. Therefore, this dissertation is an investigation of “te mwautakataka” social, economic implication on people’s livelihoods and the environment. Additionally, this research outlines how the Government has managed “te mwautakataka” impacts in the study area of South Tarawa in order to make some recommendations for future risk management.

The research was implemented in South Tarawa in the Republic of Kiribati and involved standard social science methodologies including interviews of key informants and visiting major institutions.

Study findings show that in South Tarawa, drought has a negative implication on peoples’ livelihood. It also creates health problems because of dust and reduced water availability. More importantly, the negative influence on the environment especially on edible fruit trees and food crops, are noticeable. Additionally, well water turns saline in some places. As a result, the Government establishes the Drought Committee to warn and mobilize the community in South Tarawa.

To conclude, droughts with the longest magnitude have the most destructive effect on the environment and peoples’ livelihood in Kiribati in general. As for the South Tarawa, the 1998 - 1999 “te mwautakataka” was the worst drought event in terms of severity and magnitude which had negative social and economic implications on peoples’ livelihood and on the environment. The Government and people are well informed when drought event is imminent through the Drought Committee.

Key Words: Kiribati’s Droughts; Droughts’ social, environmental and economic impacts; Drought adaptation and mitigation.

Acronym

AMS- American Meteorological Services.

AOG- Assembly of God.

BP- Before Present.

BBC- British Broadcasting Corporation.

CBR- Crude Birth Rate.

CDR- Crude Death Rate.

COG- Church of God.

CPI- Cumulative Precipitation Index.

CSIRO- Commonwealth Scientific and Industrial Research Organization.

DC- Drought Committee.

DTF- Drought Task Force.

EDB- Equatorial Doldrums belt.

EEZ- Economic Exclusive Zone.

ENSO- El Nino Southern Oscillation

EM-DAT- Emergency Database.

EU-European Union.

EWS-Early Warning System.

FAO- Food and Agricultural Organization.

FEMA- Federal Emergency Management Agency.

GCM- Global Climate Models.

GEIC- Gilbert and Ellice Island Colony.

GDP- Gross Domestic Product.

GHGs- Greenhouse Gases.

GIS- Geographical Information System.

HEIS- Household Expenses Income Survey.

IPCC- International Panel of Climate Change.

ITCZ- Inter Tropical Convergence Zone.

JSS- Junior Secondary Schools.

JW- Jehovah Witness.

KAP - Kiribati Adaptation Project.

KAP- Knowledge, Attitudes and Practise.

KPC- Kiribati Protestant Church.

LDS-Latter Day Saints.

KILT- Kiribati Indentured Labour Trade.

KMS- Kiribati Meteorological Services.

KNBSAP- Kiribati National Biodiversity Strategy Action Plan.

KNSO-Kiribati National Statistic Office.

LDC- Least Developing Countries.

MELAD- Ministry of Environment, Land and Agricultural Development.

MHMS- Ministry of Health and Medical Services.

MISA- Ministry of Internal and Social Affairs.

MFED- Ministry of Finance and Economic Development.

MFMR- Ministry of Fisheries and Marine Resources Development

MPWU- Ministry of Public Works and Utilities.

NAPA- National Adaptation Plan of Action.

NASA- National Aeronautics Space Agency.

NCCHAP- National Climate Change and Health Actions Plans.

NCDC- National Climatic Data Centre.

NDC- National Disaster Council.

NDMA- National Disaster Management Authority.

NDMO- National Disaster Management Office.

NDS- National Development Strategy.

NIWA- National Institute and Water Atmospheric Research.

OCHA- Office for the Coordination of Human Affairs.

PACE-SD - Pacific Centre for Environment and Sustainable Development.

PDSI- Palmer Drought Severity Index.

PIC- Pacific Island Countries.

PCSSP- Pacific Climate Change Science Programme.

PUB- Public Utilities Board.

RERF- Reserve Equalization Reserve Fund.

SDA- Seventh Day Adventist.

SIDS- Small Island Developing States.

SPC- Secretariat of the Pacific Communities.

SPCZ- South Pacific Convergence Zone.

SPI- Standard Precipitation Index.

SPSS-Statistical Package for Social Science.

SOPAC- South Pacific Applied Geosciences Commission.

SST- Sea Surface Temperature.

SWSI- Surface Water Surface Index.

TTM- Taiwan Technical Mission.

UNEP- United Nation Environment Programme.

UNISDR- United Nation International Strategy for Disaster Reduction.

UP- University of Porto.

USP- The University of the South Pacific.

WB-World Bank.

WHO- World Health Organization.

WMO- World Meteorological Organization.

Glossary

Aumeang- A wet season characterized by bad weather.

Aumaiaki- A dry season characterized by fine weather.

Bwabwai- Giant Swamp taro that grows in an open pit dug to the water lens.

Botaki ni Unimwane- Council of Elders.

Climate Change- Refers to any change in climate change over time, due to natural variability or as a result of human activity.

Climate Variability- Refers to variations in the mean state of climate system expressed during a certain period of time and expressed in statistics (such as standard deviations, the occurrence of extremes, etc).

EL Nino- An irregular rainfall behaviour affecting certain globe areas like the equatorial Pacific region characterized by the appearance of unusually warm, nutrient-poor water

ENSO - The term coined in the early 1980s in recognition of the intimate linkage between El Niño events and the Southern Oscillation, which, prior to the late 1960s, had been viewed as two unrelated phenomena. The interactive global ocean-atmosphere cycle comprising El Niño and La Niña is often called the ENSO cycle.

Evapotranspiration - the process by which water is transferred from the land to the atmosphere by evaporation from the soil and other surfaces and by transpiration from plants

Inaai –A ground mat woven from a coconut leaves.

Kakairua- True hospitality to guests.

Kaokioki- Traditional liquor made from toddy derived from coconut tree sap.

Kaonako - A small octopus that commonly seen on the reef flat.

Kaonono system- A system of sharing something like foods or whatever between two or more people based on friendships and others.

Kora –A local rope made from coconut husk

La Nina –An irregular rainfall behaviour affecting certain globe areas like the equatorial Pacific region characterized by an extraordinary cooling in sea surface temperature

Rongo- Refers to the unavailability of food on the land and the sea which could be the product of man-made or natural induced event.

Maroro-A type of conversation between the two or more people which can be either formal or informal depending on the context.

Mwaie - A common name for all traditional dances.

Mwaneaba - A traditional meeting house.

Mwautakataka- Refers to the unavailability of precipitation for a certain period of time which has a negative repercussion on all living things on earths.

NAPA- It is an approach to enable Least Developing Countries to communicate their immediate and urgent needs for adaptation to the Conference of the Parties. The process involved in the development of the NAPA is designed to ensure the principles of stakeholder participation, country driven-ness, multidisciplinary input, complementarities to other projects, and cost effectiveness.

Takataka- It refers to the copra or dried meat of the coconut.

Toamau- Balance in term of composition of age and gender.

Tuae - A preserved paste

Utu- It refers to member of the clan.

Unimwane - It refers to an old man.

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“.....we are not sure about it until the crops have withered and died.”

(Tannehill, 1947, p.15)

CHAPTER ONE

Chapter 1

1.1 Introduction

Throughout human existence drought has been a threat to the survival of societies. It has been a trigger for massive human migrations, famines, and wars, altering the course of history. Also today drought continues to affect communities in countless ways even as we are entering the 21st century (Wilhite & Vanyarkho, 2000). It is considered as one of the major threats among so-called natural hazards. It affects people's livelihoods and community's socio-economic development (UNISDR, 2009). Its impact is non-structural and covers a wide huge range of areas compared to other natural hazard such as flooding, hurricanes and earthquakes. As a result the quantification of its impact and provision of relief are far more difficult for droughts than for other natural hazard (Mishra and Singh, 2010). Drought triggers disasters that already 30 years ago affected more people than any other hazards as stated in the 1984 report by the Swedish Red Cross (Byrant, 2005) and (Hagman, 1984) respectively. Also today drought causes widespread impacts that can affect millions of people in a single case.

Drought happens as a result of multiple factor and therefore defining drought is difficult (Wilhite 2000, pg 6). According to Wilhite and Glantz (1985), drought can be categorized into four types such as meteorological, agricultural, hydrological and social-economic drought.

In Kiribati, there are two vernacular terms used to interpret drought which are often mistakenly used by the people; one is "te Rongo" and the other is 'te Mwautakataka'. The former definition could be either a product of man-made or natural induced event or a combination of both which is resulted in the unavailability of food on the land and sea. The latter interpretation is an outcome of a climatic event only that affected the availability of the water resources on the land due to the absence of rainfall for quite a certain period of time which differ from places and contexts and which on the other hand has a negative repercussion on water dependent users such as trees, animals and peoples'

According to the Emergency Database (EM-DAT) drought occurs in the entire sphere of the globe as cited by UNISDR (2009, pg 2). Intensity and frequency however are highest in tropical and subtropical regions while the temperate regions are less prone to drought. It is mainly associated with the movement of climatic drivers such as EL Nino Southern Oscillation (ENSO)⁴ such as the La Nina⁵ and El Nino⁶ and the Inter Tropical Convergence Zone (ITCZ). Human factors such as over-exploitation of water resources during dry spells add to these meteorological challenges. Figure 1 shows the areas in the world that are prone to drought.

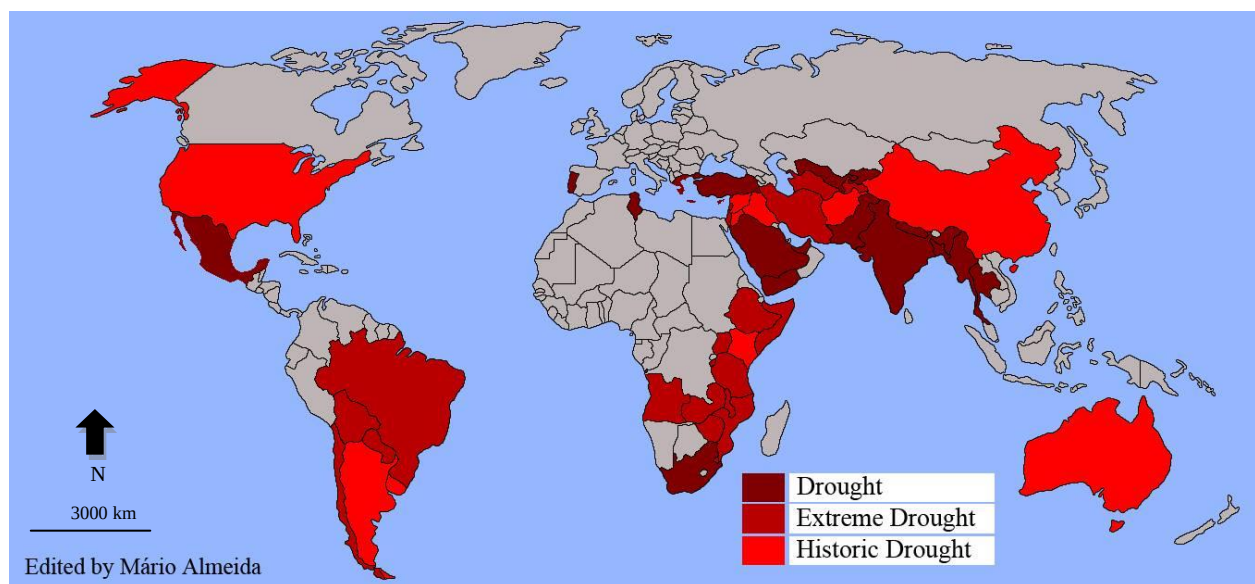


Figure 1. Map showing major areas prone to drought.

Source: <http://unitedcats.wordpress.com/2009/02/11/another-fly-in-the-ointment-global-drought/> (Retrieved from 3rd October, 2012).

⁴ The term coined in the early 1980s in recognition of the intimate linkage between El Niño events and the Southern Oscillation, which, prior to the late 1960s, had been viewed as two unrelated phenomena. The interactive global ocean-atmosphere cycle comprising El Niño and La Niña is often called the ENSO cycle.

⁵ La Nina- A cooling in sea surface temperature in the central and eastern equatorial Pacific that occurs at irregular intervals

⁶ An irregular warming of a sea surface temperature occurring in the Equatorial Pacific region and beyond accompanied by nutrient poor water off northern Peru and Ecuador, typically late December.

Although the above world map does not show the Pacific Islands Countries (PICs) due to their smallness in size on global scale with the exception of Papua New Guinea, drought occurs in Pacific Islands mainly as a result of La Nina and El Nino events. In Kiribati, drought is normally associated with the La Nina event (PCCSP, 2011). Its impact will fully investigate in this dissertation in general in Kiribati before zooming to the case study of South Tarawa, the main atoll of Kiribati harboring also the countries capital. With climate change⁷, drought becomes an important issue in the Pacific Islands including Kiribati due to climate change and climate variability⁸(IPCC, 2013).

Therefore, for the purpose of this mini-thesis, the definition will be taken which understands drought as an outcome of a climatic event that affects the availability of water resources on the land due to the absence of rainfall for an extended period of time is “*te mwautakataka*”. This definition will be used as a threshold to define drought based on precipitation data only (Meteorological drought) although there are other thresholds that could be used to define event such as agricultural, hydrology and socio- economical drought that could be employed as well as stated above.

⁷ Climate Change- refers to any change in climate change over time, due to natural variability or as a result of human activity.

⁸ It refers to variations in the mean state and other statistics (such as standard deviations, the occurrence of extremes, etc) of the climate on all spatial and temporal scales beyond that of individual weather patterns.

1.2 Background of the Study

1.2.1 Overview of drought incidence in the Pacific Islands and Kiribati.

The 1998 to 1999 La Nina event that occurred in the Central and Eastern Pacific affected countries like Kiribati, Tuvalu and Nauru while the El Nino event caused drought in Fiji and Marshal Islands in 1998. In fact, the occurrence of this ENSO has opposite impacts within the Pacific Islands. For instance, the 1998 La Nina which affected the Central and Eastern Pacific like Kiribati, Tuvalu, and Nauru created drought in these places whereas in the Western Pacific it brought heavy rainfall in countries such as Indonesia, Malaysia and Northern Australia according to the National Aeronautics Space Agency Earth Observatory (Graham, 1999). Nevertheless, according to the International Emergency Database on disasters as cited by Bettencourt et al, (2006), there were 10 reported droughts events within the Pacific region since 1950 to 2004. These droughts affected almost 630,000 people although there are none reported fatal facilities (see Table 1).

Type of hazards	Number	Reported Fatalities	Population Affected	Reported Losses (in 2004, US \$ m)
Windstorms	157	1380	2,496,808	5,903.90
Droughts	10	0	62,958	137
Floods	8	40	246,644	94.8
Earthquakes	17	53	22,254	330.6
Others	15	274	21,520	60

Regions	Number	Reported Fatalities	Population Affected	Reported Losses (in 2004, US \$)
Melanesia	110	1130	2,115,332	1,654.90
Polynesia	71	494	1,041,012	1,797.40
Micronesia	26	123	260,662	3,074.04
Total Pacific	207	1747	3,417,006	6,526.30

Table 1. Number of reported disasters in the Pacific Islands (1950-2004).

Source: EM-DAT: the OFDA/CRED International Disaster Database for 1950-2004 adjusted by SOPAC (2005) for 1994-2005 data. (Retrieved on the 5th October, 2012).

Despite the above recording of the disaster database, it is apparent that past drought events in the Pacific Islands including Kiribati had been overlooked due to the absence of data. For instance, Etuati (2010) highlights that drought prompted I-Kiribati residing in the Southern Groups such as Tamana and Arorae to engage in the indentured labor in Fiji and other Pacific islands including Guatemala in the mid 19th century (1877-1878, 1881-1883, 1889-1891) to escape the hardship people suffered from the prolong severity of drought as stated in the peak graph. They were willingly to volunteer to work somewhere else. The graph below in figure 2 depicted the number of labors recruited during the severity of droughts during the Kiribati Indentured Labor Trade (KILT).

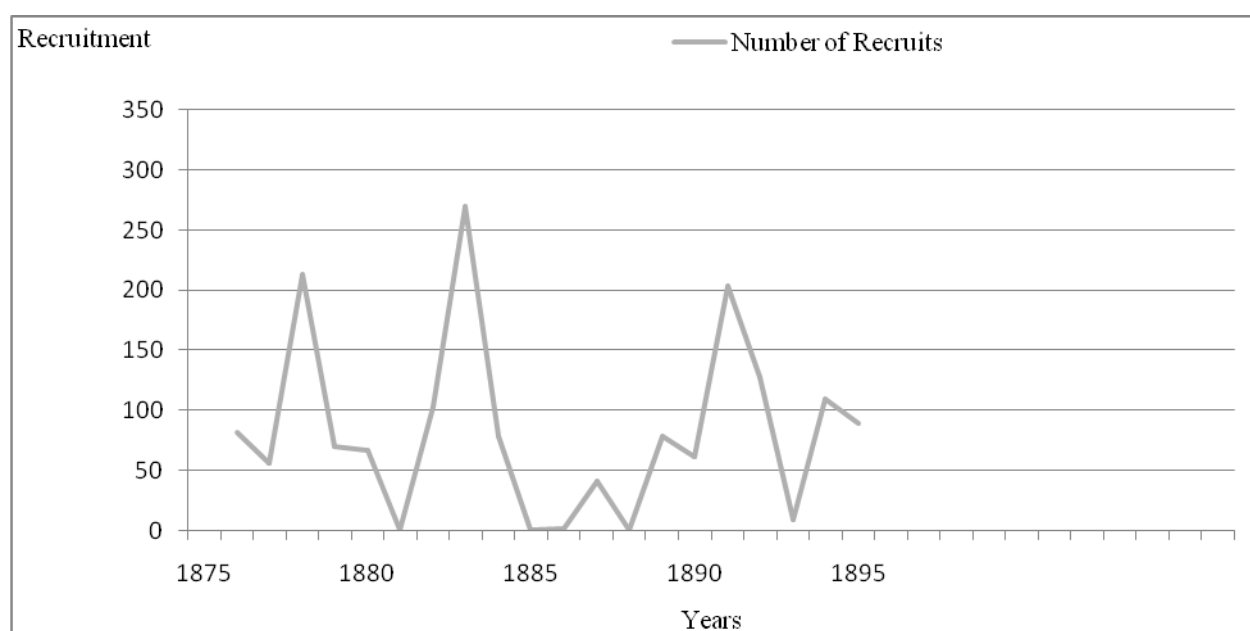


Figure 2. The peak time of recruitment during the severity of drought since 1875- 1895.

(Source: Etuati, 2010)

Another wave of external migration occurred due to drought effect is in the late 1950s' and 1960s' for the Islanders on Phoenix Group as they were resettled in the Solomon Islands by the British Government, the former colonizer of Gilbert and Ellice Islands, as the Phoenix Islands were not suitable for permanent settlement as the well water seriously salinized making it not good for drinking. (Government of Kiribati, 2007)

Drought is more common in southern Kiribati, Ocean Island in the very west of Kiribati and the Lines and Phoenix Groups in Eastern Kiribati (Teebaki, ny). In Northern Kiribati where rainfall

is abundant droughts occur rarely. Droughts are usually associated with the El Nino Southern Oscillation (ENSO) cycle especially the La Nina event which brings lower rainfall (PCCSP, 2011). Though its occurrence is unpredictable, there has been an improvement in knowledge using advanced technology and satellite images to detect its movement by climatologist with other Scientists. During its occurrence the sea surface temperature (SST) is much colder than it is usual and thus affecting the surrounding temperature and climate of a place. During its occurrence, the prevailing trade wind intensifies and moving to the Western Pacific toward Indonesia, Malaysia, Papua New Guinea and Northern Australia bringing warm moist air and heavy rainfall and thus causing flooding and bad weather in these regions. Figure 3 below shows the 2010 to 2011 La Nina conditions by blue color of colder sea surface temperature (SST) than usual; red color indicates warmer SST than usual (El Nino) and light blue and red indicates normal (as usual) SST in the Central and Eastern Pacific where Kiribati is also located.

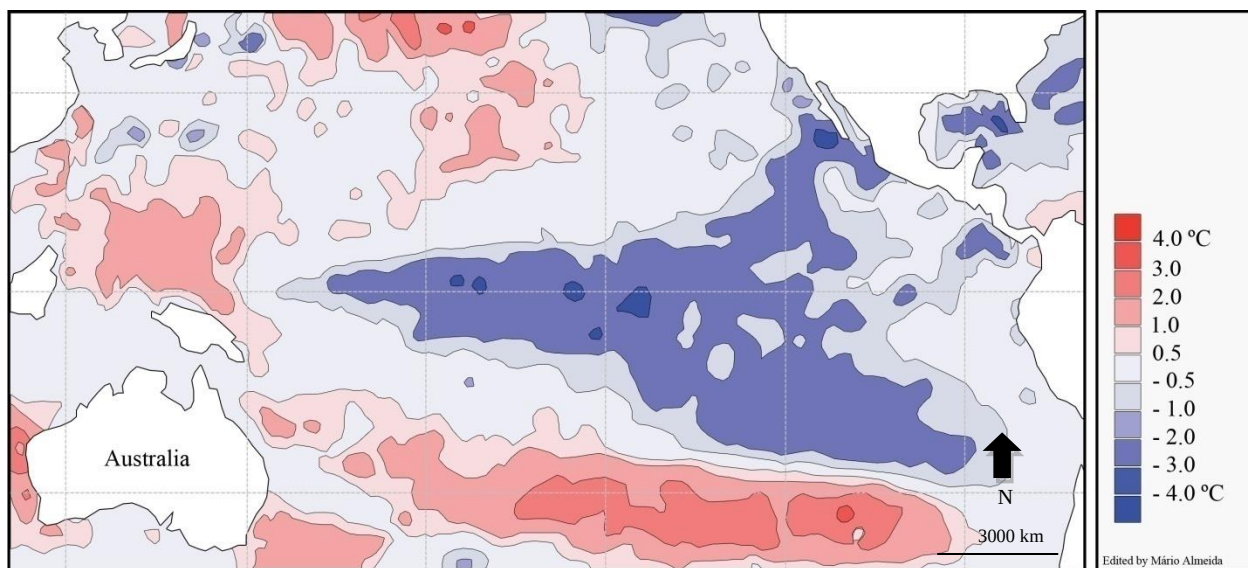


Figure 3. SST, colder than normal during the La Nina condition in 2010-2011

(Source: Australian Government Bureau of Meteorology (AGBM), 2012). Retrieved on the 16th April, 2014.

In Kiribati regions or groups of islands that are prone to drought struggle a lot. The National Climate Change and Health Actions Plans (NCCHAPs) reported that drought in Kiribati was usually associated with the La Nina event and can be severe. Recent droughts occurred in 1988-1989, 1998-1999, 2009 and 2011 (Kiribati Report, 2011). The Republic of Kiribati Country Report (1999) highlighted that the worst droughts occurred in 1949-1950, 1973-1974 and as well in 1989-1990 and

1998-1999. There was a minor drought occurring in 2007 as indicated in KAP phase pilot survey in 2008(Hogan, 2008) and in 2010 to 2011 as shown in Figure 3. In August 2013, when the fieldwork for this thesis was conducted, there also had been drought conditions in South Tarawa.

Based on a report by Pacific Climate Change Science Program (PCCSP, 2011), there were 17 La Nina events in South Tarawa in the period 1950-2009 while the El Nino episode were 13 as stated in Figure 4 below (Note the grey colors indicate the normal condition).

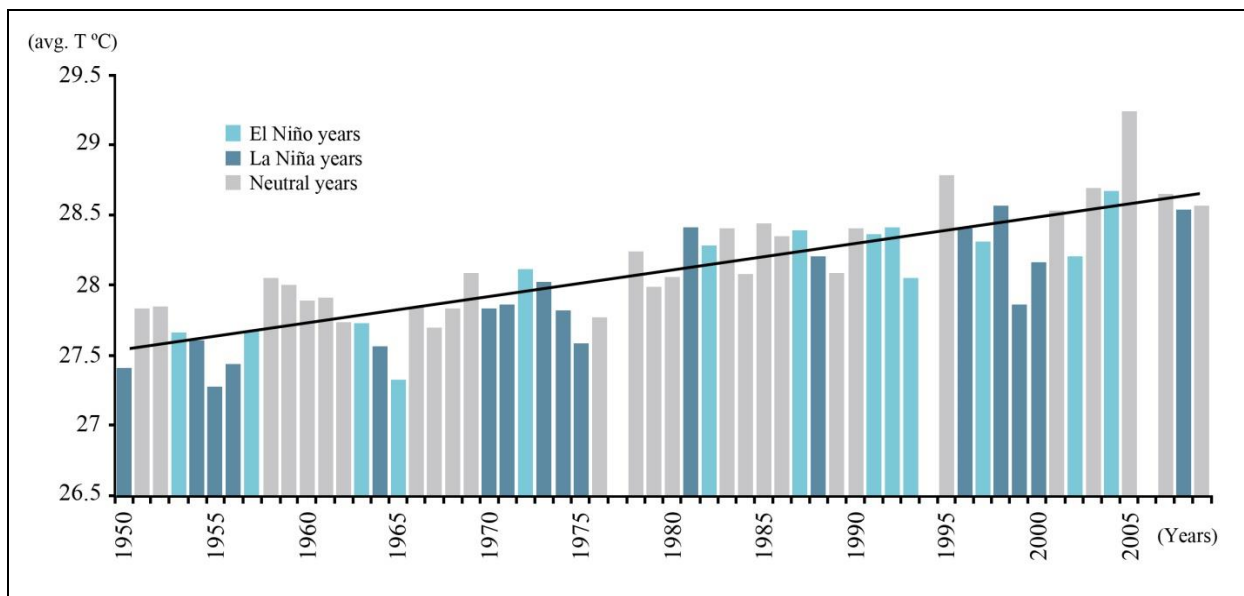


Figure 4. Number of La Nina and El Nino since 1950 to 2005,

Source: PCCSP (2011)

Analyzing the above graph and plotting the La Nina event only with the temperature, it is apparent that the trend of the La Nina event is increasing as shown in Figure 5 below, which indicates that there is a positive warming or dry season imminent with less rainfall in the future.

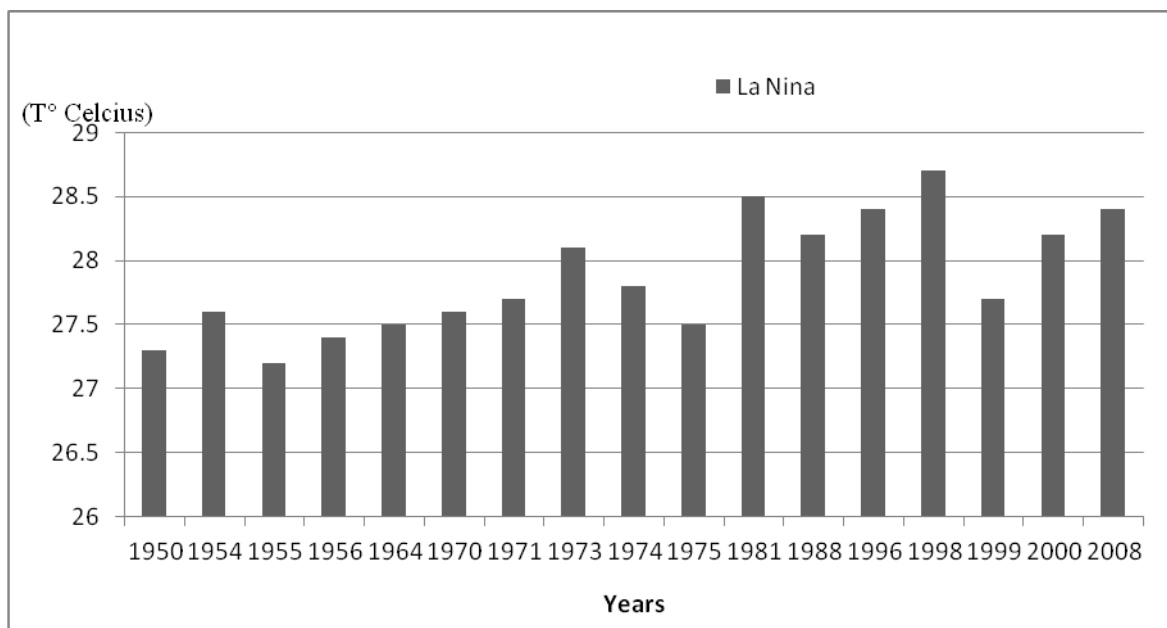


Figure 5. La Nina events since 1950-2009.

(Source: compiled by the Author)

Based on the three International Panel Climate Change (IPCC) projections of emission scenarios of Carbon dioxide concentrations such as low emission (550ppm), medium emissions (700ppm) and high emission (>800ppm) for 2030, 2055 and 2090 (PCCSP, 2011,p.5), it is anticipated that Kiribati's climate would be changing in the future with an increase in average temperature that will result in more hot days and warm nights. This is also relevant to the average annual and seasonal rainfall based on the Global Climate Models (GCM) although there is an uncertainty in the rainfall projections as not all models show consistent results. With this uncertainty in the projected rainfall trends especially for Tarawa, "*te mwautakaka*" can be unpredictable or more frequent although it was envisaged that "*te mwautakataka*" would be less frequent in this century for Kiribati climate (PCCSP, 2011). This skepticism regarding Tarawa was also highlighted in the report published by the National Institute of Water and Atmospheric Research (NIWA, 2008). No one really knows exactly what the future holds as models are not consistent and also future scenarios depend on the rate of emission of Greenhouse Gases (GHG's) which is still under negotiation by World Leaders. Even if agreement is achieved actual emissions remain unpredictable as there is no real guarantee that agreed emissions are respected. Especially the future trend of carbon dioxide, which is the major contributor to the so-called anthropogenic

“*Global warming*”, is difficult to predict. Economic growth and with it sharp increases in energy consumption of big developing countries such as Brazil, China, India, and others have the potential to undo emission reductions in the old developed countries. This then will have a direct negative impact on Small Island Developing States (SIDS) like Kiribati.

Finally the comments made by an old man, Biribo’s confirmed doubts that the country has been experiencing extreme droughts in the past few decades (Kiribati Report, 2011) including the 2010 and 2011 drought event and also drought conditions experienced while doing this research in the study area in August 2013.

This mini-thesis is to answer the following questions:-

- i. Is “*te mwautakataka*” significant issue now in Kiribati?
- ii. How does “*te mwautakataka*” impacts the people and the environment as a whole?
- iii. What has been done by the Government to mitigate the impact of “*te mwautakataka*” on the community as a whole and especially to the case study?

1.2.2 Status of drought literature in Kiribati

Compared with other voluminous literature on “*te mwautakataka*” and its associated impacts on the environment, people’s livelihood and communities social-economic development from developed and developing countries from beyond the Pacific region, very scarce exist in the literature about “*te mwautakataka*” and its impacts on the environment in South Tarawa or Kiribati in general, only a handful on climate change effect as stated by White et al. (2007), Kuruppu (2009), White et al. (1999) on groundwater resources impact. Little so far has been done on people's livelihood in South Tarawa, although Etuati (2010) reported on the nature of labour recruitment in the Southern Kiribati in the mid 19th century which coincided with the occurrence of extreme drought plagued those islands. It is very likely that the drought affected people’s livelihood and forced these islanders to engage in work elsewhere. The Kiribati Indentured Labour Trade (KILT) thus seems to be closely connected to drought and the desperate situation people were confronted with. Therefore this is a challenging task question why “*te mwautakataka*” and its impact was often overlooked considering the number of

droughts happening in the country since the middle of the 20th Century to 2009 as reported by PCCSP(2011). It is quite interesting that a lot of literature exists on Climate change impacts in the country. This includes the Kiribati Adaptation Project (KAP) started in 2003 by the World Bank and the National Adaptation of Programs of Action (NAPA)⁹ of the same year, which is fairly broad in nature, but contains little or even nothing on “te mwautakataka” and its associate negative social, economic and environment implications on people’s livelihoods at national level and in the study area.

1.2.3 Livelihoods in Kiribati

According to the definition of “livelihood” as suggested by Chambers and Conroy (1991, p. 6) a livelihood “comprises the capabilities, assets (including both material and social resources) and activities required for a means of living. A livelihood is sustainable when it can cope with and recover from stress and shocks and maintain or enhance its capabilities and assets both now and in the future, while not undermining the natural resources base”. Implicit in this definition are assets and means of living plus coping strategies to enhance people capabilities. In this dissertation these assets will be investigated deeply including peoples activities for a means of making living (either for subsistence or semi-subsistence) at national level and more specifically at the level of the case study, South Tarawa. It will be investigated how droughts put pressures on livelihood systems and how the Government tries to deal with this.

In Kiribati in general, as well as in South Tarawa, subsistence and sustainable means of livelihood were based on indigenous tree crops, namely coconut tree (*Coco nuferas*), pandanus tree (*Pandanus tectorius*), bwabwai (*Cyrtosperma chamissonis*), breadfruit (*Artocarpus altilis*) and banana (*Musa*). The productivity of these tree crops is dependent on a healthy environment. The coconut tree produces the important export product, copra; the pandanus tree bears fruits which were traditionally preserved for consumption especially during drought years; bwabwai is a prestigious crop; breadfruit and banana are the only fruit trees that provide varied diet from the mainstay of coconut, bwabwai, and fish (Government of Kiribati, 2007). Apart from that

⁹ It is an approach to enable LDCs to communicate their immediate and urgent needs for adaptation to the Conference of the Parties. The process involved in the development of the NAPA is designed to ensure the principles of stakeholder participation, country driven-ness, multidisciplinary input, complementarities to other projects, and cost effectiveness.

vegetables and food crops such as cabbages, tomatoes, eggplants, kumalas (sweet potatoes) amongst others contribute to the main diet in urban Tarawa and assist the islanders to have a healthy lifestyle though most of these vegetables are introduced.

In this dissertation, it is about elements or items that support peoples' livelihood, such as natural resources base from the land and the sea. For instance, copra from coconut trees, breadfruit, bwabwai (Giant Swamp taro), vegetables, pandanus, native figs amongst others including water for personal uses are examples from land based resources whereas marine resources such as seaweed, mollusks, invertebrates and vertebrates including coastal and deepwater fish species . All these resources support people's ways of life (either individually, socially and economically) and their existence are now being threatened by global warming impacts such as sea level rise, coastal erosion, ocean acidification, altered rainfall pattern, increasing air and sea-surface temperature and unpredictable events such as drought, storm surge and extreme high winds (PCCSP,2011). On top of that, to exacerbate the existing threat; increasing population, loss of agricultural land and overfishing had it toll on the environment in South Tarawa. It is a question, whether these supporting elements to enhance people's livelihoods can be sustainable in the future considering the threat posed from nature especially "*te mwautakataka*" as stated above and this is quite a challenging on the part of the Government and other stakeholders to try to mitigate it impacts on people livelihood.

1.3 Aim and Objectives

The general aim is to analyze the negative impact of "*te mwautakataka*" in Kiribati in general with more emphasis on the case study, South Tarawa and then explore ways as how Government tries to deals with it. The following objectives of this study are based on this aim:-

- To define drought in general and relate to the case-study-South Tarawa
- To identify the threshold and magnitude of drought event in the study area, South Tarawa, Kiribati
- To investigate the social, economic and environmental impact of drought in Kiribati in general with more specific to the case study on people livelihood in relation to the longest drought event including making reference to other drought events as well.

- To explore how the Government deals with the impact of drought in the cases study especially on people livelihood with possible recommendations based on the survey from the respondents.

1.4 Significance and Rationale of the study:

The study is important because:

1. It will fill the information lacuna on “*te mwautakataka*” in the study area especially on its impacts on peoples’ livelihoods and Kiribati in general
2. It is hoped that it will highlight people’s perception on drought impact and this can promote further dialogue through exchanging of ideas on drought experiences between the communities, private stakeholders and the Government in order to deal with it.
3. It is hoped that the Government identify the gap existed and what should be done to alleviate the impact on people’s livelihood in the study area.
4. It is hoped that it will increase the enthusiasm of local Kiribati nationals to undertake this study and to see more support from the Government to those who want to venture in this challenging initiative.

1.5 Study Methodology

Data acquisitions during the course of fieldwork were based on both qualitative and quantitative research methods. Both methodologies are very effective to depict the desired result and outcome if both employed at the same time (Patton & Cochran, 2002). In this study the questionnaires were formulated and straightforward in order for the respondents to express their views freely and this was complemented by “*Te Maroro*”¹⁰ approach. Such approach facilitated further exchanging and expression of views between the participants and the researcher in order to maximize the possible outcomes from the questionnaire.(see chapter 3). Furthermore, visiting Government institutions to collect data such as rainfall and temperature, information on copra

¹⁰ It is referring to a conversation between two or more people which can be either formal or informal depending on the context.

and fisheries production, information on Government activities to deal with climate change and drought, and other information were also sought.

A literature review was also employed to broaden the researcher's knowledge. This was done through checking online journals, books, magazines, reports, newspapers and conference papers including library sources such as books, magazines amongst others including visiting other online database and institutions.

“*Te Maroro approach*” were organized including taking photographs with *Key Informants*¹¹ in order to get as much information that related to the purpose of this thesis.

The study area was South Tarawa since it is the most populous island in the country where more than half of the total population of Kiribati residing according to the 2010 Census Report (SPC & KNSO., 2012). Figure 6 shows the territory of Kiribati with the location of South Tarawa. The application of Geographic Information System (GIS) such as Arc Map was employed to show the population map of South Tarawa revealed in Figure 7 including table 2 to show the total population of South Tarawa and Kiribati and the major administrative centers of South Tarawa in Table 3.

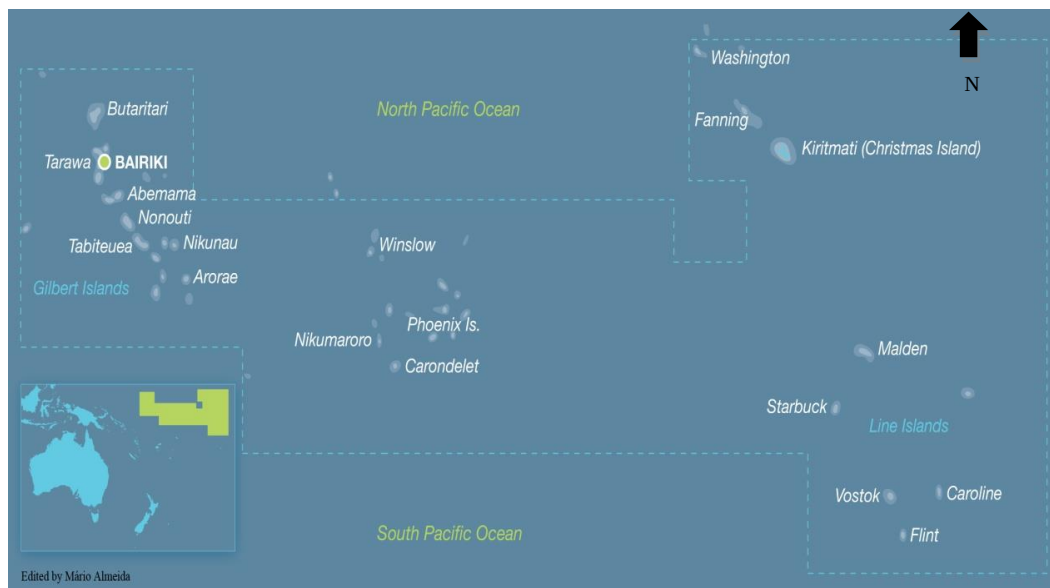


Figure 6. Map of Kiribati

(Source: PICCSP, 2011)

¹¹ It is referring to a person who is knowledgeable about the subject or something.

	South Tarawa	Kiribati
Total Population	50,182	103,58

Table 2. Total Population of South Tarawa and Kiribati.

(Source: SPC & KNSO,2010)

Major Administrative Centres in South Tarawa
Betio
Bairiki
Bikenibeu
Nawerewere (Causeway)
Tanaea

Table 3. Major Administrative Centre in South Tarawa.

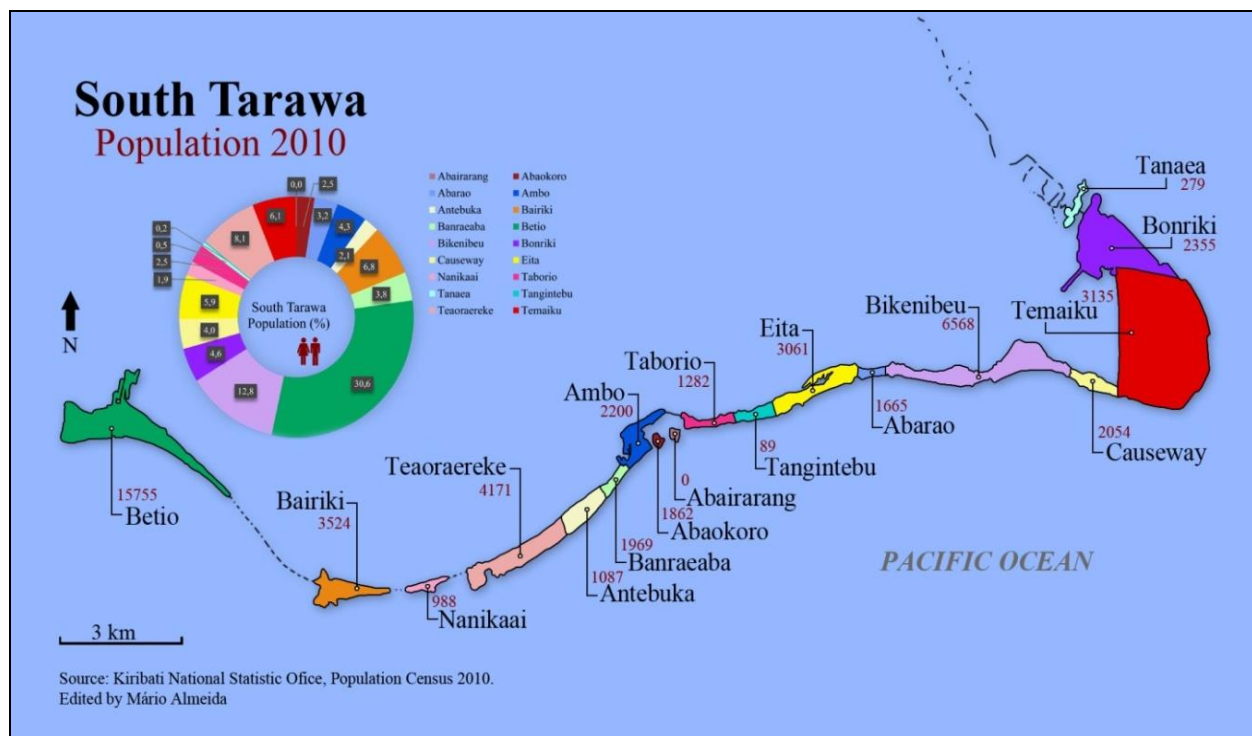


Figure 7. Map of South Tarawa

(Source: GIS Arc Map)

1.6 Conceptual Framework of Thesis

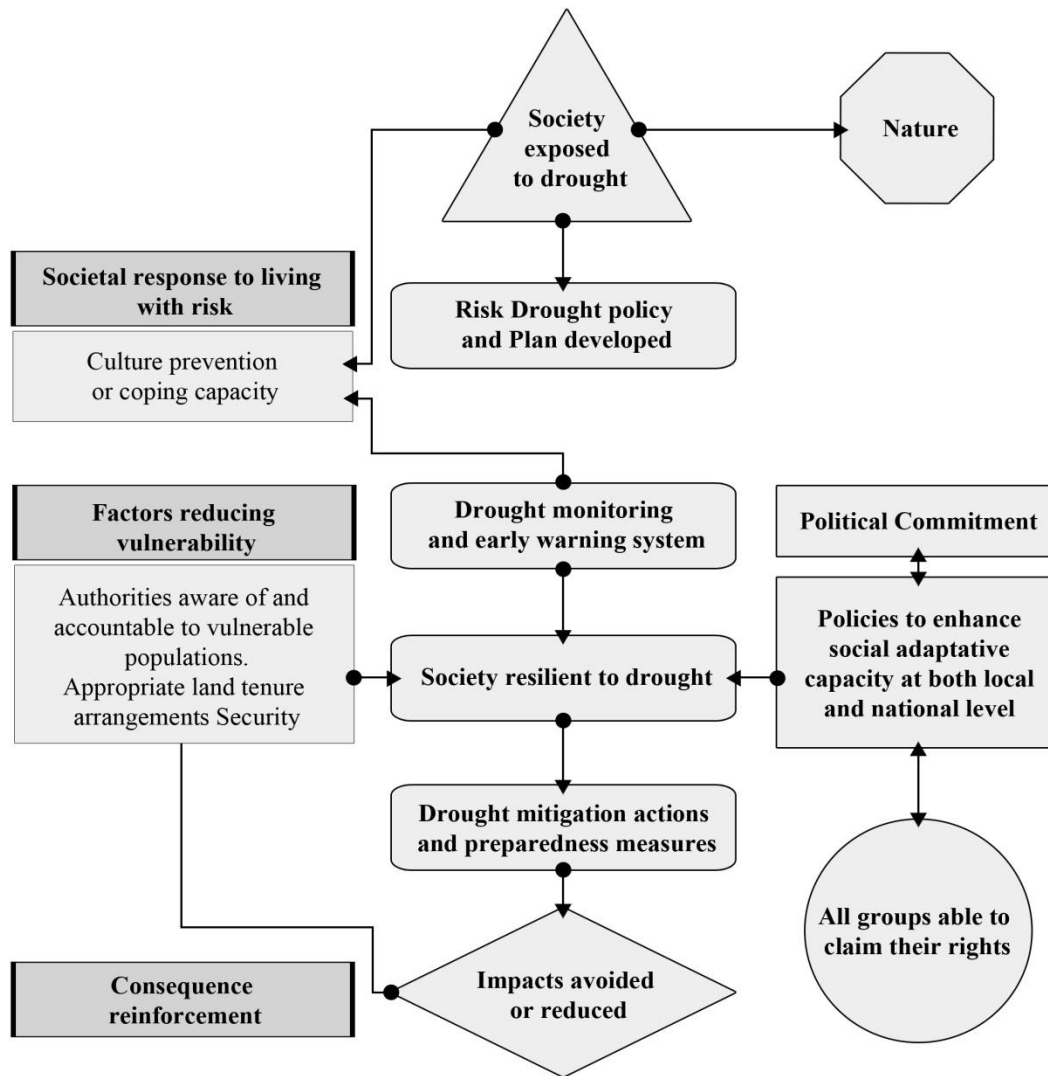


Diagram 1. Conceptual Framework of a dissertation

(Source: Adapted from Drought Risk Reduction Framework and Practices. Retrieved from http://www.unisdr.org/files/11541_DroughtRiskReduction2009library.pdf).

1.7 Structure of the Thesis

This thesis has five chapters. Chapter 1 consists of the introduction which deals with the research problems, framework and significance of the study. Chapter 2 describes the State of Art which discusses the theoretical part in terms of exploring the general impacts of drought from a global perspective and then focusing on the Pacific context and then to the study area. In terms of the conceptual framework of drought, the thesis looks at possible thresholds of drought that can be used to define drought in the study area. Chapter 3 describes the methodologies used for the research and fieldwork in South Tarawa. In chapter 4 the findings are analyzed and then discussed concentrating on the social-economic impact of drought in the study area. Chapter 5 finally seeks to answer questions and objectives of the research challenges and tries to come forward with possible recommendations. The last part of the thesis provides the conclusion.

“Books are the carriers of civilization. Without books, history is silent, literature dumb, science crippled, thought and speculation at a standstill. They are engines of change, window on the world, lighthouses erected in the sea of time”.

(Barbara W Tuchman, 1980)

CHAPTER TWO

Chapter 2

2.1. Introduction.

This chapter will discuss the state of the art in terms of the theoretical and conceptual framework of drought. As stated earlier the thesis first will discuss the general impact of drought and then the discussion concentrates on the Pacific Islands context and finally to the study area. The conceptual framework will look at how to mitigate drought impacts at national level and also glimpses at drought characteristic, definitions from the various literature including drought typologies and indices in general that can be applied and are used as thresholds to define drought also in the study area. The concluding remark will concentrate on selecting the right drought event definition and indices to be used in the study area.

2.1. Part 1: General Impact of Drought on Global Scale

Drought is one of the major natural threats among natural hazards to the people's livelihoods and socio-economic development (UNISDR, 2009). Its effect is non-structural and covered a wide huge of areas compared to other natural hazard such as flooding, hurricanes and earthquakes and therefore quantification of its impact and provision of relief are far more difficult for droughts than for other natural hazard (Mishra & Singh, 2010). For instance, the impact of the 1988 large area of drought on the US economy had been estimated at \$40 billion, which is 2-3 times the estimated loss caused by the 1989 San Francisco earthquake (Riebsame, 1991). Based on the data available from the National Climatic Data Centre (NCDC), USA in 2002, nearly 10% of the total land area of the United States experienced either severe or extreme drought at any given time during the last century (National Climatic Data Centre, 2002). In 1995, the U.S Federal Emergency Management Agency (FEMA) estimated annual losses attributable to drought at US\$6-8 billion. Drought occurs somewhere in the United States each year, with an average of 12% of the nation (excluding Alaska and Hawaii) in the severe to extreme drought category. The maximum spatial extent of severe and extreme drought occurred in 1934, when 65% of the nation was affected. White and Haas estimated in 1975 that the average annual crops losses

associated with drought in the Great Plains of the United States estimated to be around US\$700 million (Gilbert & Hass, 1975). In 1996, widespread and severe drought conditions existed in the southwest and south central states, the recurrence of drought in 1998 in this same region and its expansion into the southeast, and the return of drought in 1999 to the southwest, southeast, and south central states and its expansion into the mid-Atlantic and northeast states have raised serious concerns about our nation's continuing vulnerability to extended periods of drought-induced water shortages. In 2000, drought again was widespread in the spring and summer months. It has resulted in severe impacts in three regions of the country: southeast and Gulf Coast, southwest and south central and central and western Corn Belt states (Wilhite & Svoboda, 2000). As a result of the vulnerability of drought to the United States, drought preparedness planning is become a significant tool for the Government at all levels to at all levels to apply to reduce the risks to future events. In the United States planning has been employed by local, state, regional, and tribal governments. In 1982, for example, only 3 states had developed drought plans. Today, 30 states have prepared drought plans and other states are at various stages of plan development (ibid, 2000)

During the past 30 years Europe has been affected by a number of major drought events, most notably in 1976 (Northern and Western Europe), 1989 (most of Europe), 1991 (most of Europe), and more recently the prolonged drought over large parts of Europe associated with the summer heat wave in 2003 (Feyen & Dankers, 2009). The most serious drought in the Iberian Peninsula in 60 years occurred in 2005, reducing overall European Union (EU) cereal yields by an estimated ten per cent (UNEP, 2006). Since 1991, the yearly average economic impact of droughts in Europe has been €5.3 billion, with the economic damage of the 2003 drought in Europe amounting to at least €8.7 billion (European Communities, 2007). This was the overall impact but to specific country and regions, it has a tremendous impact as well. For instance, in Portugal, in 2005, the country was hit by a major drought which cost the country almost \$300 million euros affecting poorest villages in Southern Alentejo region and destroying grain crops, tomatoes, vines, orchards and even pastures for cattle's and affecting the level of the water in the soils. To aggravate the problem fires destroyed nearly 340,000 hectares and recorded to be the second worst drought event for forest fire. Moreover, the 2005 drought contributed to a 45 percent slump in grain output, a 20 percent fall in wine production and a fruit harvest 13 percent

smaller than the year before (Khalip, 2012). Likewise in Spain the 2007-2008 drought event was the most severe of the last century and the total losses were estimated 1,661 million Euros (for a one year period), almost 1% of the Catalanian Gross Domestic Product (GDP) which affect the various sectors such as farming, gardening, swimming-pool companies and others including the direct and indirect impact to the Catalan River Basin Authority such as measures for increasing water availability and securing water supply, increasing water quality, monitoring and control activity, and public warning and communication campaigns expenses (Martin-Ortega & Markandya, 2009).

In Asia, for instance, a severe drought hit much of South-West Asia between 1999 and 2003, including Afghanistan, Kyrgyzstan, Islamic Republic of Iran, Iraq, Pakistan, Tajikistan, Turkmenistan, Uzbekistan and parts of Kazakhstan (Levinson & Waple, 2004). The persistent multi-year drought in Central and South-West Asia has affected close to 60 million people. Agriculture, animal husbandry, water resources, and public health have been particularly stressed throughout the region. Preliminary analysis suggests that the drought is related to large-scale variations in the climate across the Indian and Pacific Oceans, including the recent "La Niña" in the Eastern Pacific. In 2006, a severe drought in a region of Southern China has left 520,000 people short of drinking water and damaged crops. The drought affected areas throughout the poor, mountainous Guangxi region on China's southern coast nearly 102,000 hectares (254,000 acres) of crops were damaged, causing losses of more than 400 million RMB Yuan (US\$50 million). In addition, China's South-Western city of Chongqing, located along the upper reaches of the Yangtze River, suffered from its worst drought in half a century and Chongqing financial losses of nearly 8.04 billion RMB Yuan (US\$1.04 billion). Nearly 8 million local residents had difficulty accessing drinkable water, and some 2.07 million hectares of farmland have been affected (Liu, 2007). In India, drought is a recurrent feature and had been happening since prehistoric times. Records reveal that drought affected different parts of the country affecting agriculture, livestock, water supply and people's livelihoods and cost millions of dollars (Gupta, Tyagi, & Sehgal, 2011, p. 1795). For instance, the 1900 and 1964 drought events killed over 1 million people and affected 500,000 peoples respectively in West Bengal and Rajasthan while the drought in July 2002 affected different areas such as Uttar Pradesh, Madhya Pradesh, Rajasthan, Punjab, Haryana, Delhi, Karnataka, Kerala, Nagaland, Orissa, Chhattisgarh, Himachal

Pradesh, Gujarat, Maharashtra, Andhra Pradesh and Tamil Nadu affecting 300,000,000 people and caused damages worth US\$ 910,721,000 (Gupta et al., 2011, p. 1798). Due to the number of droughts affecting the country the Government devised a body that coordinated all disasters relief and crisis known as the National Disaster Management Authority (NDMA) with Drought Management Cells affiliated to it to coordinate all drought relief (Government of India, 2004). In the last 20 years India has evolved many new strategies to cope with droughts by a change from a purely relief focus to the present drought management strategy. Monitoring and declaration are important components of disaster management and governance in India. Drought declaration is announced when the rainfall is –20% to –59% (early warning), –60% to 99% (drought) and –1005 of normal (severe drought) conditions (Nagarajan, 2003). Current drought management mechanism includes institutional mechanisms, employment generation and social welfare practices, assistance and support by Central and State Governments, and operation of Early Warning System (EWS) (Gupta et al., 2011, p. 1802).

In African drought is also a recurrent feature affecting various parts of the continent at different timescale. For instance, in the arid lands of Kenya, Ethiopia and Somalia suffer from water scarcity almost on an annual basis (Jode & Tilstone, 2012). In 2011 this region experienced two consecutive failed rainy seasons, resulting in one of the worst droughts since 1950/51 in some areas, and over 12 million people affected. As seasonal water points (water pans, birkhads and shallow wells) dried up, people in these areas relied almost exclusively on deep boreholes for water. In some places people walked over 100 kilometres to access such water points and even then their access was often only possible after payment for water. As part of its emergency drought response activities in Kenya, Ethiopia and Somalia, Oxfam supported the provision of water to some members of the population who were getting less than 5 litres per person per day (the minimum quantity of water needed for survival and basic hygiene). A significant proportion of this water was provided by water trucking operations; in which water was transported via large tanker trucks from permanent water sources (boreholes accessing deep groundwater) to areas with no permanent water points. Transport distances ranged from 20 to 120kms from the water point to the final delivery point. These interventions lasted for 2 to 3 months until the rains arrived. In Kenya the 1996 to 1997 drought had a far-reaching social economic impact which includes the loss of agricultural production, food, energy and water shortages, mass migration of

population and animals and conflict over limited water resources within some dryland location (Ogallo, 2000). Similarly in Darfur, Sudan, the 1998 drought had caused mass migration, conflict and war between ethnic groups to seize or protect scarce water and food supplies. As a result of this drought-induced famine, more than 70,000 people were killed due to starvation, hunger and conflict (Sachs, 2006).

In Australia drought was also a recurring theme with the most recent, the so called ‘millennium’ drought, having lasted for almost a decade (Bonds, Lake, & Arthington, 2008). This severe drought had affected most of Southern and Eastern Australia and was regarded as one of the worst in the region since European settlement (Murphy & Timbal, 2008), with many rivers experiencing record low flows over this period in some cases almost 40% below previous records (European Commission, 2007) and the annual rainfall recorded during that time was 40-60% below the annual normal rainfall (Australian Bureau of Statistic, 2010), thus decreasing Sydney’s largest reservoir to 40 % full and many rural towns in east Australia face shortages within a month (Vidal, 2006). The Australian Bureau of Agriculture and Resource Economics estimates that the 2006 drought reduced the national winter cereal crop by 36% and cost rural Australia around AUD \$3.5 billion, leaving many farmers in financial crisis including business communities in New South Wales, Victoria, South Australia and Queensland (Wong, Lambert, Leonard, & Metcalfe, 2009). It reduced the country’s economic growth by around 0.75 percent and restrictions on water use affected more than 80 percent of Australian households and therefore the Government made a prompt action by convening an emergency water summit in Canberra and allocated AUD200m to businesses which service drought-stricken area and making payment of AUD91m to the affected farmers (ABM, 2010).

In the Pacific islands such as Tuvalu drought threatening the population of over 10,000 in 2011 and therefore the Government declared a state of emergency due to the shortage of water and breakdown of the desalination plant and outbreak of gastroenteritis diseases such as diarrhea, nausea, vomiting, crampy and abdominal pain (Manhire, 2011). Similarly in Fiji, the 1986-1987 drought was the worst drought affecting different part of the country and affecting the water supply especially in rural areas and therefore water restriction was enforced. Additionally the agricultural sector was affected especially the sugar cane and there was fire outbreak (Pahalad, Gosai, & McGree, 2003). Moreover, the 1998 Fiji drought severely impacted 40% of the

country's sugarcane crops and directly impacted an estimated 28000 households (Morrell & Scialabba, 2009). In Marshal Islands, the 1998 drought had a tremendous impact on the thickness of the water lens thus affected the quality and quantity of the water lens. The consequence, there was a severe drinking shortage on Majuro Island and therefore the President of the Republic of Marshal Islands requested emergency disaster assistance from the United States to alleviate the problem (Presley, 2005). In South Tarawa, Kiribati, the 1998-1999 drought was the worst drought as far as the rainfall data from 1947 to 1999 was concerned although there were other severe droughts prior to this period such as in 1949-1950, 1973-1974, 1989-1990 and 1998-1999 and its effect on the environment was tremendous especially well water turn saline in some areas, dry ground create floating dust thus created sicknesses such as pink eyes, asthma and diarrhoea, poor growth of breadfruit and coconut trees and even vegetables died (Republic of Kiribati Country Report, 2009). In addition, the drought of 1998 to 2001 decreases the thickness of large freshwater lenses and increases the salinity of fresh groundwater in the combined groundwater pumped from Buota and Bonriki groundwater reserves (White et al., 2007). Although the electrical conductivity peaked at approximately 1000 microsiemen per cm at the end of 2001, the water was still acceptable for domestic use. Furthermore, the license revenue from the fishing distant fleets' fee fell from A\$40.3 million in 1998 as the EL Nino impact was felt, to A\$31.8 million during the La Nina in 1999 and then decreasing again to A\$17.2 million in 2000 according to the National Development Strategy (NDS) (2000) as mentioned by Thomas (2003,pg 15). Likewise, the copra production decreased from \$9 million in 1998 to A\$1.1 million in 2005 (FAO, 2012). Another similar reporting that shows the decline in exports of copra, fish and seaweed fell each year from \$14m in 1999 to \$7m in 2002 (Republic of Kiribati, 2003).

As a result of drought related impact worldwide, the government established the Drought Committee (DC) comprised of various government agencies with their various responsibilities during drought which was coordinated by the National Disaster Management Office (NDMO) located at the President Office/Headquarter. (Refer to chapter 5 for further details).

2.1. Part 2: The Conceptual Framework of Drought Risk Reduction

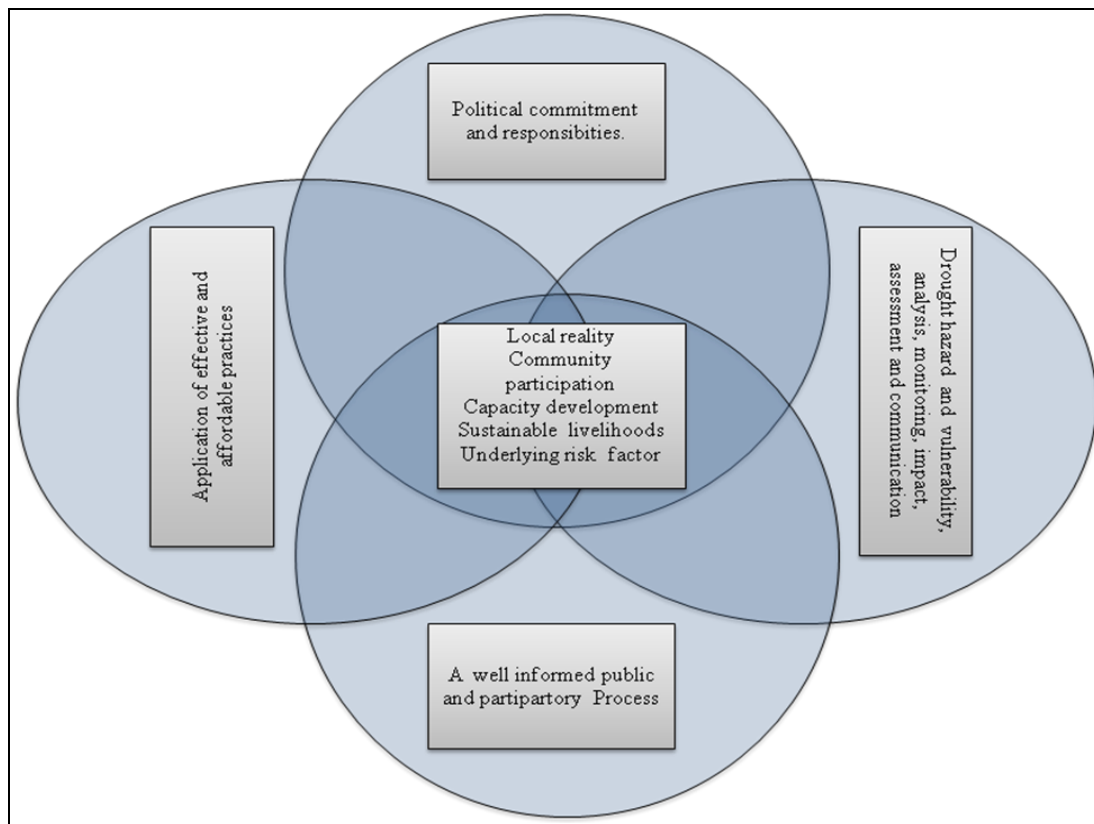


Figure 8. The Conceptual Framework of Drought Risk Reduction

(Source: UNISDR, 2009)

The Conceptual framework at figure 8 above looks at Governance and Policy at the apex in term of political commitment and responsibilities. This is a crucial element for drought risk management as drought risk planning is monitored, directed and managed by the Government through a statutory body which communicating to the general public if risks identify from the oncoming drought and therefore issue early warning. The general public should know what to do to protect their property and manage water wisely based on public awareness and education conducted before by the Drought Task force for instance. This will lessen impact and at the same time develop a resilient communities based on capacity building through a participatory workshop. So political commitment, high level commitment, strong institutions mechanisms

(policy, legislative and organizational) clear responsibilities at central and local level with long term investment in risk reduction measurement in terms of prevention, mitigation and preparedness is essential for drought risk reduction.

2.2. Disaster Risk Reduction.

As vulnerability to drought has increased globally as stated by Wilhite & Svoboda (2000), it is no longer the case nowadays as used to be in the past where the emphasis was placed on the crisis management only which focused on the impact of assessment, response, recovery and reconstruction after the disaster struck. There is a need to intermarry or incorporate crisis management with risk component or management such as preparedness, mitigation, prediction and early warning system prior to disaster occurrence to fully complement the disaster management cycle as shown in the flow diagram below in figure 9 to ensure that the impact of disaster could be attenuated (Wilhite and Svoboda, 2000, p. 8).

The Cycle of Disaster Management

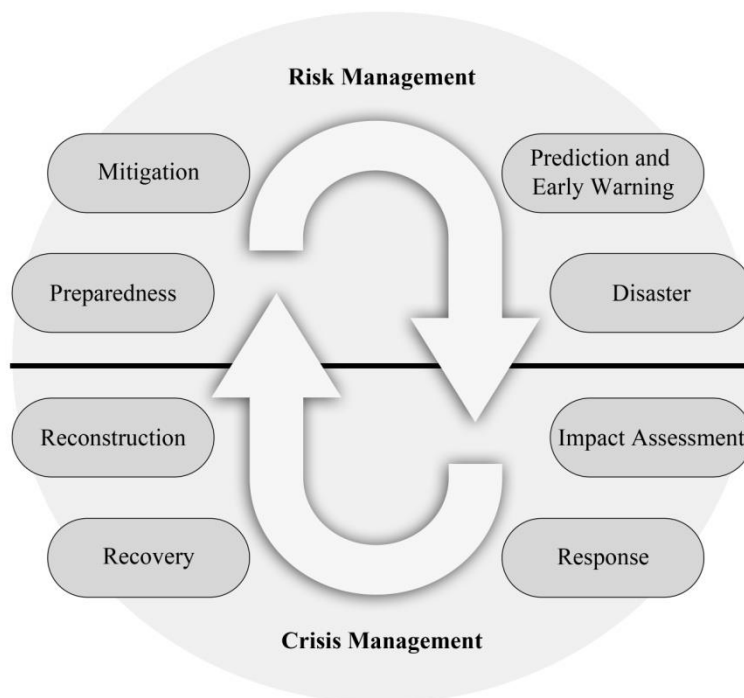


Figure 9. The cycle of Disaster Management

(Source: Wilhite and Svoboda, 2000)

As for drought, it is intended that there should be a plan that is dynamic, reflecting changing government policies, technologies, natural resources management practices, and so forth. The plan should contain three basic components: monitoring and early warning, risk assessment, and mitigation and response and more importantly on accurate and timely assessments to trigger mitigation and emergency response programs. It is intended to serve as a checklist to identify the issues that should be addressed in the plan development, with appropriate modifications. An overview of the 10 steps of the drought planning process as illustrated by Wilhite, Sivakumar, and Wood (2000) was shown in the flow diagram below in figure 10:-

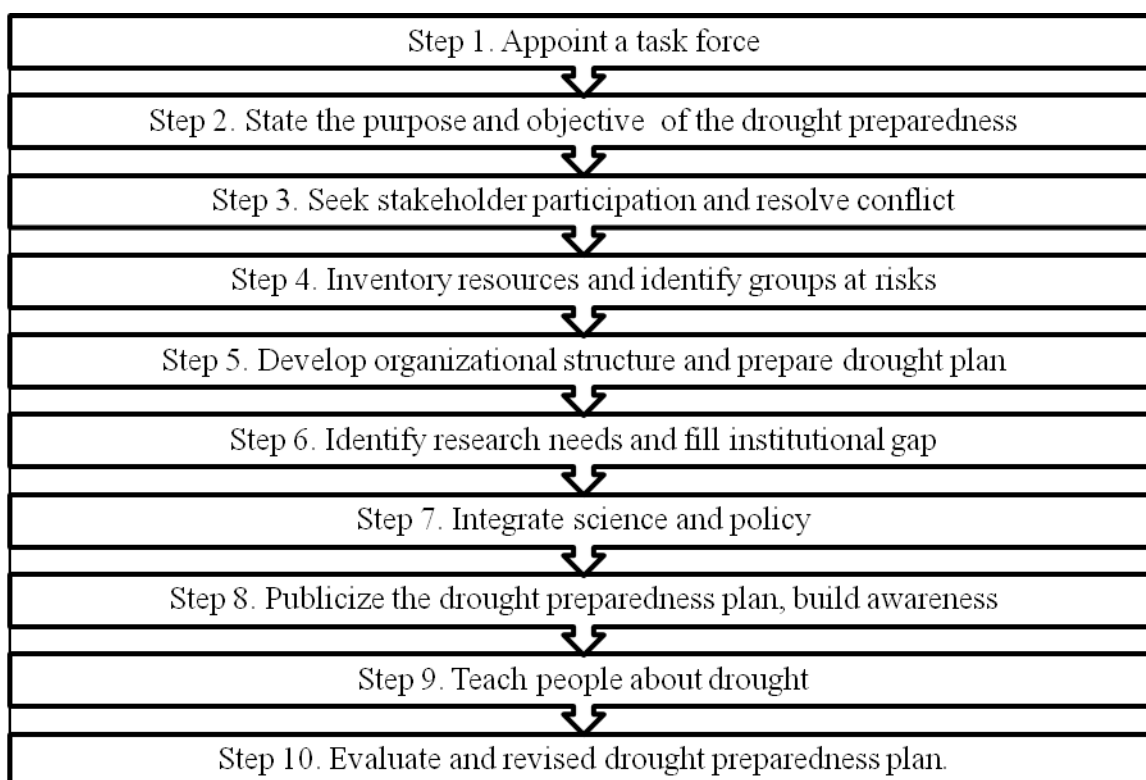


Figure 10. 10 steps planning process

(Source: Wilhite, Sivakumar and Wood, 2000)

Step 1 and 2 both deal with the establishment of the Drought Task Force (DTF) to coordinate and implement drought plans. In this case, selecting the right people who have a thorough understanding of the planning process and what the drought plan should be fulfilled in terms of its purposes and objectives. Step 3 and 4 are mainly for stakeholders' involvement in the

planning process, resolving conflict and conducting an inventory of resources available to the planning process and also identifying areas or groups most risk from drought impact. Risk is defined by both the exposure of a location to the drought hazard and the vulnerability of that location to periods of drought induced water shortages (Blaikie, Cannon, DavisI, & Wisner, 1994). Step 5 describes the process of developing an organizational structure for completion of the tasks necessary for preparing the plan while step 6 and 7 emphasis the need for ongoing research and coordination between scientists and policy-makers. Step 8 and 9 are stressing the importance of promoting and testing the plan before drought occurs. The last step focuses on the evaluation of the planning process by revising the planning process to assess its current effectiveness and consistency in the post-drought period. So all these steps should be considered as part of the planning process to assist and complement the task of the DTF.

2.3 General drought characteristic, definition, typologies and indices

2.3.1 General characteristic of Drought

Droughts can lead to environmental disasters and have attracted the attention of environmentalists, ecologists, hydrologists, meteorologists, geologists and agricultural scientists. Droughts occur in virtually all climatic zones, such as high as well as low rainfall areas (Mishra and Singh, 2000) and even in places where other natural disasters such as tropical cyclone, earthquake and volcanoes are non-existence such in those parts of Kiribati that are located along the equator. It is the least understood disaster because of its slow-onset characteristic nature and therefore defining its onset and end is still hard to determine (Wilhite, 2000, p. 6). Wilhite and Glantz (1985) analyzed more than 150 definitions in their classification study, and more exists, but many do not adequately define drought in meaningful terms for scientists and policy makers. To aggravate the problem, climatologists continue to struggle with recognizing the onset of a drought and scientists and policy makers continue to debate on the basis (i.e., criteria) for declaring an end of a drought (ibid, 2000) as it not only affects only one sector, but many sectors. The above problem had been noted by Tannehill's comment in his book as it stated as:-

“We have no clear good definition of drought. We may say truthfully that we scarcely know a drought when we see one. We welcome the first clear day after a rainy spell. Rainless days continue for a time and we are pleased to have a long spell

of such fine weather. It keeps on and we are little worried. A few days more and we are really in trouble. The first rainless days in a spell of fine weather contributes as much to a drought as the last, but no one knows how serious it will be until the last dry day is gone and the rain come again. We are not sure about it until the crops have withered and died.

(Tannehill, 1947, p. 15).

The absence of a precise and universally accepted definition adds to the confusion about whether or not a drought exists and if it does its degree of severity. For instance, declaring an onset of drought in a high rainfall area (such as a threshold of 40th percentile of rainfall for drought onset declaration) would be misleading and meaningless to a place where aridity is a permanent feature of the climate and where rainfall is lowest. Therefore Wilhite and Glantz (1985) concluded that definitions of droughts should reflect a regional bias since water supply is largely a function of climate regime. It must be noted that the importance of drought lies in its impact and therefore the definition of drought must be region and application (or impact) specific in order to be used in an operational mode by decision-makers. In other words, the drought definition needs to be contextualized to suit a particular region and place to define the drought event within a particular place.

2.3.2 What is drought?

Although some of the most common drought definitions are summarized in (Tate & Gustard, 2000), (Demuth & Bakenhus, 1994) and (Dracup, Lee, & Paulson, 1980), Wilhite and Glantz (1985) categorize drought broadly as either conceptual or operational according to Tallaksen (2000). Conceptual definitions are of dictionary or generic type, generally defining the boundaries of the concept of drought and are thus generic in their descriptions which cannot detect the onset and end of a drought but do incorporate the concept of intensity and duration of a event. For instance, the Encyclopedia of Climate and Weather” (Schneider, 1996) defines drought as “an extended period - a season, a year, or several years- of deficient rainfall relative to the statistical multi-year mean for a region” (Wilhite, 2000, p. 8). The World Meteorological Organization (WMO) defines drought means a sustained, extended deficiency in precipitation’(WMO, 1975). The UN Convention to Combat Drought and Desertification (UN Secretariat General, 1994) defines ‘drought means the naturally occurring phenomenon that exists when precipitation has been significantly below normal

recorded levels, causing serious hydrological imbalances that adversely affect land resource production systems' (ibid, p. 5). The Food and Agriculture Organization (FAO) of the United Nations defines a drought hazard as 'the percentage of years when crops fail from the lack of moisture' (FAO, 1983). Mishra and Singh (2010) define drought as mostly related to the reduction in the amount of precipitation received over an extended period of time, such as a season or a year. Only abnormally dry conditions, which lead to a lack of water to meet normal requirement, should be recognized as drought (Gibbs, 1975). Drought is also the consequence of a natural reduction in the amount of precipitation over extended period of time, usually a season or more in length, often associated with other climatic factors (such as high temperatures, high winds and low relative humidity) that can aggravate the severity of the event as highlighted by Sivakumar (2005) and Wilhite (2000). Similarly, drought is generally defined as a prolonged period of dryness or shortage of water (Giambelluca et al., 1991). Additionally, drought is a natural phenomenon on whose occurrence varies in frequency, severity and duration. Gumbel (1963, p. 5) define a 'drought as the smallest annual value of daily streamflow.' Palmer (1965, p.3) describe a 'drought as a significant deviation from the normal hydrologic conditions of an area.' Linsley et al (1959) define 'drought as a sustained period of time without significant rainfall'. Moreover, drought is both a hazard and a disaster (Gocic & Trajkovic, 2013). In fact, Tannehill (1947) defines drought as a deficiency of precipitation from expected or normal that, when a season or longer period of time extended over, is insufficient to meet the demands of human activities, resulting in economic, social and environmental impacts. The end of a drought is associated with the end of the water deficit, which usually occurs after significant rainfall (Vandas, Winter, & Battaglin, 2002). So to analyze all the above definition, it is apparent that the definition varies and all point towards the rainfall anomalies, not for a short but a longer period of time. Hence to sum up, drought is a product of rainfall deficiency from the expected or normal which continues for a sustained period of time and thus negatively affecting water users such as human beings and land's flora and fauna and therefore considered as a slow onset disaster.

The operational definition of drought attempts to define the precise characteristic and thresholds that define the onset, continuation, and termination of drought episodes, as well as their severity. These definitions are the foundation of an effective early warning system and can also be used to analyze drought frequency, and duration for a given historical period. More importantly, this

definition formed the basis of the differentiating the typology of drought into actual realistically “*drought event definition*”¹² namely meteorological drought, agricultural drought, hydrological drought and socio-economical drought as proclaimed by various scholars as stated above and then assigning a “*drought index*”¹³ in terms of assigning numbers for each drought typology to observe each drought behaviour in order to predict the onset, duration, severity, spatial coverage and termination of a particular drought type.

2.4 Drought Typologies.

Even though drought definitions vary as stated above and all are initiated from rainfall deficit depending on the context of a region, a better understanding to measure drought is illustrated by Wilhite and Glantz (1985) , American Meteorological Society (AMS)(2004), Alley (1984), WMO (1975) and White (1990) scientific classification and agreed upon that there are four different types of drought. These are the meteorological drought, hydrological drought, agricultural drought and social-economic drought.

2.4.1 Meteorological Drought.

Meteorological drought is expressed on the degree of dryness (in comparison to some “normal” or average) and the duration of the dry period. In other words, the severity (intensity of dryness) and duration are the key factors in this definition but really looks at cumulative precipitation deficiencies in terms of comparing monthly data with average values (Chang, 1991; Estrela, Penarrocha & Millan, 2000; Gibbs, 1975). Drought onset generally occurs with a meteorological drought.

2.4.2 Agricultural Drought.

Agriculture drought links daily precipitation to evaporation (ET) rates to determine the rate of soil water depletion and then expresses these relationships in terms of drought effects on plants behaviour at various phenological stages of development. In other words, it is the product of soil moisture deficiencies.

¹² It refers to any drought events in a time series including an onset and end of a drought.

¹³ It refers often to a single number characterizing the general drought behavior at a measurement site.

2.4.3 Hydrological Drought.

Hydrological droughts are associated with the effects of precipitation shortfall on surface or sub surface water supply (i.e., stream flow, reservoir, lake levels and groundwater) rather than with rainfall deficiencies and resulting in significant society impacts. This type of drought used stream flow and water level to determine this kind of drought.

2.4.4 Social- Economic Drought.

The socio-economic drought is occurring when the demands of economic goods and services (such as water, hay, foods, clothes and hydro electrical power) exceed the supply as a result of a water related shortfall in water supply. In other words, this type of drought occurs when the demand for a particular good exceeds supply as a result of precipitation anomalies. This drought type is interconnected with elements of meteorological, hydrological and agricultural droughts. For example, in Uruguay in 1988–89, drought resulted in significantly reduced hydroelectric power production because power plants were dependent on stream. In other cases, reduction in reservoirs and groundwater levels in downstream portions of the basin may result in serious impacts on public water supplies, hydro electric power production, recreation, transportation, agriculture and other sectors. (Wilhite, 2000, p. 12)

The flow chart in Figure 11 below illustrates the relationship of the different types of drought commencing from the meteorological drought leading to other drought as drought progressing over time. (Note the social, economic and environmental impacts are shown at the bottom of the chart, independent of the time scale, indicating that such impacts can occur at any stage during a drought)

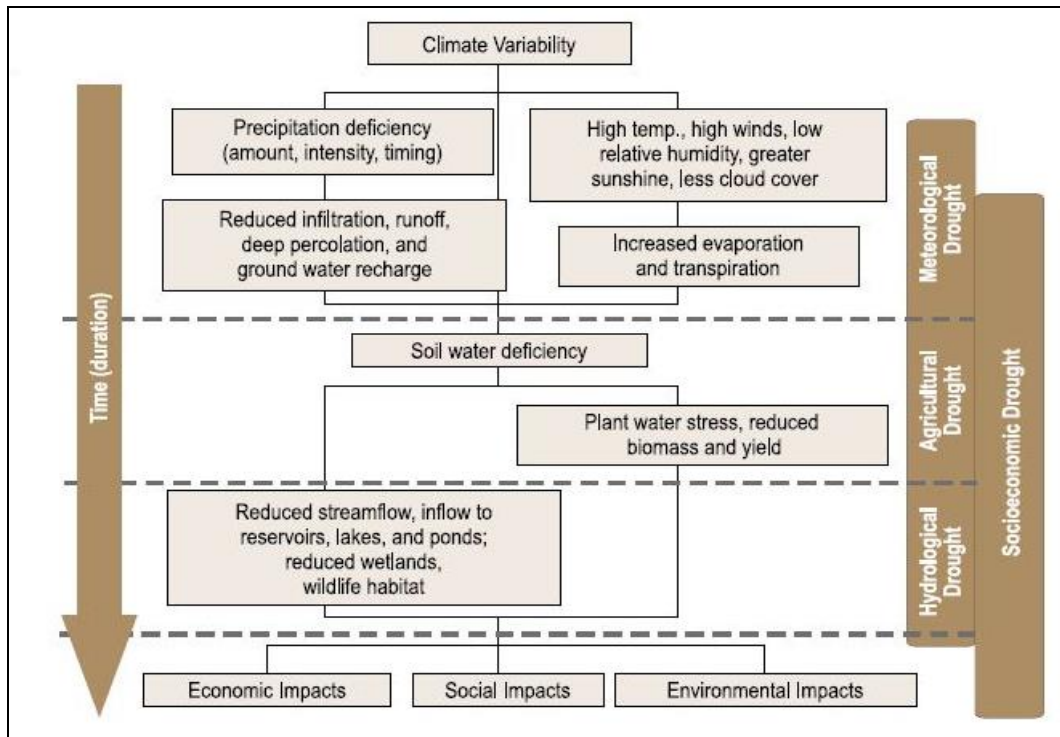


Figure 11. Flow diagram of drought typologies

(Source : National Drought Mitigation Centre,
http://www.unisdr.org/files/11541_DroughtRiskReduction2009library.pdf)

The relationship between the drought types above is that a meteorological drought in term of rainfall deficiency is the primary cause of a drought. As drought persist for a long time, it will lead to an agricultural drought due to lack of soil water . If precipitation deficiencies continues, a hydrological drought in terms of surface water shortage develop. As a result of these impacts, it lead to social- economic drought in term of shortage of supply of goods due to water shortfall and therefore the demands of that particular good and service can not cope with the supplier. In economical term, the demand of a particular good surpluses or exceeding the supply and therefore creating a supply deficit from the supplier in that particular good or service.

2.5 Drought Indices

Drought indices are important elements of drought monitoring and assessment since they show the complex interrelationships between many climate and climate inter-related parameters.

According to Wilhite, Sivakumar and Wood (2000) indices make it easier to communicate information about climate anomalies to diverse user audiences and allow scientists to assess quantitative climate anomalies in terms of intensity, duration, frequency and spatial extent.

The World Meteorological Organisation (WMO) defines drought index as an index which is related to some of the cumulative effects of a prolonged and abnormal moisture deficiency (WMO, 1992). Additionally a drought index is “a prime variable for assessing the effect of a drought and defining different drought parameters, which include intensity, duration, severity and spatial extent” (Mishra and Singh, 2010, p. 207). To put it simply, drought indices are a way to measure different types of drought (using variables such as rainfall, temperature, soil-moisture to meet plant needs, streamflow or decreasing of level of surface water and underground water including goods and services to the general public) and to assess its intensity, duration, severity and spatial extent or scales.

Although there are several indices or ways to measure the above-mentioned drought typologies as stated by Mishra and Singh (2000), Palmer (1965), Hissdal and Tallaksen (2000), Heims (2002) and WMO (1992), table 4 below displays the general characteristics of current drought indices with authors and publication dates for the last 50 years (Mari, 2012). Other details of drought indices characteristics can also be sighted in Byun’s and Wilhite’s case study on “Objective quantification of drought severity and duration” (Byun & Wilhite, 1999). The most common ones are the Standard Precipitation Index (SPI), the Palmer Drought Severity Index (PDSI), Rainfall anomalies, Surface Water Supply Index, Foley Drought Index and Percentage of Normal. All these indices are commonly used in meteorological drought. Although these drought indices are independent of each other, their application can be used in different contexts depending on the available information such as rainfall, soil-moisture contents amongst others to determine the drought event and spatial scales (Ceglar, 2010, p. 3). These indices have their strengths and weaknesses, which will be discussed in the sub-subsequent subheadings.

Drought Indices	Some Authors	Year of Publications
Palmer Drought Severity Index (PSDI)	Palmer	1965
Rainfall Anomaly Index (RAI)	van Roy	1965
Deciles	Gibbs and Maber	1967
Crops Moisture Index (CMI)	Palmer	1968
Blalme and Mooly Drought index (BMDI)	Blame and Mooly	1980
Surface Water Supply Index (SWSI)	Shafer and Dezman	1982
National Rainfall Index (NRI)	Gommes and Petrassi	1984
Standard Precipitation Index (SPI)	Mckee et al	1995
Reclamation Drought Index (RDI)	Weghorst	1996
Soil Moisture Drought Index (SMDI)	Hollinger et al	1993
Crop- Specific Drought Index (CSDI)	Meyer and Hubbard	1995
Com Drought Index	Meyer and Pulliman	1992
Soy-Bean Drought Index (SBDI)	Meyer and Hubbard	1995
Vegetation Condition Index (VCI)	Liu and Kogan	1996

Table 4. List of drought indices with some authors and year of publications.

(Source: Mari, 2012)

2.5.1 Standard Precipitation Index (SPI)

The Standard Precipitation Index (SPI) is a tool which was developed primarily for defining and monitoring drought (WMO, 2012), in terms of forecasting (Mishra and Desai, 2005a), frequency analysis (Mishra, Singh & Delai, 2009), spatial temporal analyses (Mishra and Desai, 2005b) and climate change impact (Misra and Singh, 2009). Hence, its usage allows an analyst to determine the rarity of a drought at a given time scale (temporal resolution) of interest for any rainfall station with historic data. It is also useful in analysing wet periods/cycles as it is in analysiing dry periods/cycles. It also can be used to monitor short term water supplies such as soil moisture which is important for agricultural production and long term water resources such as groundwater supplies, streamflow and lake and reservoir levels. Soil mositure conditions respond to precipitation anomalies on a relatively short scale while groundwater, streamflow and reservoir storage reflect the longterm precipitation anomalies.

The calculation for SPI for any given location is based on the long term precipitation record of the desired period. This long term is fitted to a probability distribution, which is then transformed into a normal distribution so the mean SPI for the location and desired period is zero (Edwards and

Mckee 1997). Positive SPI values indicate greater than meridian precipitation and negative values indicate less than median precipitation. Because the SPI is normalised, wetter and drier climates can be represented in the same way; thus wet periods can also be monitored using the SPI.

Table 5 below shows an example of SPI application to define the threshold or criteria to define drought events and intensities illustrated by Mckee and others (1993) . For instance, a drought events occurs anytime when the SPI is continuously negative and reaches an intensity of -1.0 or less. The events ends when the SPI becomes positive. Each drought event therefore, has a duration defined by its beginning and end, and an intenisty for each month that the event continues. The positive sum of the SPI for all the months within a drought event can be termed the drought's "magnitude" or "duration of its occurance or coverage".

SPI Values	
2.0+	Extremely Wet
1.5 to 1.99	Very Wet
1.0 to 1.49	Moderately Wet
-.99 to .99	Near Normal
-1.0 to -1.49	Moderately Dry
-1.5 to -1.99	Severely Dry
-2 and less	Extremely Dry

Table 5. SPI Values

(Source: WMO, 2012 , http://www.wamis.org/agm/pubs/SPI/WMO_1090_EN.pdf)

Strength:- Precipitation is the only input parameter. The SPI is flexible and can be computed for different time scales even if it applies to different localities and climate contexts. Additionally, it can provide early warning of drought for shorter time scales such as 1, 3 and 5 and also can use to assess drought severity. It is less complex than the Palmer Drought Severity Index and many other indices(WMO,2012).

Weakness:- : It can only quantify the precipitation deficit and ignores other variables that effect atmospheric water demand such as temperature, wind speed, water pressure deficit and solar radiation that has impact on evapotranspiration¹⁴.

2.5.2 Palmer Drought Severity Index (PDSI)

The PSDI is a meteorological drought index that can be used to determine spatial and temporal drought characteristics and severity, including periodic behavior of drought within different timescales. Its implementation has been concentrated on monitoring hydrological trends, crops forecasts and as well as for potential fire severity. It uses precipitation, temperature and the available water content of the soil to measure or calculate the departure of the moisture supply (Palmer,1965).

Strength:

It gives decision makers with measurement of the abnormality of the recent weather for a region. It also provides an opportunity to place current conditions in historical perspective. It provides spatial and temporal representations of historical droughts.

Weaknesses:

It is more suitable for agriculture than for hydrological droughts for longer droughts (Mckee et al, 1995). Rains values are questionable for winter months and at higher elevations since precipitation is all considered as rain. Additionally, runoff only occurs after all soil layers have become saturated, which can underestimate the total runoff. Lastly it can be slow to respond to developing and diminishing droughts.

2.5.3 Deciles

This is another technique of arranging monthly precipitation into deciles or percentiles developed by Gibbs and Maher (1967) to avoid some of the weaknesses within the percent of normal approach. This technique is done by dividing the distribution of occurrences over a long term precipitation record into tenths of the distribution. They called each of these categories a “decile”. For instance, the first decile is the rainfall amount not exceeded by the lowest 10% of

¹⁴ the process by which water is transferred from the land to the atmosphere by evaporation from the soil and other surfaces and by transpiration from plants

the precipitation occurrences. The second decile is the precipitation amount not exceeded by the lowest 20% of occurrences and so the process continues until the rainfall amount identified by the tenth decile is the largest precipitation amount within the long term record. By definition, the fifth decile is the median, and it is the precipitation amount not exceeded by 50% of the occurrences. The deciles are grouped into 5 classification as shown in table 5 below.

Decile Classifications

Decile 1-2 Lowest 20%	Much below normal
Deciles 3-4 (Near Lowest 20%)	Below normal
Decile 5-6 (Middle 20%)	Near normal
Deciles 7-8 (Near Highest 20%)	above normal
Deciles 9-10 (Highest 20%)	Much above normal

Table 6. The decile classification as per Gibbs and Maher (1967)

(Source: Sivakumar et al, 2010)

Strength:

It provides an accurate statistical measurement of precipitation.

Weaknesses:

Accurate calculations require long climatic data record.

2.5.4 Surface Water Supply Index

The Surface Water Supply Index (SWSI) was invented by Shafer and Dezman (1982) as a hydrological drought index. It is calculated on monthly non-exceedance probability from available historical records of reservoir, streamflow, snow pack and precipitation. The purpose of SWSI is to monitor abnormalities in surface water supply sources. Its calculation is dependent on the season. For instance, during winter season, only snowpack, precipitation and reservoir storage is computed while in summer months, streamflow replaces snowpack as a component within the SWSI (Wilhite and Glantz 1985; McKee et al, 1993). The calculation of a SWSI for a particular basin is as follows: monthly data are collected and summed up for all precipitation stations, reservoirs, and snowpack/streamflow measuring stations over the basin. Each summed component is normalised using a frequency analysis gathered from a long-term data set. The

probability of non-exceedence (the probability that subsequent sums of that component will not be greater than the current sum) is determined for each component based on a frequency analysis. Each component has a weight assigned to it depending on its typical contribution to the surface water within a particular basin, and the weighted components are summed to determine a SWSI value representing the entire basin. The SWSI is centered on Zero and has a range between -4.2 and +4.2. (ibid,1982).

Strength:

It is a good measure to monitor the impact of hydrologic droughts on urban and industrial water supplies, irrigation and hydroelectric power generation. It is easy to use.

Weaknesses:

SWSI calculation is unique to each area and therefore it is difficult to compare SWSI values between basins (Mckee, Doesken & Kleist, 1991). Changing a data collection for a new station or water management basin requires a new algorithm to calculate a new index for that particular basin.

2.5.5 Foley Drought Index

The Foley Drought Index is also known as the Cumulative Precipitation Anomalies (CPA) as first proposed by Foley (1957). It is used to measure the shortage of precipitation compared to the long term mean. The actual precipitation for a period is calculated by dividing the expected precipitation for that same period by the expected annual rainfall. It is used also as an additional drought index for monitoring drought situation (Willeke, Hosking, Wallis, & Guttman, 1994).

Strength:

Its cumulative function was preferred because the effect of several months in a row with below average precipitation could be assessed (Keyantash & Dracup, 2002). The timescales of this method are not fixed and can vary from monthly to annual precipitation.

Weaknesses:

The mean precipitation is often not the same as the median as the mean indicates a normal distribution, while precipitation is often not normal distributed (Hayes, 2007). It does not

indicate the beginning of a dry spell and therefore drought onset/initiation is usually the point when precipitation anomaly is decreasing.

2.5.6 Percent of Normal.

Percent of Normal is a simple method for comparing observed to normal precipitation for a particular location and time period. Observed precipitation is divided by normal mean precipitation (usually based on 30 years of data) and the result is expressed as a percentage. It can be calculated for any time scale of interest such as day, week, month, season and year. Data are not normalised (ibid, 2007).

Strength:-

It is effective in a single region or season.

Weaknesses:-

It cannot determine the frequency of the departures from the normal or compare with different locations. Also, it cannot identify specific impact of drought or the inhibition factor for drought risk mitigation plans (Willeke et al., 1994). Moreover, the mean or average precipitation is often not the same as the median precipitation which is always the middle value for all the individual precipitation measurement which is the 50th percentile.

2.6 Drought Event Definition for South Tarawa.

Based on the aforementioned drought event definitions and indices, for the purpose of this thesis the Meteorological drought will be analysed to define drought events in the case study based on precipitation anomalies. The percentile method will be employed to determine the threshold, severity and magnitude of drought events based on rainfall data from 1947-2011 for South Tarawa and Standard Precipitation Index (SPI) for comparative analysis for the worst drought years since 1947 to 1982 which will be discussed in details in the chapter 3.

“Qualitative analysis transforms data into findings”

(Michael Quinn Paton, 2002.p.432)

CHAPTER THREE

Chapter 3

3.1 Introduction

This chapter discusses the three research methodologies stated in chapter one in the first part in details that involves qualitative and quantitative investigation in terms of focus group questionnaires, “*te maroro* approach” and collecting figures from different Government Ministries. It is divided into sections. The first part will look at Kiribati in general and then the study area. First, it will discuss its geographical location in global and regional perspectives, demographic composition, climate, biogeography, history, cultures, government structure, demographic and social-economic characteristics of Kiribati. The second part is translating both quantitative and qualitative data into a readable, meaningful or visual way for easy analysis and interpretation.

3.1 Part One: Research Methodology

The fieldwork was done according to the Code of Ethic of Research protocols of the University of Porto, Portugal where confidentiality and the right of the respondents were given priority. During data collection respondents and key informants were given freedom of choice to answer the questions or not. They remain anonymous during the course of investigation and publication of the findings, if they chose so. In particular explicitly permission was sought to use their photo in this mini-thesis writing for validation that the actual work was done.

3.1.1 Data Acquisition: Primary Data

The data collection was carried out in South Tarawa, the capital atoll of the Republic of Kiribati during the dry season in August 2013 and lasted for almost three weeks. This coincided with the end of one post graduate academic year at the University of Porto (UP), Portugal. The fieldwork had two objectives. Firstly, it was meant to collect data (both quantitative and qualitative) from

concerned Ministries and secondly to establish a link between the researcher and the authorities. Through this it became easier to communicate through telephone calls and emails between the researcher and authorities if there was any doubt or further clarification was needed from the researcher side.

The different ministries departments or divisions consulted the Health Statistical Units from the Ministry of Health and Medical Services (MHMS) for South Tarawa Mortality rate, rainfall and temperature data from the Kiribati Meteorological Services (KMS) at Betio as shown in Figure 12 below. For Climate and State of the Environment data or reports the Environment Unit located at Bikenibeu was consulted. For agricultural data the Agriculture division at Tanaea was consulted. Both units and divisions fall under the Ministry of Environment, Land and Agricultural Development (MELAD) located at Bikenibeu. For the total tuna catches in Kiribati water, the Fisheries division from the Ministry of Fisheries and Marine Resources Development (MFMR) was contacted at Bairiki and the Kiribati National Statistic Office from the Ministry of Finance and Economic Development (MFED) based at Bairiki for other additional data. Other departments that had been visited were the Water Engineering section and the Public Utilities Board headquarters at Betio from the Ministry of Public Works and Utilities (MPWU).

The photo below showed some of the key informants consulted during fieldwork.

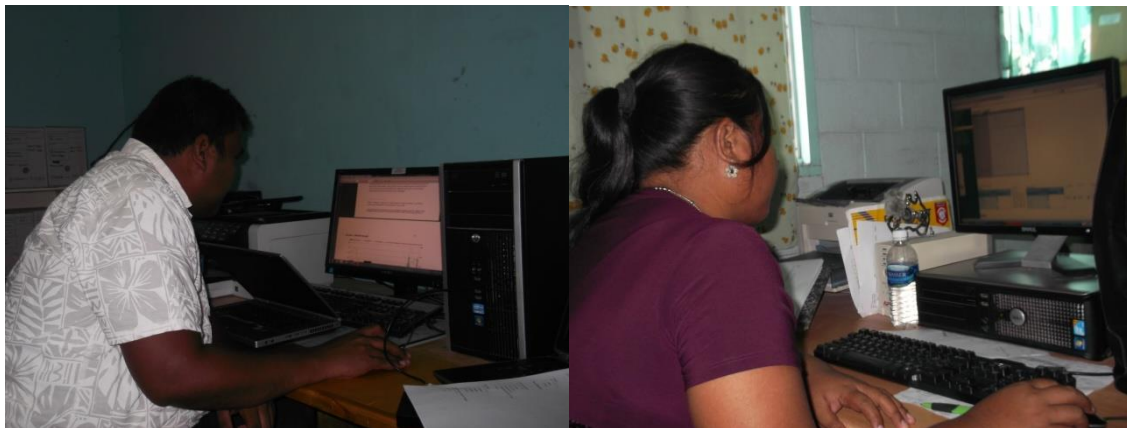


Figure 12. KMS Office at Betio on the left and Statistic Office from MHMS at Nowerewere on the right

(Source: My personal photo)

Data acquisition from the above different ministries can be summed up based on the following steps:-.

- i. Collecting Meteorological data on temperature and rainfall since the period 1947 to 2011 from the Kiribati Meteorological Services (KMS) for South Tarawa only.
- ii. Collecting statistical data from the Ministry of Health and Services relating to the mortality cases in South Tarawa from 1993-2004.
- iii. Collection of data from the National Statistic Office from the Ministry of Finance and Economic Planning relating to Agriculture in terms of copra production for Kiribati and South Tarawa from the period 1993-2011.
- iv. Collection of total fisheries catches of tuna from foreign vessels in Kiribati water for the period of 1994 -2007 from the Ministry of Fisheries and Marine Resources.

3.1.2 Literature Review: Secondary Data

A literature review was conducted relating to “*te mwautakataka*” in general and also in the study area in order to provide to the scholar further insight of what had been done in this regard in the country, other countries of the Pacific Islands and even beyond the region. For instance, digging of library books, newspapers and magazines including the use of online sources such as academic journal articles, newspapers, and magazines and reports from international conferences and other sources were utilized in the investigation at the Faculty of Arts at Letras, University of Porto (UP). Browsing other online databases such as EM_DATA (Emergency Database), Science Direct, Pacific Disaster Net, and South Pacific Applied Geoscience Commission (SOPAC) and Secretariat of the Pacific Community (SPC) virtual libraries amongst others, were consulted to get additional data.

Visiting regional institutions such as SOPAC and SPC headquarters based in Suva, Fiji Islands was also carried out during the research to get supplementary data on drought including the University of the South Pacific (USP) Libraries and online databases.



Figure 13. Main headquarter of SOPAC in Suva, Fiji Islands

(Source: Google Image)

3.1.3 Stratified Sampling Techniques: Focus Group

Due to a large number of people residing in South Tarawa and a limited time frame to execute fieldwork, a sampling of the population was the best option to be able to concentrate on particular focus groups and selection of various age groups. The sampling of focus groups gave a representation of the perspectives of islanders living in urban Tarawa. The groups selected comprised people between the age of 21-30years, 31-40years, 41-50 years and 51+ years who then were selected randomly from the population of different villages namely Betio, Bairiki, Teoraereke, Bikenibeu, Ananau Causeway, Temaiku and Tanaea. The selection of the respondents to the questionnaires was biased toward the older population since they had a longer lifespan with more life experiences on past drought events in Tarawa compared to the younger population.

There were 55 questionnaires distributed to the different age focus groups of both sexes. The questionnaire was written in plain English to make it understandable for the respondents and also structured in open-ended questions style in order to get the most responses out from the respondents. Explanation of the questionnaire was provided to old illiterate respondents. The analysis of the questionnaire was done during the actual writing of this mini-thesis in Porto, Portugal. The photo below in Figure 14 depicted such an approach that the researcher used during the course of a research to a member of a focus group within the age of 51+ at Ananau Causeway village.



Figure 14. Questionnaire strategy facilitated by "Te Maroro" Approach

(Source: Personal photo)

3.1.4 *Te Maroro* approach

This approach resembled other research approaches such as *talanoa* manifested by Vaioleti (2006) *taona tabon inam* (Tearo, 2003; Korauaba, 2012) where the researcher and respondents used local vernacular as a medium of exchange of ideas including pursuing traditional etiquette to observe before commencing the conversation like seeking permission from the respondent and blessing from the host. Such an approach are culturally inclusive and are considered as the most effective ways of sharing emotions of both parties (researcher and respondent) and to make communication more meaningful as both parties express themselves openly and freely in a friendly way.

Te Maroro was organized with key informants over the telephone asking them for a convenient time to meet. This was to make them aware of the meeting and to be able to available themselves during the meeting amongst their busy schedule while the other strategy visiting them in their respective houses/residences and seeking approval and finding the most convenient time for *te "maroro"* regarding their views on the "*te mautakataka*" and life experiences' including answering the questionnaire.

3.1.5 Tools: GIS, SPSS, Excel, Google Map and Image, Camera and Microsoft Excel, SPI Calculator

The application of GIS Arc Map was used to create the population map of South Tarawa. Google map was used to reveal its location globally and regionally and images of office buildings, and people including cameras for taking photographs of respondents and key informants.

The SPSS¹⁵ (Statistical Package for Social Science) was used to analyse the questionnaires and plot them on a table or graph either as a pie chart or bar graph for easy interpretation and analysis.

3.1.6 Procedure for calculation of drought magnitude using percentile for Tarawa

Rainfall data for South Tarawa (1947-2011) was utilized to determine the above using either the decile or percentiles method. In this case, percentiles were employed and the rainfall data was rearranged based on the two seasons of Kiribati such as the wet season (November- April) and the dry season (May-October) to calculate the threshold for drought for South Tarawa. Through this the researcher explored the options that could be utilized to determine the possible threshold for the severity and magnitude of drought event using the 50th percentile, 30th percentile, 20th percentile and the 10th percentile was calculated using Microsoft Excel. The procedure of calculating the percentile was calculating the total amount of rainfall for each season using Microsoft Excel including the total rainfall for all seasons. The second step was to calculate the average rainfall for each month based on those years or average total rainfall for the two seasons. Once this was done, the standard deviation was calculated for each month for those years. The next step was then dividing the standard deviation with the mean to determine the range of dispersion from the average and then the 50th, 30th, 20th and 10th percentiles was calculated. The list below shows the options that could be used to define the threshold for severity and drought event magnitude for the case study.

1. The first option is to use the total amount of rain for all year
2. The second option is to choose the total amount of rainfall during the wet season.

¹⁵ is a software package used for statistical analysis.

3. The third option is to choose as well the total amount of rainfall during the dry season.

From the above choices, for the purpose of the case study, the best choice was to use option 1 from the month of November 1998 to April 2001. The 10th percentile is the lowest of all the percentiles .

It is more logically and wise to choose option 1 than the other options since the result obtained are not consistent and reliable due to missing rainfall data for the period of 1989 for the month of March, May, June, July, August, September, November and December and this affect the validity of the result within those calculated percentiles for the total annual precipitation period of 1947 to 2011.

3.1.7 Procedure for SPI Calculation for worst drought event at Tarawa

The method of calculating the SPI values was computed using the SPI Calculator for any long-term precipitation record. The longer the precipitation record, the better as it gives higher confidence in the statistics or result. Missing data can be considered as -99 for missing value(s) for month(s) as Zero is a value for month(s) in arid regions or places that have wet and dry seasons. In this case, the precipitation values are arranged in three columns format such as year, month and precipitation as input files in Excel but must be renamed with xxx. a cor extension file in notepad before executing the program. Once this done, then right click the SPI calculator and then save it. Then execute (double click) the program and follow the instructions in the pop up window such as choose the SPI timescales and specify the months to be computed in the program. Enter an input and output name for the file name and should be saved as .dat extension file. The result will be the computed SPI values presented in Notepad or word processing documents. The SPI calculator can be sited at WMO website online.

3.2 Part 2.1. Country Profile: Kiribati

3.2.1 Brief Description of Kiribati history

Kiribati was first settled by early Austronesian speaking peoples long before 1st Century A.D(Kiribati, 2003). Subsequent war with neighbouring countries such as Fiji and Tonga introduced elements of the Melanesian and Polynesians into Micronesian culture. Inter-marriage tended to blur cultural differences and resulted in a significant degree of cultural homogenization (US, 1990).

During colonial times the major islands group was called the Gilbert Islands named after an English explorer Captain Thomas Gilbert who made contact with the natives in 1820s on a ship under a Russian Admiral Adam von Krusenstern (BBC, 2011). The discoveries of the northern chain of Kiribati islands such as Makin and Butaritari (Buen Viaje Islands) were made earlier by a Portuguese-born Spanish explorer, Captain Pedro Fernandez de Queirós in 1606 (Kelly, 1966), and the Southern island of Nikunau by the English Captain John Byron in 1765 (ibid,2003). Kiribati is a former colony of the British Empire together with the Ellice Islands and was known as Gilbert and Ellice Island Colony (GEIC). The two countries were declared colony in 1915 until their peaceful separation in 1975 prior to their independence. Tuvalu (formerly Ellice) became independent in 1978 while Kiribati on the 12th July, 1979. The main atolls of Tarawa is also renowned for the Battle of Tarawa during the Second World War between the Japanese and American Forces in 1943, which was one of the bloodiest battles in the Pacific history as far as the US Marines Corps are concerned and lasted 76 hours.

3.2.2 Geography: Location

Kiribati (formerly known as Tuarua) is an island nation consists of 32 islands scattered along the Pacific Ocean. It is located at approximately between latitudes 4⁰North and 12⁰South and longitudes 171⁰ West and 177⁰ East .It is close to the Marshall Islands in the North, Nauru towards the West; to the South and South East there are Tuvalu, Tokelau and the Cook Islands. The Republic of Kiribati is the only country in the World that has part in all the four hemispheres of the World (Northern, Eastern, Southern and Western). It is considered a cyclone-free country

though it experienced strong gale force wind from the cyclone or hurricanes if cyclone passes to nearby countries in the southern and northern part of the country.

All the islands are low lying with the exception of Banaba (formerly known as Ocean Island), a raised limestone island elevated about 80 meters above sea level being an important centre of phosphate mining in the Pacific Ocean. Of all the islands in Kiribati, only 21 are in habitat. Figure 15 shows the location of Kiribati in relation to its neighbouring countries.

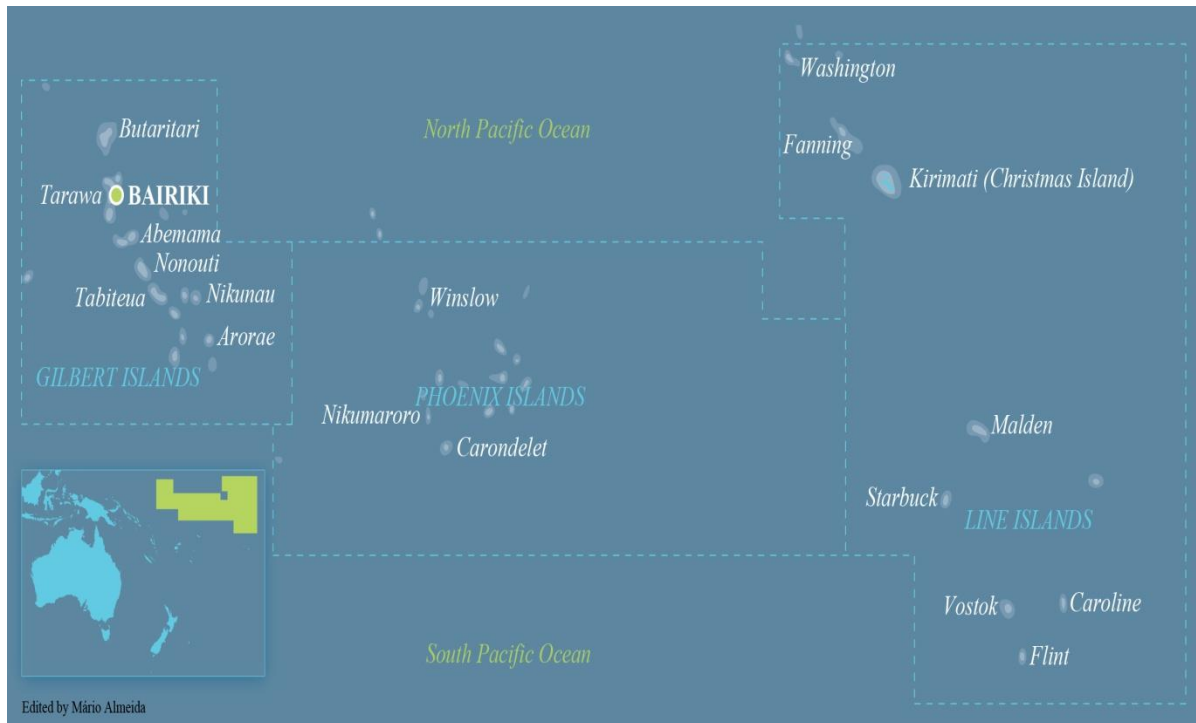


Figure 15. The location of Kiribati within the region and the rest of the World.

(Source: www.pacificclimatechangescience.org. Retrieved on the 28th January, 2014)

The Kiribati Islands are subdivided again into three major groups: the Gilbert group, the Line Islands and the Phoenix group of islands as illustrated in Figure 16. The seat of the Government is situated at Tarawa atoll in the Gilbert Group although Kiritimati in the Line group and also the Phoenix group have a major government post and schools to accommodate people. The Gilbert group consists of 16 islands which are sub-divided into the northern, central and southern group. The Northern Group consists of Makin, Butaritari, Marakei, Abaiang and Tarawa. The central group comprises of Maiana, Kuria, Aranuka and Abemama while the Southern group is made of Nonouti, Onotoa, Beru, Nikunau, Tamana and Arorae. Banaba (Ocean islands) is also part of

the Gilbert group but located further to the West. The Phoenix group consists of Canton (Kanton), McKean, Nikumaroro, Manra, Atafu and Bernie Island. Kanton is the only island that is inhabited in this group: a few households of Government employees are stationed there. The Line Group consist of Kiritimati (Christmas island), Tabuaeran (Fanning Island) and Teraina (Washington Island) which are the only 3 inhabited islands while the rest of the islands such as Malden, Starbuck Island, Caroline (Millenium) and Vostok Island are uninhabited islands. There are two main international ports of entry for international airlines to Kiribati such as Tarawa in the Gilbert Group and Kiritimati (Christmas) Island in the Line group while Betio's port at Tarawa Island is the major international port of call for foreign vessels as well as London village at Kiritimati. In fact, Kiribati can be categorized into the Eastern and Western Kiribati since it is dissected by the International Date Line and therefore have different time zone prior to the unification of the time zone on the 1st of January, 1995 by the former President, His Excellency Mr Teburoro Tito. Kiritimati atoll is one of the largest atolls in the world and situated in the Line group, about 3300 kilometres north- east of the main capital of the Republic of Kiribati, Tarawa.

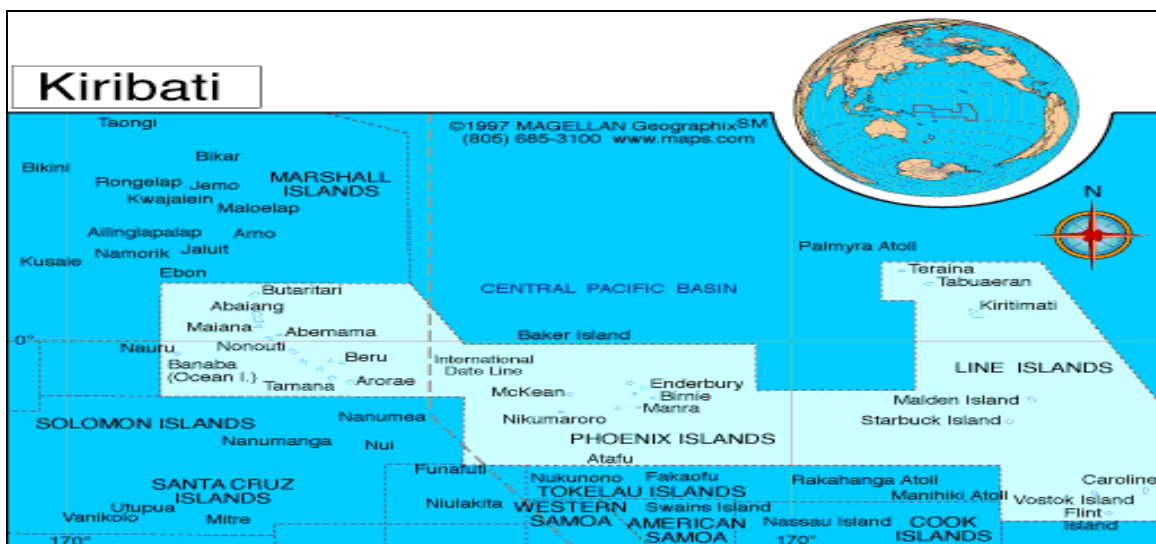


Figure 16. The three major region of Kiribati (Gilbert Islands, Phoenix Islands and Line Islands

(Source: <http://www.infoplease.com/atlas/country/kiribati.html>. Retrieved on the 2nd February, 2014)

3.2.3 The Climate

Kiribati is located in the dry belt of the equatorial oceanic climate zone. The climate is influenced by seasonal movement of the Inter Tropical Convergence Zone (ITCZ), the equatorial Doldrum Belt (EDB) and to some extent by the South Pacific Convergence Zone (SPCZ) (Wilson & Programme, 1994).

The mean daily temperatures range from 26⁰ Celsius to 32⁰ Celsius with the minimum and maximum being 22⁰ Celsius and 37⁰ Celsius; humidity is variable on all the islands. Annual rainfall is extremely variable both annually and between the islands. The average annual rainfall in the Gilbert Group range from about 1000mm for the two Southern drier Islands (Tamana and Arorae) to 3000mm for the wetter Islands such as Butaritari and Makin in the far north whereas in the Phoenix Group, the average rainfall range from 750mm-1,300mm while in the Lines Islands, the annual rainfall ranges between 690mm on Malden to 2,900mm on Teraina. Kiritimati is relatively dry most of the years as it located on the border between the wet and dry belts north of the equator. Banaba, the Central and Southern Gilbert including the Phoenix Islands and Kiritimati are subject to periodic droughts when rainfall as little as 200mm falls in one year as stated by Teeb'aki (ny) and Thomas (2003).

Kiribati has two seasons; the wet and dry season. The former is known locally as “Te Aumeang” and commence from November to April. It brings bad weather in term of strong gales accompanied by thunderstorms and heavy precipitation. It characterized by the predominant north-westerly wind or westerlies wind. The latter is known as “Te Aumaiaki” and starts from May to October. It is characterized by fine weather and the presence of prevailing south-east trade winds or easterlies wind with minimal rainfall that can bring drought situations.

3.2.4 Geomorphology

Though the atolls and coral reef islands are geologically relatively young in the Pacific Islands (including others beyond the region) compared with major continental landscape such as Asia and Europe their formation in terms of emergence above sea level on top of extinct volcanoes coincided with the retreat of sea level by 1 to 2 meters during the mid to late Holocene epoch about 8000 years BP (Before Present) (Thomas, 2009). This has been proven with drill cores

comes from Tarawa revealed leached limestone dating to some 125,000 years ago, overlain by lithologies dating to less than 8000 years ago (Marshall & Jacobson, 1985). Thus, Holocene reef growth is believed to have started around 8000 years ago. With time, reefs growth grows upward to form an island arc. Agents of erosion such as ocean current and waves eroded these corals into debris to form beaches or sand at the base of the corals to form islets or what we know today as Islands. McLean (1989) argues that the beginning of formation was around 3,500 years ago. Evidence shows that present coastal sediments on Kiritimati were exposed by 3000BP and that the atoll might have been suitable for human settlement throughout the period of human colonization in Remote Oceania (Anderson et al, 2000).

All the islands of Kiribati are made of coral reefs built up over dead sea mount to form “Atolls” and “Fringing Reef Islands”. Atolls refer to group of islands that are enclosed with a lagoon whereas the latter is the absence of a lagoon. All islands in Kiribati resemble these reef structures formations which are elevated less than 2 to 3 meters above sea level. The only exception is Banaba (Ocean Island), with its reddish-brown slightly acidic soil which is also found extensively in the Line and Phoenix Groups. For the remaining other atolls, due to their island formation which is derived from calcium carbonate, the soils are highly porous and alkaline with little organic matter. The fertility of the soil is much dependent on organic matter for the concentration and recycling of plants nutrients and organic values for subsoil are always low (<50%) (Thaman, 1992). This makes farming on the atolls challenging and time consuming due to the poor nature of the soil. The only exceptions of those islands as stated above where guano deposits (phosphate) are exist in abundance.

3.2.5 Biogeography

Due to its isolation and remoteness from major distributional continental sources and poor soil type characteristics, the flora and fauna of all islands in Kiribati are amongst the poorest in the world. Biodiversity on land is extremely limited in the country. Thaman (1987) and Fosberg and Sachet (1987) stated that there are some 83 species found in Kiribati but none are endemic and the total sum of introduced vascular plants approximated to be 306 species which include exotics and weeds as well as cited by Thomas (2003, p.11). There is only one endemic bird species known locally as “*Te Bokikokiko*” (*Acrocephalus aequinoctialis*) at Kiritimati Island while the

remaining islands have none (ibid, 2003). All fauna and flora of Kiribati is the product of aboriginal introduction and the entire environment on all the inhabitant Islands are highly disturbed with the exception of uninhabited Islands in the Lines and Phoenix Groups such as Millenium Island amongst others.

The major type of flora that is common on the islands of Kiribati are the coconut trees, breadfruit, figs, pandanus trees, pawpaw trees and plants such as babai (Giant swamp taro/ *Cyrtosperma chamissonis*), pumpkin, kumala including other introduced vegetables such as cabbages, tomatoes, eggplants, watermelon amongst others although there are other non-edible herbaceous plants, grasses and shrubs that co-exist and distributed around the environment of all the atolls of Kiribati including coastal mangroves of different varieties.

As for the fauna, the chicken, ducks, cats, pigs, and dogs are the most common domesticated animals seen around in the country such as in Kiritimati and Tarawa. Wild diverse birds' species are commonly seen in abundance in the Line and Phoenix Groups especially on Kiritimati and other uninhabited groups within this group (MELAD, 2007).

The marine provides rich and diverse coral reefs, sea grasses, algae, fish and shells species including other edible marine organisms 'ranging from coastal to deep water marine species. So far, the studied undertaken by the Kiribati National Biodiversity Strategy Action Plan (KNBSAP) in 2005 indicated there were nearly 500 species of finfish, 96 species of invertebrates and six turtle species documented for Kiribati as reported by Republic of Kiribati Diagnostic Trade Integration study (Republic of Kiribati, 2008).

3.2.6 Demography

The population of Kiribati is dynamic and still growing. Since 1931 up to 2010, the population has increased rapidly with a major concern with urban population (as indicated in the Line graph below in Figure 17) in the capital of Kiribati, South Tarawa. According to figure 14 below, the population of Kiribati had increased from 29, 671 people in 1931 to 103,058 people in 2010. This can be translated into annual population growth rate of 1.5% increases between 1931 and 2010. Based on the latest census figure in 2010, the population of Kiribati is 103,058 people of which 50,796 made of male and the rest female (SPC & KNSO., 2012). The average density of Kiribati in 2010 is 142 people/km² and the life expectancy for female is 80 years while male 70

years old. This show that female has longer lifespan than male counterpart. The Crude Birth Rate (CBR) is 31.1 per 1000 for the whole Kiribati in 2010 and the Crude Death Rate (CDR) is estimated to be 7.8 deaths per 1000. The total fertility rate is 2.7 per female in 2010 in Kiribati and the leading causes of death are digestive (8.7%) and cardiovascular (8.5%) diseases as reported by (Lopez et al., 2011).

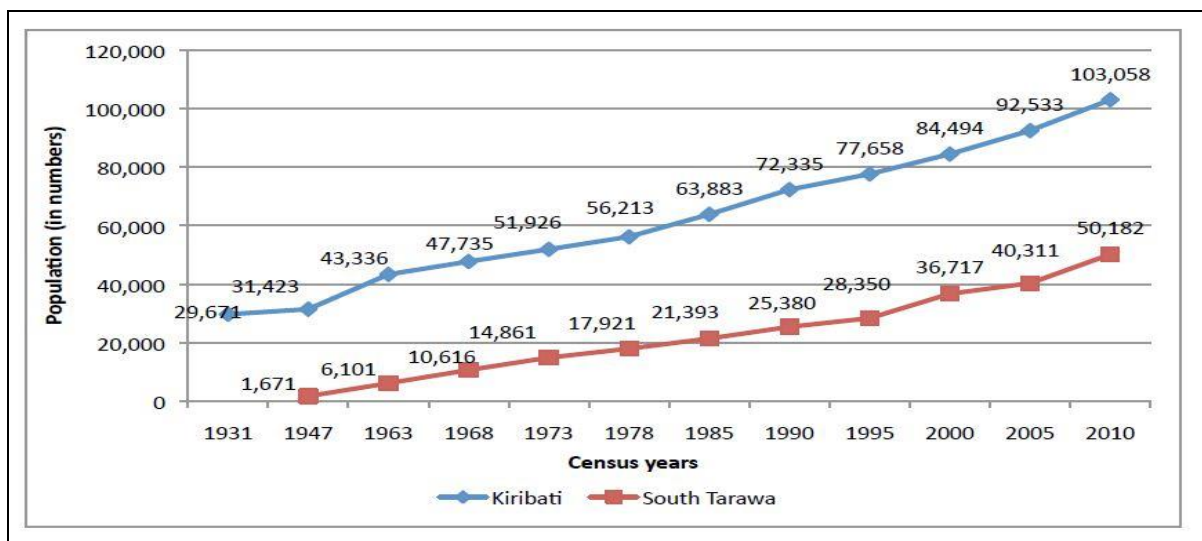


Figure 17. Population growth of Kiribati and South Tarawa since 1931 to 2010

(Source: SPC & KNSO Census 2010).

The structure of the population is young and growing since there are more young people within the age limit of 15years and below (36%) compared to the matured population above 60 years old (only 5%) as highlighted in the population pyramid broad base structure in Figure 18 underneath according the population indicator for 2005 and 2010 (SPC & KNSO., 2012).

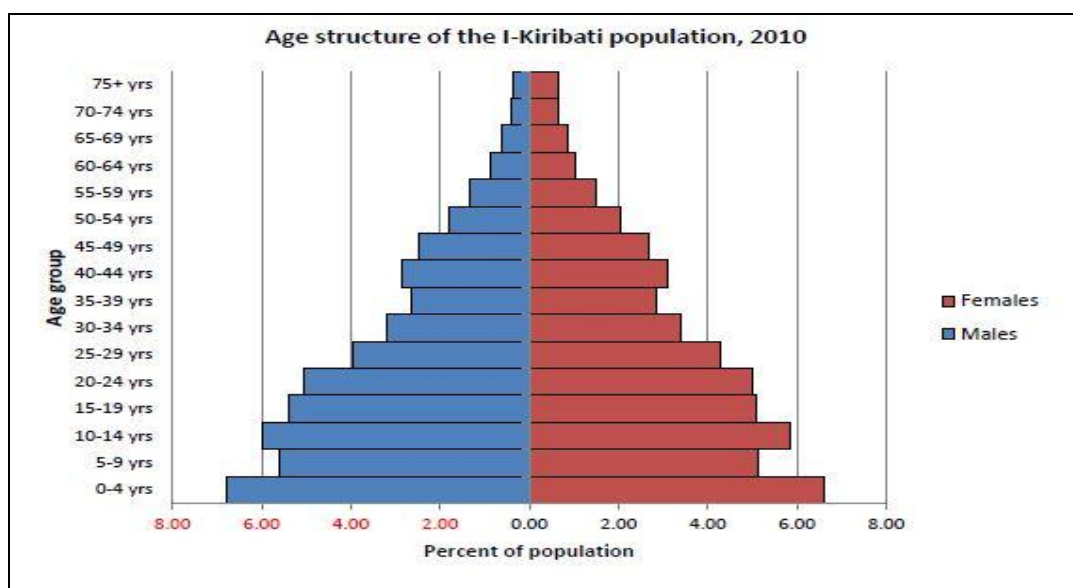


Figure 18. Population pyramid for the different age group of Kiribati, 2010.

(Source: National Statistics Preliminary Census 2010).

The population is comprised of different ethnic groups, of which 90% are pure I-Kiribati, 10% are part I-Kiribati and other ethnicities and 1% identified as Non-I-Kiribati (foreigners) like New Zealanders, Australians and others).

The major dominant religion in Kiribati is Roman Catholic (56% of the population) followed by the Kiribati Protestant Church (KPC) (34%), then the Latter Day Saints (LDS) is 5%, the Bahai (2.3%) and Seventh Day Adventist (SDA) is 2%, Jehovah Witness (JW) (0.4%), Assembly of God (AoG) (0.4%), while others (0.2% each) such as Pentecost, Church of Christ and Church of God (COG). The only non- Christian is the Muslim (0.1%) which is existed only in South Tarawa.

In terms of educational attainment, 15 years and over was the age category that was used to measure the level of education within the population. For instance, based on the graph Figure 18 below, the proportion of people attending secondary schools is 56.2 % for males while 56.8 % for females. For tertiary or vocational education level, 3.5% for males while 2.8% for females. For primary education, 30.8% for male while female 29.9%. For those who have no education, 9.5% for males whereas 10.6% for females.

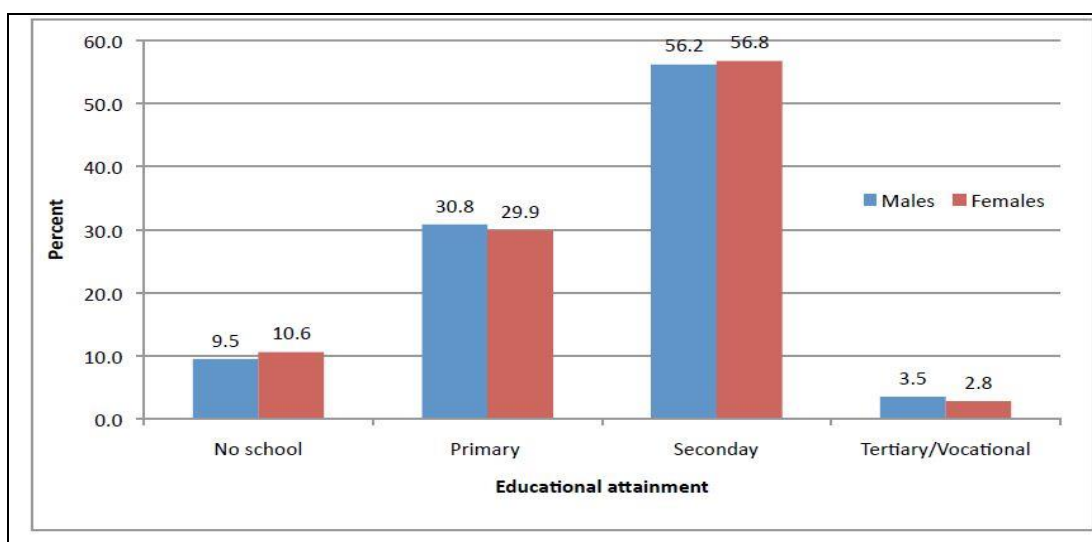


Figure 19. Proportion of education attainment in Kiribati.

(Source: SPC and KNSO, 2010)

As for literacy rates in terms of able to read and write in any simple language of local vernacular (Kiribati), English and others, it is 97.7% as stated in table 7 below. Urban and rural rate are almost identical which shows that people can read, write and understand in any of the common spoken languages. There is no literacy difference between males and females.

Literacy Rates			
Region	Males	Females	Total
Urban	98.6	98.5	98.6
Rural	96.9	97	96.9
Kiribati	97.7	97.8	97.7

Table 7. Percentage of literacy rate at urban and rural context at Kiribati.

(Source: SPC & KNSO, 2010)

The 2010 census recorded 27,096 people as employed which represents 69.4% of the Kiribati labour force. The active working age group in Kiribati is 15-50 years old. Of these, 56.6 % are males and 43.4 are females. From the labour force only 3.1 % have higher education. More than half of the working population (57%) has attained secondary education level, with just over 30% has a primary education and about 10% of the working population has no education. For those

not in the labour force or engaged in the paid employment such students, disabled, retired amongst others, it was recorded to be 26, 840 people as stated in table 8 below

Economic Activity	Region		
	Urban	Rural	Total
1. Labour Force			
1.1 Employed-paid workers			
Employer	510	608	1,118
Employee	10,143	6,989	17, 132
Employee Government	4,443	2,278	6,721
Employee Private	3,213	1,045	4,258
Producing goods for Sale	2,487	3,666	6,153
Self-employed	428	915	1,343
Total Employed paid workers	11,081	8,512	19,593
1.2 Employed -unpaid workers			
Voluntary Work	220	358	578
Unpaid Family Work	424	2,491	2,915
Subsistence Village Work	789	3,221	4,010
Total Employed -Unpaid Workers	1,433	6,070	7,503
Total Employed	12,514	14,582	27,096
1.3 Unemployed	6,883	5,055	11,938
Total in the labour Force	19,397	19,637	39,034

Table 8. Employment and unemployment status in Kiribati in urban and rural population.

(Source: SPC&KNSO, 2010)

3.2.7 Cultural-Social and Economic Characteristics.

Though the impact of modernization and globalization engulfs the I-Kiribati traditional way of life in many aspects, the culture of I-Kiribati remains strong and intact. For instance, one of the cultural social aspects of I-Kiribati people that are renowned for is the concept of “*te kakairua*” literally mean true hospitality especially to non member of their clans or to other non I-Kiribati origin who visited them as shown in Figure 20. Part of this” *kakairua*” is entertaining the guest with “*Te Mwaie*”, a traditional local dance of I-Kiribati people and providing refreshment and drinks including presenting gifts such as local mats and other local made handicrafts as souvenir.

Another social aspect that is predominant within the rural society is based on participatory decision-making by

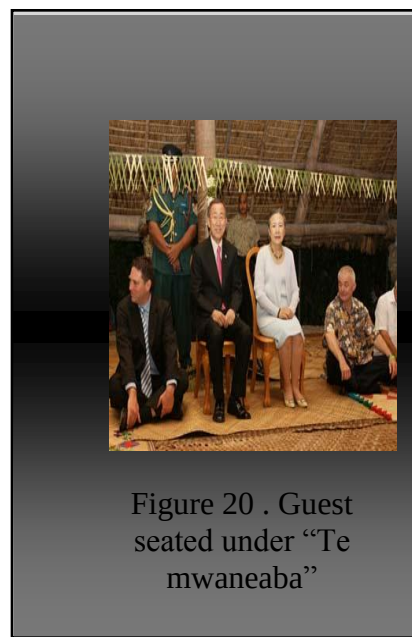


Figure 20 . Guest seated under “Te mwaneaba”

“*Unimwane*” (group of elder men) inside the meeting place known locally as “*Te Mwaneaba*” and their decision is final and binding. It is a taboo to interfere with their decision since they are the most respected people in the community. This also applies to other communal gathering such as a welcoming feast for visitors or other important cultural events like dancing competition and canoe racing amongst others. Whatever it has been decided by them, it has to be fulfilled by the community and failure to comply can result in the exclusion from the community or paying a fine or whatever is decided. For instance, if it is decided that selling “*Kaokioki*” (alcohol made from toddy) in the village should be banned then no one is allowed to sell liquor and whoever is caught has to pay a (says A\$100 dollars). Failure to pay within a given timeframe can result in more severe repercussions to the perpetrator and family members like feeding the whole village members in the evening at the “*Maneaba*”.

All islands in Kiribati have their bye laws made by the Island Council supported by the “*Botaki ni Unimwane*”¹⁶. Even at community level in outer islands the councils are very influential and crucial to the functioning of the village. In fact, “*Botaki ni Unimwane*” can make their own bye-laws which can differ from other villages within the same islands as it is decided in the “*maneaba*”. The word “*maneaba*” is coined from two words such as “*manea*” to accommodate and “*aba*” means both the land and people where the two co-exist such as the people live on the land and the land on which they live (Tabokai, 1993). Hence, “*te maneaba*” is a traditional meeting house which has an important role in Kiribati culture because it signifies peace and happiness, tolerance, status, leadership, cooperation and togetherness. As Whincup (2010) states, “the traditional “*mwaneaba*” is the social nexus of village life in Kiribati. It is in this structure that village decisions are made by “*unimwane*”, the old men, whose seating arrangements show their authority and status within the community. “*Te mwaneaba*” is also the site of significant social and political activities. It is a place of dignity and formality” (Whincup, 2010). Hence, one’s could infer that in essence “*te mwaneaba*” embodied peoples’ cultures in terms of traditional skills and knowledge, beliefs, custom and tradition and their interrelationship with each other and even with the natural environment.

¹⁶ Council of Elders

The other cultural social norm that was practiced in the past and still continues to exist in contemporary rural and urban settings to some extent is the concept of “te Kaonono system”. This system is like “reciprocity” where people exchange things for mutual benefit such as exchanging a piece of lands in different localities or bwabwai pits for their own advantages or giving something to family member or close neighbour like extra food. For instance, a fisherman upon returning can give extra fish to his neighbour if he has caught a lot of fish. In this case, the receiver can give something back later in the same or different form. The other social cultural aspect is “te bubuti” which is being asking for something and then returns it after using like borrowing a bicycle or whatever is needed. This is more a shameful act and not permissible but only implemented under certain circumstances when the person is in a desperate situation or in dire need of something to accomplish. The latter is very much common during a function such as wedding or celebration when there is a shortage of water or cooking pots and therefore one has to ask the neighbour or next of kin or asking neighbours or friends. Similar is to seek support in digging a well or building a house. Such sharing and assisting connects people togetherness and develops mutual bondage between them. Nonetheless, these systems such as “te kaonono” and “te bubuti” are often practiced during severe drought where families members assist each other like sharing food or rainwater for drinking and even asking for support from others. Based on past incidence in outer (rural) islands during desperate times of natural hazards such as “te mwautakataka”, “te batua” (old man) from each “kainga” (a residential group of a small number of extended families(ILO, 2006) or “mwenga” (household) dictate and control the action of their “utu”(member of their clan or families). If the situation persists and worsens and when water and food source are affected then this is communicated to “te botaki ni Unimwane” during a meeting and the chairman of this body then reports to the Chief Councillor who represents the Government. The Government then looks for a solution to assist the islanders. One good example I had discussed before is the case of I- Kiribati people resettled in the Solomon Islands due to the salinity of well water on the island due to severe drought in the mid- 20th century. The “te botaki ni Unimwane” must have been reporting the situation to the then colonial government (Britain) at that time which then led to the resettlement of the islanders to another part of the British empire.

In traditional villages throughout Kiribati, people's ways of life's is very much depends on subsistence economy. This is the case especially in rural areas although the influence of monetary system and so-called "modernization" had also impacted people's lifestyle tremendously. The consequence, people have to adjust to the changes brought about. I-Kiribati people like other Pacific Islands communities are very reliant on the natural resources surrounding them to earn a livelihood. Though the land does not produced much in terms of agro-biodiversity due to its isolation, smallness and poor quality of the soil, this does not deter people from making a living and sometimes even earn cash from the limited resources and fragile environment. For instance, coconut trees are usually considered as the "tree of life" as they have many uses: people use it for herbal medicine, other personal uses and for generating income. For example, the stem can be used for building materials and the leaves for making brooms and te "iinali" (a ground mats woven from coconut leaves) are used to thatch roofs. The husk is used to make the "te kora" (local rope). All these items can be sold at affordable prices. The fruit is used for food and drinks and even to make "te takataka" copra, a major revenue source to rural communities which is needed to produce coconut oil. "Te karewe" (toddy) is a sweet juice (derived from the coconut sap) and major substitute for sugar in rural communities and urban areas alike. From this toddy also liquor can be made and sweet syrup (like honey made from bee hive) if it is heated to form crystals of syrups. Some of the common products from coconut tree such as toddy, copra, string (top image) and brooms (lower image) that produced from Kiribati are shown below in the diagram 2.

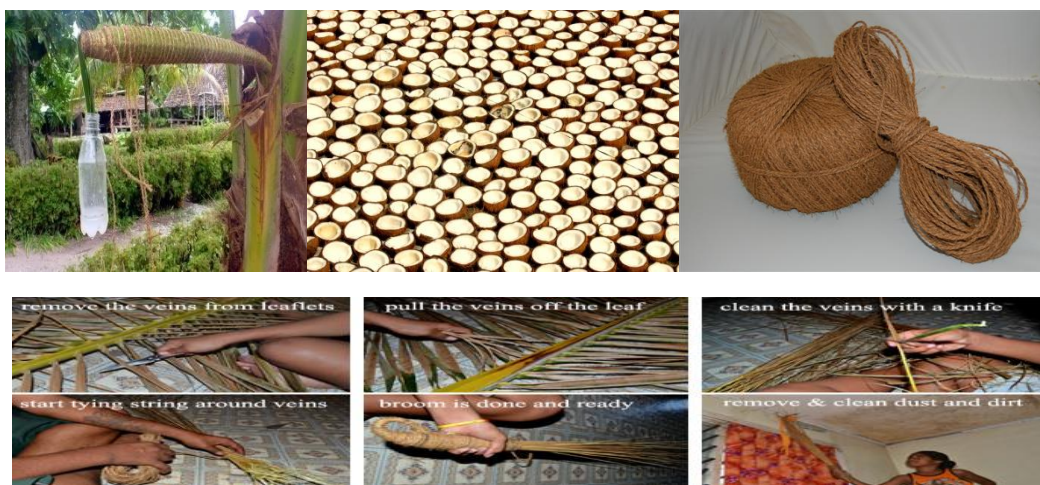


Diagram 2. The products derived from the coconut tree

(Source: Google image)

The pandanus tree (*pandanus tectorius*) has also many uses. It is used as herbal remedy, food and construction material as well as for cash generating income. For instance, the fruit can be eaten when it is ripe and can also be cooked and eaten or made into “te tuae” (a preserved paste) (SPC, 2006). In the Southern Gilbert Islands, it is stored for longer periods and can be used during feasts and other gathering including during drought events.

The Giant Swamp taro (*bwabwai*) is a hydrophytes (water- loving) plant. Its roots (tuber) are eaten only on special occasion. There are many varieties on all the islands in Kiribati. The plant can take more than 5 years to mature. Therefore like mentioned before it is uncommon to see the plant in everyday meals, but it is considered as a precious food, reserved for very special occasions.

The breadfruit tree is another food source for subsistence as well as for income generating activities. It is also an herbal medicine. The fruit is eaten when it is ripe. It can be cook when it reaches maturity. The stem of the tree is used for making canoes.

Vegetables such as pawpaw, kumala (sweet potato), tomatoes, eggplants, cucumbers, pumpkins and cabbages and bananas are common in urban areas for food security and generating income. In outer islands, some of these vegetables such as cabbage, eggplant, cucumber and tomatoes are rare depending on the availability of seed from the agriculture division. The graph below in Figure 21 highlights the kind of food crops grown in most households in Kiribati in 2010.

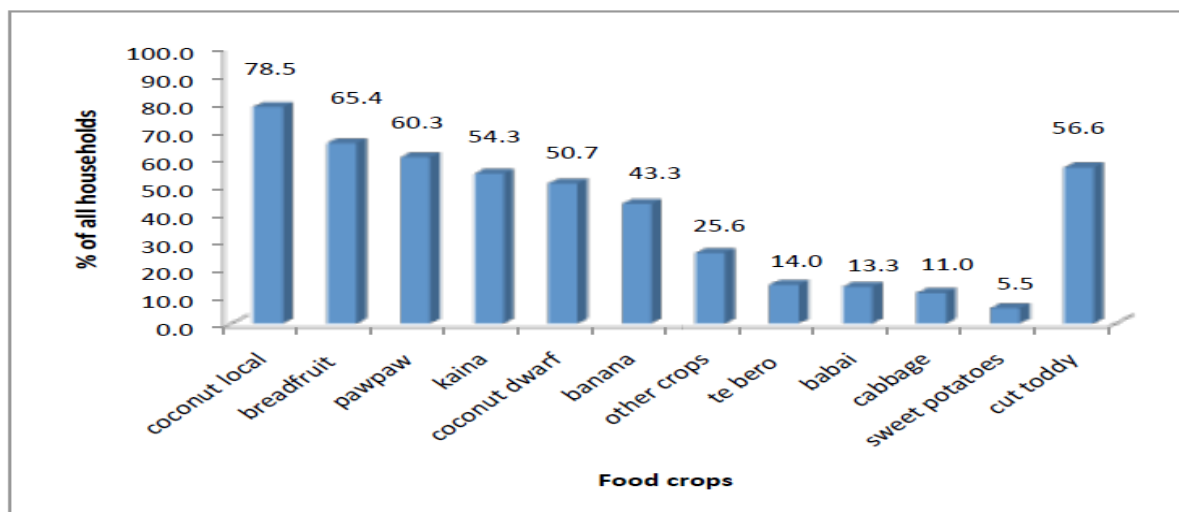


Figure 21. Proportion of food crops grown by household in Kiribati, 2010.

(SPC and KNSO, 2010)

Since there is no surface water in most of the islands in the Gilbert Group and the Line and Phoenix Groups the only water available is from the underground water which is made available through wells. Precipitation is principally the only recharge to the groundwater water table which is vulnerable to rainfall variation. The only exceptions are Kiritimati and Fanning Island where freshwater ponds exists supporting bwabwai, banana, coconut and other foodcrops (MISA, 2008).

The sea on the other hand assists islanders to sustain their livelihood on a daily basis and fish is important for food security. Excess fish can be shared with neighbours or sold or preserved by salting and drying under the sun for later consumption. This dry salted fish can be stored for long periods and used for food during drought periods or bad weather. In fact, inshore fishing provides the bulk of protein for most I-Kiribati, even in South Tarawa. The proportion of fresh fisheries resources locally caught and consumed ranks among the highest in the Pacific region as stated by Thomas (2003) and by estimation, Kiribati is the highest per capita consumption of fish-intake in the world(Gillett, 2011). However, senior fisheries personnel indicated in 2008 in Kiribati that 60% to70% coastal fisheries production for subsistence purposes based on the 2006 HEIS(Gillett, 2009). This trend can be seen in the number of households engaged in fishing activities in Kiribati manifested in Figure 22 between rural and urban communities based on the 2010 population census.

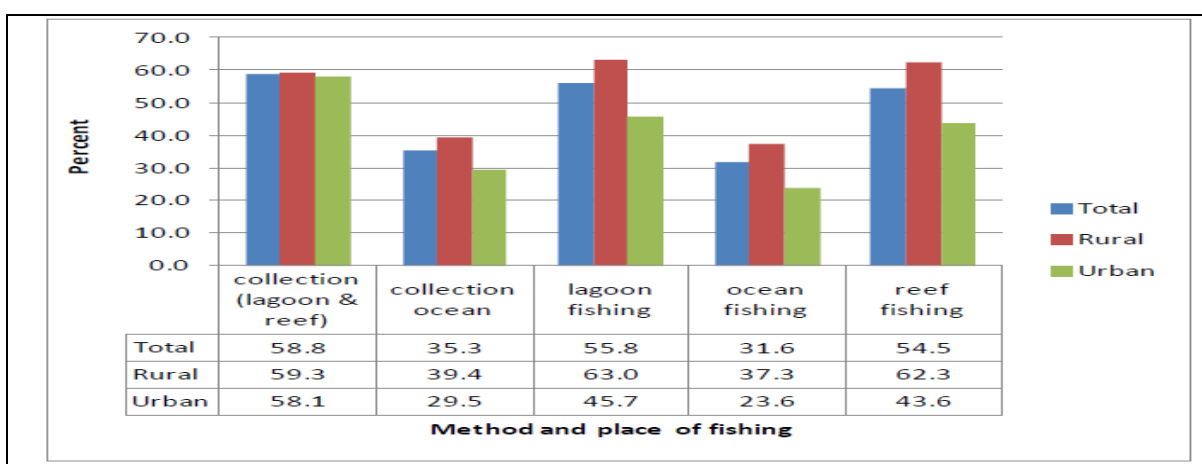


Figure 22. Proportion of households by fishing activity in Kiribati, 2010.

(Source: SPC and KNSO, 2010)

Kiribati society has strong egalitarian values and therefore every household must be “*toamau*” - balance in terms of composition of age and gender so that division of labour and everyday needs are met (Kidd & Mackenzie, 2002). According to the 2005 census, household in Kiribati are defined as groups of persons who share living accommodation and who pool their income and wealth, and who consume certain types of goods and services (Hogan, 2008). A household activity is a shared responsibility such as male do the fishing, cutting toddy and do gardening while women do the cooking and are looking after the welfare of the children and family members for the continuity and maintenance of “*te utu*”. Women’s role in outer islands are still confined largely to domestic duties and food gathering while land and local politics are reserved for men, though there are some effort to improve gender equality in the country notably through the education system by the Government.

As stated by Kidd and Mackenzie (2002), livelihoods vary significantly in Kiribati between urban areas and outer islands. In outer islands, households with huge number of members are living in extended families engaged in subsistence agriculture and fishing. The main subsistence tree crops as stated before are coconuts, breadfruit, pandanus, bananas and the bwabwai grown in a man-made pit that need to be carefully tended and mulched. Pumpkins, sweet potatoes and other handy crops such as tomatoes and cabbages are also grown. There are few employment opportunities in outer islands and an increasing number of households struggle due to limited labour capacity because of rural migration from able-bodied people to urban area. This contradicts urban areas where subsistence activities are not viable due to high population density and urban environment context as life is more demanding to meet daily expenses and therefore people have to shift to cash economy (Kuruppu, 2009a). Though there are lots of employment opportunities in urban areas, unemployment is still higher due to increasing population (especially amongst the younger population) and wages are low (ibid., 2002). Squatter settlements are on the rise with poor sanitation in major centres of urban Tarawa. The average annual household income for Kiribati was about A\$8,700, though there are some variation between the islands: in South Tarawa it was A\$11, 500 while on Fanning Island in the Line and Phoenix Group was it was A\$12,300 based on the 2006 Household Expenditure Income Survey (HEIS) (FAO, 2012). “Poverty”, in the Pacific Islands often called “Hardship” is a reality in Kiribati both in urban and rural setting. The society is increasingly monetized making life’s

more difficult for people to meet basic necessities as low income earners. They often have limited access to basic services such as health care, education and clean water and also face a lack of opportunity to participate fully in the socio-economic life of the community (Abbott, 2010). On the international arena, Kiribati is ranked 11th of the Pacific 14th Pacific Islands Countries and 129th in the world in the UNDP's Human Development Index. It ranks very low on the UN economic vulnerability index since 1991, with a score of 50 or below for most of these years and 91st out of the 178 countries on the 2010 Transparency International Corruption Index (Republic of Kiribati, 2008). In terms morbidity and infant mortality, living conditions and per capita GDP, Kiribati is amongst the lowest in the PIC (Pacific Islands Countries) regions. The relatively high infant and child death rates reflect the situations that children in Kiribati still die from readily preventable causes (Chung, 2005, p. 14). The incidence of HIV/AIDS is alarming. It is increasing from return seafarers working on Germany and Japanese vessels. Women participation in decision-making is improving but remains relatively low (UNESCO & IIEP, 2002). Social security in terms of cash benefit on a monthly basis is only provided to the elderly reaching above the age of 65. Overall, Kiribati has a relatively stable government with a democratic type of governing system resembling the British Westminster style of governing.

Since the closure of the British phosphate mining in 1979, Kiribati lost its major revenue source which accounted up to 80% of the GNP. The country therefore has no option but to rely on copra and fishing production which are abundance in the country as a major source of revenue. Copra production derived from the coconut tree is the major export commodity for the country apart from other marine commodity such as beach-der-mer, fins and seaweed and other coral reef fish including tuna and pet fish. Though these two commodities are major revenue sources, it is not enough to counteract its trade deficit and therefore continues to be dependent on foreign aids, remittances from seafarers, fishing license from distant fishing vessels, tourism and interest derived from the Revenue Equalization Reserve Fund (RERF) and bureaucrats. This RERF was invested offshore in 1956 with over half a million A\$ to act as a reserve fund (thus the named) if the phosphate resources are exhausted. With careful investment, it started to grow until it reached A\$60 million by the end of 1979 (Trease, 1993). It had reached more than A\$600 million in 2007, but then declined to A\$537 million in 2009 due to the global financial crisis and from the need of the Government of Kiribati to finance budgetary shortfalls (Kiribati, 2011). Marine

resources are believed to hold economic potential if fully developed. The country has rich marine resources like tuna fisheries and extensive deep-sea poly-metallic metals such as a cobalt-rich crust and manganese nodule (Matos & Kotobalavu, 1989). The Economic Exclusive Zone (EEZ) of Kiribati is the largest in the Pacific with around 3.5 million square kilometers stretching 2,505km from north to south and 3,870km from east to west. It is ranked 12th in the world for the size of EEZ.

Kiribati has a low capita gross national product (GNP range from US\$969 in 2001 to US\$1085 in 2009), coupled with weak infrastructure and limited human resources and narrow production base. The country is therefore classified as a least-developing country in the United Nation categorization of countries on the basis of their wealth and stages of their socio-economic wealth (Government of Kiribati, 2013).

3.2.Part 2.2 Case Study - South Tarawa

3.2.1. Physical Characteristic

South Tarawa is located at longitude of $1^{\circ}28'N$ and latitude $173^{\circ}2'E$. It is a narrow strip of land that stretch about 15.76 km from Betio to Tanaea that is connected by causeways. The longest causeway is the Dai Nippon Causeways between Betio and Bairiki. Most of the land is less than 3 meters above sea level with an average width of only 450 meters between the ocean and the lagoon (Government of Kiribati, 2012b). South Tarawa houses capital of Kiribati. It is the hub of the Republic of Kiribati. There are three major centers at South Tarawa, Bikenibeu, Bairiki and Betio. The airport is located at Bonriki, the seaport at Betio while the state house at Bairiki and the major hospital is at Nowerewere. There are extensive fringing reefs, lagoons; shoals and sand flat along its coasts. The land is under severe pressure from increasing population and urban development such as construction and settlement expansion. Hence, the environment is highly disturbed with primary forests being removed. Figure 23 below shows the location of major centers and villages of South Tarawa.

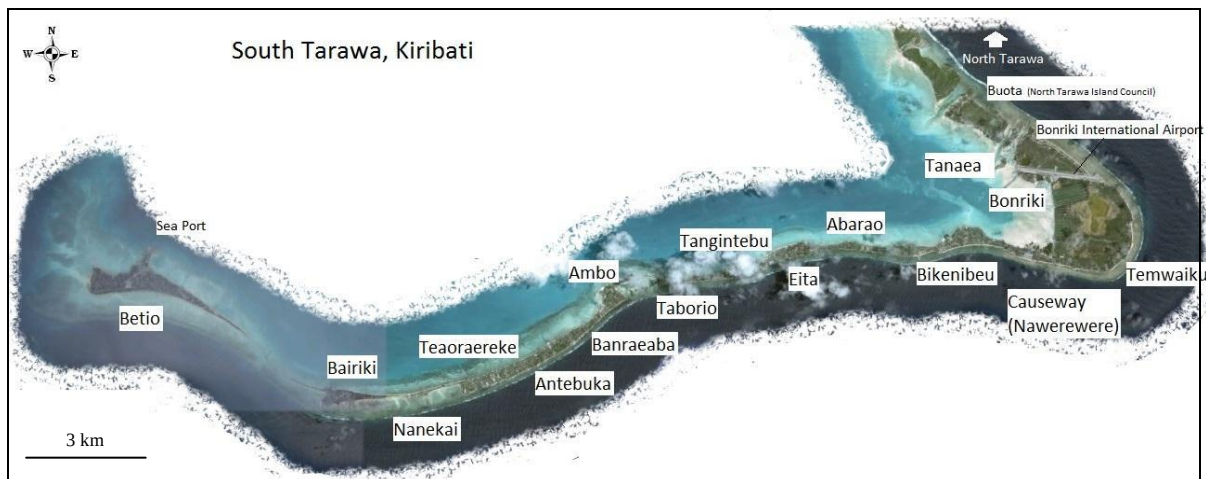


Figure 23. Map of South Tarawa, Kiribati

(Source: Government of Kiribati, 2012b)

3.2.2 Climate

The climate is mostly hot and humid with an average yearly rainfall of 2,497mm. The mean annual temperature varies but is in the range of 26 degree Celsius to 32 degree Celsius and the

annual SST is around 26 degree Celsius to 30 degree Celsius (PCCSP, 2011). The prevailing wind is the south east trade wind during “te aumaiaki” and westerly wind during the “te aumeang”. Between 1947 and 2011 the average temperature does not change much. It had been in the range of 30⁰ Celsius to 32⁰ Celsius while the total annual rainfall was fluctuating between more than 4000mm in 1993 and the lowest of 397.3 mm in 1950 and 511.2 mm in 1998 (see Figure 24 and 25); rainfall data for 1988 is not considered due to missing data for several month) (refer to temperature and rainfall data for South Tarawa in appendix 1,2,3)

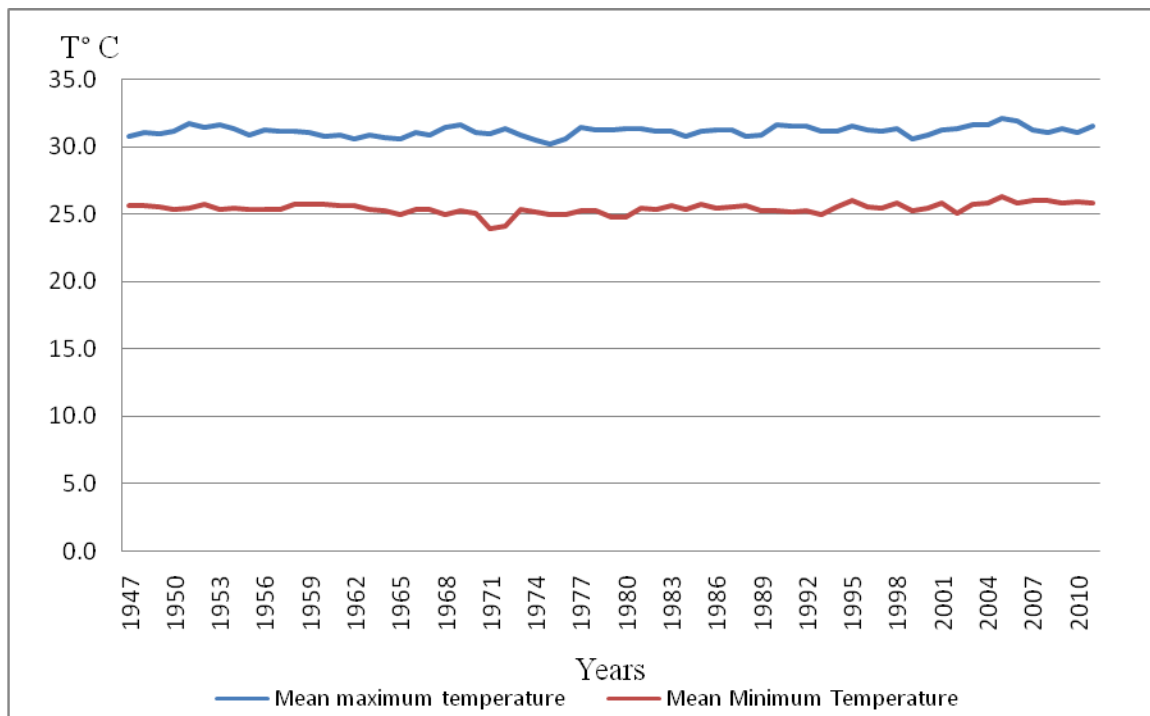


Figure 24. Mean and Maximum Temperature Graph of South Tarawa since 1947-2011

(Source: Compiled by the author)

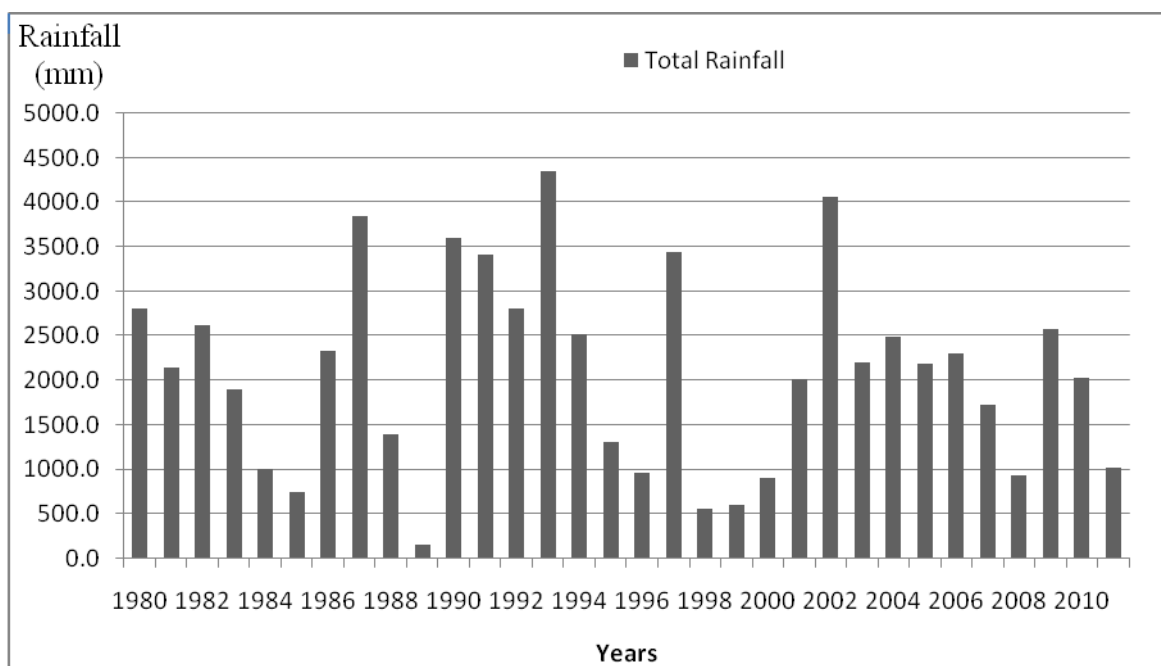


Figure 25. Total Annual Rainfall of South Tarawa since 1947-2011

(Source: Compiled by the author)

3.2.3 Population

According to the 2010 census figure there were 50,182 people or 48.3 % of Kiribati's total population living in South Tarawa making it of the most populous islands in the Gilbert Group. The population density of South Tarawa is 3,184 people per square kilometres and the average household size is 7 people with a range of 12 and 4 people. The Crude Birth Rate (CBR) for South Tarawa is 35.8 births per 1000 whereas in outer islands it is 26.8 (SPC&KNSO, 2010). The crude death rate in 2010 is 7.8 per 1000 as reported by the Birth and Death Registration Office. Since 2005 the population of South Tarawa has grown from 40,311 to 50,182 people in 2010 with a population growth of 9,871 people. This can be translated into an annual high growth rate population of 4.45% (refer to appendix 6). Of all major urban centres', Betio is the most populous centre while Nanikai is the least populous village on the island as seen in the table 9 below including the population map of South Tarawa in Figure 7.

Village	Population	% of the total
Bonriki	2,607	5
Temaiku	3,123	6
Hospital	2,324	5
Bikenibeu Urban Area	5,940	12
Eastern Area	13,994	27.12
Abarao	2,431	5
Eita	3,153	6
Taborio	1,357	3
Ambo	2,297	5
Antebuka	3,102	6
Teaoraereke	4,106	8
Central Area	16,446	32.63
Nanikai	1,035	2
Bairiki Urban Area	3,281	7
Betio Urban Area	15,646	31
Western Area	19,962	39.61
South Tarawa	50,402	100

Table 9. Population of settlements in South Tarawa

(Source: Government of Kiribati, 2012b).

The population of South Tarawa has a bit higher literacy rate if compared to the rural population. The majority of the land is owned by families although the Government sub-leased approximately 30% of the land and pays them at the end of the year. The only state land is located at Temaiku Bight, a reclaimed land of approximately 200 hectares and is used for the State agricultural purposes, fish pond and other developmental activities.

3.2.4 Water Supply

Water supply for households is connected to a piped network of treated groundwater pumped from infiltration galleries from Bonriki and Buota to the water tanks or standpipes (Falkland, 2001). Fewer than 65% of the South Tarawa households are connected to this service and the number of connections is in decline due to dissatisfaction. Private rainwater tanker provide supplementary water and most households have wells, which are used for non-potable purposes or as a stand- by source during periods of water shortage (Kuruppu, 2009b). The 2010 Census

Report identified major source of drinking water for the household in South Tarawa such as 67% of the household connected to the treated water from the Public Utilities Board (PUB) supply, 10 % of the household have protected well water while 9 % of the households have water tanks and 12 % of households had open well water while less than 1% depend on bottle water and others (KNSO, 2012). This clearly shows that people have different source of drinking water. However, what is alarming is that all groundwater tested on South Tarawa lens is microbiologically contaminated and should not be used for drinking or cooking purposes without being boiled. To exacerbate the problem heavy metals and chemicals are also believed to intrude the water lens in the main settlements of Betio, Bairiki, and Teaboraereke making water unsuitable for drinking in those areas even after being boiled (ibid, 2012).

3.2.5 Economic activity

The bulk of Kiribati's population is concentrated on South Tarawa. The atoll is also the centre of economic activities in Kiribati. 34% of the urban population (over 15 years) resides on South Tarawa. Many are engaged in formal cash employment. Still there is a great burden to the Government trying to create more job opportunities for the rapidly growing urban population. 21 % of the population in working ages were unemployed, 5% were engaged in voluntary or subsistence work, and 41% were not in the labour force (studying, retired, babysitters or otherwise not available for work). In total, two thirds (66%) of adults (over 15) in Tarawa are either out of the labour force, unemployed or engaged in subsistence activities (Government of Kiribati, 2012b). Though subsistence is very dominant in urban lifestyles, there is also a need to generate revenue to meet daily expenses and therefore people's ways of life is based on either full to semi-subsistence agriculture and fishing activities. This example becomes evident when seeing unemployed woman selling breadfruit and fish in the markets at Bairiki and Bikenibeu (Figure 26)

Agriculture is not practiced on a large scale due to the shortage of space: large portion of the land is occupied by houses, churches, Maneaba, schools, government buildings and roads. Vegetation in the urban environment consists predominantly of edible coconut, breadfruits, banana and pandanus trees including bwabwai. Household gardening of vegetables such as cabbage, tomatoes, eggplants, cucumber and watermelon amongst others is on the rise in urban areas thanks to the assistance of the Taiwanese Technical Mission (TTM) based at Temaiku and the Agricultural department of the

Ministry of Environment, Land, and Agricultural Development (MELAD). Such organizations provide advice, information and propagated seedlings to urban dwellers. As a consequence, there are an increasing number of vegetables stalls near roads where farmers sell farm produce to generate income and therefore assist to improve the diets of urban dwellers.



Figure 26. Woman selling breadfruit at Bairiki (on the left); fish vendors (on the right) at Bikenibeu, South Tarawa

(Source: Rimon, 2011)

As shown in Figure 22 urban fishermen in South Tarawa collect shellfish and do lagoon fishing. They constitute the highest percentage of household (58.1%) engagement followed by lagoon fishing (45.7%) and reef fishing (43.6%) while collection ocean (29.5%) and ocean fishing was 23.6% (SPC & KNSO, 2012).

There are efforts by the Government to consolidate the economy and to boost economic development in order to create more urban employment in urban Tarawa. This is quite successful in terms of providing jobs and cash income. Although there is an improvement in the creation of jobs; it is alarming to see that population growth continues to be the major obstacle to full employment in South Tarawa. It is believe that planned urbanization is a prerequisite for economic growth, diversification and sustainable development (ibid, 2012b) coupled with proactive plan for decentralization of outer islands to divert urban population from major urban centres'. Though the government has made some progress by building Junior Secondary Schools (JSS) in outer islands as well as medical health centres' and major hospital for southern Kiribati, there is a need to create

economic activities to boost the economy of rural areas. Big challenges are financial constraints and insufficient infrastructure.

Kiribati still faces lots of problems of funding capital for infrastructure and service delivery to urban communities. There is at present little interplay at the macro level policy between economic planning, physical land use and environmental planning (ibid, 2012b).

3.3 Social-Economic and Environmental Performances of Kiribati (1947-2011)

3.3.1 Agricultural Economic Performance

3.3.1A. Agricultural Production Graph in Kiribati (1992-2012)

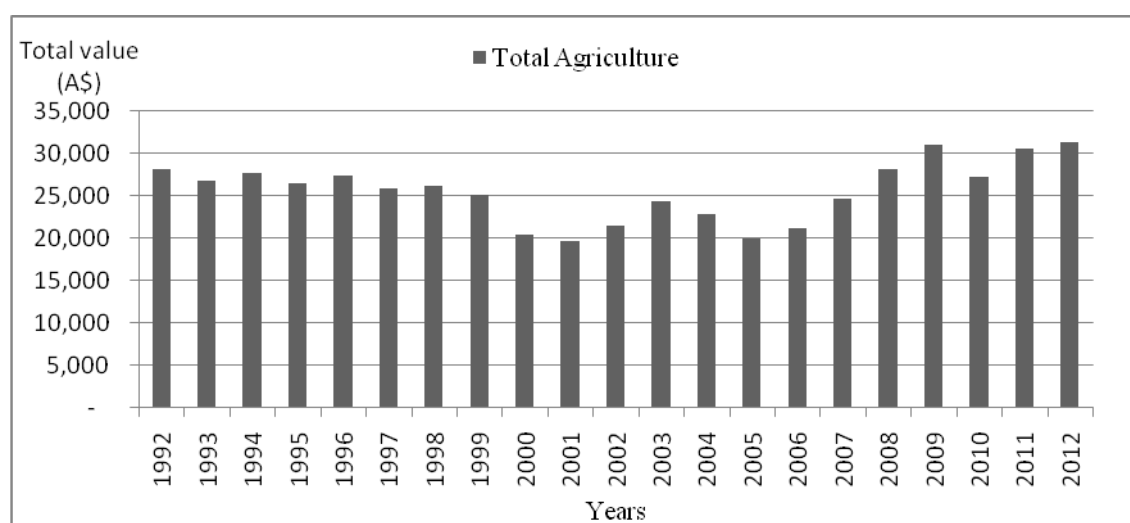


Figure 27. Total agricultural (Copra and Non- Copra) production in Kiribati
(Source: Kiribati National Statistic Office (KNSO))

3.3.1B.Total Copra Production and Exports for Kiribati:1970-2009

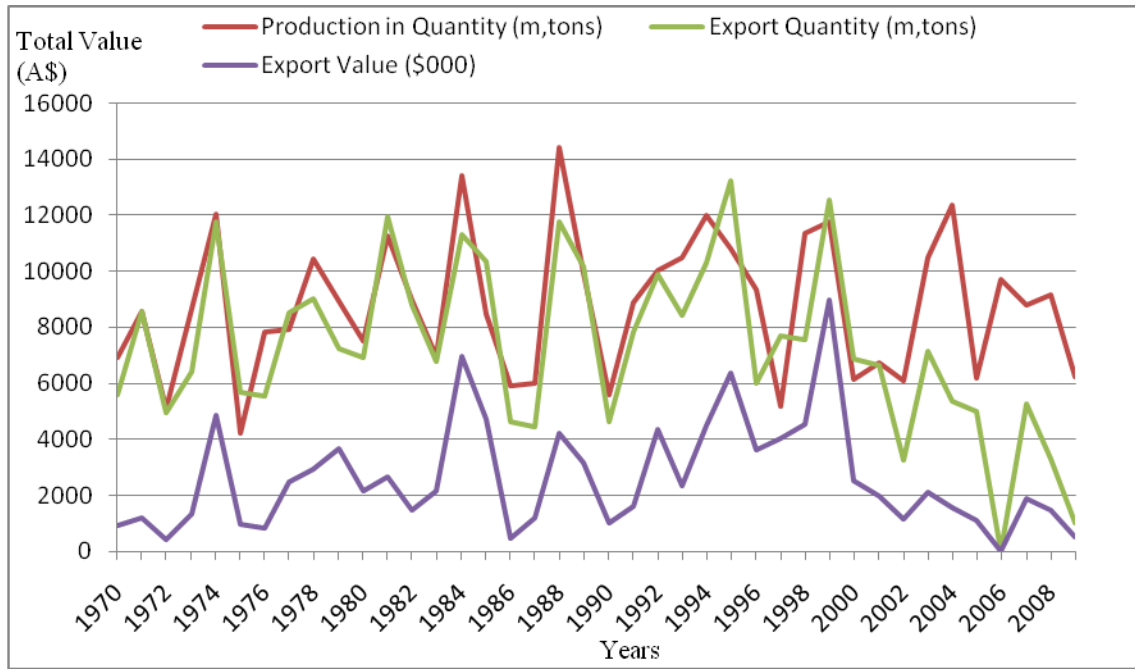


Figure 28. Copra Production and Exports for Kiribati

(Source: KNSO)

3.3.1C. Total Copra Production for Selected Islands in Kiribati from 1993-2011

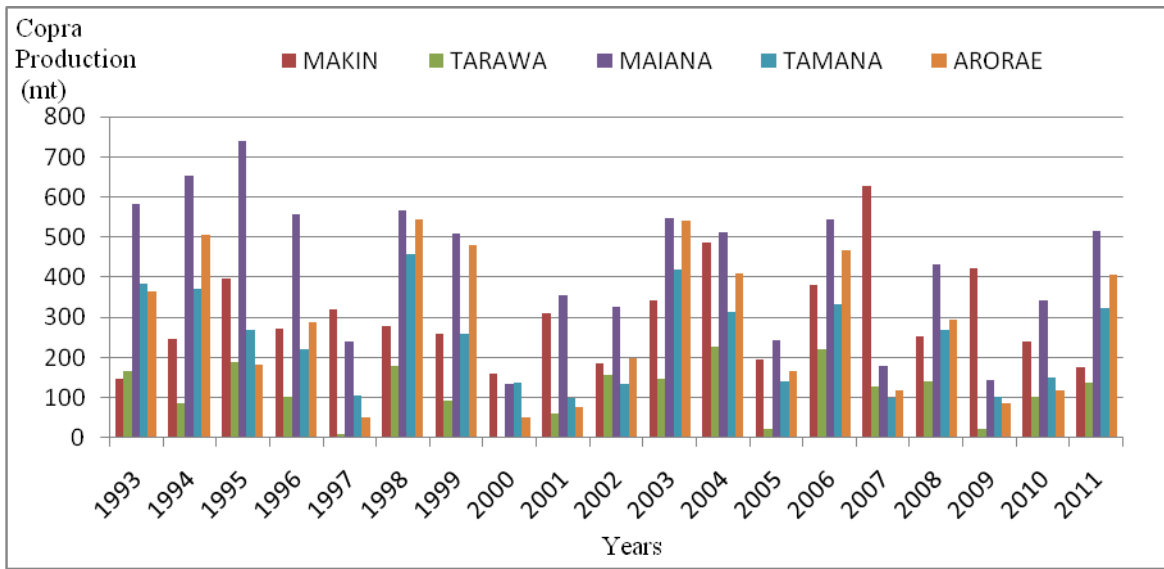


Figure 29. Copra production from selected Islands from Kiribati

(Source: KNSO)

3.3.1D. Total Sale and Consumption for Vegetables and Foodcrops (Non–Copra Agriculture) in Kiribati (1992-2012).

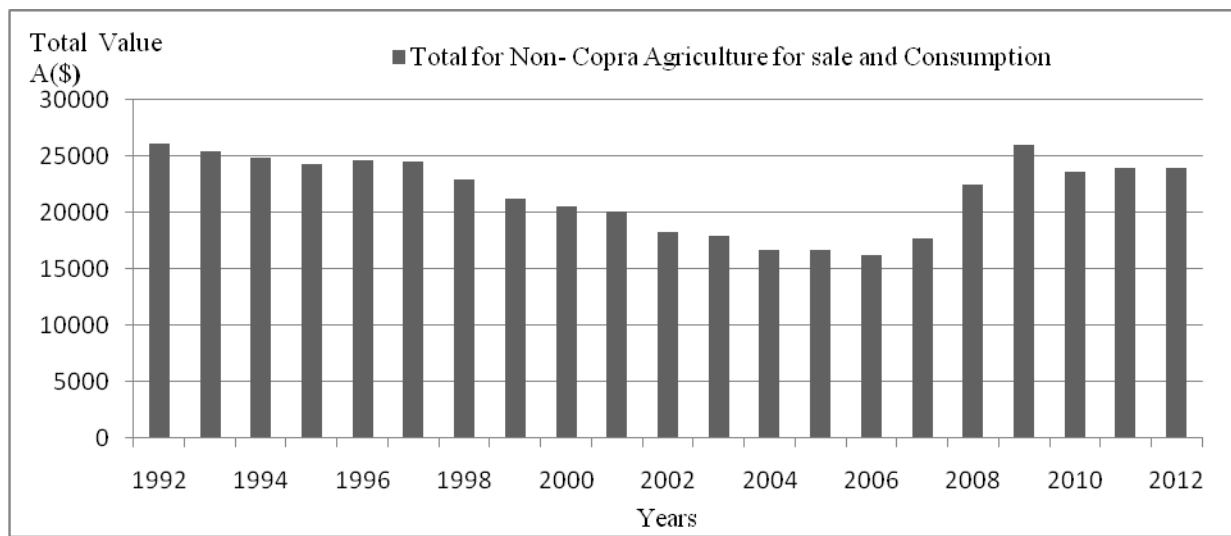


Figure 30. Sale and Consumption expenses for vegetables and food crops in Kiribati
(Source: Kiribati National Statistic Office)

3.3.1E. Food crops and Vegetables for Consumption Only (1992-2012)

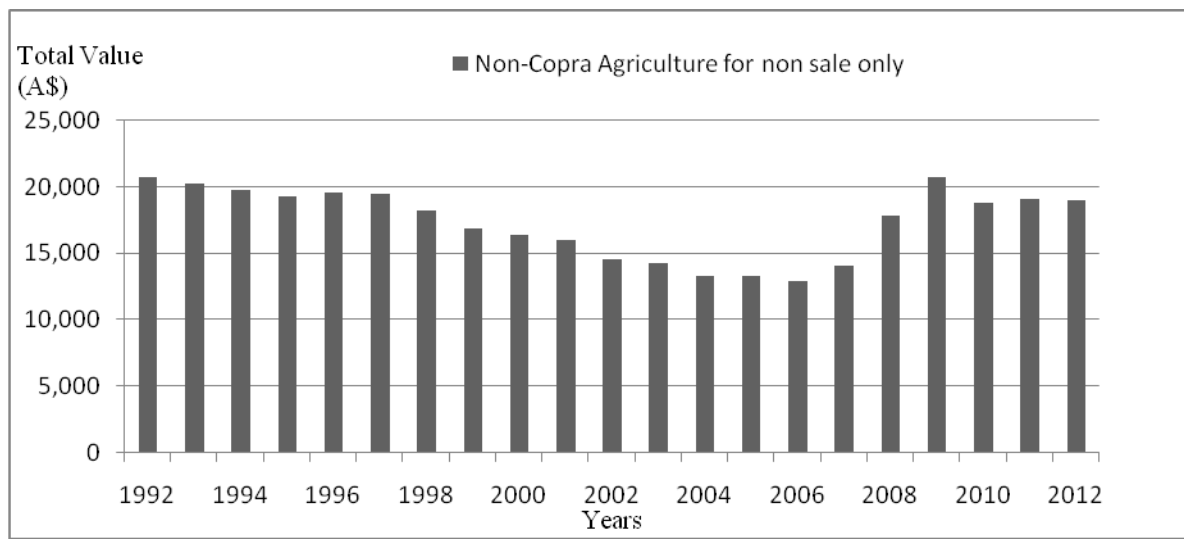


Figure 31. Non Copra Agriculture Consumption expenses in Kiribati.
(Source: KNSO)

3.3.1F. Food crops and Vegetables for sale in Kiribati (1992-2012)

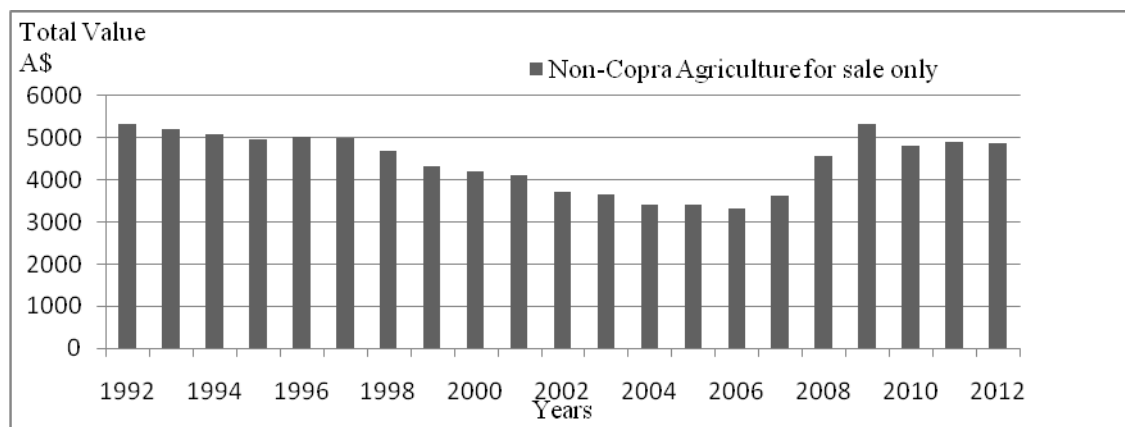


Figure 32. Food Crops and Vegetables for Sale expenses only in Kiribati
(Source: KNSO)

3.3.2 Fisheries Economic Performance in Kiribati.

3.3.2A.Total Catch of Tuna in Kiribati Water by Foreign Vessels (1996-2010).

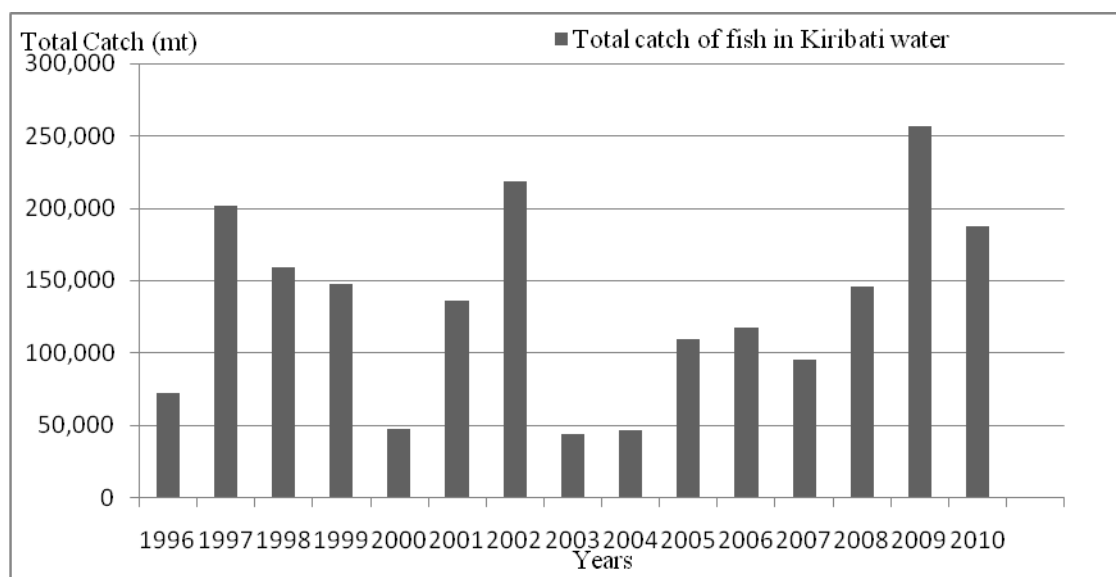


Figure 33. Tuna Catches in Kiribati Water by Foreign Vessels
(Source:KNSO)

3.2B. Total Catches for Commercial and Informal Sector Fishing for 1992-2012

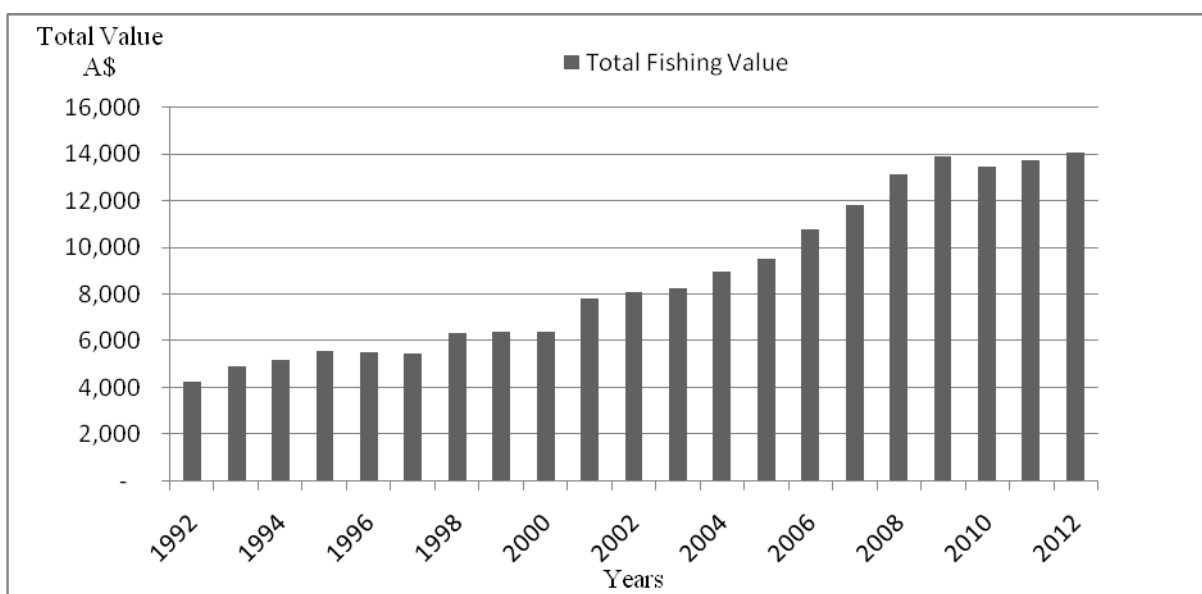


Figure 34. Total Annual Value Catches for Commercial and Informal Sector Fishing in Kiribati

(Source: KNSO)

3.3.2C. Comparison of Economic Performance in Kiribati between Agricultural and Fisheries in Kiribati.

Based on the above the economic performances of agriculture production in point 3.3.1A (both Copra and Non- Copra production for consumption and sale), it is apparent that there is a negative impact on the production of the overall agricultural production such as Copra and Non-Copra production. For instance, during the drought of 1998 to 2001, the amount of production from the drought period in 1998 was A\$26,192 and decreasing to A\$25,130 in 1998 and then dropped again to A\$20,428 in 2000 and 2001 to A\$19,732 (Refer to appendix5).

For copra production and export for Kiribati from 1970 to 2009 as shown in 3.3.1B, it seemed that the trend of export quantity, production quantity and export value are increasing from 1998 reaching it peak in 1999 and then decreasing drastically to 2000 and 2001 (See appendix 5).

As for copra production for some selected islands in point 3.3.1C above, Makin's Island production for 1998 was 277 metric tones in 1998 and then decreasing again in 1999 and 2000 to 258 to 161 metric tones respectively. As for Maiana's Island, the production was 568 metric tones in 1998 to 510 in 1999 and declining again to 133 metric tones in 2000 while for Tarawa it

was 180 metric tones in 1998 and then decreased again in 1999 to 92 metric tones and in 2000 there was none maybe because the coconut is badly affected due to the prolong intense heat and magnitude of a drought event which caused the coconut to drop early (prematured) and thus leading to the scarcity of copra. As for Arorae and Tamana Islands, both located in Southern Kiribati total production for Arorae Island is 543 metric tones in 1998 and then decreasing in 1999 and 2000 from 480 metric tones to 58 metric tones respectively (refer to appendix 4).

As for the total sale and consumption for vegetables and food crops in Kiribati in point 3.3.1D, the total amount was A\$ 22,955 in 1998 and then decreasing to A\$21,256 in 1999 and then decreasing again in 2000 and 2001 from A\$20,583 to A\$20,145 respectively.

For sale only in 3.3.1E, it is apparent that the trend of decreasing was also evident. For instance, in 1998 the total amount of sale was A\$4,682 and then declined in A\$4,335 in 1999 and then decreasing again in 2000 and 2001 from A\$4,198 to A\$4,109 respectively (see appendix 5).

To glimpse for food crops and vegetables for consumption pattern only in point 3.3.1F, it was evident that expenses were decreasing as well. For instance, in 1998 the amount of expenses stood at A\$18,273 and in 1999 it was declining to A\$16,921 and then declining again in 2000 and 2001 for A\$16,385 and A\$16,036 respectively (refer to appendix 5).

In terms of the total catches in Kiribati water by offshore fishing fleet by foreign vessels such as Pole Line (PL), Purse Seine (PS) and Long Line (LL) in point 3.3.2A, it is also obvious that “te mwautakataka” affected the tuna catches as well from these fishing fleets. For instance, in 1998 the total catches was 159,012 metric tones and then declining again to 147,563 metric tones in 1999. In 2000, it was dropped again to 47,014 metric tones and then increasing again to 136,149.032 metric tones in 2001 (Refer to appendix 8).

In terms of total commercial catches and the informal sector of fishing for 1992-2012, it seems to be stable since there was only a slight difference in the total amount of catches even though the trend was increasing as seen in the graph in point 3.3.2B. In 1999, the total annual value of the catch was A\$6,320 while in 1999 it was a slightly higher at A\$6,366 and in 2000 at A\$6,415. It then increased further to A\$7,821. It is apparent that total catches for commercial and informal sector fishing activity are stable and the trend seems to be upwards for all types of coastal fishing activities (Refer to appendix 9).

3.3. 3 Social Performances from te mwautakataka in Kiribati

A lot of literature on Climate Change (CC) studied that had been implemented in the country so far to investigate the social impact to people ways of life and one component of this study is the impact of more intense and increased sunlight in Kiribati. For instance, the studied undertaken by Social Expert Dr Ueantabo Mackenzie in 2003 on behalf of the Kiribati Adaptation Project (KAP) steering committee and funded by the World Bank and Japanese Government to probe the impact of climate change in the four groups of islands such as Kiritimati (Line Group), Butaritari (Northern Gilbert Group), Abemama (Central Gilbert Group), and Tamana (Southern Gilbert Group) manifested the problem identified by the communities such as coastal erosion, diminishing fish stocks, increased and more intensive temperature and sunlight and rising sea (Mackenzie, 2003). Based on this survey, the social impact from increased and more intensive sunlight emphasized in the finding as pointed out by Mackenzie's based on the perception of the various informants about the changes occurred is manifested in the table 10 below.

Perceptions on Intense sunlight	
People feel the heat when they walk on the ground and most are wearing slippers to protect their feet from the heat	It now takes lesser time for coconut meats to be prised from its shells. It normally take two to three days, now this stage is reached even at the end of the first day.
Short lifespan for pandanus leaf thatch; ie after 3 to 4 years and its gets very brittle and easy to tear away	People feel the increased warmth on the land and at the sea and the discomfort it more than ever before. Warmth is felt from the moment the sun rises in the early hours of the morning is not longer being felt
Hair and body oil no longer solidifies in the morning and no more dew on the ground in the morning	Increased use of fans
Recurrance of diseases like flu and conjunctivitis	Shorter period of times devoted to working under the sun as some respondents have to rearrange their work schedule

Table 10. Perceptions of the informants on increased and intense sunlight

(Source: Mackenzie, 2003)

Though the above studied implemented in 2003 during the normal cycle of the climate (absence of La Nina and El Nino event) based on the record of PCCSP in Figure 4, such social implications also felt during “*te mwautakataka*” as it has been proven from a recent study in Australia based on the drought incidence in 2002 that global warming was a major contributing factor that enhanced temperature and sunlight to Australia’s severe and worst drought since at least 1950 (Karoly, Risbey, & Reynolds, 2003).

The other literature in other case study that manifested the social impact on climate change is the studied undertaken by children in Kiribati and Vanuatu in 2011. Part of this survey is to explore issue of drought emotional responses and according to the school children responses from Kiribati, “*heat makes us feel uncomfortable*” including “*I am thirsty because without rain, there is no drinking water*” and “*the water inside our well is salty*” (Burton, Mustelin, & Urich, 2011). Quite interestingly, similar research undertaken in South Tarawa and Betio by the staff from the Foundation of the South Pacific Kiribati (FSPK) and assisted by the Ministry of Education, Teachers and Community Leaders from Betio and South Tarawa in implementing the survey on the Knowledge, Attitudes and Practice (KAP) in 2011 for children and youth from those areas for the Child Centered for Climate Change Adaptation (4CA) program in Kiribati. Based on the findings from this survey, the following results are obtained which has a negative implications on the lifestyle of children and youth especially from the spread of diseases, food shortage and lack of fresh water as a result of ongoing climate change and disaster risk especially drought and sea level rise which are considered as the most significant threat amongst communities in the study areas as Kiribati is vulnerable to the above risks from nature (FSPK, 2012).

Another social implication of “*te mwautakataka*” is external migration as highlighted before by Etuati (2010) in the case of the islanders from Tamana and Arorae whereby these islanders voluntarily to work as indentured labours to escape severe drought affecting their islands through KILT during the mid 20th century. Additionally, another similar incidence that triggers external migration from “*te mwautakataka*” is the case of the islanders from Phoenix group where they were resettled in Solomon Islands due to the well water is highly salinised making it not suitable for permanent settlement (Government of Kiribati, 2007).

As for internal migration due to the case of internal migration within Kiribati due to climate change impact, though there was no documentation on internal migration from the impact of “*te mwautakataka*” from other literature, there might be a possibility that the impact of “*te mwautakataka*” can cause intra-migration as a result of poor growth of coconut trees and thus affect copra production from rural area including poor growth of edible plants and food crops coupled with the salinity of well water. All these problems can create stress and hardship to the families and therefore can force them to migrate to other areas where there are more opportunities existing such as in the case of South Tarawa. Though the blight light of urban setting is a major attraction for exodus of rural dwellers to urban Tarawa, “*te mwautakataka*” can indirectly or directly force people to leave their islands as it can contribute to stress to rural dwellers due to “poverty of opportunities” as less copra to generate income and hence force them to come to urban area to enhance their livelihood by seeking employment and other opportunities in order to support their families. This is one of the reasons of the Informant B from the Southern Island such as Nikunau during the 1980s’ drought based on the interview with him during the survey to come and stay with relative in South Tarawa till now though it was not included in the questionnaires. Similar incidence was occurring based on the Informant C observation relating to the situation in 2007 at Banaba where he decided to come and stay with his working brother in South Tarawa due to the severe shortage of water on the island and added “*it was a desperate time and stress for families at Banaba since water was really conserve and guarded from children, not a single drop you have to waste as we keep it for drinking especially to our children*”. Banaba is the only island in Kiribati that has no underground water or water lens and the people depend on rainwater collected in huge rain water catchments or cisterns established during the phosphate mining era by the British Government (Government of Kiribati, 2012a). Therefore, ones’ can image the hardship people living on this island during prolong drought event.

Based on the researcher observation during the survey in South Tarawa in August, 2013, it is apparent that the social health problem that is resulted from “*te mwautakataka*” due to floating dust is also cause of widespread of pink eye (conjunctivitis) amongst children and even adult including water borne diseases like diarrhoea possibly from poor water quality and unhygienic.

Hence these problems are also prevalent in other part of Kiribati during the drought situation similar to the major findings from Mackenzie's in 2003 as stated above.

3.3.4 Environment Performance from “te mwautakataka” in Kiribati.

There are lots of literatures about the negative impact of “te mwautakataka” as reported in the various literatures. For instance, the Government of Kiribati Country Report (1999) stated that “te mwautakataka” that hit Kiribati since march 1998 impacted negatively the breadfruit trees losing their leaves including the taste of the well water turned salty and the dry ground causing floating dirt (dry mist) in South Tarawa whereas on Banaba, the rainwater was severely impacted. Additionally, Mackenzie (2003) highlighted similar incidence occurring in the case studied areas such as the yellowing of the leaves of coconut trees, which affect the size, quality and quantity of coconuts including the decline in food crops such as banana and breadfruit amongst others plus water from villages wells are getting brackish, and people are resorting to water from wells in the bush. Similarly according to the survey conducted by KAP Phase 2 pilot baseline study report in January 2008, it was noted based from the informants that well, crops and trees affected in the study area such in Nabeina village, North Tarawa and Nanikai, South Tarawa including other islands during the 2007 drought as reported by Christie Hogan (2008). Moreover, the report disclosed by the Radio Australian Broadcasting Cooperation and Tibiriano's in 2008 highlighted the plight of the Islanders in the Southern Kiribati where there was shortage of water due to the presence of drought inflicting the region in 1999 (Coutts, 2008). Such water contamination was also felt in the Phoenix group which led to the relocation of the Islanders to the Solomon Islands as stated by the (Government of Kiribati, 2007). Furthermore, the 1972-1973 droughts struck mainly Islands in the southern Gilbert group such as Tabiteua South, Arorae and Nikunau affecting the water supply and as a result the World Health Organization (WHO) donated funding for the construction of infiltration water galleries to feed the windmill-pumping systems that was made in the 1970s'(Metutera, 2002). Moreover, the recent drought from April 2007 to early 2009 severely affected water supplies in the Southern Gilbert and Banaba Island as ground water turned brackish (saline) and the leaves of most plants turned yellow. Copra production, the main income source for people in Outer Islands declined (Australian Bureau of Meteorological (ABM) &CSIRO, 2011, p. 90).

Though the negative impact of “*te mwautakataka*” manifested on the terrestrial environment above, it has also had a negative repercussion on the marine environment. As stated before by Gillett (2009), the favorable fishing areas shift eastward during the EL Nino from Papua New Guinea (PNG) and Federate State of Micronesia toward the Kiribati EEZ, resulting in large tuna catches in the Gilbert, Phoenix and Line Islands. Based on the finding from Gillett’s, it is evident that the La Nina episode led to the decline in tuna species in Kiribati offshore waters. This could be attributed to the shift of the warm current along the equatorial region toward the western Pacific resulting in the lower sea surface temperature along the Eastern Pacific such as Eastern Kiribati and thus weakening the upwelling rich nutrient along the western coast of the South America which marine species feed on. On the other hand, NAPA (2007, p. 5) indicated that inshore fisheries are known to be less productive during drought conditions normally associated with the La Nina (Government of Kiribati, 2007).

.4 Case Study: South Tarawa

3.4.1 Economic Performance of Coastal Fishing from *te Mautakataka* (1995-2003)

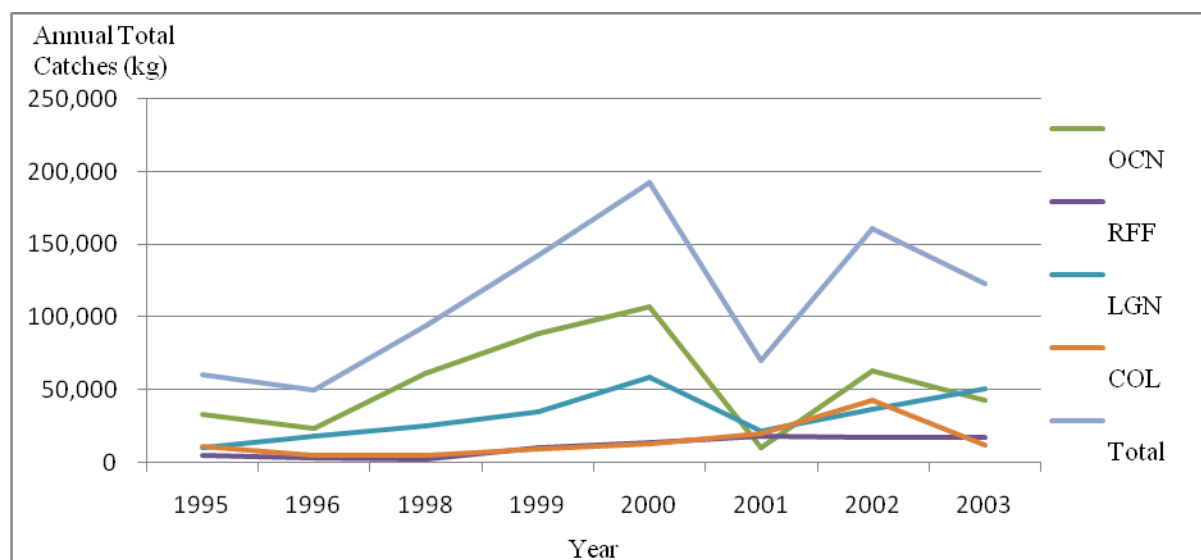


Figure 35. The total catches of all sectors in South Tarawa since 1995 to 2003 (OCN-Ocean Fishing, RFF-Reef Fishing, LGN-Lagoon Fishing, COL-Collection Fishing)

(Source: Fisheries Division)

3.4.1A. Informant Offshore Fishing Business Sale Record

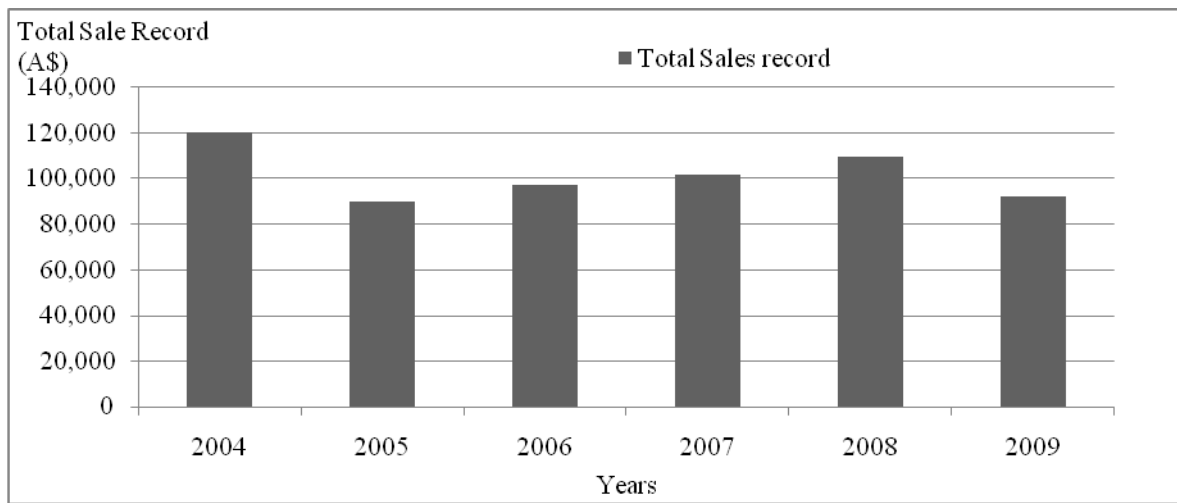


Figure 36. Informant A Offshore Fishing Business Sale Record

(Compiled by the Author)

3.4.2 Economic Performance on copra production at Tarawa Island from te Mwautakataka (1992-2011)

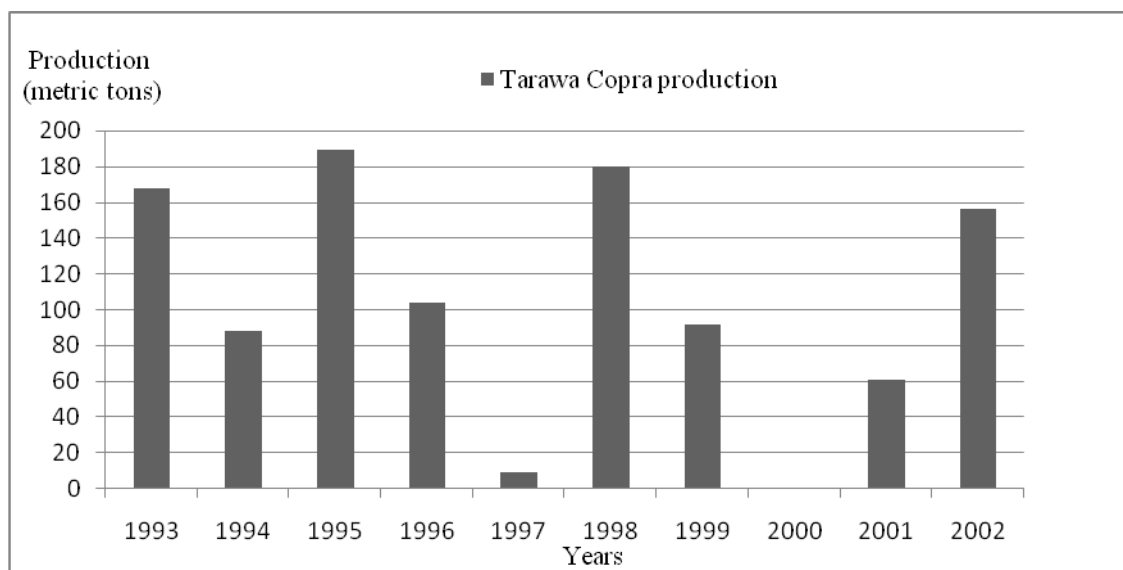


Figure 37. Economic performance of copra production at Tarawa Island since 1993-2002

(Source: KNSO)

3.4.3 Economic Performance of Combined Recorded Total Sale of Vegetables Stalls at various location in South Tarawa, Kiribati.

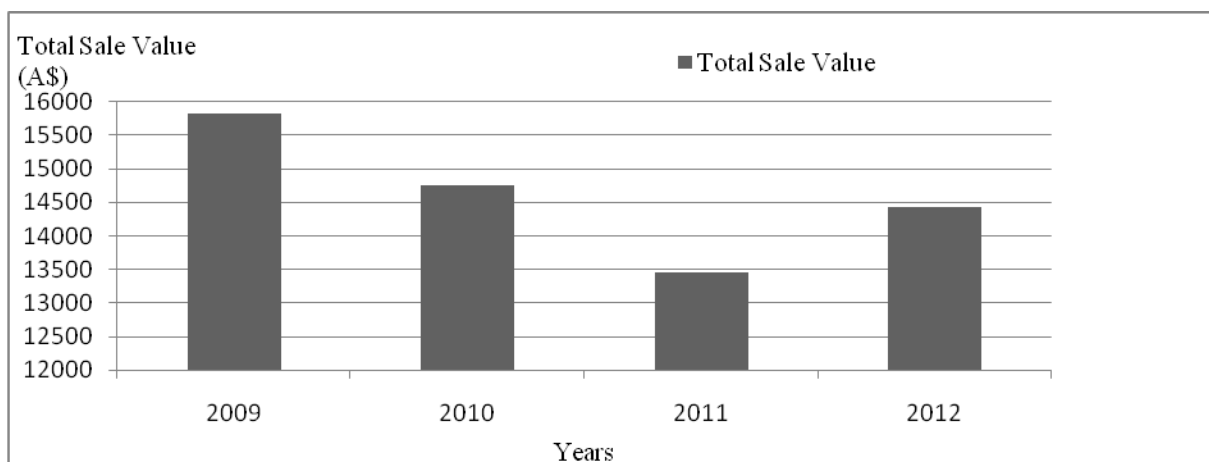


Figure 38. Total sales of vegetables at various locations in South Tarawa.

(Source: Tarawan Organic Farmers Marketing Association. (TOFMA))

3.4.4 Social Performance of Te mwautakataka for South Tarawa.

3.4.4.1. Health Impact of “Te Mwautakataka” from MHMS

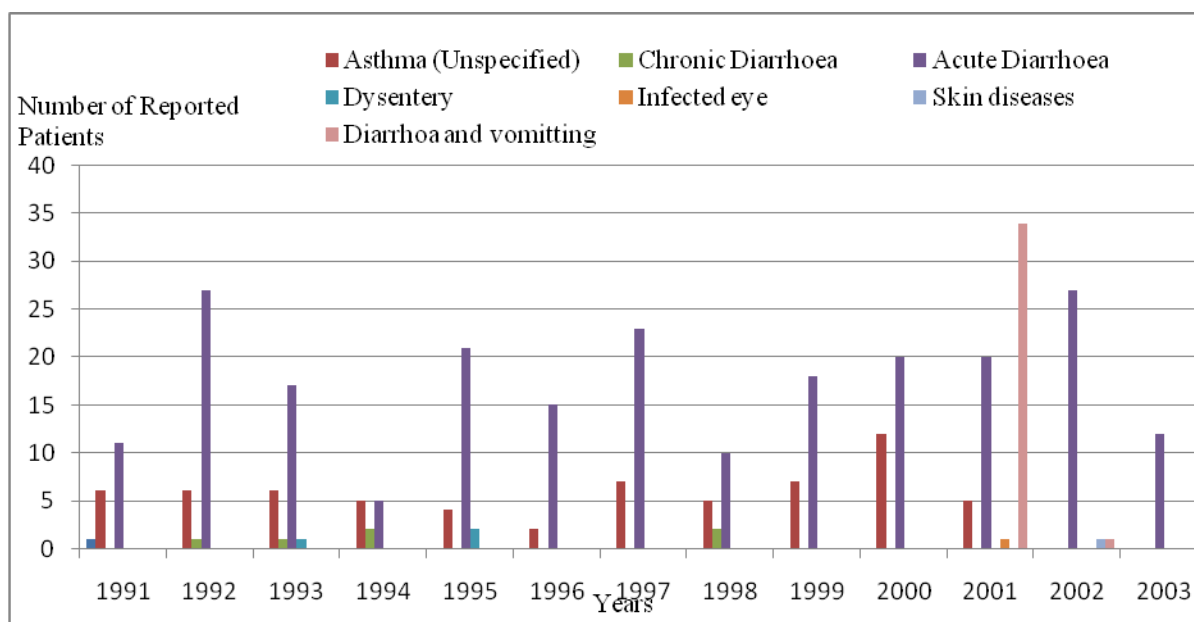


Figure 39. Mortality rate in South Tarawa due to Sicknesses

(Source: Ministry of Health and Medical Services, (MHMS))

3.4.4.2. Health Impact based on responses conducted in South Tarawa

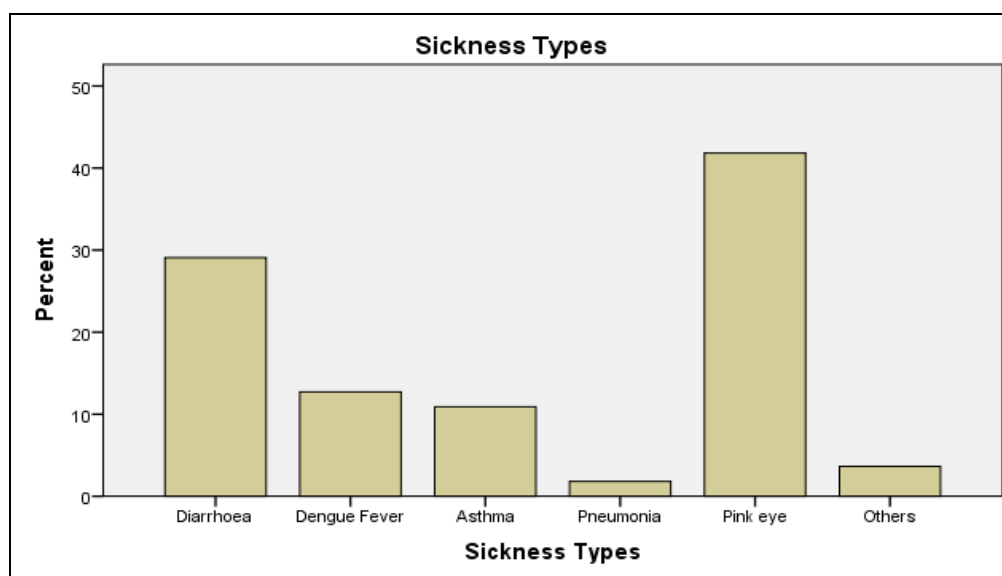


Figure 40. Type of Sicknesses by Respondents in 2013.

3.4.4.3.Social Impact on people Livelihood based on the Respondents.

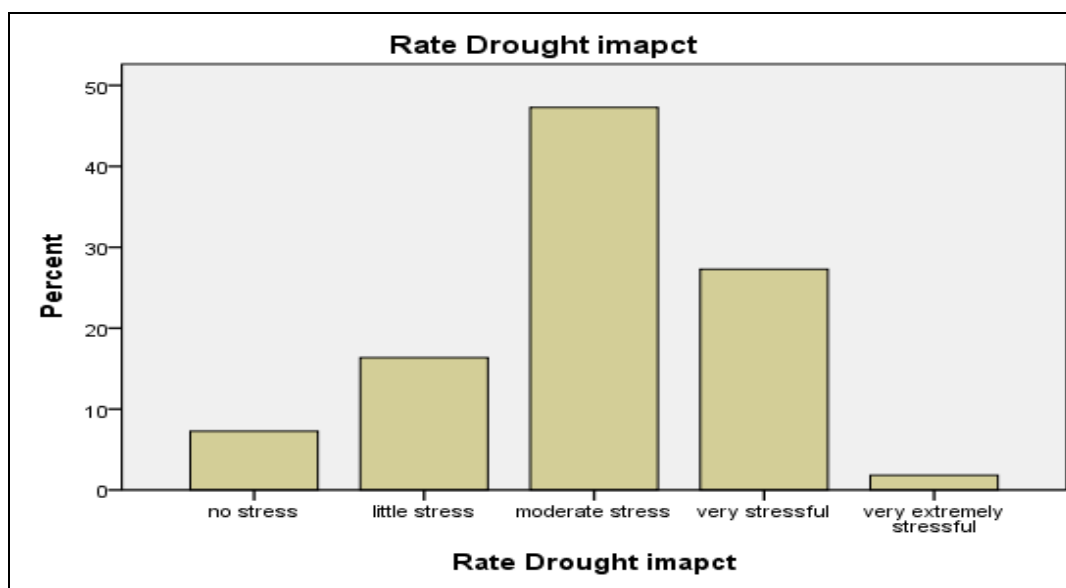


Figure 41. How stressful drought is based on respondents in 2013.

3.4.5 Comparison of the Economic Performance in South Tarawa between Fishing and Agriculture.

3.4.5.1. Fishing Activity

In the case of coastal fishing in 3.4.1 above the trend of ocean and lagoon fishing were increasing dramatically during the 1998-2000 where both reach their peaks and then decrease again suddenly to 2001. As for reef fishing and collecting sea food like shells the trend shows a slow increase slowly from middle of 1998 to 2002 and then a decrease in 2003.

As for the case 3.4.1A, due to the missing records of the 1990s' sale record by Informant A, the 2007 to 2011 records are utilized as reference to analyze drought impacts, offshore fishing using engine motorboats the sale record fluctuates as it is decreasing from 2004 to 2005 and then increasing again from 2005 to 2008 and then decreasing again in 2009 and then a slight increased in 2010.

3.4.5.2. Agricultural Activity

In the case of copra production(see 3.4.2), production was decreasing for the 1998 and 1999 drought event from 108 metric to 98 metric tones respectively while in 2000, there is no production and then production increased again to 61metric tones in 2001.

As for the sale record of agricultural products such as cabbage, tomatoes amongst others in 3.4.3, there was a decreasing in total sales from 2009 to 2011 and then again an increase. The La Nina event as well occurred within these periods in Kiribati as stated in Figure 3 and also from the report by ABM and CSIRO in 2011.

3.4.6. Comparison on the Social Performance of 3.4.4.1 and 3.4.4.2

Based on the Health Statistical figure issued by the Statistic Section from the Ministry of Health and Medical Services (MHMS),there have been many cases of acute diarrhoea. During the La

Nina event in 1997, there were 23 reported cases then decreased to 10 in 1998 and starts increased in 1999 and 2000 to 18 to 20 cases respectively. A similar trend was also noticeable in the case of asthma where in 1997 7 cases have been, which then decreased to 5 in 1998 and then increased to 7 and to 12 in 1999 and 2000 respectively. There is one case of infected eye in 2001

In comparison with the result undertaken by the researcher, it appears that there are common sicknesses used to be prevalent during “*te mwautakataka*” event such as diarrhoea, pink eye, asthma, pneumonia and others of which pink eye (41.8%) showing the predominate cases affecting different age groups due to the presence of floating dust and proceeded by diarrhoea by 29%, dengue fever (12.7%), asthma (10.9%), pneumonia (1.8%) while others 3.6%.

In terms of how stressful the impact of “*te mwautakataka*” have been from the respondents ‘perspectives, it is evident that 47.2% stated that it was moderately stressful, while 27.2% claimed that it was very stressful, 16.3% reported little stress, 1.8% declared it was extremely stressful and 7.2% considered it as not stressful.

3.4.7 Environmental Impact of Te Mwautakataka in South Tarawa

There are many drought events that happened in Tarawa as shown in the study undertaken by the PICCSP (2011). The study reports on the number of La Nina events which were rarely recorded due to the scarcity of literature on such events. The Republic of Kiribati Country Report (2000) prepared by the National Disaster Management Office (NDMO), Public Utilities Board and Sewerage Division and Kiribati Meteorological Office (KMO) highlights the challenge posed by the drought event of 1998 and 1999 on the environment. Breadfruit trees were no longer productive as their leaves were losing out. The taste of the well water tasted salty and the dry ground caused floating dirt (dry mist). The impacts of droughts could also be substantial, though difficult to quantify. The 1998 and 1999 drought, for example dried rainwater tanks in South Tarawa and caused shallow groundwater reserves to become brackish (White et al, 1999).

Based on the observation of the researcher and reminiscent of past drought events since 1990, it creates stress to families’ member when well water turn saline and trees experienced poor growth as leaves burn and turn yellow due to the stress created by heat with no rainfall for quite a long period of time. The dust is a nuisance in roads when they are not sealed with tar and even if they are sealed, the wind carries floating dust to houses and trees making it unhealthy to everyone.

Figure 42 vividly manifest the situation in South Tarawa during the drought event in August, 2013 during the research period. The atoll was very dry and as a result dust and dirt filled often the air.



Figure 42. Floating dust from passing vehicles and wind
(Source: personal)

“We cannot solve our problems with the same level of thinking that created them”

Albert Einstein

CHAPTER FOUR

Chapter 4

4.1 Introduction

This chapter presents the findings of the research using the methods as described in chapter 3. Major purposes is to determine the threshold of the drought severity and magnitude of drought including analyzing social- economic and environment performances of “*te mwautakataka*” in Kiribati in general and in the case study area of South Tarawa in particular. The first part will look at the drought context analyzing the questionnaire results using SPSS software and then compare and analyze the severity and magnitude of the “*te mwautakataka*” in the study area using the drought event definition. The second part will analyze the social, economic and environmental performance of “*te mwautakataka*” portrayed in section 3.3.3C of chapter 3 in Kiribati as a whole and in the study area as well. After that a comparison and analysis of results of responses and information presented in chapter 3 will be done. The last part will look at Government strategies to reduce drought impact in the study area with recommendations based on the responses.4.2 Part One: Summary result of respondents based on SPSS

4.2.1 Tabulated number of respondents in terms of age and gender

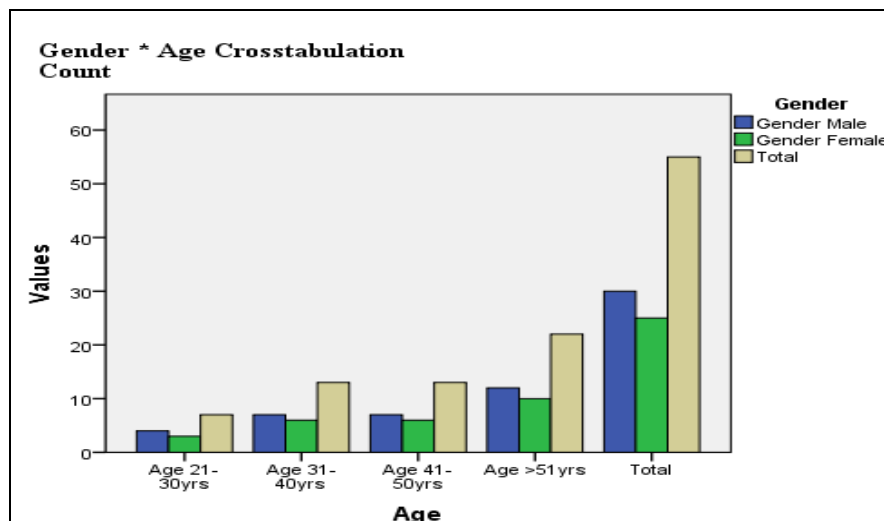


Figure 43. Number of Respondents in terms of age and gender

Figure 43 shows the total number of the respondents which is 55. There are 25 males and the rest females. In terms of the age groups, there are more people within the age group of greater than 51 compared to the rest. As for the age range of 31-40 years and 41-50 years, the total number are the same while for the 21-30 years, only 7 people. So, the idea is to get more perspectives from the old people as they have more life experiences about the past compared to the younger generation.

4.2.2 Summary of respondents by gender and educational level

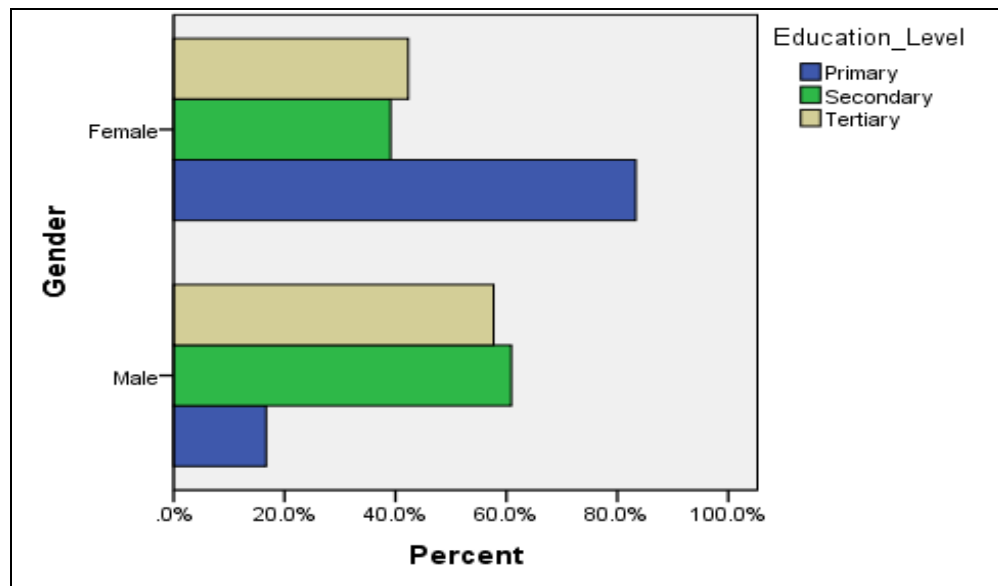


Figure 44. Summary of Respondents in terms of their ages and gender in percentages

Figure 44 above shows that the difference in gender and education level. For instance, there are more male who reached secondary level than female counterpart. The same also applies to the tertiary level while the primary is the opposite effect where 83.33% of the female attained primary levels while the rest for male.

4.2.3 Cross tabulation of Respondents in terms of their age and villages

Figure 45 below shows the cross tabulation summary of the respondents in terms of their age and villages in percentages. From the bar graph, it shows the distribution of age groups within the study area. For instance, for the age group of 51 and over, there are more respondents from Bikenibeu village followed by Betio, then Teaoaraereke while Bairiki has only one respondent. For the age group of 31-40 and 41-50, there are more respondents from Bikenibeu follow by

Betio while Tanea is the least number of respondents. For the 21-30, Temaiku has the highest number while the rest have one each while none at Tanea.

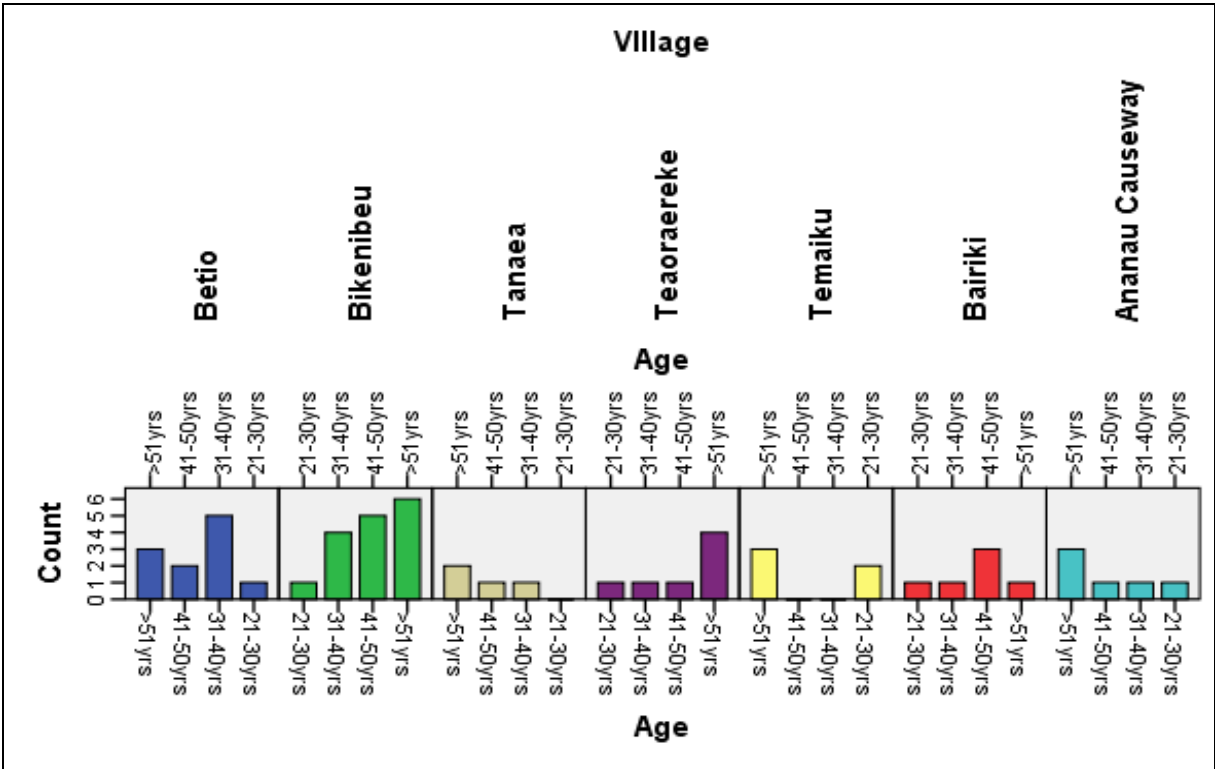


Figure 45. Cross tabulation of age and villages of the respondents

4.2.4 Cross tabulation of drought knowledge, source and signs from respondents

When asked about any drought knowledge, source and signs, it is apparent that the respondents had prior knowledge about drought as shown in figure 46 and 47 respectively. For instance, in Figure 47, 1.82% from the respondents stated that they had no knowledge of drought while 98.18% had prior knowledge on drought as stated in figure 47 and the major sources of knowledge are friends, schools, newspapers, radio, TV, neighbour and others as stated in a multi colour pie charts with the percentage number of respondents.

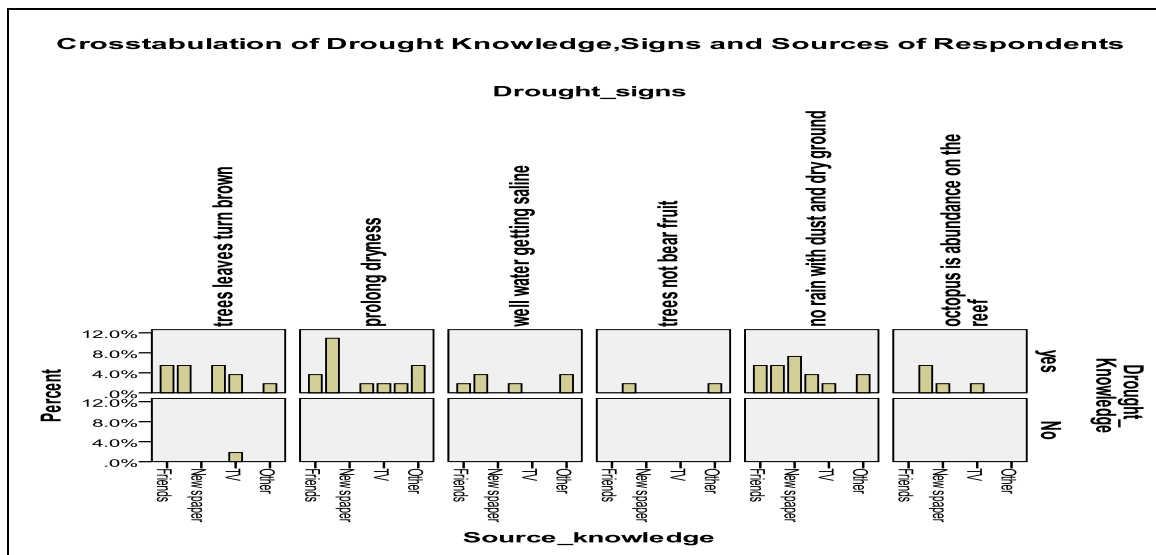


Figure 46. Cross tabulation of the result of drought knowledge, signs and sources of Respondents

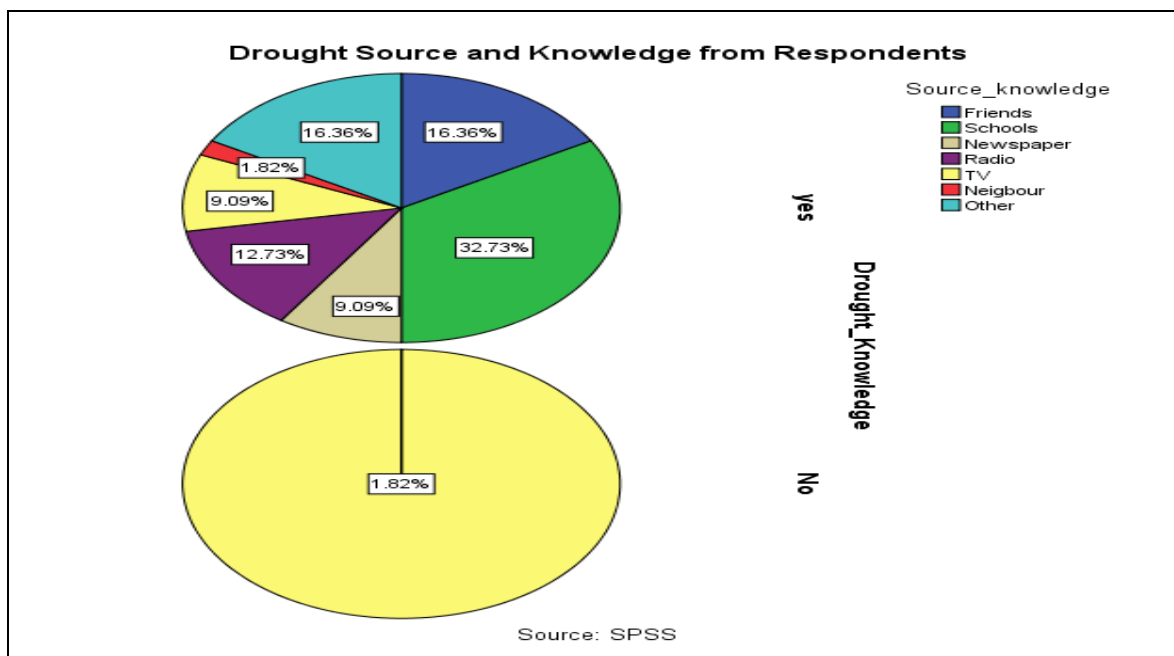


Figure 47. Percentage of respondents for drought Source Knowledge.

4.2.5 Drought vernacular name from respondents

In terms of the local vernacular terms for drought, there is a difference in opinion, but the majority of the respondents (60%) stated that it is called “*te mwautakataka*” as seen in Figure 48 below whereas 21.82% regarded it as “*te rongo*” while 18.18% has no ideas or responses.

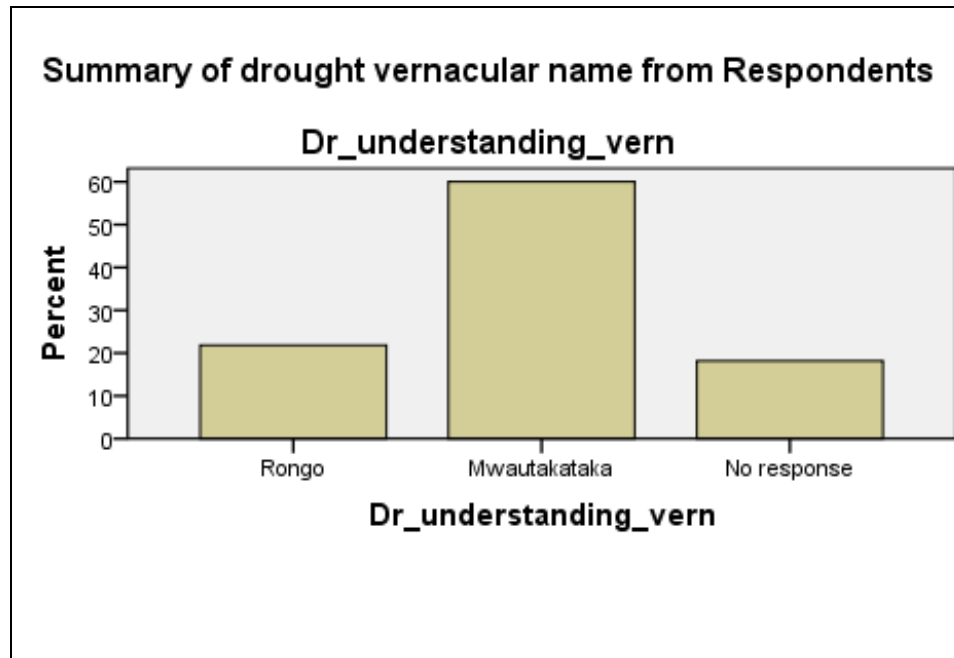


Figure 48. Respondents’ understanding on drought vernacular name

4.2.6 Drought Occurrence and trend from Respondents

In terms of drought occurrence and trend, the respondents have different views regarding drought occurrence as shown by the respondents’ responses such as 6 months, 1 year, 1.5 years, 2 years, 3 years, more than 3 years and others. In terms of drought trend, there is also variation on their responses as shown in Figure 49 below.

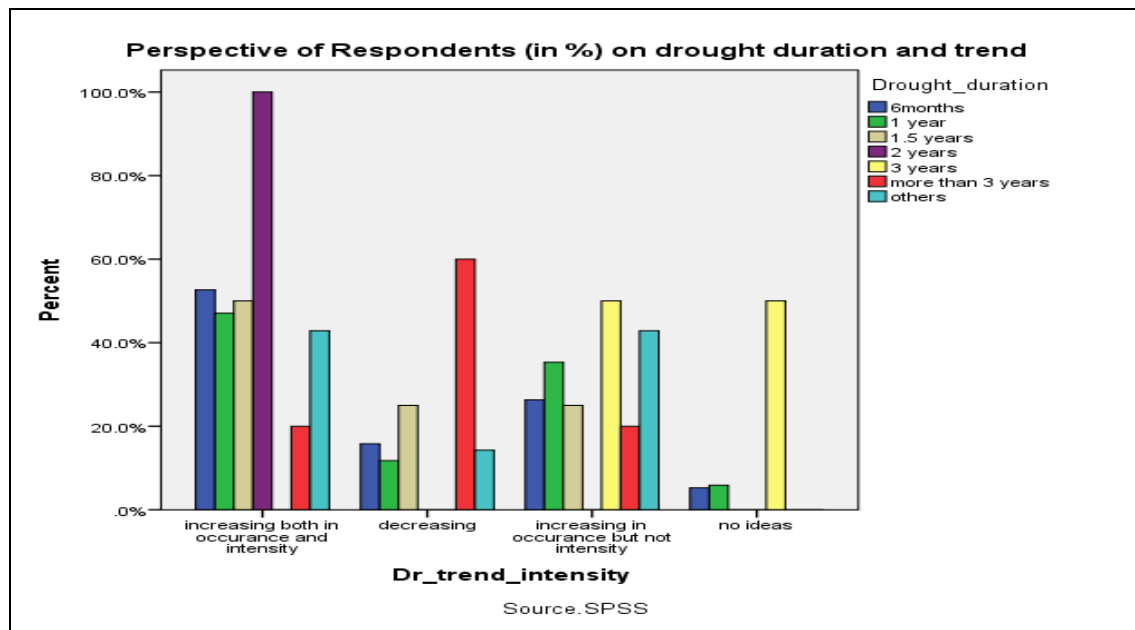


Figure 49. The perspective of respondents in % on drought duration and trend

Based on the analysis of rainfall sites for all GCM in Kiribati, it is indicated that for the majority of locations 70-80 percent of droughts last up to 10 months although there is a sizeable fraction of droughts that persist over a year (NIWA, 2008). A frequency analysis of drought duration suggests that droughts of 12 months duration is expected on average once every 5 to 10 years. Further persistent drought (i.e., lasting for at least 2 years) occur infrequently and especially during La Nina periods. They can be expected on average once every 20 to 50 years. As for South Tarawa about 7-8 droughts are expected to occur per decade and a drought with 10 months duration is expected to occur once every 3.9 years for South Tarawa. Droughts which last at least 2 years are expected on average once every 20 to 50 years.

4.2.7 Drought worst years from respondents

In terms of drought worst drought years, it is evident based on the result from the respondents that the 2007-2008 was the worst drought year (29.1%) as shown in table 11 below.

Worst Drought Years	Number of Respondents	Respondents (%)	Worst Drought Years
1980-1981	3	5.5	1980-1982
1988-1989	8	14.5	1988-1990
1998-1999	5	9.1	1998-2000
2007-2008	16	29.1	2007-2009
Others worst years	14	25.5	Others worst years
No ideas of worst years	7	12.7	No ideas of worst years
No responses	2	3.6	No responses

Table 11. The worst drought year in South Tarawa based on the Respondents.

Despite the above responses from the respondents, it is interesting to see that according to the Republic of Kiribati Country Report (1999) the year 1998 and 1999 was reported as the worst drought since the South Tarawa Water Supply was commissioned with a modified gallery well system in 1988 even though it was ranked as the fourth worst drought since the rainfall records were kept in 1947. The Report also stated that years 1949-1950, 1973-1974 and 1989-1990 were the worst droughts with the 1949-1950 drought indexes of 67mm, while the 1988-1989 had 102mm and 1998-1999 have a drought index of 67 but when looking at the accumulated monthly rainfall from August 1998 to November 1998, the total rainfall was 12.9mm and when comparing with the same period for 1988, the total rainfall was 34.5 mm. From this simple calculation, it could be deduced that the 1998-1999 had been the worst drought in Kiribati recent history.

4.2.8 Analysis of Percentile and SPI Result

In comparison to the calculated value of rainfall data since 1947 to 2011 using the percentiles method to glimpse at the lowest monthly precipitation during “*te aumeng*” and “*te aumaiaki*” season, it is apparent that the result obtained for the two seasons orientation and the total season calculation for the various percentiles calculation were varied. This could be attributed to missing data as stated before. Quite interestingly, there are total annual lowest precipitation values below the total threshold of the 10th percentile which is 690mm from November to October noticed in the calculation as shown in figure 50 below.

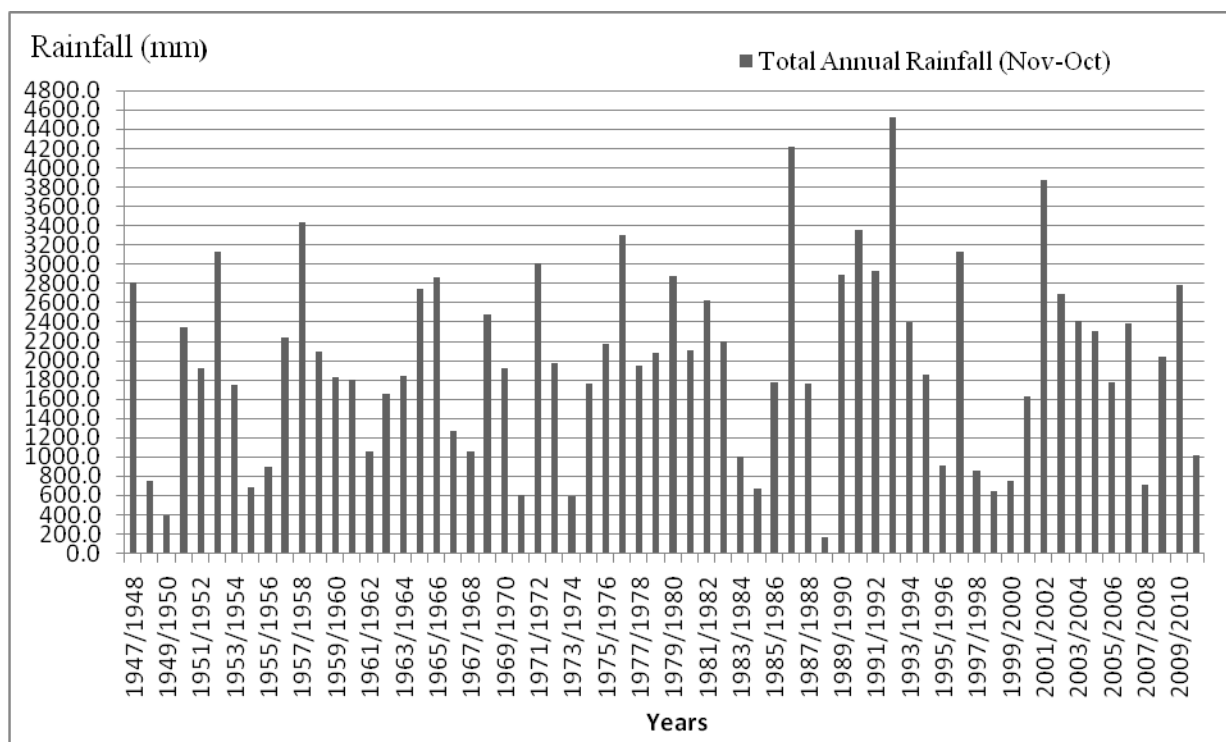


Figure 50. Total Annual Precipitation based on the calculated 10th percentile since 1947-2011.

Table 12 below further exemplifies those precipitation anomalies such as 1949 to 1950 (298.8`mm), 1954 to 1955 (682mm), 1970 to 1971 (605.5mm), 1973 to 1974 (596mm) and 1998 to 1999 (647mm) in ascending order to see the real pattern of which year is the worst drought year.

Years	Total Lowest Annual Rainfall (mm)	Worst Drought Year	Aumaiaki (May-October)	Au Meang (Nov-April)
November 1949-October 1950	298.8	1st	187.3	111.5
November 1973-October 1974	596	2nd	518	78
November 1970-October 1971	605.5	3rd	437	168.5
November 1998- October 1999	647	4th	355	292
November 1954- October 1955	682	5th	399.3	283.6

Table 12. Lowest annual rainfall based on the two seasons' orientation below the 10th percentile threshold

(Source: Compiled by the Author)

The above percentile result compared with the SPI result based on the 35 years records since 1949 to 1982 (as other years not included due to the missing data) shows that the worst drought year is

consistent with the findings based on the total calculated accumulated SPI values for the 12 months precipitation period using SPI calculator program data as shown in the graph below in Figure 51 although there are some variation in the result obtained maybe this could be attributed to the missing values in 1974 and 1975 and therefore affect the validity and reliability of the SPI result.

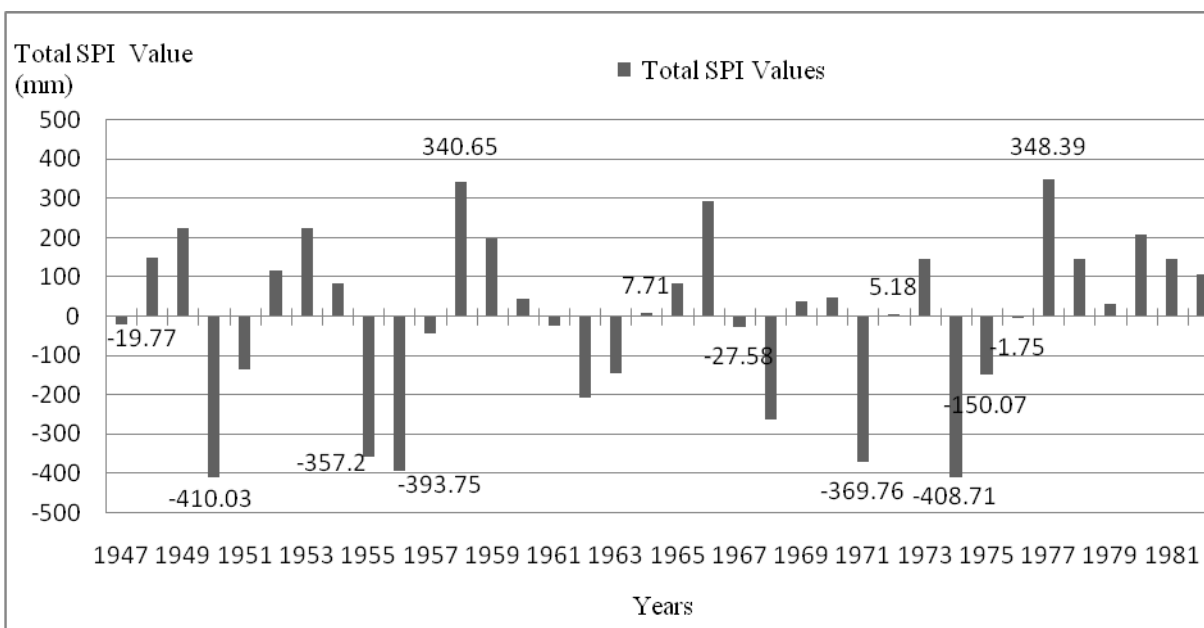


Figure 51. Severity of drought years for Tarawa since 1947-1982

The graph above shows drought events by negative values while the positive values represent non-drought events. If the negative values analyzed only, it is clear that the 1950 is the most extreme year (-410mm), followed by 1974 (-408.7mm) and then 1956 (-393mm), 1971(-369mm) and 1955 (-357.2mm). The least extreme year for the drought period is 1976 with a value of -1.75mm as 1947 is not considered due to missing values in SPI outputs. For non drought events, the maximum SPI value in 1977 is 348 mm trailed by 1958 (340mm) while the minimum SPI value for the year 1972 is 5.18mm followed by 1964 (7.71mm). To sum up, it is evident that the worst drought year was 1950 based on total accumulated rainfall for the 12 months period of 1947-2011 based on the percentile method only while the SPI values indicated as well based on the 35 years duration.

If the above worst drought percentile years result (as shown in table 11) are analyzed only based on the precipitation monthly anomalies for “Te Aumaiki” and “Te Aumeang” respectively in compliance to the total 10th percentile for the two seasons, it is evident based on “Te Aumeang”

(the wet season) that November 1949 to April 1950 drought event only last for a year with a precipitation value of 111.5mm. The following year November 1950 to April 1951 received 743.7mm which is exceeding the total extreme 10th percentile threshold as shown in Figure 52. As for the November 1973- April 1974 drought event, the total amount of precipitation is 78mm and then succeeded by high rainfall the following year of the same season by 1329 mm. In the case of the 1970-1971, the amount of rainfall is 168mm and then increases to 722mm just exceeding the critical threshold level by 32mm. In the case of the 1998-1999 drought events, the total precipitation is 292mm while decreasing again in 1999-2000 to 174.9mm and in 2000 to 2001 it is increasing to 837.5mm. Quite interestingly, the 1997 to 1998 rainfall is 629.7mm which also below the threshold level. This gives a clear indication that the magnitude of this drought event covers 72months which is quite long according to the precipitation record of Tarawa. The 19954-1955 has a value of 283mm and then increases again to 368.4mm in 1955 to 1956 while in 1956 to 1957 it increases dramatically to 772.9mm.

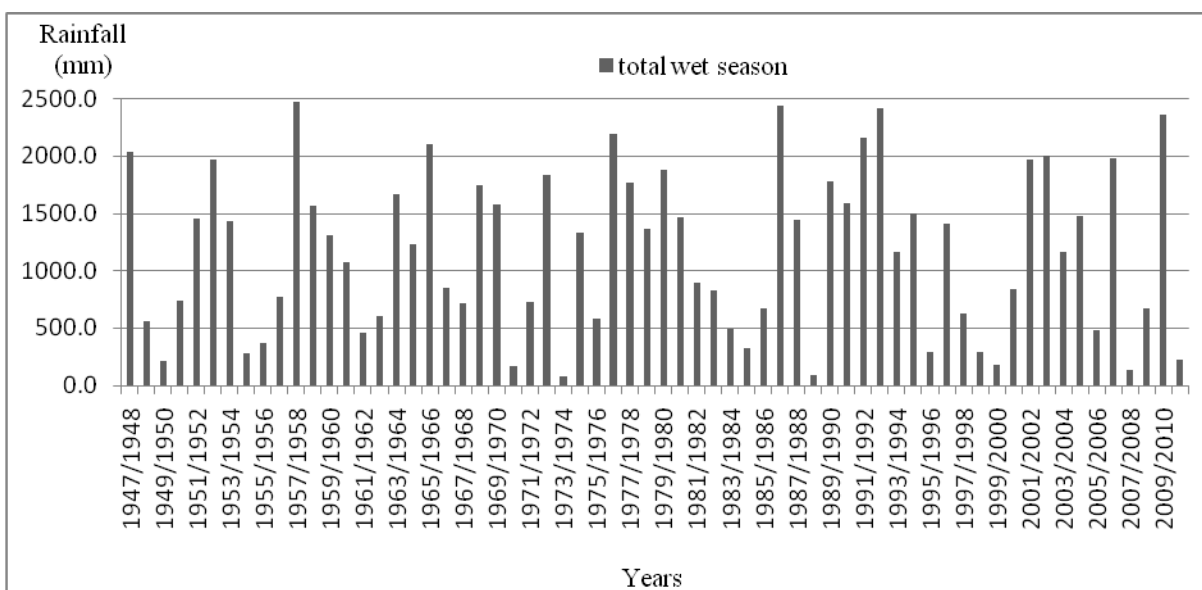


Figure 52. The total monthly wet season (Nov-April) for Tarawa for 1947-2011.

(Source: KMS; compiled by the Author)

In terms of the magnitude trend in “te Aumaiki season” as shown in Figure 53, similar trends has been observed for drought events with 1949-1950 being the lowest (187.3mm) and then increasing again the succeeding year 1950-1951 (1603.5mm). In the case of the 1970-1971 years, it is 168.5mm and then rises to 2289mm the following year. As for the 1998-1999 drought

events, it is recorded to be 292mm and then increases again to 355mm to 581mm in 1998-1999 and 1999-2000 respectively while 2000-2001, it is reaching 788.9mm. The same applies to the 19973-1974 drought events and then decreasing again to 436mm and then increases to 1595mm.

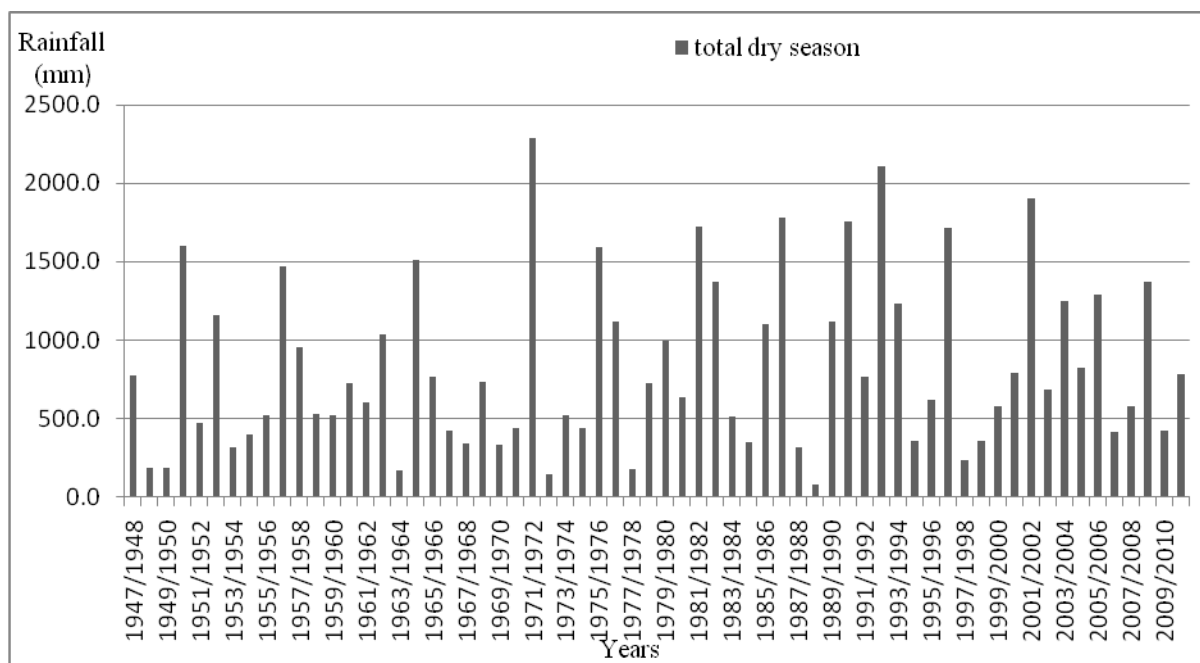


Figure 53. The dry season for Tarawa between 1947-2011.

(Source: KMS; compiled by the Author)

It is clear from the above graph that the magnitude of drought is greatest along the 1997-1998 to the 2000 -2001 which covers a duration of 3 years. This is the longest drought event that occurred as far as rainfall data is concerned at Tarawa atoll based on the calculated 10th percentile threshold. The drought occurs in both seasons. To analyze again the drought years with the greatest magnitude such as 1997-1998, 1998-1999, 1999-2000 in terms of monthly precipitation anomalies, it is clear that the 1998 drought event from the months of August, September, October, November has the lowest monthly precipitation as stated in table 12 below. If it is compared with the 1950, 1974, 1971 and 1954 it shows that 1998 has very severe rainfall anomalies with a total of 12.9mm while 1950 sums up to 221.3 and 1954 to 99.4mm. Hence from this simple calculation, the 1998 can be considered as the driest and most severe drought year amongst the worst drought events (Table 13).

Years	August (mm)	September (mm)	October (mm)	November (mm)	Total (mm)	Rank
1998	4	0.9	3.3	4.7	12.9	1st
1954	73.4	128.3	9.1	4.1	99.4	2nd
1974	50	62	60	37	209	3rd
1950	76.2	30.5	45.5	69.1	221.3	4th
1971	41	41	100	69	251	5th

Table 13. Selected monthly rainfall anomalies

(Source: Rainfall data, KMS)

The severe monthly precipitation for “*te aumeang*” season (November-April) as stated in table 10 above occurs in 1973-1974 with a precipitation value of 78mm followed by 1949-1950 (111.5mm) while the maximum value occurs in 1998-1999 (355mm). For “*te aumaiaki*” season (May to October), 1949-1950 is the maximum driest months with a precipitation value of 187.3mm pursue by 1998-1999 (355mm) while the minimum driest months occurs in 1970-1971 (437mm).

4.3 Part Two: Social, Environmental and Economic Impacts on the Study area

4.3.1 Analysis of Coastal and Offshore Fishing Economic Impact on South Tarawa, Kiribati.

Based on the performance of Coastal Fishing in Figure 35, it is apparent that the total catches of all the fishing methods such as Ocean Fishing (OCN) using canoes or outboard, reef fishing (RFF), lagoon fishing (LGN) and Collection fishing like shells all shows a positive trend or increasing from 1996 to 2000 as their peak year and then decreasing again in 2000. In comparison with the performance of offshore fishing using outboard motor in figure 35, it seems that the trend is also increasing from 2005 to 2008 as it can be seen in the sale record but and then decreasing again in 2009. Drought was occurring as well in 2007 and 2008 respectively. If it is compared with the responses from people perception on drought impact on marine species in figure 54 below, it is apparent that the majority of marine species are abundance especially fish and octopus as shown in the green and blue bars below though 25 % of the respondents implied that it is affected .

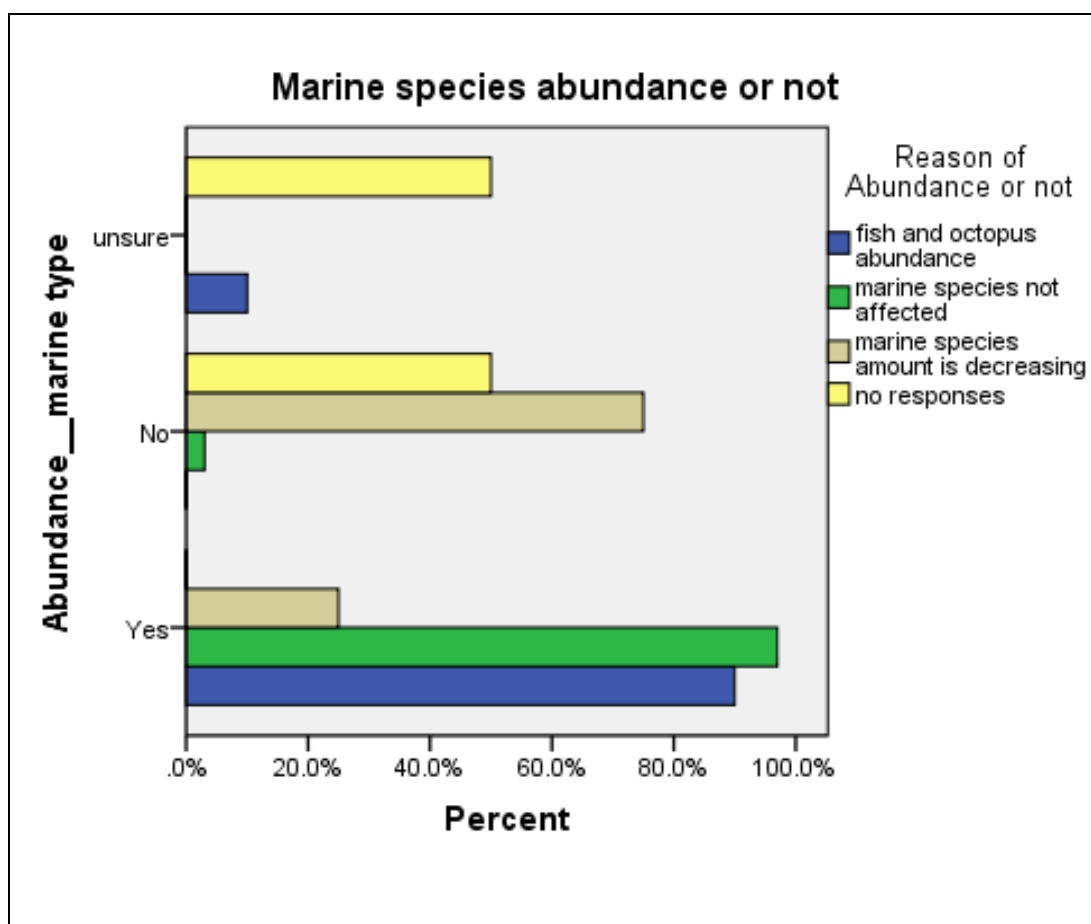


Figure 54. Respondents' perception on marine species status.

4.3.2 Analysis of Agricultural Economic Performances in Tarawa, Kiribati

In the case of copra production for Tarawa atoll in Figure 37, the production seemed to be decreasing for the period 1998 and 1999 drought event from 108 metric to 98 metric tonnes respectively while in 2000, there is none and then increasing again to 61metric tonnes in 2001.

As for the sale record of agricultural products such as cabbage, tomatoes amongst others in figure 38, it is decreasing in a total sale from 2009 to 2011 and then increasing again. The decreasing sale coincides with the La Nina event which occurred in Kiribati in 2010 and 2011 as shown in Figure 3. Compared with the responses from the respondents in Figure 55 below, 61% of the respondents stated that crops and vegetables don't grow well in drought although 3.6% stated that crops are not affected from intense sunlight and protected from shading.

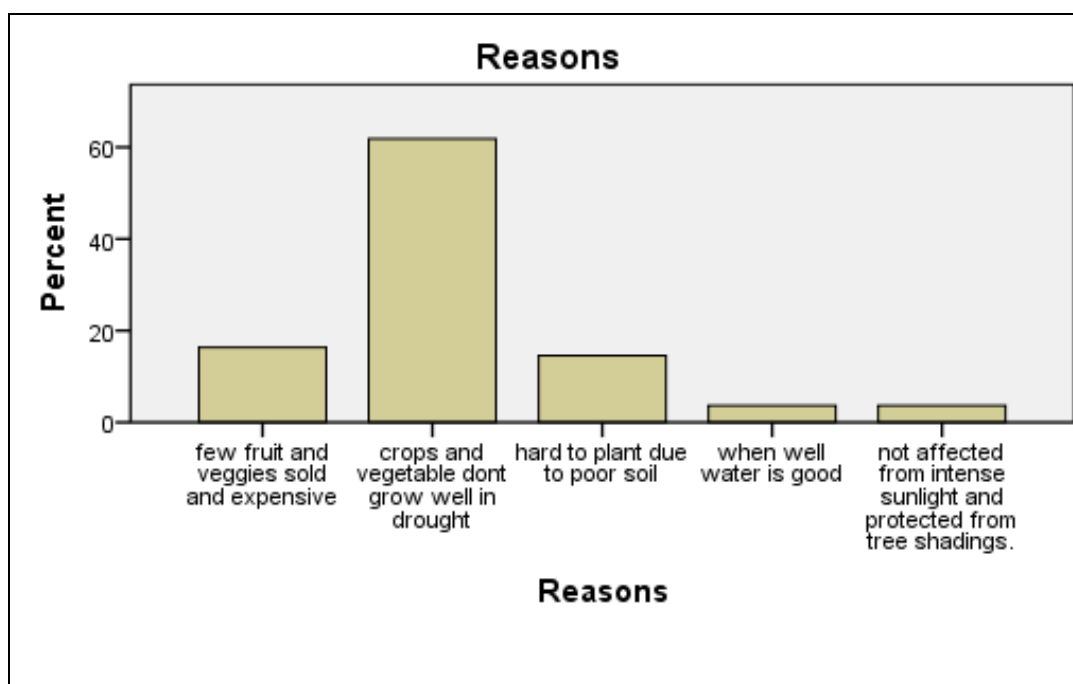


Figure 55. Perception of Respondents regarding foodcrops and vegetables.

4.3.3 Analysis of Social performances of Te Mwautakataka on peoples' livelihood in South Tarawa

Based on the questionnaire survey that was implemented to assess the impact of drought on people's livelihood, 74.5 % of the respondents stated that drought affects their livelihood while 23.6% stated that this is not the case and 1.9% did not respond as shown in Figure 56.

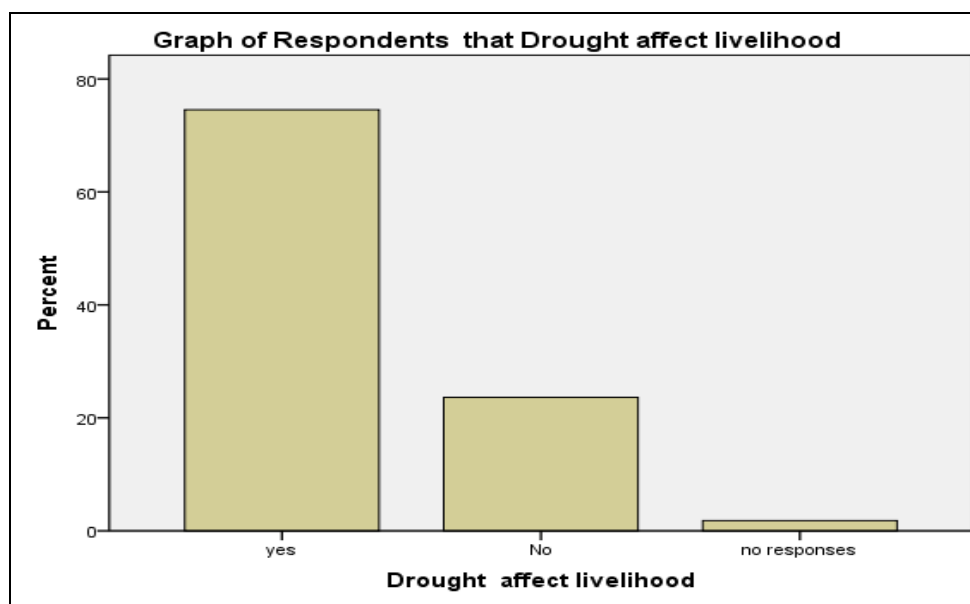


Figure 56. Respondents' perception on drought impact on livelihood

From this, it is apparent that the majority state that drought directly affects their major sources of livelihood especially those derived from the land environment which people depend on them for their survival and means of generating income. Elaborating on this 25.5% of the respondents stated that breadfruits trees did not bear good fruit, 12.7 % claimed that coconut trees leaves turn yellow, 7.3% stated that bwabwai plant leaves turn yellow and this could affect the quality of the corm (root) of the plants, 21.8 % stated that vegetables died, 1.8 % mentioned that native fig growth is affected while 3.6 % stated that livestock source of food such as plants are affected. (See Figure 57 below).

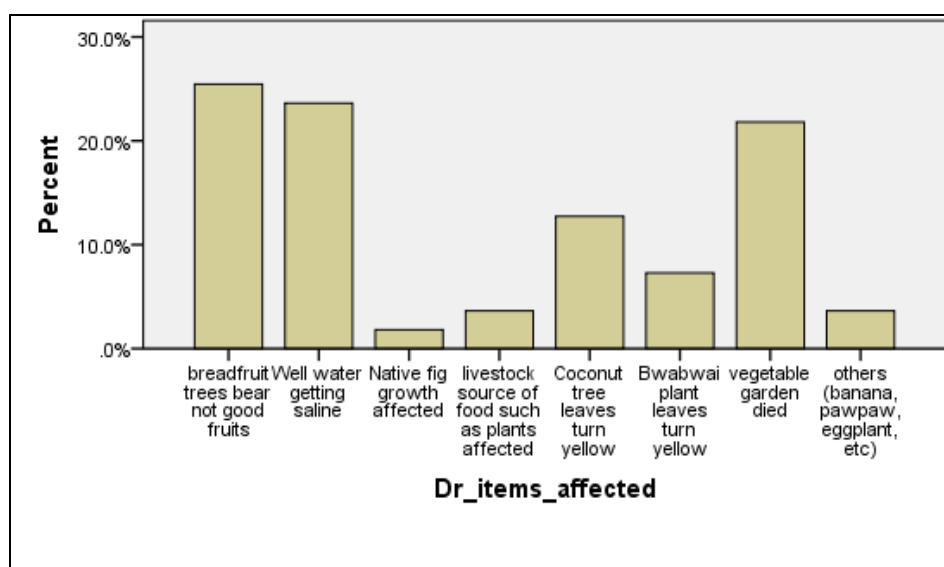


Figure 57. Major land based livelihoods affected in South Tarawa mentioned by Respondents

When the respondents asked if they engaged in any business activity and if it is affected by drought event, their answers are different as stated in Figure 58 below. For instance, 26% farmers said that their business was affected while fishermen are differed in views as 13.4% stated it was affected while 6% did not. Others (such as small shops, money lending and others) are not affected (25%) while other business stated their income generating activities are affected such as selling brooms, breadfruits and toddy juice and vinegar.

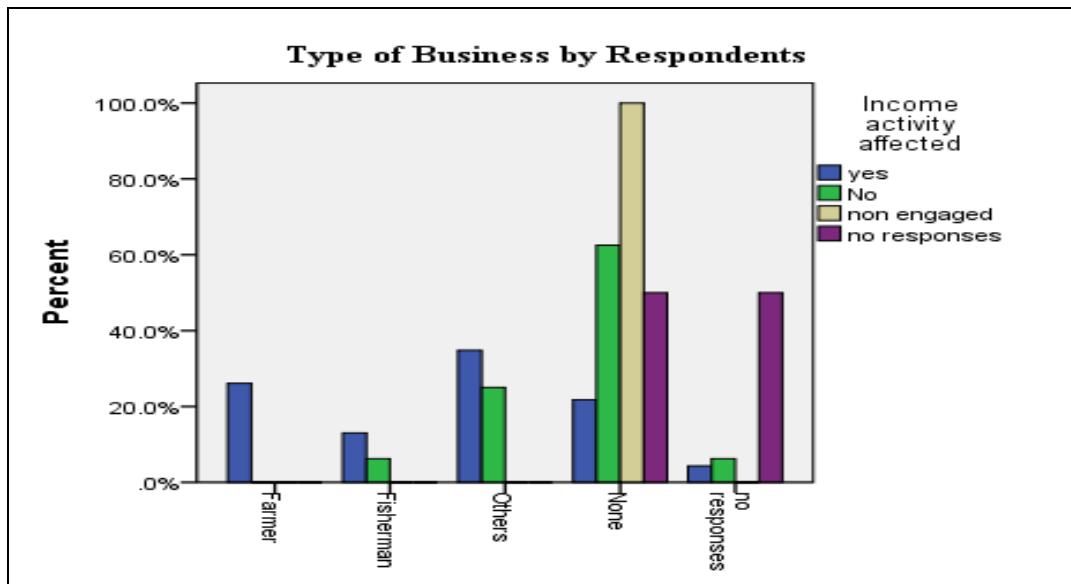


Figure 58. Types of business by respondents

When asked drought affects their family expenses, their responses are varied as shown in Figure 59.

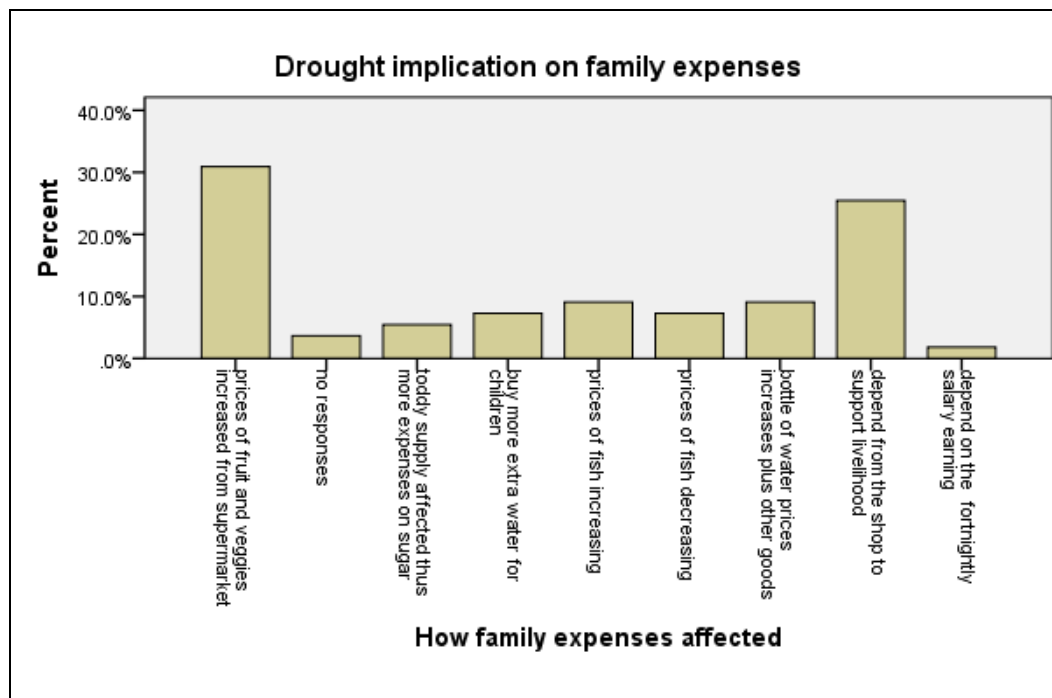


Figure 59. Family expenses affected by drought based on respondents.

For instance, 30.9% stated that prices of fruit and vegetables increased from supermarkets, 7% buy extra water for children, 5 % stated that toddy supply affected thus more expenses on sugar, 9 % stated bottle of water prices increases plus other goods including prices of fish at the supermarket while 25% depend from the shop to support livelihood though 1% depend on their fortnightly salary earning. If these responses analyzed, it seemed that trend on family expenses is greatly affected. Even those relying on their salaries; their family expenses on food alone will be affected as well as prices of goods as stated above increases as business people taking advantage of the situation to generate income. The finding from other study also highlighted this problem in South Tarawa during drought that should the groundwater deteriorate to the extent that these trees have reduced yields or no longer bear fruit, households income could experience an increase 10% of their food budgets which may pressure them to prioritize their income towards foods and away from schooling or hygiene products (UN)CHA, 2011).

As for the water tap in Figure 60, 9.09% stated that water turned saline during drought event, 63.6 % respondents' stated tap water affected as it rationed in their areas and 20% experienced a low pressure and therefore creating hardship on the family.

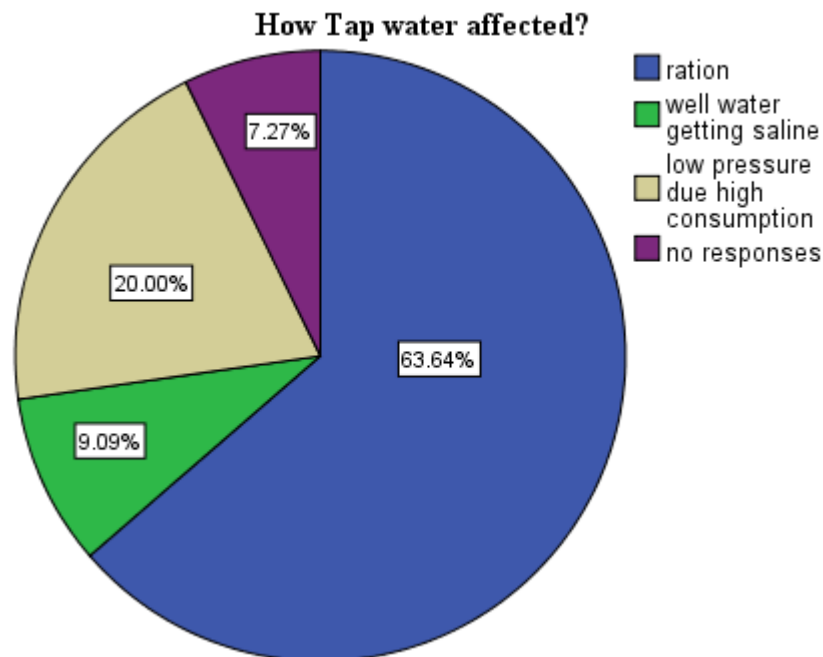


Figure 60. Drought impact on regulated tap water supply.

When asked did they get extra water from their neighbours during drought, 56.4% respondents said no while 43.6% said yes as shown in table 14. The reasons for those who did not varied as 18.2% mentioned not to cause a burden to them as they reserve their water as well for their family and also they had limited water supply while 14.5% had plenty of water supply as stated in Figure 62. The other respondents (1.8%) who received water have a good relationship. For those who received water from their neighbour when interviewed, only in certain circumstances like in scarcity of rainwater during prolong drought event or feast or social function when they ran out of water with them or when a lot of people stayed with them and so they asked their close neighbour. So the impact of drought can brings people together to work together and assist each other like sharing water in time of stress only.

Relationship on Extra water		
Respondents (Number)	Respondents (%)	Category
24	43.6	Yes
31	31	No

Table 14. Responses on extra water from respondents

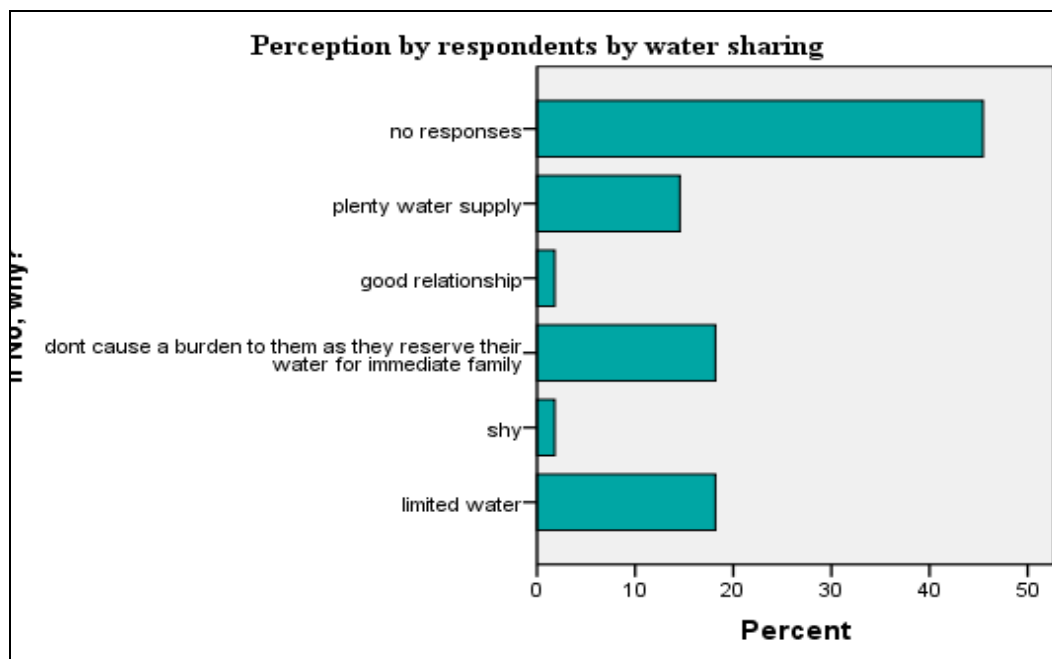


Figure 61. Reasons of water sharing (or not) by respondents

Another social negative implication that is obvious is the spread of diseases due to congestion and poor sanitation. For instance, asthma, pneumonia, diarrhoea and conjunctivitis are prevalent and spread easily during the 1998-2000 droughts events. This can be seen in the number of cases of mortality rate reported to the Health Statistic as stated in Figure 39. Considering the high number of people living in South Tarawa with a population density of 3,184 people per square kilometres, there might be an inconsistency and reliable of the data attributed to the missing number of patients reported to the Health or Clinic Centres in villages prior and during 1991 including 2002. However, what crucial here is that drought event contribute to the spread of diseases' in overcrowded places especially in major towns. If compared with the result obtained from the respondents' as how drought affects their livelihood in term of sicknesses, it is understandable that the following sicknesses are common such as diarrhoea, dengue fever, asthma, pneumonia and others of which pink eye (41.8%) was the predominant case affecting population (different age groups) due to the presence of floating dust as stated in Figure 40. Diarrhoea (29.1%) follows which could be attributed to poor water quality and diets including not cleaning hand before meals (unhygienic) while pneumonia (1.8%) is the lowest due to intense heat as stated in Figure 62 below.

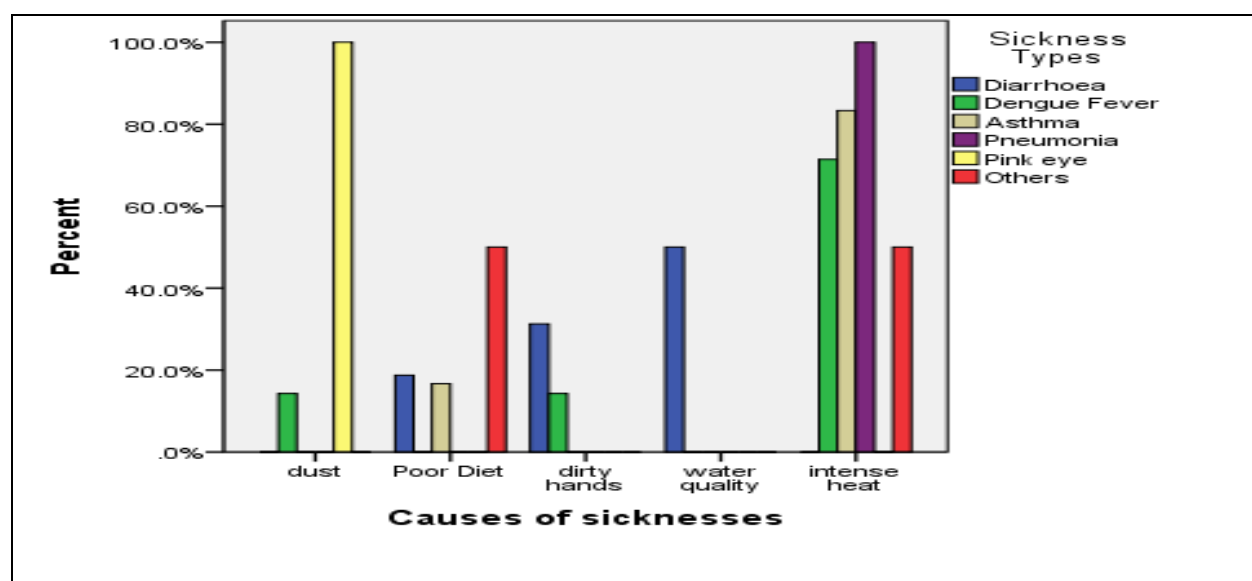


Figure 62. Causes and types of sicknesses.

As reported by Tokamauea (2009), the impact of drought was substantial and the 1998-99 droughts for example, dried rainwater tanks in South Tarawa and caused shallow groundwater reserves which became brackish and caused fatal diseases. When rain arrived in March and April 1999 it contaminated groundwater wells causing a high incidence of diarrhoea. There was no correlation found between drought and the occurrence of water-borne diseases. This is confirmed according to the health statistic from the Ministry of Health and monitoring data from the Health Environment Unit jointly produced by the UN Office for the Coordination of Humanitarian Affairs (OCHA Pacific), UNICEF and Applied Geosciences and Technology Division of the Secretariat of the Pacific Community (SPC/SOPAC)(UNOCHA, 2011, p.3). However, there is no doubt that drought contributes directly or indirectly to the causes of water borne disease such as diarrhoea. Without the occurrence of prolonged drought these diseases would not be able to form and spread as floating dust might contaminate rainwater and increased sanitation problems. Such suspicion is raised by a World Bank (WB) report regarding the anticipated health impact based on Kiribati climate models for 2050. The report predicts that if rainfall is decreasing, drought would increase the incidence of diarrhoea as water shortages exacerbate sanitation problems. Furthermore the projected rise in temperature may increase the incidence of diarrhoea, primarily by increasing the likelihood of spoiled or contaminated food (WB, 2000, p. 26).

Overall, in terms of how stressful the impact of “*te mwautakataka*” from the respondents perspectives as stated in Figure 41, almost half (47.2%) stated that it is moderately stressful, while 27.2% claimed that it is very stressful, and 1.8% said it was extremely stressful. On the other hand 16.3% assumed little stress, and 7.2% affirmed it is not stressful at all. From the above responses, one’s can confirm that drought was really stressful to the people as the majority of the responses indicated that drought was very stressful and had negative implications to their livelihoods.

4.3.4 Analysis of te mwautakataka implication to the environment in South Tarawa.

Based on the information on 3.4.7 regarding the status of Tarawa land environment during drought events, it is visible that the impact is great such as trees like coconut, breadfruit and pandanus leaves are affected and the growth of these trees especially during the 1998-1999 drought event with the latest 2009 -2011 had been disturbed. The soils were really dry and hard

causing floating dirt and dust during windy times and passing vehicles as manifested in the image on figure 39. The well water turned brackish or saline in some areas such as Bikenibeu, Eita, Bairiki and others.

As for the marine environment, inshore fisheries tend to be less productive during the La Niña episode (Government of Kiribati, 2007) though according to the findings from the respondents, the majority stated that drought is a “blessing in disguise” as they get more fish and small octopus (*kaonako*) around the reef flat although a small percentage (25%) implied that marine species were decreasing. Similar sentiment were mentioned with regards to “*te maroro*” when a well known informant business fisherman in South Tarawa said that during a hot season “*e a maeu marawa*”¹⁷. If compared with the data from the fisheries division, ocean fishing (using canoe or outboard motor) and the lagoon with reef fishing are increasing dramatically during the 1998-2000 period and then decreasing again. The collection fishing on the reef flat shows a slight increased throughout the drought period of 1998 to mid 2001. Although such positive trend in coastal fishing happened it is believed that inshore fisheries is negatively impacted as stated above due to climate change effect maybe as an impact of coral bleaching as it is a reality in Kiribati including Tarawa (Donner, 2007).

4.4 Part 3. Government strategy to Mitigate Disaster in Kiribati

4.4.1 National Disaster Risk Management Plan

The creation of the National Disaster Act in 1993 in the Republic of Kiribati signified the commitment of the Government in the protection of the people and their properties from any natural or man-made disaster. The Act provides guidelines in the mitigation and recovery strategy to various Government institution and other stakeholders such as Non-Government Organization (NGOs) like Kiribati Red Cross, various Church groups and others that are obligated to the safety of the citizens including provision of disaster relief. For instance, if there is a disaster in the country, then there is a high level of coordination and communication between various Ministries with the National Disaster Council at the apex via the National Disaster Management Office including NGOs such as Church Groups and other stakeholders to mobilize the public or communities within South Tarawa or Kiribati as a whole in order

¹⁷ It figuratively means “the ocean is alive with plenty tuna species”

to mitigate the impacts of any disaster that struck the main capital of South Tarawa or Kiribati as a whole.

In such case the Police Task Force has to coordinate emergency response to prevent chaos developing. At the same time it is mobilizing the general public in an orderly manner while the Red Cross and other NGOs provide relief such as food and water, clothes, shelters amongst others. Below is the structure of the Disaster Response Plan to the community (Diagram 3).

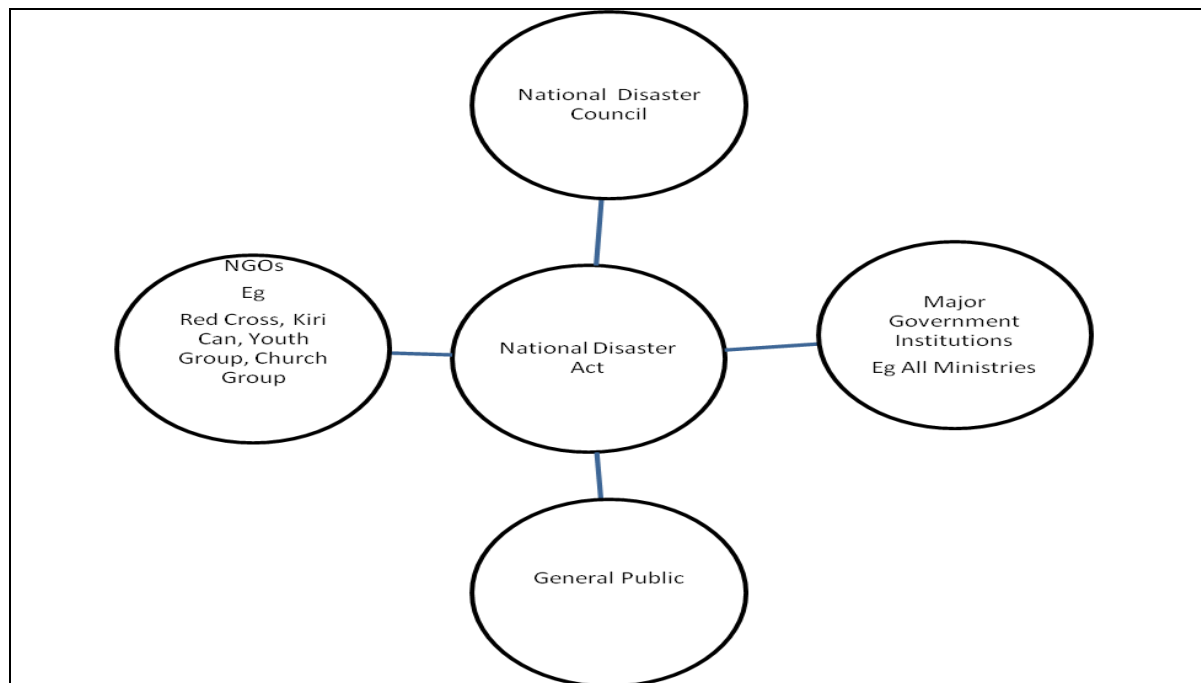


Diagram 3. National Disaster Response Plan

(Source: Tokavou, 2010)

4.4.2 Government Drought Response Plan

In the case of drought mitigation in Kiribati, there is no Drought Response plan for Kiribati as a whole but only for South Tarawa. For South Tarawa there is a Drought Committee (DC) which is chaired by the National Disaster Management Office (NDMO). It comprises technical members that are heads of various divisions such as the Public Utilities Board (PUB), the Water Engineering Units (WEU), Kiribati Meteorological Services (KMS) and the Environment Health Division from

the Ministry of Health and Medical Services (MHMS). Other division from other Ministries can be added if it deemed necessary as stated in diagram 4 (Government of Kiribati, 2011).

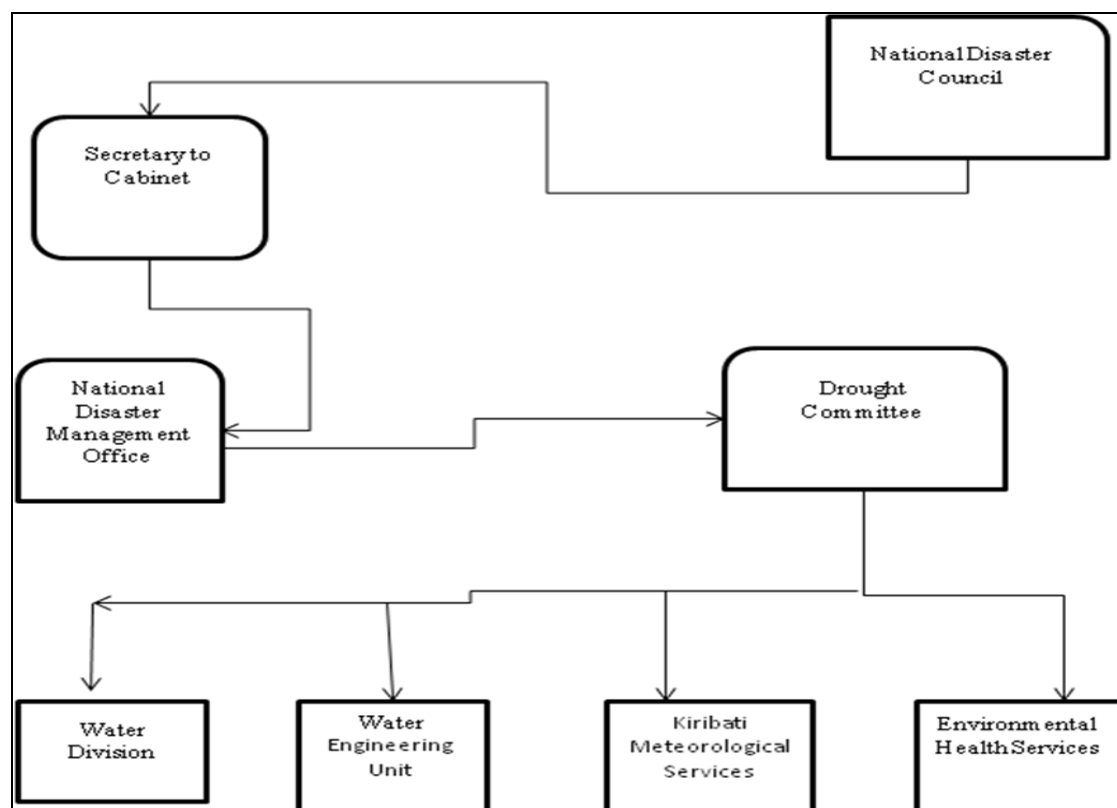


Diagram 4. Drought Response Organizational Structure

(Source: Government of Kiribati, 2011)

Diagram 5 manifest the Drought Response Organizational Structure in South Tarawa especially on the procedures of alerting drought warning by the DC members such as:-

- DC is to be convened based on the advice and the request of any member to decide on the issuance or lifting of an alert and its level.
- A situational analysis paper is to be drafted with input from DC agencies on the status of the national water resources and climate outlook for raising and uplifting

an alert Level to inform National Disaster Council (NDC). In this case, the Drought Committee chair (NDMO) is to make recommendations on a particular Level of Alert to the chair of the NDC through the development of this situational analysis paper.

- The DC is responsible for issuing Alert Levels 1 and 2 and any public warning associated with the onset of drought.
- Upon the release of Alert 1 and 2, the Chair of DC (NDMO) is compelled to submit a situational analysis paper to NDC through the Secretary to Cabinet as an information and status update.
- NDC is responsible to advice Cabinet to issue Alert 3 for “Drought Declaration” upon the advice from the Drought Committee.
- NDMO will be responsible for coordinating any associated actions based on Drought Response Action Plan (DRAP).

Despite the above procedures for warning, the DC agencies works according to the DRAP depending on the type of alert levels issued with proposed actions in order to warn, prepare and mobilize the communities. In this case, level 0 is no alert while level 1 and 2 signifies warning to the general public. Level 3 is a critical stage whereby drought is declared based on the advice from KMS outlooks for rainfall and the most recent observed status of the freshwater lens (reserved galleries) at Buota and Bonriki that supply the communities if it level is reduced and deteriorating.

Alert 1 is issued if the rainfall amount is less than the 40th percentile (250mm) for 3 months drought index while alert 2 is lifted if the condition persists for the averaged of more than 36, 48 and 60 months drought index but still lesser than the same percentile (40th). Alert 3 is issued if the rainfall is lesser than the 10th percentile (50mm) for longer period such as 36, 48 and 60 months drought index.

Hence, prior to alert 1 issuance, that is alert 0; KMS produce on a monthly basis rainfall outlook to DC members and awareness on managing the water wisely due to deteriorating rainfall outlook. Once Alert 1 comes into effect, KMS is advice NDMO to make announcement through media such as radio, newspaper article and television about the rainfall outlook condition and

hence warn the public about water conservation. At the same time, DC comes into effect and then coordination and communication between agencies is strengthened and increased. In this case, the coordinating agency such as PUB announced scheduled water delivery through radio and newspapers and also tries to reduce leakage at household to protect water. The Environment Health also makes awareness on radio, brochures or articles on water quality measures within the community and advice water purification. WEU makes early warning of the impacts to small groundwater lenses and advice over the radio and newspapers about the potential impact on well water such as increased salinity over time and bacteriological content may increase.

If the situation persists until it reaches level 2, PUB also makes awareness activities and early warning of impacts to major groundwater sources at Buota and Bonriki water galleries especially on the trend of salinity levels to the general public over the media and submit report to the DC. At the same time, PUB identifies vulnerable water-users and improved water supply at those at risk most within the population especially those who are not connected or access to the main PUB supply like squatter settlements or received low pressure water due to leakage or breakage in the pipe. If the situation is still worsened due to extended dry condition (no rainfall) and reaches the 10th percentile threshold or lesser, drought is then declared. In this case, water rationing is enforced by PUB and water conservation awareness within the community is implemented. Delivery of water is executed to the most affected communities by PUB. KMS with WEU continues to monitor the rainfall outlook and underground status and warn the public.

4.4.3 Perception about DC existence by Respondents

Based on the respondents, there are different responses regarding the popularity of the DC as their responses are varied within their age and gender as shown below in Figure 63. For instance, within the age of >51 years, there are 12% female while 6.6% male had an idea about DC. Within the age category of 41-50 years, 8.8% female and 13.3% had a prior knowledge about DC while 8.8% for female and 3.3% for male for the age of 31-40 years old. In the case of the age group of 21-30 years old, 6.67% for male only. It seemed that older people knew the existence of DC in South Tarawa compared to the younger population. It could be attributed to the older generation stay homes and listening to news from the media while the younger populations are active and stay out.

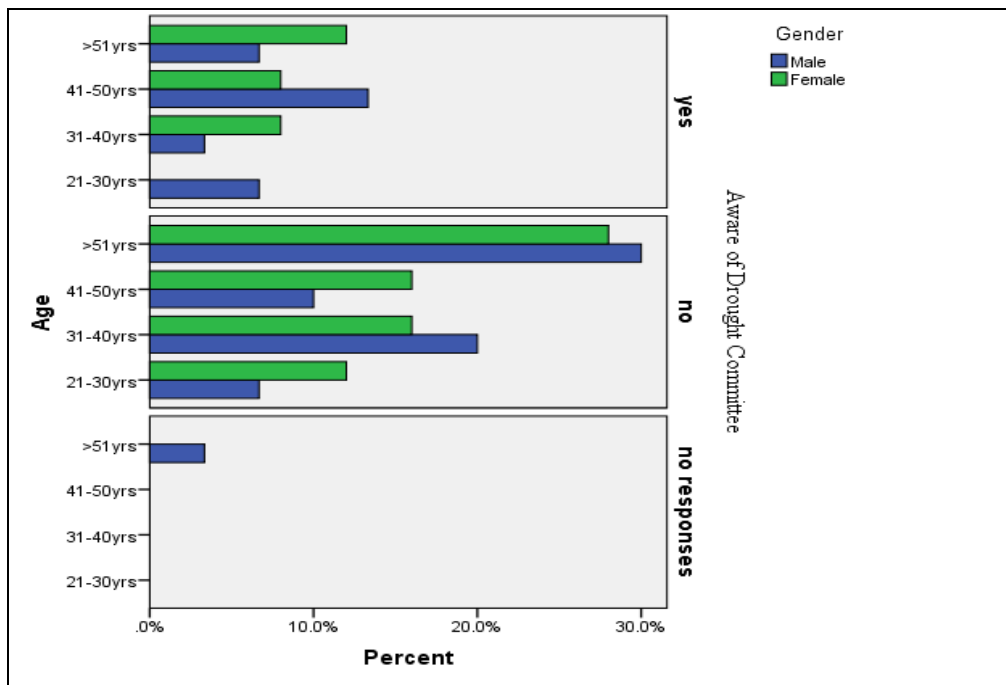


Figure 63. DC popularity by respondents based on Age and Gender

4.4.4 DC Popularity by Respondents

It is interesting to see based from the responses regarding the status of DC in terms of its popularity as 65% from the respondents stated that they had received drought warning, 27% did not, 1.8% claimed “not often” while 5 % had “no responses” as stated in figure 64 below.

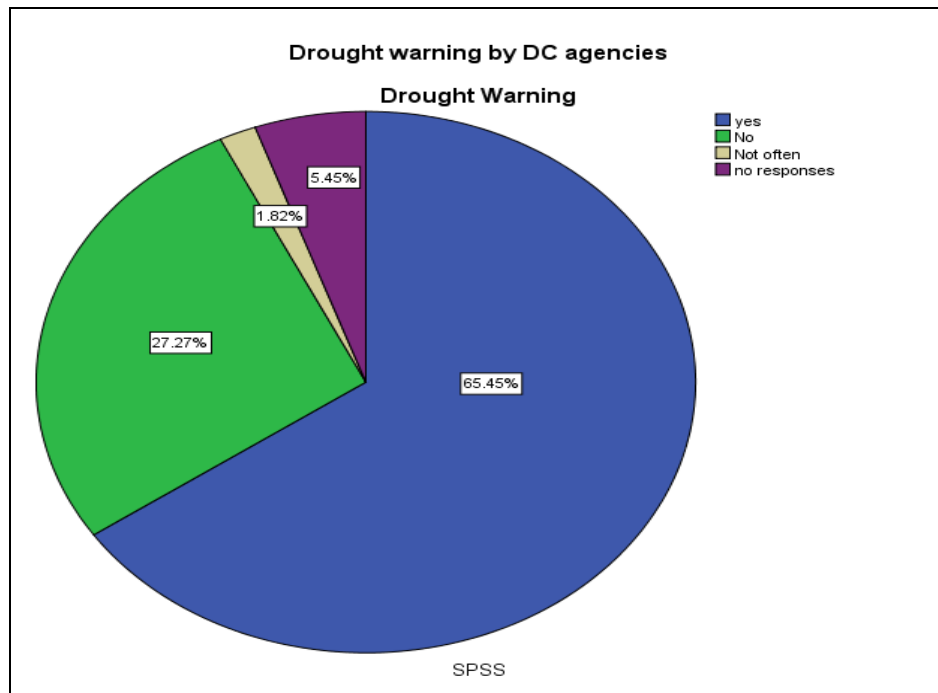


Figure 64. Drought warning by DC agencies.

There is a drought warning announced by DC agencies such as KMS (10%) through the media. The sources of drought warning is the radio (highest) followed by the local television, then the newspapers and a small percentages from the neighbourhood as stated in Figure 65 below.

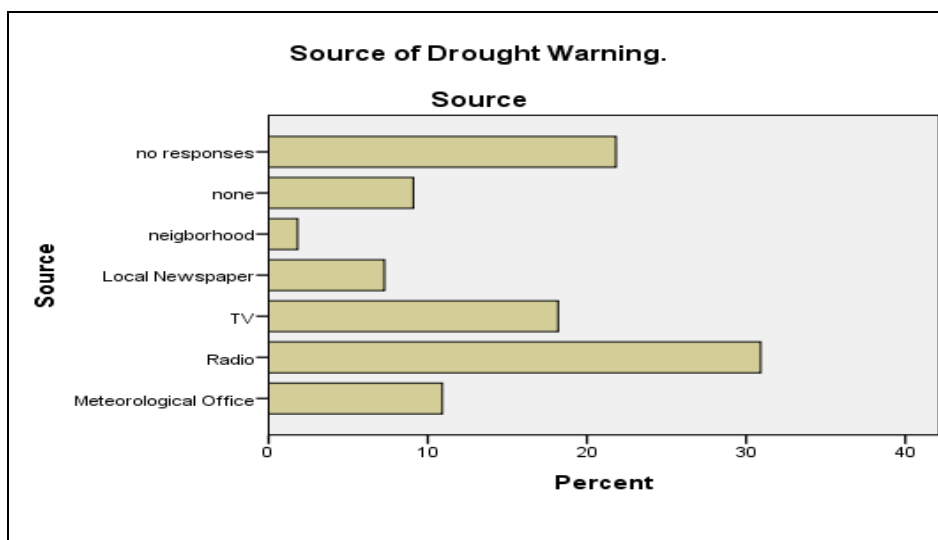


Figure 65. Source of drought warning

4.4.5 DC assistance to the Public during drought event

In terms of any kind of assistance given from the DC and other NGOs to the general public during a drought event, there seems to be no clear policy and responses varied as stated in Figure 66. For instance, 45% of the respondents stated that they received water supply from Government. This could be in the form of delivered water by the Government Water Tank Vehicle. 1.8 % received food provision from NGOs' (properly from the Red Cross and Church Groups) while 40% stated "none" and 12.7% had no responses. It seems that the DC cannot issue food and other financial means to all the affected communities since it does not have the resources to do that. Water is a precious resource that everyone needs it for sustenance in order to make a living. With the increasing population in South Tarawa and because of the increasing demand of water especially during drought, the government built a "Desalination plant" in South Tarawa to help and ease the problem of shortage of water when water is regulated to flow on a timely basis.

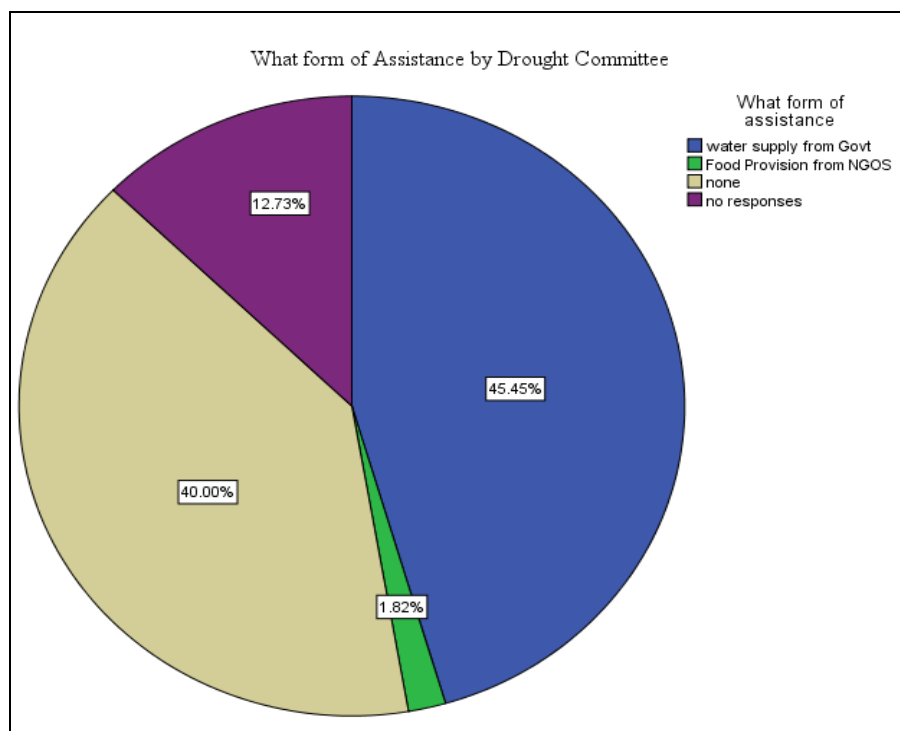


Figure 66. Form of Assistance by DC.

“The best way to escape from a problem is to solve it”

Brendan Francis

CHAPTER FIVE

Chapter 5

5.1 Our Achievements

This section summary the main points of the above chapters and then pursue with the conclusion part which highlights the major findings and provides recommendations mentioned by the respondents.

Chapters 1 glimpse at the introduction in term of drought characteristic, impacts on global perspectives and typologies and then elaborate on its global occurrence with a global map to show major places where drought occurs and then zoom to the Pacific Context and Kiribati. It also looks briefly at factors that determine the causes of drought in Kiribati. The background study glares at drought incidence in the Pacific Island Countries including factors that causes drought event within their respective countries including Kiribati. Additionally, it also gazes at International Emergency database on the number of disasters event occurring in the Pacific Islands Countries since 1950 – 2004 which drought is also part of it including past drought incidence in Kiribati history. Moreover, it is also investigate the literature review on the status of drought including the vernacular term which will be used as a threshold to determine drought event in the study area. This chapter also covers major livelihoods in Kiribati including South Tarawa which are mainly impacted and this posed a challenging task on the Government to alleviate its impacts on peoples' livelihood and end with the aim and set of objectives to be achieved, the significance and rationale of the study, the study methodology employed and the conceptual framework of the thesis. The last part of this chapter is the structure of chapters' content for the thesis.

Chapter 2 gazes at the drought negative impacts on a global scale and then zoom to the Pacific context including the study area in Kiribati. Additionally, it is also looks at the Conceptual Framework of Drought Risk Reduction including the cycle of the disaster management which involves several steps and then specific to the 10 steps of drought planning processes. Furthermore, it also explores the possible drought definitions in details from the different

scholars as drought definition should be context specific to suit a particular place, the various types of drought such as meteorological, agricultural, hydrological and socio- economic drought which are used as a threshold to define drought event in a particular place. Moreover, it is also exploring the different types of indices with their strength and weaknesses that could be utilized in the case study. It concludes with the drought event definition that will be used in the study area.

Chapter 3 covers two parts. First it identifies the social science methodologies employed during the implementation of this research such as questionnaires to the focus group, “te maroro” approach and browsing online journals articles, newspapers and other sources such as books, newspapers and correspondence through emails with key informants including consulting the different institutions regarding qualitative and quantitative data. Furthermore, it also manifest tools used in the compilation of this dissertation such as SPSS, Camera, Microsoft Excel, and GIS Arc Map to complement the research including the calculation procedures for the percentile and SPI to work out the worst drought years. Moreover, the second part of this chapter is highlighting the country profile in term of brief history, geography, climate, geomorphology and biogeography and demography and the cultural, social, and economic status of Kiribati. As for South Tarawa, it glimpses on the physical characteristic, climate, population, water supply and economic activity. It ends with description of the social-economic and environmental performances of Kiribati and then the study area-South Tarawa.

Chapter 4 elaborates in details the solutions or major findings of the research questions that need to be investigated through the objectives in Chapter 1. It is divided into three parts, as the first part highlight the summary tabulated result based on the SPSS. The second part look at the social, environmental and economic impacts on the study area while the last part highlight the strategies used by the Government of Kiribati to mitigate drought impacts on peoples’ livelihood in the study area.

Chapter 5 is the conclusion part which summarizes all the main part in the four chapters and then all the major findings on drought impact in Kiribati in general and then specifically glimpse on the case-study. It is also highlight recent Government activities and explore some possible recommendations from the respondents.

Drought is a multi variable factor and therefore defining a drought event should be context specific as there is no single or universal or common definition of drought. There are four types of droughts such as meteorological, agricultural, hydrological, and socio-economic drought. In Kiribati, drought is known as “*te mwautakataka*” and it is utilized as a threshold to define drought event in the case study- South Tarawa. In South Tarawa, the drought warning comes in effect when the precipitation is decreasing and reaches 40th percentiles where the rainfall is 250mm. The official declaration of drought is when the rainfall reaches a threshold of 10th percentile with the observed status of the main water gallery at Temaiku and Buota that supply the public with freshwater.

Based on the analysis of the rainfall data between 1947 and 2011 to determine the worst and severe drought years based on the two seasons orientation using the percentiles and SPI method for the total annual precipitation, it is apparent that the November 1949 to October 1950 is the worst drought year as far as the rainfall data is concerned. In this period Tarawa received only a total precipitation of 298.8mm. In terms of selected months of August, September, October and November for a comparison between the five worst drought years for the most severe months, the 1998 is the most severe or driest year as the total precipitation for the selected four lowest monthly precipitations of 12.9mm; the lowest compared to other years. In terms of the greatest drought magnitude or longest drought events the 1998 to 2000 drought event is the longest and has the greatest impacts because of its duration which covers 3 years as shown in the Wet and Dry Seasons Graph respectively in Figure 52 and 53.

The negative social, economic and environmental impacts of the “*te mwautakataka*” are varied and from Islands to Islands and locations for the whole of Kiribati. For instance, its implication on peoples’ livelihood is clearly manifested from the people of the Southern Islands such as Tamana and Arorae in the mid 20th Century when the Islanders voluntary through KILT to work as labors in Fiji and other countries or the relocation of the Phoenix Islanders. Other negative implications are on school children in Kiribati when they are feeling uncomfortable due to intense sunlight and scarcity of drinking water especially rainwater. Drought also affects the working hours of the people in rural communities as they start work early from 5.30am in the morning so they can finish early avoiding the scorch of intense heat. Just imagine the situation from prolong drought events. The spread of recurrence diseases is common such as flu and conjunctivitis due to floating dusts and intense heat that affect people well being and makes them

inactive. Moreover, the increasing use of local fans during the day shows how the people feel uncomfortable during the day from intense heat. In terms of the economic performance of the country, it is evident that *te mwautakataka* affects the fishing industry through decreasing fishing license revenue as it has been the case of the 1998-1999 drought event as also highlighted by Thomas (2003). This also applies to the total number of catches of tuna by foreign vessels through offshore fishing in Kiribati water within the same period as stated in Figure 33. In the case of the total amount of catches for commercial and informal sector in Kiribati in Figure 34, there is a positive trend which shows that coastal fishing is not necessarily affected by drought. Agricultural production of Kiribati (copra and non-copra) production was decreasing from 1998 to 2000 as shown in Figure 27. This also applies to the production and export value period as it decreased from 1999 to 2001 in Figure 28. Additionally, the negative trend can also be seen in the trend in the combined sale and consumption of vegetables in Figure 30 including the separated consumption and sale expenses only of vegetables in Figure 31 and 32 respectively. In terms of the environment, the negative impact on trees is tremendous as breadfruit tree leaves turn brown and the coconut trees leaves turn yellow which affect the size, quality and quantity of coconut which people depend on to generate cash from copra and thus affect peoples' livelihood. Moreover, the well water turns saline (or brackish) affecting the quality of the water source which is used for drinking in outer islands and even at Tarawa.

In the study area, South Tarawa, it is evident that the negative impact of “*te mwautakataka*” is noticeable especially the 1998-1999 drought events. For instance, the 1998-1999 drought events affected people's livelihoods in the sense that the coconut and breadfruit trees were affected as their leaves turned brown and thus affected the growth of these trees and their fruits which they depend on for food security and generating money. For instance, the breadfruits fruits (both ripe and unripe) is used to be sell in the market and the leaves of the coconut trees is used to make brooms and even the coconut is sold in the market.

The Giant swamp taro (*te babai*) is also affected as the trees turn brown and thus affecting the quality the corm (roots) of the tree. The corm of ‘*te babai*’ is a precious food as it only eaten on special occasion. When it dies, people have to buy more expensive food from the shop such as rice, cassava and taro as a substitute for it. Vegetables farming such as cabbages, tomatoes, eggplants, watermelon, beans and others for sustenance are also affected.

The water turns saline and affects people's health as the quality of water is deteriorating. The dry condition of the soil and roads is also a nuisance to the people as it creates sicknesses such as diarrhoea and conjunctivitis when dust carries pathogens. Coastal fishing on the other hand seems not to be affected based both on respondents and data collected from the fisheries department on all types of fishing activities such as ocean, reef, lagoon and collection. These data validate this positive trend though it in the literature it is stated that inshore fishing activities is decreasing most likely as a result of coral bleaching at Tarawa. There is a need to reinvestigate the impact on coastal fishing in Tarawa to substantiate previous findings or to do similar research like this to cast more light on the impact of drought on coastal fishing and to see the real trend during prolong drought events. It seemed that people livelihoods' on coastal fishing are not affected during droughts event as abundance of fish species and octopuses on the reefs are reported.

The government is well informed and prepared to mobilize the communities in South Tarawa and throughout Kiribati when "*te mwautakataka*" is about to happen. There is no drought response plan in place for the whole of Kiribati but only for South Tarawa. In South Tarawa, the presence of DC to monitor drought onset and termination shows how committed the Government is to mitigate the impact of drought in the study area especially on peoples' livelihood such as drought warning to the people through the media and also giving advice and information to the people by the different agencies including the delivery of water supply to the affected communities. However the Government at this stage cannot assist everyone to give food ration in the study area. Hence, it is apparent that the different tasks assigned to the DC agencies to mobilize the community are really effective.

To conclude, drought is known as "*te Mwautakataka*" in the study area. It has very destructive effects to people and to the environment in Kiribati and South Tarawa. The negative social and economic implications are to the macro-economy as well as to peoples' livelihoods in Kiribati. The case study shows that the Government and the people are well informed when a drought event is imminent through the DC. Hence, drought is a crucial issue in the study area and Kiribati as a whole as a result of its recurrence and serious impacts on people.

5.2 Recommendations to Government strategies and activities.

The Government of Kiribati is taking climate change and its impacts very serious. In recent years, significant improvement in understanding the relationship between disasters and development developed. This led to the emergence of Disaster Risk Management Plan (which provides a framework to manage this complex environment) and was drawn from the National Disaster Acts 1993, National Disaster Management Plan 1995, the 2010 Draft National Disaster Plan and the knowledge and expertise of key personnel from government and non-government organizations (Government of Kiribati, 2012).

However, one of the most recent developments initiated by the Government of Kiribati in mobilizing the community is the Climate Change Public high-level hearing held on the 19th April, 2013 at the Bairiki Square in South Tarawa to build resilience from climate change impact. Among these impacts there is also drought due to climate variability (Government of Kiribati, 2013). The public hearing was live broadcast on the television and also aired through the national radio for rural dwellers in outer islands where members of the public could raise doubts to members of the Panel later. The Panel is made up by the Parliament Select Committee on Climate Change and involves key figures namely Head of State, Head of Faith-Organizations, Head Of Gender-Based Organizations, Leaders of Political Parties, Representatives of Youth, Independent Local Scientists and Regional Scientific Organizations and concerned citizens. Additionally, in May 2014 the Government of Kiribati purchased 6,000 acres of land on Vanua Levu, the second biggest island of Fiji. The land is to be utilized to support food production and strengthen food security for the people of Kiribati. This will also help in times of drought and declining agricultural production in Kiribati itself.

Despite the above initiatives by the Government, there is a need to develop a Drought Response Plan for the whole of Kiribati and also to cater for the immediate need of the communities highlighted in Figure 67. One's should note that drought also plays an important role here as it has the potential to seriously compromise people's well being and therefore if these recommendations from the respondents are considered in the planning, then I am confident that it can assist in the Disaster Risk Management especially on future risk drought impact on the community in the study area and even Kiribati in general.

Given below are the possible recommendations from the respondent regarding the Government and NGOs' that need to be considered by both parties as stated in Figure 67. These are shown as follows:-

- ✓ Increase public awareness
- ✓ Identify priority needs and funding assistance to the community.
- ✓ Good cooperation and coordination between NGOs' and Government.
- ✓ Request technical experts to demonstrate how to reserve local food.
- ✓ Provide escape ways for migration if drought worsens.
- ✓ Promote workshops to share drought experiences.
- ✓ Install more water tanks to Government buildings.

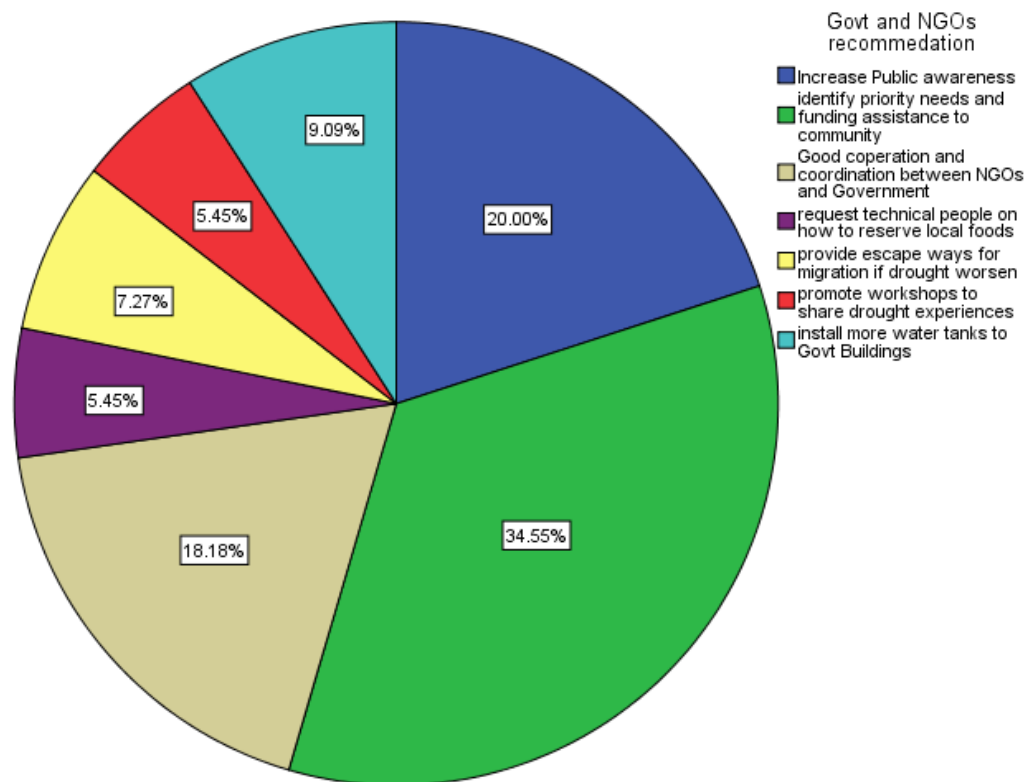


Figure 67. Possible recommendations from the respondents.

As member of the Pacific Island Forum Secretariat, the South Pacific Community (including SOPAC), many activities of drought mitigation are carried out on Pacific Island basis including funded projects initiated by the World Bank, European Union, UNDP, WHO amongst others also benefit Kiribati and its people.

To master the impacts of climate change and in particular drought, however the country will do better with outside support to be able to mitigate adverse conditions.

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Appendices

Appendix 1.

Mean Maximum Temperature for Tarawa, Kiribati

Mean Maximum Temperature data (mm) for Tarawa, Kiribati													
Station J61000		Latitude 01 21 N		Longitude 172 56 E		Height 2m							
Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1947	30.1	31.0	31.1	30.9	30.8	28.3	31.0	31.1	31.5	31.4	31.6	30.7	30.8
1948	30.2	30.7	30.3	30.7	30.9	31.2	31.5	31.6	31.9	31.6	31.0	31.1	31.1
1949	30.1	31.1	30.6	30.6	31.2	31.3	30.6	31.2	31.3	31.2	31.1	31.2	31.0
1950	30.8	31.0	30.7	31.0	31.3	31.4	31.2	31.1	30.8	31.6	31.7	31.4	31.2
1951	31.1	31.3	31.4	31.9	31.6	31.3	31.5	31.7	32.1	32.4	33.1	31.8	31.8
1952	31.1	31.3	30.7	31.3	31.5	31.3	31.3	31.8	31.8	32.2	31.9	31.3	31.5
1953	31.1	30.9	31.2	31.2	31.4	31.7	32.2	31.8	31.9	32.6	32.7	30.9	31.6
1954	31.1	31.3	31.2	31.1	31.3	31.6	31.1	30.9	31.6	31.6	31.8	31.8	31.4
1955	31.9	30.8	31.3	31.0	31.1	30.7	30.3	30.4	30.6	30.4	30.7	30.9	30.8
1956	31.5	30.5	30.7	31.3	31.5	31.1	30.6	30.8	31.1	31.5	31.8	32.3	31.2
1957	32.1	32.0	31.2	31.2	31.7	31.5	31.0	31.2	29.8	31.2	30.4	30.7	31.2
1958	31.0	30.9	30.7	30.8	31.4	31.5	31.1	31.5	31.4	31.6	30.9	30.8	31.1
1959	31.0	30.2	30.9	31.0	31.2	31.1	30.8	31.0	31.4	31.4	31.1	31.2	31.0
1960	30.4	30.3	30.3	30.5	30.7	30.5	30.8	30.7	31.2	31.1	31.8	31.2	30.8
1961	30.8	30.7	30.4	30.8	30.8	30.6	30.8	30.8	31.3	31.1	31.2	31.2	30.9
1962	30.2	30.3	30.2	30.3	30.6	30.9	30.6	30.7	30.7	31.2	31.1	30.7	30.6
1963	30.3	30.2	30.1	30.7	31.1	31.1	31.2	31.4	31.6	31.4	31.1	30.4	30.9
1964	30.5	30.4	30.3	30.7	31.1	30.8	30.8	30.6	30.9	30.8	30.3	30.6	30.7
1965	31.3	30.3	30.1	30.1	31.0	30.8	30.7	30.1	30.6	30.4	30.8	30.5	30.6
1966	30.1	30.3	30.6	30.7	31.4	31.6	31.3	31.4	31.6	31.2	31.3	31.2	31.1
1967	30.1	29.8	30.6	30.7	31.6	31.2	30.9	30.8	31.2	31.3	31.6	31.0	30.9
1968	31.2	30.8	30.8	31.2	31.6	31.6	31.6	31.6	31.5	31.8	32.0	32.2	31.5
1969	31.2	31.2	31.1	31.4	31.8	31.2	31.3	31.8	31.9	32.7	32.7	31.9	31.7
1970	31.3	31.0	31.0	30.9	31.2	31.0	30.8	30.9	31.4	31.5	31.0	30.5	31.0
1971	30.6	30.4	30.7	30.6	31.0	30.7	30.7	30.9	31.5	31.4	31.3	31.3	30.9
1972	30.9	31.6	31.3	31.8	32.2	31.9	30.9	30.9	30.6	30.8	31.6	32.1	31.4
1973	30.7	31.0	31.4	31.3	31.3	31.5	30.8	31.0	30.4	30.4	30.4	30.1	30.9
1974	29.8	29.8	30.1	30.7	30.7	30.8	30.5	30.5	30.6	30.6	30.5	30.8	30.5
1975	30.7	30.4	29.9	30.0	30.3	30.1	30.2	30.3	30.3	30.1	30.1	29.9	30.2
1976	30.4	30.2	30.4	30.3	30.6	30.3	30.1	30.2	30.8	31.7	31.4	30.8	30.6
1977	0.0	0.0	0.0	0.0	30.9	31.3	31.5	31.9	31.4	31.8	31.6	31.3	31.5
1978	30.9	31.3	30.8	30.9	31.2	31.0	31.3	31.3	31.5	31.8	31.7	31.5	31.3
1979	30.9	30.8	30.3	30.8	31.1	31.0	31.4	31.6	31.9	31.9	32.0	31.4	31.3
1980	31.4	31.3	30.6	31.0	31.4	31.6	31.5	31.5	31.3	31.8	31.7	31.5	31.4
1981	31.3	31.4	31.2	30.9	31.0	30.9	31.2	31.7	31.8	32.1	31.6	31.0	31.3
1982	31.5	31.2	31.5	31.4	31.8	31.9	30.4	30.7	30.8	30.7	30.7	31.1	31.1
1983	31.4	31.2	31.5	31.6	30.6	31.1	31.1	31.0	31.5	30.6	31.1	31.1	31.2
1984	30.5	30.2	30.6	30.5	30.4	30.3	30.5	30.8	31.5	31.4	31.6	31.3	30.8
1985	31.2	31.0	30.8	30.8	31.1	31.2	30.9	31.1	31.2	31.6	32.0	31.4	31.2
1986	31.2	31.0	31.0	30.8	31.5	31.7	31.1	31.6	31.2	31.8	31.7	30.7	31.3
1987	31.2	31.0	30.9	30.9	31.3	31.0	30.3	31.1	31.5	32.0	32.2	31.7	31.3
1988	31.2	31.0	30.9	30.8	30.7	30.8	30.6	31.0	31.0	30.5	30.7	30.4	30.8
1989	30.5	30.1	30.3	30.6	30.5	30.6	30.8	30.7	31.1	31.4	31.6	32.4	30.9
1990	31.0	31.8	31.2	31.2	31.6	31.4	31.7	31.6	31.6	32.2	32.1	31.9	31.6
1991	31.4	31.9	31.0	31.7	31.9	31.5	31.5	31.6	31.7	31.8	31.2	31.6	31.6
1992	31.4	31.1	31.2	30.9	31.4	31.5	32.0	31.9	32.1	32.0	31.9	31.1	31.5
1993	30.9	31.1	30.9	31.0	30.9	31.2	31.1	31.3	31.6	31.1	31.8	31.3	31.2
1994	31.2	30.6	30.6	31.0	31.4	31.4	0.0	31.4	31.4	31.2	31.5	31.1	31.2
1995	31.3	31.9	31.7	31.5	31.5	31.7	31.6	31.4	31.3	31.3	31.2	31.9	31.5
1996	31.4	31.8	30.7	30.7	30.8	30.8	31.1	31.4	31.5	31.2	31.4	32.0	31.2
1997	31.8	31.1	31.7	31.0	31.1	31.0	31.1	30.8	31.1	30.7	31.3	31.2	31.2
1998	31.4	31.7	32.1	31.9	31.3	31.2	31.2	31.2	31.3	30.9	30.8	30.9	31.3
1999	29.7	30.5	30.1	30.3	30.2	30.3	30.7	30.5	30.9	31.3	31.1	30.8	30.5
2000	30.6	30.2	30.2	30.5	30.5	30.7	30.7	31.1	31.6	31.2	31.4	31.2	30.8
2001	30.8	30.5	30.7	31.1	31.2	31.2	31.2	31.6	32.1	32.1	32.0	31.1	31.3
2002	31.0	31.2	31.0	31.4	31.9	31.7	31.8	31.0	31.3	31.2	31.6	31.0	31.3
2003	30.6	31.3	31.3	31.6	31.8	31.7	31.5	31.7	32.0	32.3	32.1	32.1	31.7
2004	30.7	31.5	30.8	31.2	31.5	31.1	31.6	31.3	32.0	32.2	32.4	32.0	31.6
2005	32.2	32.1	32.1	31.9	32.0	32.3	32.2	32.3	32.1	32.5	32.3	31.6	32.1
2006	31.7	31.7	31.7	31.4	32.1	32.1	32.1	32.4	33.5	30.9	31.9	31.6	31.9
2007	31.7	31.0	30.2	31.3	30.7	31.5	31.4	31.4	31.6	31.6	31.4	31.2	31.3
2008	30.6	31.4	30.2	31.0	30.6	30.7	31.0	31.1	31.5	32.1	31.5	31.1	31.1
2009	31.0	30.7	31.0	31.5	31.6	31.6	31.3	31.4	31.7	32.0	32.0	30.3	31.3
2010	30.9	32.0	31.2	0.0	31.6	31.3	31.1	31.1	31.1	31.0	30.4	30.5	31.1
2011	32.8	30.7	31.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	31.5

(Source: KMS)

Appendix 2

Mean Minimum Temperature data (mm) for Tarawa, Kiribati

Mean Minimum Temperature data (mm) for Tarawa, Kiribati													
Station J61000 Latitude 01 21 N Longitude 172 56 E Height 2m													
Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1947	25.4	25.8	25.6	25.6	25.4	25.7	25.7	25.7	25.8	26.1	25.8	25.6	25.7
1948	25.3	25.6	25.4	25.2	25.5	25.6	25.8	25.8	26.3	26.0	25.6	25.7	25.7
1949	25.3	25.6	25.4	25.2	25.8	25.7	25.3	25.7	25.8	25.8	25.2	25.6	25.5
1950	25.1	25.3	25.2	25.6	25.3	25.5	25.3	25.2	25.2	25.3	25.1	25.7	25.3
1951	25.6	25.6	25.6	25.6	25.3	25.2	25.2	24.8	25.4	25.9	26.2	25.5	25.5
1952	26.0	25.9	25.6	26.2	25.8	25.5	25.6	25.6	25.6	26.3	25.4	25.6	25.8
1953	24.9	25.1	25.2	24.9	25.4	25.6	25.2	25.6	25.1	26.1	26.2	25.4	25.4
1954	25.3	25.1	25.4	25.7	25.7	26.0	25.4	25.1	25.6	25.6	24.9	25.9	25.5
1955	25.7	25.2	25.4	25.0	25.9	25.5	25.8	25.8	25.3	25.3	25.3	24.7	25.4
1956	25.3	25.1	25.7	25.6	25.5	24.8	24.8	25.4	25.3	25.6	25.6	25.9	25.4
1957	25.4	26.0	25.2	25.6	25.7	25.3	25.0	25.2	24.6	25.4	25.7	25.6	25.4
1958	25.9	25.7	25.2	25.6	26.2	25.9	25.3	25.8	26.1	26.0	25.4	25.3	25.7
1959	26.2	25.2	25.9	26.0	25.8	25.9	25.3	24.9	26.0	25.9	25.5	26.1	25.7
1960	25.5	25.2	25.3	25.6	25.9	25.4	25.8	26.0	26.1	25.5	26.5	26.1	25.7
1961	25.7	25.7	25.4	25.9	25.9	25.7	25.4	25.7	25.6	25.7	25.5	25.8	25.7
1962	25.8	25.8	25.3	25.4	26.0	25.6	25.4	25.4	25.4	26.2	25.9	25.6	25.7
1963	25.1	25.4	25.4	25.3	26.1	25.5	24.9	25.4	25.7	25.1	25.1	25.2	25.4
1964	25.6	25.4	25.4	25.6	25.6	25.3	25.3	25.5	25.8	24.9	24.3	24.7	25.3
1965	25.1	24.7	24.9	24.9	25.7	24.9	24.7	24.5	24.8	25.0	25.4	25.2	25.0
1966	25.2	25.2	25.2	25.4	25.7	25.6	25.3	25.8	25.2	25.4	24.9	25.3	25.4
1967	25.3	24.9	25.3	25.3	25.9	25.6	25.4	25.1	25.2	25.3	25.2	25.4	25.3
1968	25.3	24.8	25.3	25.1	25.0	25.1	25.3	24.8	24.7	24.9	24.5	24.9	25.0
1969	24.8	25.0	24.8	25.3	25.9	25.0	25.3	25.2	25.2	25.6	25.7	25.2	25.3
1970	25.4	25.5	25.4	25.4	25.9	25.4	24.9	25.3	25.4	25.1	23.8	23.9	25.1
1971	23.5	23.7	24.1	23.8	24.2	24.1	23.7	23.9	24.1	23.9	23.9	24.1	23.9
1972	23.7	24.8	23.9	23.9	24.3	24.0	23.1	23.2	23.6	24.6	25.2	25.3	24.1
1973	25.1	25.7	25.7	25.5	25.4	25.7	25.3	25.6	25.5	25.0	25.2	24.9	25.4
1974	24.2	24.9	25.3	25.2	25.3	25.5	25.2	25.2	25.2	25.5	25.2	25.3	25.2
1975	25.1	25.2	24.4	24.8	25.2	24.4	25.3	25.3	25.3	25.1	25.0	24.8	25.0
1976	24.8	25.2	25.1	24.8	25.3	24.2	24.5	24.0	25.1	25.6	25.6	25.0	24.9
1977	N/A	N/A	N/A	N/A	25.0	25.0	25.1	25.2	24.9	26.4	25.0	25.5	16.8
1978	25.1	25.4	25.0	25.2	25.8	25.3	24.9	25.1	25.3	25.0	25.7	25.1	25.2
1979	25.0	24.2	23.9	25.1	24.9	24.8	24.9	24.8	25.4	24.9	24.8	24.3	24.8
1980	24.5	25.0	24.1	24.8	24.5	25.0	24.8	24.2	24.8	25.3	24.8	25.2	24.8
1981	25.6	25.4	25.0	25.1	25.6	25.5	25.6	25.2	26.1	25.8	25.8	24.9	25.5
1982	26.0	25.7	26.2	25.6	25.6	25.6	24.6	24.8	25.0	25.1	25.0	25.5	25.4
1983	26.1	26.0	25.9	26.3	25.1	25.0	25.3	25.7	25.8	25.3	25.5	25.7	25.6
1984	25.2	25.2	25.4	25.0	25.2	24.9	24.8	25.1	26.0	25.4	25.8	25.8	25.3
1985	25.8	25.7	25.7	25.5	25.7	25.7	25.4	25.8	26.0	26.2	25.6	25.6	25.7
1986	25.5	25.5	25.9	25.8	25.9	25.6	24.9	25.4	25.0	25.2	25.5	24.8	25.4
1987	25.5	25.5	25.5	24.9	25.7	25.6	25.0	25.2	25.6	25.6	26.0	26.3	25.5
1988	26.0	25.5	25.7	26.0	25.5	25.8	25.6	25.8	25.7	25.6	25.4	25.0	25.6
1989	25.3	24.9	25.2	25.3	25.1	25.5	25.7	25.5	25.2	25.7	25.3	25.0	25.3
1990	24.9	25.2	25.2	24.9	25.8	25.5	25.1	24.9	24.9	26.1	25.4	25.2	25.3
1991	25.1	25.6	25.6	25.9	25.7	25.4	24.8	24.5	24.8	24.7	24.7	25.3	25.2
1992	25.0	25.4	25.4	25.0	25.4	25.5	25.1	25.2	25.4	25.5	25.4	25.1	25.3
1993	25.1	24.7	24.4	24.9	24.7	25.1	24.9	24.9	24.8	24.9	25.5	25.5	25.0
1994	26.1	25.8	25.7	25.7	26.0	25.5	25.5	25.0	25.1	24.8	25.2	25.7	25.5
1995	26.0	25.9	25.6	26.3	26.2	26.4	25.9	26.3	26.5	26.0	25.9	25.8	26.1
1996	26.0	25.8	25.8	25.5	25.2	25.3	25.3	25.8	25.8	25.6	25.5	25.5	25.6
1997	25.8	25.1	25.4	24.3	25.2	24.5	25.5	26.4	25.7	26.3	25.4	26.2	25.5
1998	26.3	26.3	26.7	26.4	25.9	25.8	25.7	25.3	25.3	25.3	25.3	25.2	25.8
1999	24.9	25.2	24.4	25.0	24.1	25.3	25.5	25.8	25.4	25.8	25.6	25.7	25.2
2000	25.3	25.1	24.8	25.2	25.5	25.5	25.5	25.6	25.8	25.9	26.1	25.6	25.5
2001	25.3	25.4	25.4	25.4	25.7	26.2	25.3	25.6	26.2	26.7	27.2	25.3	25.8
2002	25.2	23.7	25.3	23.8	26.0	25.8	25.5	24.8	25.2	24.8	25.8	25.3	25.1
2003	25.1	25.6	24.7	25.8	25.8	25.3	25.7	25.5	26.2	26.6	25.9	26.4	25.7
2004	25.7	26.3	25.7	25.9	25.8	25.3	25.4	25.0	25.4	27.3	26.5	26.0	25.9
2005	26.7	26.5	26.2	26.5	26.4	26.7	25.9	25.9	26.1	26.7	26.0	26.3	26.3
2006	26.2	26.1	25.8	26.1	25.7	24.7	25.8	25.2	26.6	26.0	26.0	25.5	25.8
2007	25.9	25.3	25.8	25.9	25.3	25.9	26.2	26.7	26.8	25.9	26.6	26.4	26.1
2008	25.9	26.5	25.5	25.8	25.7	25.7	26.1	25.9	26.3	26.6	26.3	26.1	26.0
2009	25.8	25.8	25.8	26.5	26.2	26.0	25.8	25.5	26.1	25.9	25.6	24.7	25.8
2010	25.3	26.2	26.0	0.0	26.7	26.8	26.2	25.7	25.7	25.9	25.5	25.4	25.9
2011	26.6	24.8	26.2	25.6	26.3	25.7	25.4	26.0	25.7	25.8	26.0	26.2	25.9

(Source: KMS)

Appendix 3

Monthly Rainfall (mm) for Tarawa

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1980	430.0	124.0	357.0	487.0	250.0	241.0	125.0	181.0	121.0	77.0	213.0	200.0
1981	190.0	244.0	363.0	260.0	254.0	275.0	20.0	6.0	56.0	20.0	73.0	384.0
1982	34.0	164.0	48.0	195.0	247.0	120.0	507.0	421.0	202.0	228.0	245.0	205.8
1983	22.0	170.0	68.0	120.0	375.0	282.0	394.0	111.0	59.0	149.0	69.0	79.0
1984	110.0	54.0	33.0	148.0	122.0	97.0	37.0	114.0	39.0	101.0	19.0	125.0
1985	32.0	44.0	80.0	22.0	85.0	70.0	67.0	36.0	52.0	40.0	49.0	167.0
1986	248.0	63.0	37.0	108.0	24.0	142.0	238.0	104.0	347.0	247.0	312.0	453.0
1987	449.0	492.0	241.0	493.0	285.0	353.0	411.0	330.0	150.2	250.3	129.6	259.0
1988	411.9	378.3	169.8	92.0	211.4	53.3	17.9	9.1	6.6	17.8	1.0	20.6
1989	5.5	7.0	0.0	54.6	0.0	0.0	19.4	0.0	0.0	63.0	0.0	0.0
1990	643.3	187.0	476.5	467.7	143.8	173.3	171.1	271.4	337.0	19.1	308.3	406.9
1991	502.9	162.1	113.7	99.5	178.4	349.2	226.8	441.1	311.2	253.3	455.0	310.6
1992	203.6	300.6	332.7	553.4	292.0	101.9	117.0	106.2	81.6	70.3	128.4	509.6
1993	388.8	308.3	617.4	468.9	578.3	344.2	272.0	271.5	205.5	432.6	100.2	368.4
1994	269.0	138.0	126.2	161.4	87.2	156.1	133.2	262.1	313.3	284.3	224.7	365.6
1995	348.3	229.1	187.4	142.3	52.2	59.4	23.2	165.4	12.6	44.3	6.7	25.7
1996	33.1	92.7	65.5	67.5	184.6	69.2	102.0	18.0	65.0	179.7	28.7	41.9
1997	213.3	425.5	290.5	410.5	353.7	330.4	266.3	321.7	144.9	302.3	167.0	217.7
1998	158.2	18.2	22.4	46.2	134.6	50.5	37.3	4.0	0.9	3.3	4.7	70.9
1999	3.8	7.0	96.3	109.3	138.3	64.5	50.4	38.0	42.8	21.4	5.3	9.5
2000	9.9	27.5	47.6	75.1	57.5	84.7	154.1	102.6	73.7	108.8	65.5	94.2
2001	99.3	98.4	199.5	280.6	141.2	80.2	237.4	219.9	84.3	25.9	119.9	423.2
2002	497.8	405.6	302.9	219.1	97.8	316.2	150.8	474.0	375.8	490.9	387.7	336.6
2003	504.3	270.3	270.9	234.9	116.2	126.5	165.1	85.0	116.9	76.7	135.8	91.2
2004	156.9	184.0	171.0	427.8	225.9	290.1	202.4	230.7	176.7	123.9	29.4	272.6
2005	301.9	236.9	407.1	228.8	114.6	78.5	211.9	185.1	141.4	92.2	50.6	138.6
2006	21.1	49.7	71.0	149.0	59.1	221.6	143.3	219.9	142.0	505.7	210.4	509.5
2007	425.9	454.0	326.9	49.0	141.4	88.3	97.5	43.9	17.3	23.3	40.6	13.5
2008	13.5	1.0	19.4	41.3	160.0	187.2	118.3	54.7	12.0	47.5	122.1	149.9
2009	131.7	102.7	134.2	29.2	165.5	223.7	226.0	246.6	266.2	241.3	243.7	554.6
2010	486.3	208.8	346.6	518.6	216.7	122.0	35.3	19.0	14.8	10.7	40.2	6.2
2011	10.1	7.1	9.9	152.8	66.2	150.5	129.6	128.9	282.5	26.1	23.5	23.9

(Source: KMS)

Appendix 4

Copra production for the Islands in the Gilbert Group

ISLAND	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
MAKIN	147	247	396	271	321	277	258	161	312	186	341	487	196	382	628	252	424	239	176
BUTARITARI	202	187	330	124	146	237	257	66	246	83	163	318	105	246	285	168	288	74	133
MARAKEI	434	387	496	351	229	374	373	222	452	381	481	432	256	398	295	361	219	327	216
ABAIANG	319	341	507	218	87	458	301	36	266	271	369	408	129	557	240	313	133	380	304
TARAWA	168	88	189	104	9	180	92	N/A	61	156	147	228	21	220	128	141	21	103	137
MALANA	582	654	738	557	240	568	510	133	356	327	547	511	243	544	179	431	144	341	515
KURIA	663	580	662	504	267	477	564	166	271	270	497	510	219	463	172	444	306	299	625
ARANUKA	521	346	405	297	175	407	393	134	189	316	423	342	209	450	280	409	238	89	255
ABEMAMA	954	1613	1324	1141	636	1195	1391	419	832	824	1611	1101	593	713	2253	930	643	530	1082
NONOUTI	922	1068	909	775	302	1178	1129	150	307	417	506	1662	296	716	468	794	254	236	627
TABITEUEA	1540	1473	1200	1177	418	1489	1716	546	564	489	1199	1855	598	1391	936	1198	746	456	920
ONOTOA	516	488	363	408	146	544	551	155	161	156	471	350	175	357	192	276	117	64	361
BERU	580	658	616	530	291	570	712	258	340	281	449	821	396	474	268	533	491	236	403
NIKUNAU	764	711	790	724	375	955	904	258	581	414	784	857	556	644	654	865	394	428	841
TAMANA	383	372	268	221	105	456	258	138	100	135	419	313	141	332	99	268	101	149	323
ARORAE	364	507	183	288	52	543	480	51	76	198	542	408	166	468	119	294	86	119	406
OTHERS							11		48	50	13								

(Source: KNSO)

Copra Production and Export (metric tonnes) for the Gilbert Islands

GILBERT ISLANDS															
	PROD (Qty)	EXPORT (Qty)	Value		PROD (Qty)	EXPORT (Qty)	Value		PROD (Qty)	EXPORT (Qty)	Value		PROD (Qty)	EXPORT (Qty)	Value
Year	(m.tons)	(m.tons)	A\$000	Year	(m.tons)	(m.tons)	A\$000	Year	(m.tons)	(m.tons)	A\$000	Year	(m.tons)	(m.tons)	A\$000
1970	4915	3763	622	1980	6071	6495	1908	1990	4066	3532	778	2000	2893	6867	2501
1971	6095	6237	887	1981	9502	10561	2505	1991	7841	5308	1180	2001	5114	6648	1985
1972	3154	3624	312	1982	8081	6818	1222	1992	9188	9907	4349	2002	4904	3274	830
1973	7162	5282	1061	1983	6363	6184	1967	1993	9059	8430	2348	2003	8949	7134	2114
1974	8909	9012	3780	1984	11402	10046	6258	1994	9720	10317	4480	2004	10603	5353	1579
1975	2340	3417	721	1985	5334	7593	3859	1995	9376	13249	6367	2005	4299	5000	1094
1976	6304	4768	760	1986	4411	3278	429	1996	7690	5989	3605	2006	8355	mv	mv
1977	6523	6990	2122	1987	5176	3785	1037	1997	3799	7722	4040	2007	7196	4163	1558
1978	8390	7062	2475	1988	12695	11032	4054	1998	9908	7577	4533	2008	7677	1846	1066
1979	6791	5828	3138	1989	7323	8607	2764	1999	9900	12548	8987	Note: mv is missing values			

(Source: KNSO)

Appendix 5

Total Agricultural Production for Kiribati

Years	Total Agriculture (*)	Nominal GDP	% Agr to GDP	Non-Copra Agriculture for sale only	Non-Copra Agriculture for non sale only (consumption)	Total (**)	Total Fishing (***)	% of GDP
1992	28191	87,716	32.1	5324	20780	26104	4284	4.9
1993	26845	90,861	29.5	5197	20284	25481	4901	5.4
1994	27776	95,696	29.0	5073	19802	24875	5180	5.4
1995	26547	93,860	28.3	4953	19333	24286	5557	5.9
1996	27431	105,299	26.1	5030	19632	24662	5507	5.2
1997	25940	107,919	24.0	5003	19529	24532	5466	5.1
1998	26192	120,180	21.8	4682	18273	22955	6320	5.3
1999	25130	120,086	20.9	4335	16921	21256	6366	5.3
2000	20428	128,843	15.9	4198	16385	20583	6415	5.0
2001	19732	126,132	15.6	4109	16036	20145	7821	6.2
2002	21460	135,702	15.8	3729	14556	18285	8055	5.9
2003	24350	145,251	16.8	3660	14287	17947	8251	5.7
2004	22849	139,185	16.4	3415	13289	16704	8956	6.4
2005	20035	146,839	13.6	3405	13289	16694	9477	6.5
2006	21201	144,149	14.7	3313	12931	16244	10777	7.5
2007	24682	156,243	15.8	3624	14133	17757	11783	7.5
2008	28157	167,335	16.8	4581	17882	22463	13096	7.8
2009	31049	166,646	18.6	5315	20745	26060	13885	8.3
2010	27254	167,020	16.3	4825	18834	23659	13414	8.0
2011	30605	169,577	18.0	4892	19094	23986	13718	8.1
2012	31369	174,584	18.0	4880	19048	23928	14029	8.0

(*)Total agriculture comprises of Copra Society Value added and Copra Cutters Output plus the total of Non-Copra Non-Copra Agriculture for non sale only (consumption).
 (**) Total is equal to Combination of Non-copra agriculture and forestry production for cash sale & Non-copra agriculture and forestry production for own consumption, i.e., non-cash.
 (***) Comprises of commercial fishing & Informal sector fishing for cash and subsistence.

(Source: KNSO)

Appendix 6

Summary of main socioeconomic Indicators in South Tarawa

SUMMARY OF MAIN SOCIOECONOMIC INDICATORS – SOUTH TARAWA																
	South Tarawa including Betio					All outer islands					All Kiribati					
	2005	2010				2005	2010				2005	2010				
Population (Census)	40,311	50,182				52,222	52,876				92,533	103,058				
Percent of national population	43.6%	48.7%				56.4%	51.3%				100%	100%				
Land area, km ²	15.76	15.76				710.58	710.58				726.34	726.34				
Population density, people per km ²	2,558	3,184				73	74									
		2005-10					2005-10								2005-10	
Population growth		9,871					654								10,525	
Annual rate of growth of population, %		4.45%					0.2%								2.2%	
	<15 years	15-29	30-44	45-59	over 60	<15 years	15-29	30-44	45-59	over 60	<15 years	15-29	30-44	45-59	over 60	
Population by age group	17,119	15,784	8,959	5,813	2,507	20,065	13,924	9,503	6,240	3,144	37,184	29,708	18,462	12,053	5,651	
Population by age group, %	34%	31%	18%	12%	5%	38%	26%	18%	12%	6%	36%	29%	18%	12%	5%	
		2005	2010				2005	2010				2005	2010			
Number of private households		5,245	6,705				8,754	9,338				13,999	16,043			
Number of persons in private households		39,186	49,250				49,458	50,710				88,644	99,960			
Average household size		7.5	7.3				5.6	5.4				6.3	6.2			
	Labour market activity, people 15+					Labour market activity, people 15+					Labour market activity, people 15+					
	Cash work - formal	Cash work - market oriented	Voluntary or subsistence work	Unemployed	Not in labour force	Cash work - formal	Cash work - market oriented	Voluntary or subsistence work	Unemployed	Not in labour force	Cash work - formal	Cash work - market oriented	Voluntary or subsistence work	Unemployed	Not in labour force	
Labour force status	8,594	2,487	0	6,826	13,545	4,846	3,666	0	4,626	12,130	13,440	6,153	0	11,452	25,675	
Labour force status %	27%	8%	0%	22%	43%	19%	15%	0%	18%	48%	24%	11%	0%	20%	45%	
	Education attainment, people 15+					Education attainment, people 15+					Education attainment, people 15+					
	No school completed	Primary leaving certificate	Form 3 certificate	Senior secondary certificate	Post secondary study or qualification	No school completed	Primary leaving certificate	Form 3 certificate	Senior secondary certificate	Post secondary study or qualification	No school completed	Primary leaving certificate	Form 3 certificate	Senior secondary certificate	Post secondary study or qualification	
Education attainment	2,418	8,125	7,570	13,626	1,324	4,195	11,858	7,323	8,704	731	6,613	19,983	14,893	22,330	2,055	
Education attainment %	7%	25%	23%	41%	4%	13%	36%	22%	27%	2%	10%	30%	23%	34%	3%	
				2010					2010						2010	
Literate in [te taetae ni] Kiribati %				93%					90%						91%	

(Source: Government of Kiribati, 2012b)

Appendix 7.

Total Sale Record for Informant A

						Ekueta's Sale Records A(S)						
Month	Sale Record	Year	Month	Sale record	Year	Month	Sale Record	Year	Month	Sale Record	Year	Total Sales record
January	12,134.50	2006	January	9,500	2008	January	12,134.50	2010	January	7,596.00	2004	120,214
February	10,557.50		February	8,740.00		February	10,957.40		February	8,965.00	2005	90,069.45
March	13,323.50		March	9,573.00		March	11,230.90		March	7,500.00	2006	97435.45
April	11,085.65		April	7500.45		April	10,203.30		April	8,604.50	2007	101,605
May	8,544.50		May	8,940.50		May	9,402		May	7,650.25	2008	109,628.10
June	8,900.50		June	8950.4		June	8,540		June	8,540.45	2009	92,360.40
July	7,534.00		July	7,540.30		July	9,503.50		July	6,504.00		
August	9,055.80		August	8,790.40		August	10,345.00		August	7,684.00		
September	8,500.00		September	7,490.00		September	9,546.30		September	8,458.00		
October	10,450		October	8,500.40		October	9,503.50		October	7,540.00		
Novemebe	9,560.70		Novemebe	6,350.00		Novemebe	8,905.00		Novemebe	6,540.30		
December	10,567		December	5,560.00		December	9,560.00		December	7,650.30		
Total	120,214		Total	97435.45		Total	109,628.10		Total	93,232.80		
January	7,325.70	2007	January	9,500	2009	January	8,850.30	2011	January	6,046		
February	8,503.30		February	7,000		February	7559.5		February	5,500.50		
March	9,500.60		March	8,403.00		March	8,654.60		March	6,604.40		
April	6,900		April	6,560.00		April	7,859.50		April	5045.5		
May	8,050.50		May	7,493.00		May	6,568.50		May	4,560.50		
June	7,500.50		June	8,549.00		June	7,546.00		June	5,504.60		
July	6,600.00		July	7,500.25		July	8,456.30		July	6,543,50		
August	7,540.80		August	7095.5		August	8,456.00		August	5,640.60		
September	8,640.00		September	8,453.35		September	6,456.30		September	6,100.40		
October	5,548.00		October	9,450.45		October	7,543		October	7,403.30		
Novemebe	6,510.00		Novemebe	10,580.45		Novemebe	7,760.40		Novemebe	7,503.05		
December	7,450.05		December	11,020		December	6,650.00		December	6,940.30		
Total	90,069.45		Total	101,605		Total	92,360.40		Total	66,849		

Appendix 8.

Total amount of catches of tuna species (in metric tonnes) by gears from Long Line, Pole Line and Purse Seiner in Kiribati's EEZ.

Tuna Catches in Kiribati water by Distant Fishing fleets														
1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
72,168	201,745.00	159,012	147,563	47,044.33	136,149.03	218,265.45	43,550.09	46,452.27	109,557.67	117,128.01	94,913.61	145,715.99	256,898.47	187,357.50
Note: Total amount of Catches of Tuna species by gears such as Long line, Pole and Line and Purse Seine in kiribati Water (in metric tonnes)														

(Source: Ministry of Fisheries and Marine Resources Development)

Appendix 9

Coastal Fishing Household Survey in South Tarawa

Year Surveyed	1995	1996	1998	1999	2000	2001	2002	2003
Household Survey	3,449	3370	3673	3723	3833	4529	4529	4529
: Ocean Fishing (OCN)	33,404	23380	61332	88356	106911	10703	63507.5	42660.4
: Reef Fishing (RFF)	5,078	3256	2385	10376	13488	18089	17011	17507.3
: Lagoon Fishing (LGN)	10,587	18592	25601	34893	58620	21283	37002.3	50943.8
: Collection Fishing (COL)	11,083	4584	5012	9063	13141	19699	43165.5	11913.6
All Sector Combined (Total)	60,152	49812	94330	142688	192160	69774	160686.3	123025.1
Note: Total Catch during all weeks survey in different fishing types (Kg)								

(Ministry of Finance and Marine Resources Development)

Appendix 10

Mortality Rate in South Tarawa

	Reported Year												
Causes of Deaths	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
Asthma (Unspecified)	6	6	6	5	4	2	7	5	7	12	5	mv	mv
Chronic Diarrhoea	mv	1	1	2	mv	mv	mv	2	mv	mv	mv	mv	mv
Acute Diarrhoea	11	27	17	5	21	15	23	10	18	20	20	27	12
Dysentery	mv	mv	1	mv	2	mv	mv	mv	mv	mv	mv	mv	mv
Infected eye	mv	mv	mv	mv	mv	mv	mv	mv	mv	mv	1	mv	mv
Skin diseases	mv	mv	mv	mv	mv	mv	mv	mv	mv	mv	mv	1	mv
Diarrhoea and vomiting	mv	mv	mv	mv	mv	mv	mv	mv	mv	mv	34	1	mv
Note: mv is missing values													

(Source: Ministry of Health and Medical Services)

Appendix 11.

Total Sale Record of Agricultural Produce from Farmers.

Record of Sale/Month A(\$ from TOFMA (2009-2012)									
Year/2009	Betio	Teaoraereke	Eita	Total	Year/2010	Betio	Teaoraereke	Eita	Total
11-Jan	553	423	450.5	1426.5	11-Jan	400	350	430	1180
11-Feb	590.15	555.3	470.2	1615.65	11-Feb	500	510	450.3	1460.3
11-Mar	610.05	600.05	390.7	1600.8	11-Mar	510	520.3	570.35	1600.65
11-Apr	620.2	580.3	405.3	1605.8	11-Apr	620	545.45	500.5	1665.95
11-May	350.45	480.5	380.5	1211.45	11-May	450	400.4	452.3	1302.7
11-Jun	250	400	305.6	955.6	11-Jun	500.5	455	450	1405.5
11-Jul	150.5	450	280.9	881.4	11-Jul	525.2	320	515	1360.2
11-Aug	84	376.5	373.5	834	11-Aug	400.45	250.3	500.5	1151.25
11-Sep	610	654.5	401	1665.5	11-Sep	405.5	200.1	300	905.6
11-Oct	100	697.5	438	1235.5	11-Oct	400.3	150.3	200.1	750.7
11-Nov	265	483.85	560	1308.85	11-Nov	415	250.45	300.5	965.95
11-Dec	454.5	465.85	560.5	1480.85	11-Dec	380	300.3	320.4	1000.7
Total	4637.85	6167.35	5016.7	15821.9	Total	5506.95	4252.6	4989.95	14749.5
Year/2011	Betio	Teaoraereke	Eita	Total	Year/2012	Betio	Teaoraereke	Eita	Total
11-Jan	450	440	390	1280	12-Jan	410.5	403.75	320.5	1134.75
11-Feb	590	430	410	1430	12-Feb	423	354.3	441.2	1218.5
11-Mar	500	560	550	1610	12-Mar	483.5	438.6	384.5	1306.6
11-Apr	580.5	510.8	610.8	1702.1	12-Apr	450	404.5	448.5	1303
11-May	430.2	305.8	350	1086	12-May	420	503	381	1304
11-Jun	340	250.6	300	890.6	12-Jun	477	578.7	422	1477.7
11-Jul	180	270.75	265.15	715.9	12-Jul	257.5	453.5	332.5	1043.5
11-Aug	84	376.5	273.5	734	12-Aug	300.75	485	410.3	1196.05
11-Sep	110.6	310.2	310.5	731.3	12-Sep	310.95	425.4	365	1101.35
11-Oct	130	150	100	380	12-Oct	237.5	339.45	329.5	906.45
11-Nov	450	410	500	1360	12-Nov	344	400.3	426	1170.3
11-Dec	510	568	457	1535	12-Dec	382.5	380.3	510.4	1273.2
Total	4355.3	4582.65	4516.95	13454.9	Total	4497.2	5166.8	4771.4	14435.4

(Source: TOFMA)

Questionnaires

6/4/2014

Copy of Questionnaires for Drought - Google Forms

Questionnaire survey on Drought impact in South Tarawa, Kiribati

This questionnaire is created for drought impact analysis on peoples' livelihood in South Tarawa, Kiribati. It is assured the confidentiality of the answers
E-mail: bnamanoku@gmail.com

*** Required**

1. **Gender ***

Mark only one oval.

☐ Male

☐ Female

2. **Place of Residence ***

3. **Level of education ***

Mark only one oval.

☐ No School

☐ Primary level

☐ Secondary Level

☐ Tertiary level (USP, KTC, KIT, etc)

☐ Other:

4. **Age Group**

Check all that apply.

☐ 20-30years

☐ 31-40years

☐ 41-50years

☐ >51 years

5. **Have you heard of the term "Drought" ***

Mark only one oval.

☐ Yes

☐ No

<https://docs.google.com/forms/d/1sCnpgcx7jTKYrDpEhoi7qUpZF6OkPLmalX9RZlb4KA4/edit>

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6. Where have you heard of it?*Mark only one oval.*

- ☐ Friends
- ☐ School
- ☐ Newspaper
- ☐ Radio
- ☐ TV
- ☐ Neighbour
- ☐ Other: _____

7. What is drought in your understanding and what is it called in your local vernacular?

8. How do you know that drought is happening in the country, any signs that helps you to know that drought is happening or about to happen?

9. When does drought usually occur in the country?*Mark only one oval.*

- ☐ every 1-3 years
- ☐ every 1-4 years
- ☐ every 3-5 years
- ☐ every 4-7years
- ☐ Other: _____

10. When drought happened, how long does it last?*Check all that apply.*

- ☐ 6 months
☐ 1 year
☐ 1.5 years
☐ 2 years
☐ 3 years
☐ more than 3 years
☐ Other: _____

11. Do you think drought event is increasing or decreasing in its occurrence and intensity nowadays and why?

12. As far as you can remembered, which year is the worst drought in South Tarawa and Why? *

13. Do you have the following items in your compound to support your livelihood? (Please tick only the ones you have)*Check all that apply.*

- ☐ Breadfruit trees
☐ Well Water
☐ Native Fig
☐ Livestock
☐ Fish pond
☐ Coconut tree
☐ Bwabwai pit
☐ Vegetable garden
☐ Other: _____

14. Which of the following item(s) above is/are affected during drought and in what ways? *

15. Does that item(s) affected somehow affects your livelihood with your family during drought event and in what ways? *

16. How do you managed to solve it? *

17. Is it easy to get fruit and vegetables during drought event and why? *

18. Do you depend also on the marine resources for your daily livelihood?

Mark only one oval.

☐ Yes

☐ No

19. If your answer is yes in Number 18, could you specify please? *

20. Does it easy to get them during drought event and why?

21. Does drought affect your family expenses during drought event and how?

22. How do you manage to solve it?

23. Do you engage in a private/commercial business activity and in what kind?

24. Does drought affect your income-generating activity and in what ways?

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.....

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.....

25. Can you please record your monthly income for those period before, during and after drought event? *

Mark only one oval per row.

	Jan	Feb	March	April	May	June	July	August	September	October	Nov	Dec
Year (Prior)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Year (During)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Year (After)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

26. Which of the following sickness(es) is/are common in your area during drought event?

Check all that apply.

- ☐ Diarrhoea
- ☐ Dengue Fever
- ☐ Asthma
- ☐ pneumonia
- ☐ Pink eye
- ☐ Other:

27. What do you think could be the cause(s) of that sickness(es) you stated in question 26?

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28. Is tap water from the main water supply affected during drought event and how?

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29. How do you solve the problem in question 28?

30. Do you receive extra water from your neighbor in time of water shortage during drought?

Mark only one oval.

- ☐ Yes
☐ No

31. If your answer is No in question 30, then why?

32. Can you rate the impact of drought on your family? (0=no stress,1=little stress,2=moderate stress, 3= very stressful 4= very extremely stressful)

(No stress= live as usual, Little stress=partly edible food crops and vegetables affected, moderate stress= water- flow control enforced, very stressful= shortage of water and food supply, very extremely stressful= hardly any water and food supply)

Mark only one oval.

0	1	2	3	4
☐	☐	☐	☐	☐

33. Can you state the reason(s) why you choose that in Question number 32

34. Before drought happens, do you receive the warning of drought onset and from which source?

35. Is there any policy or laws that deals with natural disasters like drought in the country ?

36. Is it very effective to manage and reduce the impact of drought in your community ?

37. During drought events, do you receive assistance from the Government or NGOS and in what form?

38. Are you aware of the Drought Committee in South Tarawa?

Mark only one oval.

- ☐ Yes
☐ No

39. What kind of assistance do you receive from them?

40. In your opinion, what should be done to improve the work of the Drought committee to the public?

41. In your opinion, what should be done to improve the work of other Government and Non Government agency dealing with drought impact ?

42. Do you have anything to say or comment regarding anything that related to the topic that you think important for the community and the government?

Mark only one oval.

- ☐ Yes
- ☐ No

43. If your answer is yes in Number 42, please comment!
