The Impact of Climate Change on the Future of Solomon Islands' Food Security

---

Thesis submitted in partial fulfilment of the requirements for the Degree of Master of Geographical Information Science,

Department of Geography, University of Canterbury

By

Alwyn P. Danitofea

Acknowledgement

I would like to express my gratitude to my supervisor Dr. Femke Reitsma for the useful comments, remarks and engagement through the learning process of this master thesis. Furthermore I would like to thank Dr. Kelly Dombroski for supporting me to the completion of this study. Also, I like to thank the participants in my survey, who have willingly shared their precious time during the process of interviewing. I would like to thank my loved ones, who have supported me throughout entire process, both by keeping me harmonious and helping me putting pieces together. I will be grateful forever for your love.

Abstract

This study has two primary purposes: to determine the food security of the Solomon Islands and to project the possible impact of climate change on the global food system, and how it will affect food availability in Solomon Islands. This study develops a mixed model methodology to calculate the food security in urban areas and rural areas in Malaita province, Guadalcanal and Western province in the Solomon Islands. The mixed method utilizes data obtained from questionnaires, and customs data in the Solomon Islands to analyse the local food system. The essential information obtained includes household food demand, house food supply, house food self-sufficiency and top ten importer of food to Solomon Islands.

Using GIS the distance from the top ten food producers to the Solomon Islands was determined. The distance was deployed into the mixed methodology to calculate the food security in rural areas and urban areas. Using the distance that food travelled as an indicator to food security, the study shows that the food system in the rural areas of the Solomon Islands are more secure than urban areas.

Finally, the study uses projection from the International Panel on Climate Change 2014 report to project possible impact of climate change to food production in Asia and Australasia and its impact on the availability of food in the Solomon Islands. The study shows that food availability in urban areas will be massively affected if food production in Asia and Australasia is negatively affected by climate change.

1. Introduction

Countries largely depend on a mix of local food production, as the source of food supply, and the global food system (GFS) for their total food requirement. This mix varies from countries which are dependent on the GFS and those which rely on it as an additional source for the stability and sustainability of their food demand. Gregory, Ingram, and Brklacich (2005) described a food system as the production, processing, distribution, preparation and consumption of food both within a country and at the global scale across international borders (as cited in Ford, 2008). Solomon Islands' households, for example, spend more than 40% of their annual earnings on imported rice and wheat products, as reported in Solomon Islands Household Expenditure and Income Survey report 2009. The level of dependency shown by the Solomon Islands can pose a risk to the stability of food available due to the vulnerable nature of the GFS as described by Puma, Bose, Chon, and Cook (2015). The vulnerability of the GFS is enhanced by the possible negative impacts of climate change, war and fuel price on major food producing countries. The impact of climate change, however, continues to be one of the major issues of concern due to its multidimensional impact on the food systems around the globe.

Climate change is characterised by increasing atmospheric temperature, sea temperature, sea level, atmospheric humidity and sea acidity. The impact of climate change on our environment has posed a great risk to the food system due to our reliance on the environment for food. Moreover, studies continue to confirm the correlation between climate change and the depletion of food production in some African countries, Australia (Qureshi, Hanjra & ward, 2012) and certain Asian countries (Su, Weng & Chiu, 2009); henceforth, threatening the food security of many countries that depend on the GFS to complement the local food system for food security.

The impact of climate change on the GFS and food security continues to be an issue of concern due to the dependency of developing population of countries on the GFS for food security. The United Nations' Food and Agricultural Organization (FAO) had defined food security as:

(i) the availability of sufficient quantities of food of appropriate quality, supplied through domestic production or imports; (ii) access by individuals to adequate resources for acquiring appropriate foods for a nutritious diet; (iii) utilization of food through adequate diet, clean water, sanitation, and health care to reach a state of nutritional well-being where all physiological needs are met; and (iv) stability, because to be food secured, a population, household or individual must have access to adequate food at all times (FAO, 2003).

By acknowledging the definition set by FAO, it is obviously important to appreciate the significance of the GFS in maintaining food security globally for countries that are not self-sufficient in food production.

The impacts of climate change events such as droughts and cyclones may pose significant threat to global food production. Rhodes (2014) and Pickles, Thornton, Feldman, Marques and Murray (2013) have proven that excessive heavy rainfall has resulted in erosion of top soil and increase of plant parasitic bacteria that may reduce food production. Other factors such as warming of sea surface temperature and increasing pH of the sea continues to negatively influence the consistency of fish catch. Moreover, climate change also contributes to rise in water and vector borne diseases such as diarrhoea, malaria, dengue fever and influenza (McIver, Woodward, Davies, Tibwe & Iddings, 2014). Recognising the impacts of climate change on food security, researchers have extensively studied and made projections on the future of food security in relation to the impacts of climate change.

Most of the studies conducted on the impact of climate change have focused on food production, availability and stability; however, very limited studies have been conducted on the indirect effects of climate change on accessibility and food sustainability. As such, some Pacific Island countries' food security has been projected to be threatened by climate change. Kiribati, Tuvalu and other low lying atolls are facing declining agricultural area (Wyett, 2014; Dix, 2011) while other Pacific Island countries such as Solomon Islands and Papua New Guinea will face a decline in their fish catch by 2050 (Lehodey, Senina, Calmettes, Hampton & Nicol, 2013; Barnett, 2010). Moreover, most Pacific Island nations' food security is evolving to a more import dependent nature. Some factors affecting the stability of food security in the Pacific region includes weak economic base and excessive land use (Research Program on Aquatic Agricultural System, 2013).

The impact of climate change on the food security of small developing Pacific Island countries' is an important area for research. In addition, a detailed examination is needed to determine their dependency on imported food and their capacity to withstand the changes to the GFS. Using Malaita Province, Guadalcanal Province and Western Province of the Solomon Islands as a case study, this study will examine the impact of imported food on the food security of the Solomon Islands. Furthermore, it will explore the future of Solomon Islands' food security in relation to climate change. The dependency of households on imported and locally produced food is explored through a survey and by using the climate change scenarios from the Inter-Governmental Panel on Climate Change (IPCC), the food security projection for the Solomon Islands will be put forward.

The main contribution of this study to climate change and food security research will be to create a model that could be used to determine the impact of changes in imported food for food security in the Solomon Islands, specifically in various residential categories (urban and rural). Moreover, the model will create projections for the Solomon Islands' food security in order to project the future of the Solomon Islands food system. The findings from this study will be presented to the Solomon Islands government which will be used to assist planners and policy makers to improve Solomon Island's food resilience, by means of implementing policies to improve food self-sufficiency practices in Solomon Islands.

The structure of this thesis is as follows: Chapter 2 reviews literature on climate change, GFS and food security; impacts of climate change on food security globally and relating to the Solomon Islands; Solomon Islands' land tenure; and Solomon Islands' soil profile.

Chapter 3 of this thesis describes the methods which have been developed for this study which includes: data collection, processing, modelling, and analysis of climatic data and food security in the Solomon Islands.

Chapter 4 presents the results for the case study in relation to the impacts of climate change on food security and the future of food security in Solomon Islands. The results are then discussed in chapter 5 in relation to the impacts of climate change on food security in the Solomon Islands.

Chapter 6 describes the limitations of this study while chapter 7 highlights possible areas of improvements in this study which can be recommended for further consideration in later studies.

Chapter 8 of the study concludes the thesis by outlining this study's contribution to the overall negative impacts of climate change on food security and outlines possible measures which could be used to mitigate and improve food security in the Solomon Islands.

2. Literature review

2.1. Food security

The concept of food security originated during a discussion of international food problems in the 70's, highlighted in 1974 during the World Food Summit with particular emphasis on the volume and stability of food supply (FAO,2001).. The changing nature of food related issues continues to influence the concept and definition of food security over the years. In 2001, a revision was made to the definition of food security during the World Food Summit which redefined food security as "*when all people, at all times, have physical, social and economic access to sufficient, safe and nutritious food which meets their dietary needs and food preferences for an active and healthy life*" (FAO,2001).

When attempting to understand the concept of food security, one of the fundamental questions to ask is "How can we be food secure?" The question of the level of food security could be answered when we fully appreciate what constitutes the definition of food security. The factors that need to be understood when defining food security includes: food availability, food accessibility, and food utilisation (FAO, 2003).

2.1.1. Availability of food

Food availability has been the initial focus of food security and this was emphasized during the 1974 World Food Summit. Food availability focuses on the amount of food available through local production and the GFS. Puma *et al.*, (2015) carried out a case study to investigate the fragility of the GFS and confirmed that if one of the major food producing countries is ever to be affected by a natural or anthropogenic disaster, the result will be global hunger due to major global dependency on the GFS for food supply. To avoid this issue, Ford

(2009) confirmed that maintaining the local food system of a country is a very important matter. The study pointed out that the local food system is important to maintain a country's food self-sufficiency, in order to ensure food supply during any fluctuation of food supply in the GFS. Additionally, food availability and its surrounding environment determine the quality and quantity of food consumed by households or individuals (Lytle, 2009). Oexle *et al.,* (2015), and Bryant and Stevens (2006), had also confirmed the positive correlation between food availability and diet habit that leads to maintaining stability of food security in a household or in communities.

Food availability via a local food system is food that is locally produced or harvested within a specific geographical area and is local to that population. The major source of locally available food is produced from subsistence activities such as agricultural activity, fishing or hunting as discussed by Ford (2009). In a case study carried out by Puma *et al.,* (2015), the study emphasises that a country's food self-sufficiency is significant in determining the availability of locally produced food, henceforth, a major step to establish a country's food security.

The GFS on the other hand has been a major contributor to the availability of food globally. BeVier (2012) elaborated that for over 10, 000 years, the GFS has evolved from the primitive utilization of vegetative plants and livestock domestication to the large scale, and precision farming operations of industrialized agricultural operation. The evolution of GFS set the premises by which people have access to food that are not produced in their locality. For example, tuna which is caught in the Pacific region have been exported and transported to European and Asian countries (Barnett, 2010). Moreover, the global dependency on rice and wheat produced in Asia and America continues to be the main source of staple food around the globe; which contributes to global food security (Puma *et al.,* 2015).

The understanding surrounding the notion of availability of food has been broadly studied. Most of the literatures reviewed on food availability focused on the availability of food and its impact on food security, health and the eating habits.

The choice of food determines the quality and quantity of food consumed; moreover, the amount of nutritious food eaten in homes and various societies were determined by the availability of nutritious food in supermarkets, grocery stores and convenient stores (Dimitri & Rogus, 2014). The association between food availability and food intake is determined by Chen, Florax and Snyder (2013) which establishes the correlation between proximity to fast food and obese residents. These studies had confirmed that there is significant association between quality of non-nutritious food intake, food available and the proximity to residents of people having diseases such as obesity.

Alongside the importance of food availability is the threat associated with food scarcity. Puma *et al.,* (2015) revealed that the availability of staple food such as rice will continue to be threatened due to lack of redundancy in rice and wheat producing countries and more dependent countries. The Pacific region, on the other hand, will experience a decline in availability of tuna as the main source of protein during this century as explained by Bell *et al.,* 2012. Foale *et al.,* (2013) have projected that the current population growth of small island states in the Pacific region will continue to deplete the number of fish caught during this century, as demand for fish in urban areas increases.

2.1.2. Accessibility to food

The significance of access to food by vulnerable people was first recognised in 1984 by the Food and Agriculture Organization of the United Nation (FAO, 2003). During the World

Food Summit in 2001, the definition for accessibility to food was further expanded to encompass physical, social and economic access to sufficient, safe and nutritious food.

There are various factors that influence a population's access to food and according to US Department of Health and Human Services (2010), physical access is the most fundamental factor determining access to food beside other social and socio-economic factors (as cited in Widener, Farber, Neutens & Horner, 2013).

According to the Food and Agriculture Organization's trade reform and food security report (2003), physical access to food is vital to a society or individual who endeavours to maintain or consolidate its food security. It was proven by Sadler, Gilliland and Arku (2011) and Odoms-Young, Zenk and Mason (2009) that residential areas which are of walking distance to food sources such as shops have more access to diverse food types. A study done on the Inuit people in Canada by Ford (2009) has shown that barriers to physical access to certain traditional food had resulted in the decline of nutritious food supply, especially protein source from wild animals which threatens the stability of food security.

The financial status of an individual or society also contributes to accessibility to products and services. A study carried out by Ivanic and Martin (2008) on the subject of global price and poverty in low income countries had confirmed that access to high quality nutritious food is very expensive. The same case study further stated that increases in global food price had increased poverty in poorer countries due to limited access to basic services. On the other hand, wealthier people in developed countries are economically capable to access expensive quality, nutritious food (Friel & Ford, 2015).

The concept of access to food has been extensively studied in relation to physical access to food sources. Most of the previous studies done were focused on proximity of food source to residential or working environment and its correlation to food intake or health. Examples of these studies were carried out by Widener et al. (2013), Sadler et al. (2011), and Odoms-Young et al. (2009).

Another attribute to consider in relation to access to food is health. It is evident that the quality of food a population accesses determines the healthiness of the population. An example of the view surrounding food access and health was confirmed by children's access to food outlets such as fast food shops which correlates to obesity and other diseases.

2.1.3. Importance of food Utilisation

Utilisation of food has been perceived as one of the pillars of food security. According to FAO's introduction to the basic concepts of food security (2008), food utilisation is defined as the way that the body makes the most of various nutrients in the food. Furthermore, sufficient energy and nutrient intake by individuals is the result of good care and feeding practices, food preparation, and diversity of the diet and intra-household distribution of food. Combined with good biological utilisation of food consumed, this determines the nutritional status of individuals.

Acknowledging the significance of food utilisation, the main focus of the concept of food utilization is to achieve nutritious well-being of our population depending on factors such as health, water and food preparation (Wheeler & Braun, 2013).

According to McCarthey (2013), there has been substantial evidence that supports the impact of diet to health. Roberts and Barnard (2005) highlighted that chronic diseases, including cardiovascular diseases, Type 2 diabetes, metabolic syndrome and cancer, are the leading killers in western societies and is increasing rapidly in developing nations. Such trend could be improved if quality meals are prepared in homes (Engler-Stringer, Stringer & Haines, 2011; Soliah, Walter & Jones, 2012) and people can be educating on the impact of food intake on their health (Losasso *et al.*, 2012).

2.2. The impact of climate change on food security

The negative impact of climate change on crop growth cycle, crop yield and the environment has been discovered to exacerbate global food insecurity and hunger (Berg, Docoudre, Sultan, Lengaigne & Guimberteau, 2012). Considering the adverse impact of climate change, there has been many endeavours to study and predict the impact of climate change on the global food security.

2.2.1. Impact of climate change on food production

The Intergovernmental Panel on Climate Change (IPCC) 2014 report shows that the global atmospheric temperature has been projected to increase by 0.3 to 0.7 degrees Celsius from 2016 to 2035. Furthermore, climate change events such as floods, drought, severe storms and increasing precipitation brought about by increasing atmospheric temperatures were the major factors affecting crop yields.

Crop yields is an agricultural subject of global interest due to the direct impact of climate change and escalating global population's demand for food. A study carried out by Li, Takahashi, Suzuki and Kaiser (2011) confirms that maize yielding in the same region can vary significantly despite being under the same climate condition. Adams, Hurd, Lenhart and Leary (1998) had studied and confirmed that changes in the climate can cause variation in crop yielding due to factors such as hydrological balances, human response, altitude differences (as cited in Knox, Hess, Daccache and Wheeler, 2012) and technological improvement (Li *et al.*, 2011).

In recent years, studies have been focussing on beyond 2050 projections of crop yielding and crop production. These studies have confirmed that climate change has both positive and negative impact on crop yielding. A study done by Tan and Shibasaki (2003) had projected that climate change will negatively impact rice production in countries such as Spain, Italy and Paraguay; maize production in Italy and New Zealand; wheat production in Paraguay, Albania, Netherlands; and soy bean production in the Congo and Yugoslavia. Moreover, Knox *et al*., (2012) had also projected that climate change will negatively affect the production of wheat, maize, sorghum and millet in Africa and Southern region of Asia. On the contrary, other countries and crops which are expected to benefit from climate change beyond 2050 includes rice yielding in Hungary and Mexico; maize production in Germany and United Kingdom; wheat production in Canada and Czech; and soy bean in Austria and Germany (Tan *et al.*, 2003).

Fluctuation of global food productions may result in decline or increase in food that is available in the regions such as the pacific Islands. Especially to country such as the Solomon Islands who depend massively on imported carbohydrates such as rice and wheat (Research Program on Aquatic Agricultural System, 2013).

2.2.2. Climate change threat to dependency on fish

Besides agriculture, Fisheries has been a vital contributor to food security for oceanic regions such as the Asia and the Pacific (Barnett, 2010). According to Bell *et al.*, (2009), fish is the main source of protein and the per capita consumption of fish in the Pacific is amongst the highest in the world with an average of 70 kg of fish being consumed per year (Bell *et al.* 2013). More specifically in the Pacific region, rural populations are more dependent on fish for protein compared to urban dwellers. In the case of Polynesian countries, rural residents eat twice the amount of fish consumed in Polynesian urban areas (Bell *et al.*, 2009). The significance to stability of fish catch is essential to maintain protein availability hence, to maintain food security in certain geographical regions within the globe.

A population's dependency on fish has been projected to increase with escalating population in the Pacific region. Bell *et al.*, (2013) projected that by 2035, the population in the 22

Pacific Island countries will escalate to 16 million. In proportion to the escalating population, this study outlines that in 2013, the amount of fish needed for consumption was 237; 300 tonnes; by 2020 the amount of fish needed will increase to 268,000 tonnes; and by 2035 the volume to fish needed for consumption within the 22 Pacific Island countries will increase to 343,800 tonnes.

With the threatening impacts of climate change on our ocean, the dependency on fish could also be threatened especially for certain countries which depend on fish for subsistence living and commercial purpose. The research undertaken by *Bell et al.,* (2013) revealed that fish catch in certain countries in the West Central Pacific region will experience 2 to 5 per cent decline by 2035. The main causes of the decline is the increasing sea temperature, reduced oxygen, increasing pH level and migration of fish to regions of preferred water temperature. In contrary, Lehodey *et al.* (2013) have studied and confirmed that the Eastern region of the Pacific will experience an increase in fish catch by 2050; the increase will be made possible due to the favourable sea condition for fish breeding and survival as a result of climate change.

2.2.3. Impact on global nutrition

The impact of climate change on our environment may trigger the development of uncontrolled diseases such as water borne diseases, airborne diseases, and vector borne diseases due to ideal environment for viral and bacterial breeding (Friel *et al.,* 2015). Furthermore, the development of these diseases may result in increase of death, malnutrition, economic instability, hunger and most of all, food insecurity (FAO, 2015).

The impact of climate change may also result in health issues in small developing Pacific Island countries and the African countries. A study carried out by McIver *et al.,* (2014) on the health impacts of climate change in Kiribati, had confirmed serious health issues associating with climate change events. The study shows issues such as positive correlation between rainy season and diarrhoea, increase in dengue fever outbreak since 2003 with change in weather pattern and the increase in malnutrition due to loss of agricultural land caused by sea level rise. In Africa, there has been difficulty to access water that leads to increase in malnutrition, and the malnourished population is projected to increase to between 75 to 250 million by 2020 (Tirado et al., 2015).

Research also shows that climate change has an impact on food production that indirectly influences the quality and quantity of nutritious food intake. With events such as extreme precipitation and extreme heat, atmospheric conditions become more humid or increases in moisture which creates a suitable condition for breeding of bacteria, fungi and pests that damage crop productivity and nutrition (Chakraborty & Newton, 2011).

Crop productivity and nutrition in the case studied by Tirado et al. (2015) shows that, climate change may elevate or redistribute bacteria populations and may increase the occurrence of fungi in food and animal feed crop. With the decline in availability of locally produced food, a population will depend more on food that is available and accessible in nearby shops (Dimitri & Rogus, 2014) and will negatively impact lowest income households who expend a larger portion of their income on food which are price sensitive (Friel *et al.,* 2015).

Ultimately, there will be a very high possibility of low income earning households affected from food borne diseases as a result of low food quality (Lake *et al.,* 2012) and may also elevate malnourishment amongst the young population due to reliance on cheaper substitute with low nutritional values (Vermeulen *et al.,* 2014). Both of the studies carried out by Tirado *et al.,* (2015) and Vermeulen *et al.,* (2014) have projected that the negative impact of climate change on food security will escalate food nutritional issues by 2030 due to depleting global food production.

The decline in global food production from climate change will massively reduce food that is available in the GFS and will reduce food that is available for the global population. Smaller Island countries such as the Solomon Islands may also be facing shortage in food due to the impact of climate change on local food production and food available through GFS.

2.3. Climate Change impact on Solomon Islands' food security

2.3.1. Food production and availability

To understand and assess food security, food availability and production in the case study area is very important to know. In case of the Solomon Islands is quite difficult to assess food availability due to the limitation in researches relating to food production and accessibility. Generally, similar to other Pacific Islands state and territories, Solomon Islands still engages in subsistence farming and fishery as a means of food production. The most available staple carbohydrates in the Solomon Islands includes: cassava, yam, banana, taro, breadfruit and corn. Alongside starchy food, protein sources include marine produces such as fish, shells and other sea food (Lebot, 2013; Research program on Aquatic Agricultural System, 2013).

Despite reliance on local staple foods, dietary patterns have also changed over time to be more reliant on imported food products. An example of the dependency of the Solomon Islands on imported food was reported in the Population & Housing Census (2009), which found out that a major percentage of annual income spent on imported rice and flour. Moreover, there is a possibility of hunger in urban areas if there is a decline in global rice and wheat production as explained by Puma *et al.*, (2010) and climate change issues which have already been experienced in Temotu province and published by Birk (2014).

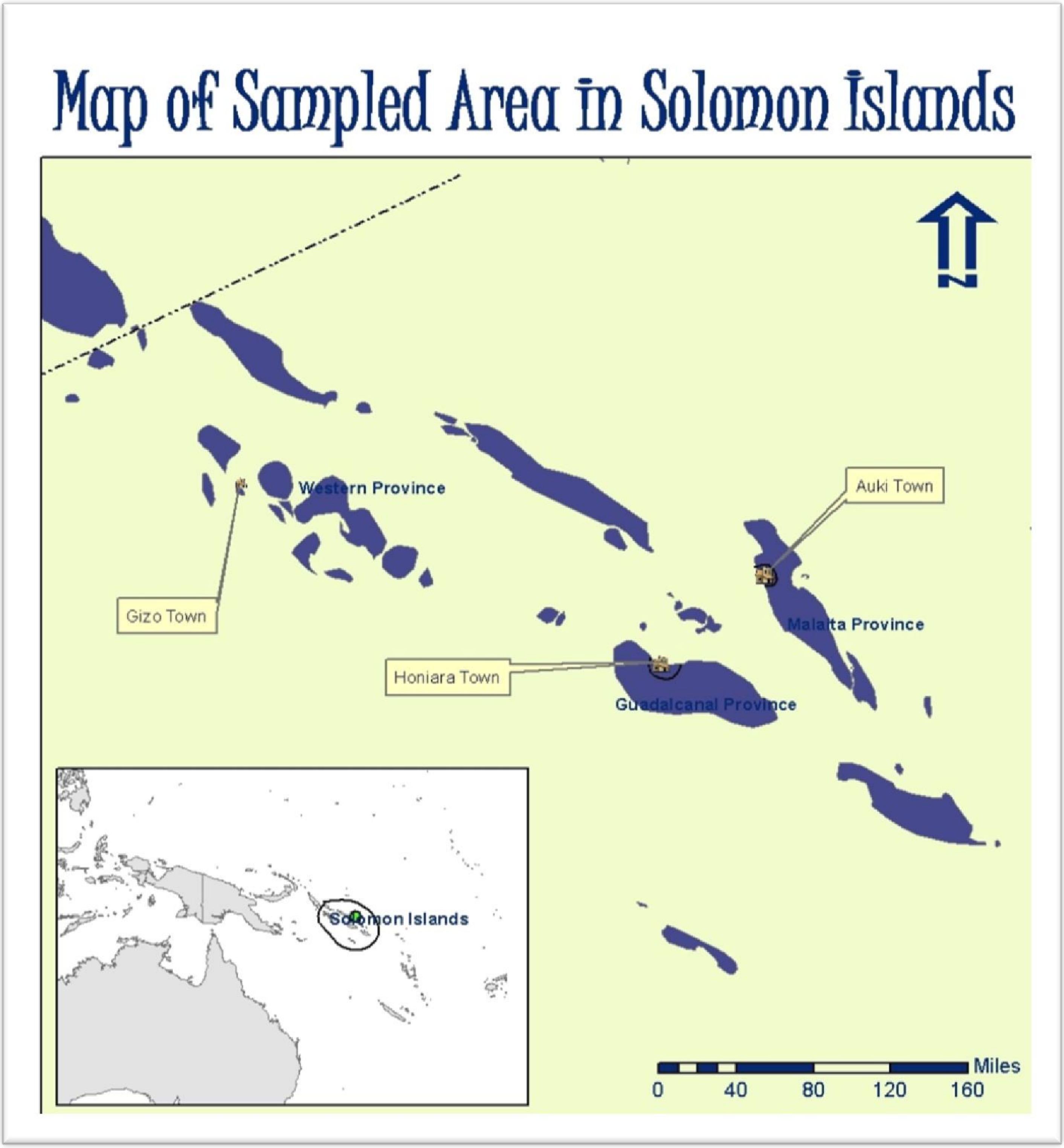
2.3.2. Land tenure in Solomon Islands

Land Tenure is a very important factor that determined food production and even access to water. In the case of the Solomon Islands, a case study was carried out by Burt (1994) on the subject of Land in Kwara'ae, Malaita Province. The study discovered that land ownership and leadership is usually vested in both males and females who are members of the tribe by lineage. This means that access to farming, hunting or fishing within a particular land is in subject to your relationship to the tribe or as consented by the tribal leaders. It is therefore very important to associate to a tribal in order to have access to a land and make farms or fish for daily consumption.

2.3.3. Accessibility to food

Food accessibility in the Solomon Islands like food availability is also another agenda being under researched. Due to the majority of the population residing in rural areas, most food is acquired by means of harvesting from their own garden or subsistence fishery. However, Western influence is gradually invading the diet pattern causing the population to depend heavily on money to buy imported goods. In addition to the shift in diet pattern, climate change has also negatively impacted food production from subsistence farming; in the population resorts to more imported staple food such as rice and flour (Research program on Aquatic Agricultural System, 2012; Barnett, 2010; Bell et al., 2013)

Due to shortage in food and incapability to have access to quality imported food, the steps taken by Islanders were to call for government aid or resort to cheaper food. An example of these two situation was discussed by Birk (2014) and Hughes and Lawrence (2005). Birk (2014) discovered that there have been changes in extreme weather patterns that affect yielding of native crops in Temotu province. Furthermore, increase drought frequency and cyclone seasons over the past decade has resulted in calls made by the Provincial Government to the National Disaster Council in 2009 for assistance in food supply.



Author: Alwyn Danitofea

Figure 2.1 Map of Solomon Islands

3. Methodology

Introduction to methodology

A mixed approach has been developed for this study to understand the impact of climate change on the future of Solomon Islands' food security. Taking into consideration the current economic situation, escalating population, depleting soil fertility and climate change, this mixed method will qualitatively explore the vulnerability of the Solomon Islands due to climate change, alongside some quantitative data about distances to food sources and resilience of food systems.

This study categorises the population into two groups: rural and urban residents. The biggest difference between the populations residing in the rural and urban areas is their different financial capacity to purchase imported food, and the availability of imported food in rural areas. The quantity of food available in rural areas of the Solomon Islands is limited to mostly food locally cultivated and harvested. Categorising the population into residential category is important in order to explore the effect of the changes in the GFS to the food security of different residential categories in the Solomon Islands.

The Solomon Island as a nation was declared a British protectorate in the 1890's, and was later declared self-governing in 1976, it has declared independent by the British Parliament on the 7th of July, 1978. The boundary of the Solomon Islands encompasses a chain of islands located to the north of Australia and the East of Papua New Guinea.

Figure 3.1 Sampled areas map of Solomon Islands

Author: Alwyn Danitofea

The Solomon Islands land mass shown in figure 3.1 has a total land mass of 28, 370 km^2 and 1,340,000 km^2 of sea area. With the total land mass available, 3.9 percent of the total land mass has been used for agriculture while 78.9 percent of the land is still forested. Additionally, 17.2 percent of the land is used for other purposes such as buildings and other infrastructure (CIA, 2013).

According to the Solomon Islands Government Department of Statistics report 2014, the total population of Solomon Islands exceeds 560,000 by 2014. The report had stated that approximately 75.1 percent of the total population is a dependent population, while only 16.5 percent of the total population are potentially providing support. With the very high dependency ratio, it is also reported that the Solomon Islands has had a 2.5 percent increase in birth rate and 2.02 percent increase in national population growth (CIA, 2013; World Health Organisation [WHO], 2015).

In the Solomon Islands, approximately 80 percent of the country's population resides in rural areas while the other 18 to 20 percent of the population resides in urban areas. The majority of the population residing in rural areas are dependent on subsistence farming and fishing as their main source of food supply (Population & Housing Census, 2009). On the other hand, the population residing in urban areas are more dependent on locally produced or imported processed food (FAO, 2008).

With the escalating population and low economic status of Solomon Islands, the human development index according to the United Nation Development Program (UNDP) continues to remain around 0.5. The index, therefore, has ranked Solomon Islands 157 in the development rankings for the world. Similar to other Pacific Island countries, the status of Solomon Islands will face an unpredictable future due to the changes in the diet habits as these countries become more dependent on low quality imported food products (Popkin, 2013).

3.1. Questionnaire content and explanation

A questionnaire was designed taking in consideration the location of questionnaire participants, number of meals per day, kind of food that is typically eaten and also if the food was imported, harvested or locally produced. Additionally, the questionnaire also captures the quantity of specific food type consumed per day in percentage and weight in kilograms (Refer to Appendix 1 for questionnaire).

In the questionnaire, all types of food sources consumed daily are classified under 3 major classes including: carbohydrate, protein and fruits/vegetables. Specific types of food such as rice are recorded under carbohydrate and are quantified in percentage out of all carbohydrates the household consumes daily. To calculate the percentage of each food source, the formula used was $\frac{s}{c} * 100$, where *s* is the estimated percent of time on a daily basis a household consumes a specific food type, and *c* denotes the sum of all food sources in the same food class. Furthermore, the definition of *c* in this case is perceived as the sum of a specific food types consumed in a household per day (Refer to the Amount consumed Daily of the Questionnaire in the Appendix 1).

Besides determining the amount of food sources consumed, the questionnaire also captures where the food had been produced. To understand the sources of the food class, three categories of sources of food class were developed including: harvested from gardens or the sea, locally produced and purchased at local shops or markets, and imported products. Harvested food refers to the food sources that are harvested directly by subsistence farmers and fishers, while locally produced and purchased food sources are those which are purchased from local markets and produced within the Solomon Islands. In addition, imported foods are those that are produced outside of Solomon Islands and purchased through the GFS (refer to appendix one for questionnaire).

To define the dependency of an individual household on the three sources of food supply, each of the sources of food production was given a percentage over the total of the three production sources which is totalled to 100 percent for a specific food. A mathematical description of the logic can be described as $\frac{LH}{100} + \frac{LP}{100} + \frac{IP}{100} = \frac{100}{100}$ where LH denotes locally harvested, LP representing locally produced and purchased and IP denoting imported product.

3.2. Survey

This section of the method involves a description of data collection methods used to collect data in this study. The data sources include: Food intake survey in the Solomon Islands (Malaita province, Guadalcanal province, and Western province), food import data from the Solomon Islands government's department of Customs and IPCC data detailing climate change impact projection on global food production.

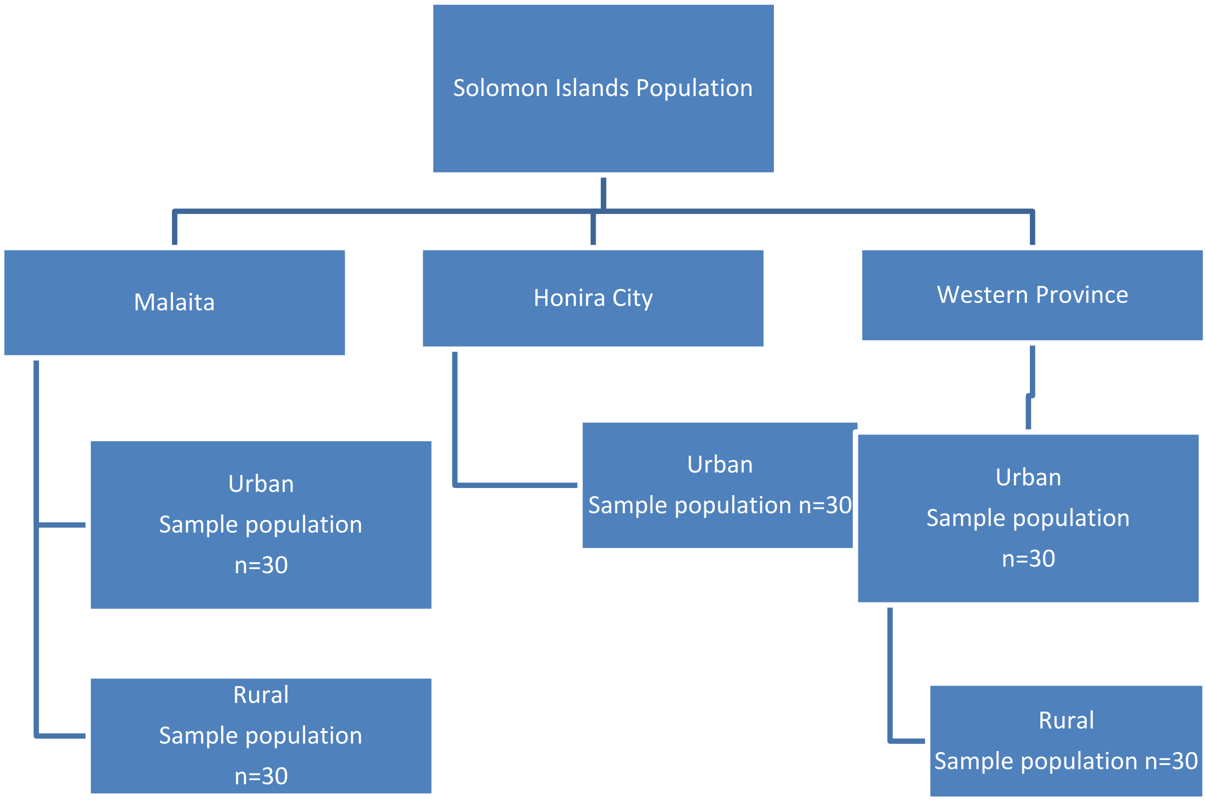
3.2.1. Food intake survey in the Solomon Islands

For the purpose of sampling, the survey utilises a stratified sampling method. The stratified random sampling technique reduces extreme samples, and ensures that there is equal representation of the food intake sample throughout the entire Solomon Islands population. To facilitate the sampling method, the entire heterogeneous population in all of the three provinces was divided into two strata: rural resident and urban resident.

After dividing the population into the two specific strata, the survey on food intake was carried out in rural and urban areas of Solomon Islands. In order to obtain the minimal population needed for the sample, n=30 was used as the minimum population need for each strata in each province.

With each of the participants completing the supervised questionnaire (Appendix 1), an information sheet was issued to introduce the purpose and the researcher carrying out the study. Additionally one on one support was also given to individuals to complete the questionnaire for those who had difficulty understanding the questionnaire or needed clarification in certain sections of the questionnaire.

Figure 3.2 Population sampling procedure



3.2.2. Financial status and food dependency

For household financial capacity, incomes of households are spatially assessed with the source of food production. The financial capacity of individual household was determined from the family's economic capacity collected in the food intake survey done in Malaita, Honiara and Western Province.

According to the households' income range, there are 7 classes of income range that determines household spending in fortnights and months. These classes are rated on a number scale from 1 to 7. The lowest scale depicts the lowest income range while seven representing the highest income range.

3.3. Food security indicators

3.3.1. Dependency on imports from sampled questionnaire data

The first step to calculating the food security for the area of case study is to determine the dependency on imported and locally produced food. In order to calculate the import dependency percentage for the entire sample population, the source of production of all the food consumed within the sample area are categorised into two categories: imported or locally produced. Furthermore, determination of the percentage of dependency is done by the cumulative sum of the specific category, divided by the cumulative sum of both of the categories multiplied by 100 percent.

Formula used for calculation of dependency percentage on local food is:

Equation 3.3:1

$$LHP\% = \left(\frac{\sum_{i=1}^{n}(LH + LP)i}{100 * i}\right) * 100$$

Where i is the record number, LH denoting percentage of food locally harvested, LP representing percentage of food locally produced and purchased at market or in shops and LHP denoting total percent of food locally produced.

In addition to calculating the dependency percentage of LHP from sample data, the average percentage of each of the source of food production is also determined. Determination of the average percentage is calculated by dividing the total percentage of each class by the total number of records. The mathematical formula used for the calculation both the classes are:

Equation 3.3:2

$$Ave\ LHP = \left(\frac{\sum_{i=1}^{n}(LH + LP)i}{n}\right)\ and$$

$$Ave\ IP = \left(\frac{\sum_{i}^{n}(IP)i}{n}\right)$$

Where i represent the record number, n represent the total records, LH denoting locally harvested, LP representing locally produced and purchased at market or in shops, IP representing imported product, Ave LHP representing the average percentage of locally harvested or produced and Ave IP representing average percentage of imported food products.

3.3.2. Food security

The model used to calculate food security in this study has been taken from Ye *et al.*, (2012). From the model, the variables used to determine food security include: food self-sufficiency index, per capita food supply and per-capita food demand. Using these variables, the mathematical definition of the model is expressed as:

Equation 3.3:3

$$FSI = \frac{\frac{s}{g} - d}{d} * 100$$

Where s denotes per-capita food supply, g denotes expected food self-sufficiency ratio, d representing per-capita food demand and FSI representing food security index.

Food self-sufficiency

In the context of a country's food security, food self-sufficiency determines a country's capacity to produce its own food for the local residents of the country. The food self-sufficiency ratio in this case, unlike the dependency, is the percentage of the sum of the percentage of all locally produced food over the total food available in the country. In order to determine food self-sufficiency in this study, the mathematical formula used by FAO to calculate food self-sufficiency was used. The two variables used to calculate food self-sufficiency in this case include: quantity of locally produced food and quantity of imported food. The mathematical expression of this concept is expressed as:

Equation 3.3:4

$$g = \frac{\sum LP}{\sum LP + \sum IP} * 100$$

Where g represents self-sufficiency index, LP denoting sum of locally produced food and IP representing sum of imported food

Per-capita food supply in this case refers to the amount of food that can be produced by an individual in the population of interest. In this method, the per-capita food supply was determined using the total food locally produced and total number of people in the sample population which is expressed as:

Equation 3.3:5

$$s = \frac{\sum LH + \sum LP}{n}$$

Where s denotes per-capita food supply, n represents sample population, LH denotes Food locally harvested and LP denotes food locally produced in Solomon Islands.

Per-capita food demand

Per-capita food demand refers to the amount of food needed by each individual that enables him or her to be food secure. Assuming that each of the individuals in the research sample are food secure, this study assesses the per-capita food demand as the amount of food needed by each individual in the sample to reach the current status of food security. Furthermore, to calculate the per-capita food demand of the entire sample population the formula used to calculate the per-capita food index is:

Equation 3.3:6

$$d = \frac{\sum LH + \sum LP + \sum IP}{n}$$

Where d denotes per-capita food demand, n represents sample population, LH denotes food locally harvested, LP denotes food locally produced in Solomon Islands and IP represents Imported food product.

3.4. Solomon Islands Customs food data

Besides acquiring data from local population by means of a supervised questionnaire, records of imported food were also requested from Solomon Islands Customs. Solomon Islands Customs is the regulatory institution under Solomon Islands' law responsible for managing all imported and exported products into and out of Solomon Islands (refer to approval for access to customs data in Appendix 2). In response to the request, records of all imported food into Solomon Islands from 2008 to 2015 are permitted for use in this study.

The data provided by Solomon Islands Customs includes different types of food that have been imported into the Solomon Islands since 2008. Other significant records included in the data set are: country of origin of the product, quantity of food product and the total cost of the product imported.

Having the Excel sheet records, all food sources are classified into three classes carbohydrate, protein and fruits/vegetables. The main purpose of this classification was to make the records comparable to the food records from the questionnaires completed in the Solomon Islands. Furthermore, categorising food sources into these classes provides the base by which percentage of each food class out of the total food imported could be calculated.

In order to quantify the volume of food imported into Solomon Islands, each of the food classes are totalled for each year from 2008 to 2015. For each of the classes, the pivot table tool from Excel groups each class together and automatically sums the weight total of all food classes. Additionally, the ratio of each of the food classes is quantified out of a hundred percent to determine the ratio that each food class makes out of the whole imported food products.

The mathematical formula used to calculate the total weight of each food class is:

$$X = \sum_{i=1}^{i} y_i$$

Where X denotes the total weight of each food class, y denotes weight and i representing each record in the Excel sheet.

In order to calculate the ratio for each food class imported for each year, the mathematical formulas used and steps taken is:

$$f = \sum_{i=1}^{i} p_i + \sum_{i=1}^{i} c_i + \sum_{i=1}^{i} fv_i$$

$$co = \frac{\sum_{i=1}^{i} c_i}{f} * 100$$

$$po = \frac{\sum_{i=1}^{i} p_i}{f} * 100$$

$$fvo = \frac{\sum_{i=1}^{i} fv_i}{f} * 100$$

Where c represents weight of carbohydrate, p represents weight of protein, fv represents the weight of fruit and vegetable, f represents total weight of food imported each year, co represents percentage of carbohydrate over total weight of food imported each year, po represents percentage of protein over total weight of food imported each year and fvo represents the percentage of fruits and vegetables over the total weight of food imported each year.

3.4.1. Top ten food producers to Solomon Islands

The identification of the top ten food importers to the Solomon Islands is a major step to calculating the resilience of Solomon Islands food security. Identifying the top ten food producing countries to Solomon Islands leads to calculating the distance the food travels prior to reaching Solomon Islands.

The top ten food producing countries importing into Solomon Islands is determined by the total weight of food produced and imported into Solomon Islands. In order to determine the quantity of food produced from a country, the pivot table tool from Excel is used. The pivot table utilises each country's acronyms to uniquely identify each country while totalling the gross weight produced from each country. Moreover, each county is also ranked using the Excel's pivot table according to the quantity of protein, carbohydrate and fruit/vegetable it has exported to the Solomon Islands.

3.4.2. Food Transportation Distance

The final step to determining the resilience of food security in this methodology is to calculate the distance between Solomon Islands and the top ten food producing countries that exporting to the Solomon Islands. The geographical information systems application used to determine the distance in this research is ArcGIS. Using ArcGIS, the steps used to calculate the distance is as followed.

1. Define the coordinate system to UTM
2. Define centred of each of the ten major exporting countries to Solomon Islands as a point
3. Define the centred of Solomon Islands as a point
4. Define each point on the map as an independent shapefile
5. Open the point distance tool from the ArcToolbox and define
6. Use shapefile, Solomon Islands centred as the input feature
7. Use each of the ten shapefile representing each of the centres of the major food producing country as near features
8. Set the search radius to kilometre and calculate the distance using the tool.

3.4.3. Food security index and distance food travelled

To incorporate distance into a food security index, this study deploys a modified version of the methodology used by Ye *et al.,* (2012) to calculate a food security index. This modified approach utilises four main variables including food supply, food dependency ratio, food demand and distance the food has travelled to reach Solomon Islands. The formula used in this study to calculate the distance based food security index is defined as:

Equation 3.3:7

$$FSindex = \left(\frac{\frac{s}{k} - d}{d}\right) \times \frac{1}{\sum D}$$

Where FSindex is the food security index, s is the supply of food per household available in the Solomon Islands by percentage, k is the imported food dependency ratio in percentage, d is the demand for food ratio in percentage and D is the food distance ratio that is calculated from distance food travelled and contribution to total food consumed.

In order to effectively use the formula, the following assumptions were made:

1. The supply of food in the Solomon Islands is equal to the demand for food in the Solomon Islands.
2. The distance the food took to reach Solomon Islands negatively impacts food security, which means the further away the source of production, the less secures the food system will be.
3. The economy of Solomon Islands will grow at an average rate that can sustain the rapid growth of Solomon Islands'population.

Applying the formula, the FSindex is massively influenced by the distance the food has travelled. In order to accommodate for the quantity of food produced in Solomon Islands, the fixed representation of distance the food had travelled is set to 1. The furthest distance food had travelled to Solomon Islands, however, could be ranging from 2 miles to an unknown distance.

An example of the FSindex when the Solomon Islands food dependency is high assuming that amount of food supply in Solomon Island is 100 percent can be calculated as:

$$FSindex = \left(\frac{\frac{100}{0.99} - 100}{100} \right) * \frac{1}{2}$$

$$FSindex = 0.005$$

When s= 100, k= 100%, d= 100% and D is equal to 2 miles.

On the other hand, FSindex in the Solomon Islands when food dependency is low can be represented when with k is equals to 0.01, d is equals to 100 kg, d is 100 kg and the Distance is more than 1. In this case the D is equals to 1000 miles.

$$FSindex = \left(\frac{\frac{100}{0.001} - 100}{100} \right) * \frac{1}{1000}$$

$$FSindex = 0.99$$

The formula used in this case to calculate FSindex, therefore, demonstrated shows a great correlation between FSindex and distance the food had travelled to reach Solomon Islands.

4. Results

This section of the thesis presents the results from the sampled areas namely Malaita province, Honiara the capital city of Solomon Islands and Gizo in the Western Province of the Solomon Islands. This section also presents the food imported and recorded by the Solomon Islands Customs Department. The questionnaire was designed to capture each household's dependency on locally produced food, imported food and the financial capacity of each household within the study areas. Furthermore, the data collected from both the questionnaire and Solomon Islands Customs was processed to show the dependency that urban and rural areas had on locally produced food and imported food which then allowed the food security in the study area to be calculated.

4.1. Urban areas

Figure 4.1 Urban areas' local and imported food intake graph

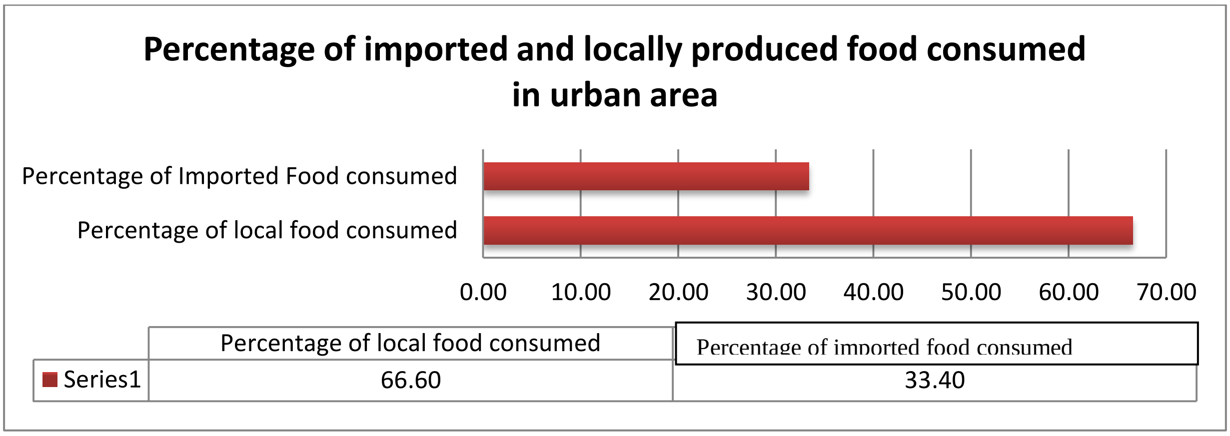
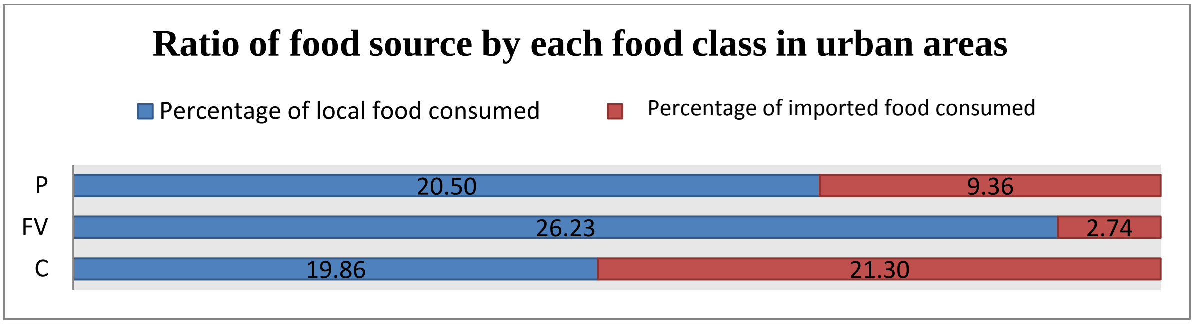


Figure 4.1 exhibits a summary of the ratio of dependency on imported food products and locally produced food collected from samples, through the questionnaires, in the urban areas of Malaita, Honiara, and Gizo. The result interestingly shows that the population residing in urban areas consumed 66.60 percent of local food and 33.404 percent of imported food. In

summary, the result implies that urban residents in Solomon Islands are more self-reliant on locally produced food.

Figure 4.2 Food class by ratio



In a more detail representation of various classes of food consumed in urban areas, Figure 4.2 presents the composition of protein, fruit/vegetable and carbohydrate consumed in urban areas which are either locally produced or imported food.

The composition of the 66.60 percent locally produced food consumed by urban residents constitute of 20.5 percent protein such as fish, chicken, legumes and shells. 26.23 percent fruit/vegetable including cabbage, eggplant, capsicum, melon, pineapple and cucumber. 19.86 percent carbohydrate including sweet potatoes, taro, yam and banana. On the otherhand, the 33.40 percent of the imported food consumed by urban residents consist of 9.36 percent protein including beans, chicken, beef, lamb and pork. 2.74 percent fruit/vegetable including chinese cabbage, capsicum, apple, pear and onion. Finally, 21.30 percent carbohydrate including noodles, rice and wheat products.

From Figure 4.2, residents of urban areas depend more on protein such as chicken, beef and fruit/vegetables like cabbage, pineapple, melon and cucumber which are locally produced than the imported substitutes. On the contrary, urban residents in the sampled areas consumed more imported carbohydrate foods such as rice and wheat products. Compared to locally produced carbohydrate.

Figure 4.3 Food source ratios in urban area

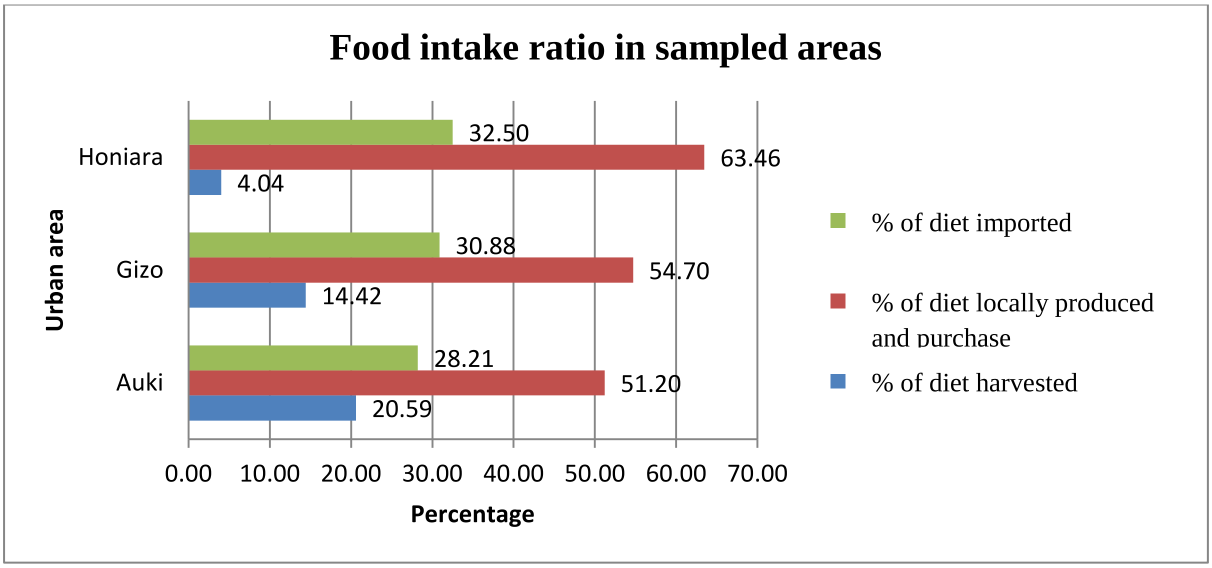


Figure 4.3 shows that all sampled urban areas are highly dependent on locally produced food that is sold in local markets and shops where more than 50 percent is locally produced and purchased as compared to subsistence activities which contributes to only less than 21 percent in all three sampled urban areas. The imported food products consumed in all three urban areas ranges between 28 to 32 percent of total food consumed.

By comparing the three urban areas studied, most food intake of households in Honiara constitutes 32.5 percent imported and 67.5 percent locally produced in Solomon Islands. In the Gizo urban area, 30.88 percent is imported whilst 69.12 percent is locally produced. Auki Township's household food intake shows that 28.21 percent is imported whereas 71.79 percent is locally produced within Solomon Islands

4.2. Rural area

Figure 4.4 Local and imported food intake in rural areas

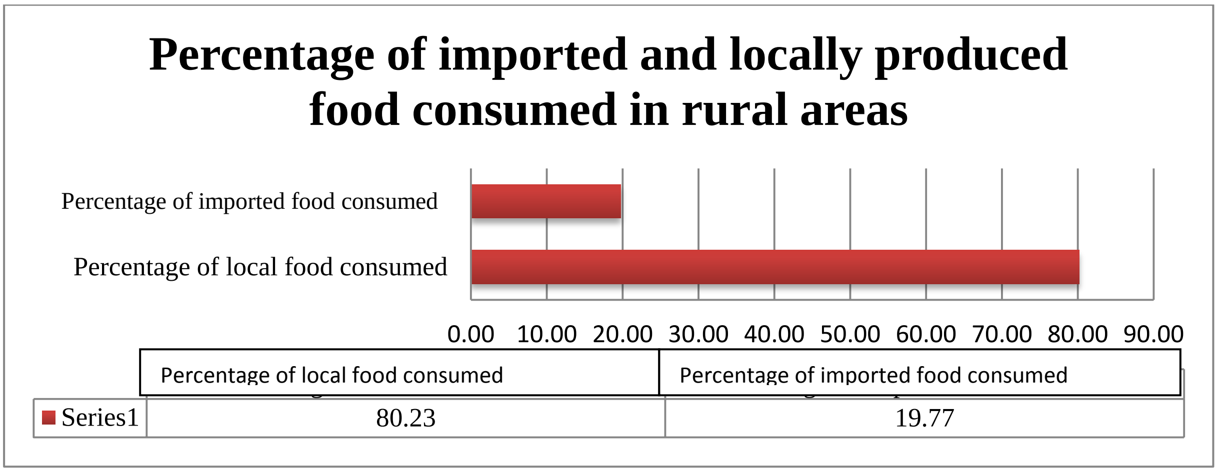


Figure 4.4 represents the percentage of imported and locally produced food consumed in the sampled rural areas in Malaita and Gizo. This chart confirms that food consumed by households in these rural areas constitutes 19.77 percent imported and 80.30 percent locally produced. In summary, the result reflects that households in rural areas of Solomon Islands are substantively self-sufficient.

Figure 4.5 Food class ratio

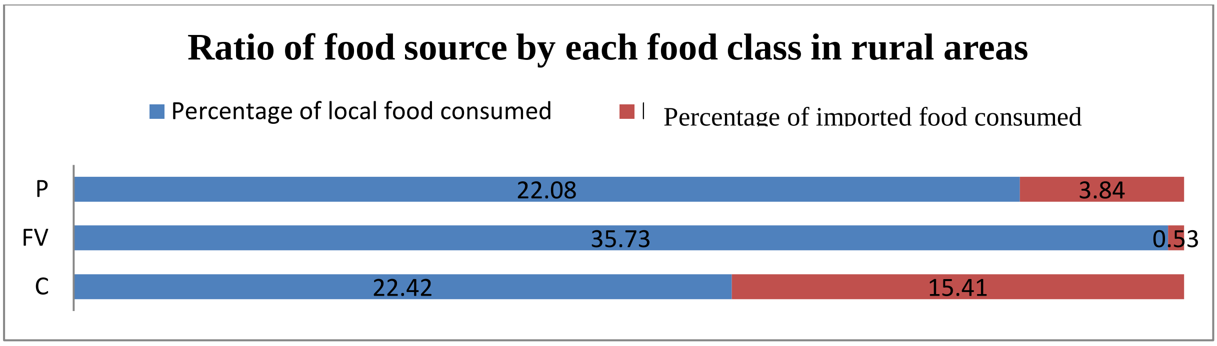


Figure 4.5 is a detailed representation of the imported food and locally produced food consumed in rural areas. In the scenario presented in Figure 4.5 both the imported and locally

produced food are classified in three classes including protein, fruit/vegetable and carbohydrate.

The 80.3 percent locally produced food consumed by rural residents constitues 22.8 percent protein (such as local chickens and fish), 35.73 percent fruit/vegetable including pineapple, cabbage, melon, eggplant and cuccumber, 22.46 percent carbohydrate food such as sweet potatoes, taro, yam and kasava. Similarly, the 33.40 percent of the imported food consumed by rural residents consitues 3.84 percent protein such as canned tuna and canned beef, 0.53 percent fruit/ vegetable and 15.41 percent carbohydrate including rice and wheaty products.

From Figure 4.5, it is evident that rural areas depend heavily on locally produced protein, locally produced carbohydrate and locally produced fruit/vegetable. In relation to the imported food consumed by rural households, the sample indicates that more than 75 percent of imported products consumed in rural households are carbohydrate, which is mainly rice.

Figure 4.6 Rural areas food intake ratio

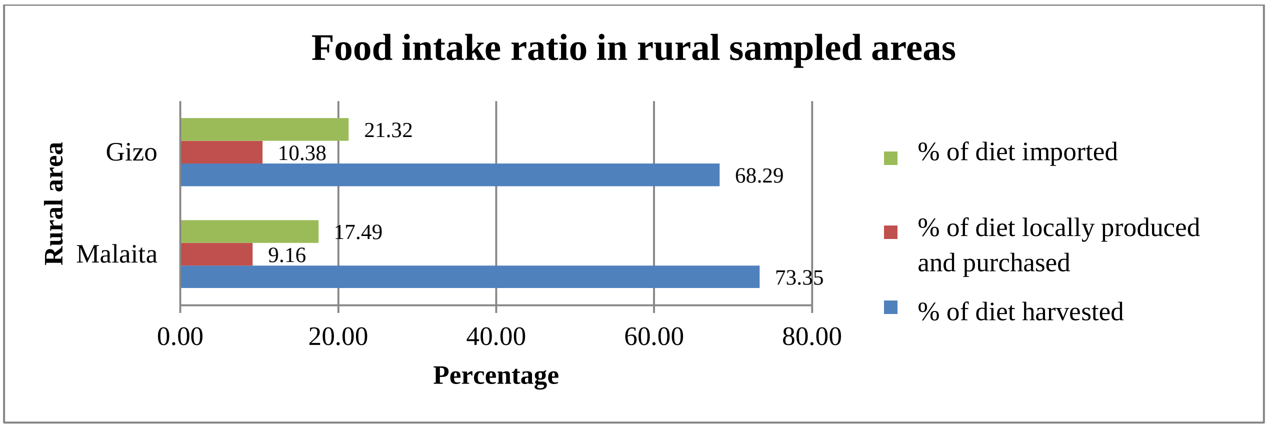


Figure 4.6 exhibits variations and similarities between foods consumed in rural areas. The sample data shows that more than 70 percent of food consumed in rural areas is locally produced and purchased, whereas subsistence activities contribute to less than 21 percent in all rural areas. The imported food products consumed in all rural areas seemed to range

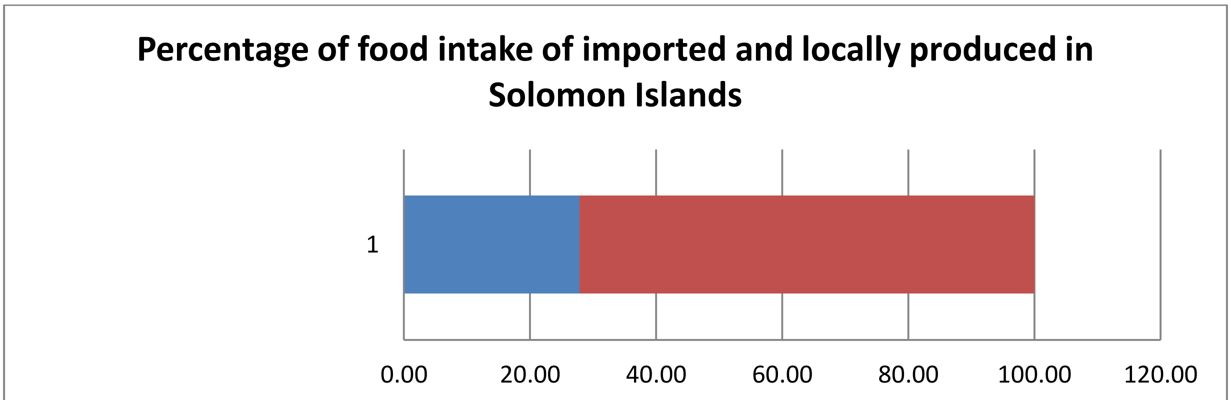
between 17 to 22 percent of total food consumed. Examples of imported products include rice, flour, canned beef and canned fish.

By comparing the rural areas studied, most food intake of average income earning households in Malaita constitute of 17.49 percent imported, 9.16 percent is locally produced and purchased at markets or shops; and 73.35 are products of subsistence activities. In Gizo rural area, 21.32 percent of food consumed is imported, 10.38 percent is locally produced and purchase at shops or markets; and 68.29 percent are products of subsistence activities.

The result presented in Figure 4.6 shows that rural households involve more on subsistence activities to obtain food for daily consumption, and rarely buy local food from markets or shops. The sample data has also shown that rural households are gradually depending on imported food.

4.3. Solomon Islands

Figure 4.7 Food intake in Solomon Islands



	1
% of Food consumed imported	27.89
% food consumed locally produced	72.11

Figure 4.7 presents the ratio of imported and locally produced food in the sampled areas in Solomon Islands. The result from the sampled data confirmed that the total food consumed

constitutes of 27.99 percent imported food and 72.105 locally produced food which includes food harvested from subsistence activities and locally produced food purchased in shops or market places. The results, therefore, portrays that households in the Solomon Islands are highly food self-sufficient and are less dependent on imported food for daily consumption.

Mostly, households in the Solomon Islands consume imported food such as rice, wheat products, canned fish, beef, chicken, apple, pear, milk and canned legumes. Locally produced food consumed in Solomon Islands mainly consists of sweet potatoes, yam, taro, banana, fish local chicken, duck, shell, legumes, melon and pineapple.

4.4. Communities' economic capacity

The basic income of each household has a great influence on the daily food intake of each household. Households with higher income have more access to diverse types of food that may be available in shops or market place. Moreover, higher quality foods are costly and could be accessible if a household is earning sufficient money or has sufficient money spare after spending on basic needs.

Table 4.4:1 Percentage of household's range of monthly income in Solomon dollars

Residents	1-1000	1001-2000	2001-3000	3001-4000	4001-6000	6001-7000	above 7000	Total
Rural area	95.12	0	0	4.88	0	0	0	100 %
Urban area	15	26	20	13	14	7	5	100 %

Table 4.4:1 exhibits the percentage of the population by households and the income they receive in a monthly period. The result shows that 95.12 percent of the households in rural areas earn between 1 dollar SBD to 1000 dollars SBD in a monthly period. On a weekly average, 95.12 percent of the rural households only earn up to 250 dollars SBD and approximately 35 dollars SBD on daily basis.

A smaller portion of the rural households earn a higher income compared to the 95.12 percent. A total of approximately 4.88 percent of rural household's income range from 3001 to 4000 SBD on a monthly cycle. This means 4.88 percent of that population on average earn a maximum of 1000 dollars SBD on a weekly base and 150 dollars SBD on a daily basis.

According to the result, access to money in the urban areas studied is distributed compared to rural areas. On a general note, the greater percentage of the population in urban areas earns less than 3000 dollars SBD on a monthly period. 15 percent of the households earn up to 1000 SBD per month, 26 percent earns between 1000-2000 dollars SBD per month and approximately 20 percent of the population earns up to 3000 dollars SBD on a monthly period. On the contrary, 39 percent of the population earns between 3001 to above 7000 dollars SBD on monthly basis.

Results from the urban areas studied shows that 13 percent of the households in urban areas earned between 3001 to 4000 dollars SBD, 14 percent accessing between 4000 to 6000 dollars SBD per month, 7 percent of households accessing between 6001 to 7000 dollars SBD per month and 5 percent accessing more than 7000 dollars SBD per month.

A detailed assessment of the result shows that the biggest portion of the population in urban areas are earning between 1001 to 2000 SBD per month and 2001to 3000 dollars SBD per month. Moreover, as the range of income increases, the percentage of households that access the larger amount also decreases.

4.5. Food self -sufficiency

Food self-sufficiency index portrays the level of dependency that different sampled areas have on locally produced food. The value of the self-sufficiency index closer to one indicates a society that is highly dependent on local food and index value close to zero indicates a society that is highly dependent on imported food products.

Table: 4.5:1 . Food dependency and demand matrix

Residential class	Imported food ratio out of total	Locally produced food ratio out of total	Per-capita food supply	Per-capita demand	Food self-sufficiency index
Auki (Urban)	28.20%	71.79%	72	100	0.718
Malaita rural area	17.35 %	82.5 %	82.9	100	0.825
Malaita Province	23.95%	76.04%	76.31	100	0.76
Gizo urban	30.876 %	69.12%	69.14	100	0.691
Gizo rural	21.324 %	78.67 %	78.6	100	0.79
Gizo (Western Province)	20.822 %	79.17 %	68.79	100	0.73
Honiara	32.013 %	67.98 %	67.98	100	0.68
Solomon Islands urban area	33.4 %	66.6 %	61.5	92.347	0.67
Solomon Islands rural	19.8 %	80.2 %	80.4	100	0.80
Solomon Islands	27.9 %	72.1 %	72.2	100	0.721

Table 4.5:1 shows the level of dependency that different sample areas has on imported and locally produced food. Rural areas evidently scores higher food self-sufficiency index compared to urban areas. It, therefore, confirms that people residing in the rural areas are

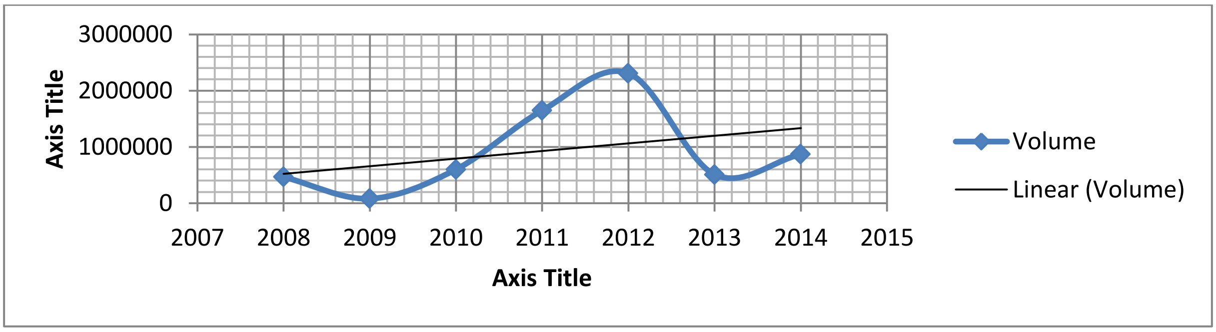
more dependent on locally produced food compared to the population residing in the urban areas. Moreover, the food self-sufficiency index for rural population in the entire sampled area is 0.80 compared to a lower index of 0.67 score for the whole urban population.

4.6. Volume of food imported into Solomon Islands since 2008

Figure 4.8 below illustrates the total volume of food imports recorded by the Customs Department into the Solomon Islands through air and sea ports over a six year period from 2008 to 2014. The volume is measured by the quantity of food imported in kilograms but for the convenience of this section of the study, the volume is simplified into tonnage.

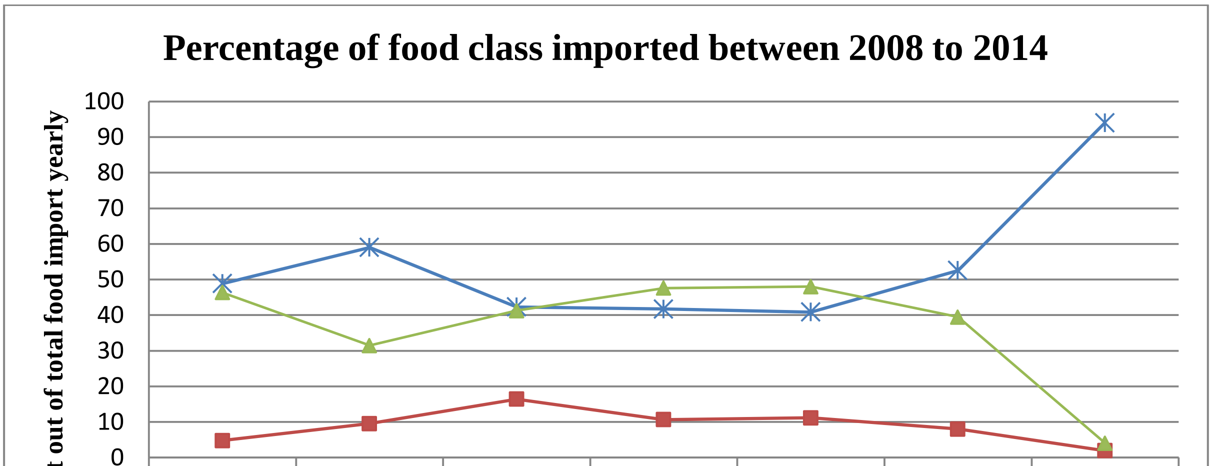
The parabolic graph depicts a distinct increase over a short period of time averaging it to a constant increase of imported food into the Solomon Islands over the years. The total food imported had decreased from 2008 to 2009 but later in 2010 Solomon Islands experienced a sharp increase of almost 97% in the volume of import food from almost 600,000 tonnes to 2.3 million tonnes in 2012. However, immediately after this period from 2012 to 2013, the volume of food import had decreased almost 100% depicting an external influencing factor. From 2013 onwards the graph slowly recovered with a slight increase of 41% of imported food.

Figure 4.8 Volume of food import into Solomon Islands



Years	2008	2009	2010	2011	2012	2013	2014
Volume in Tonnage	465569.95	80551.49	599811.28	1647572.68	2308639.87	509471.79	869650.59

Figure 4.9 Classes of food imported since 2008



	2008	2009	2010	2011	2012	2013	2014
C	48.8791903	59.0018865	42.289068	41.7094638	40.8559918	52.5389141	94.0027606
FV	4.7832741	9.54264036	16.43638	10.6838468	11.13986	8.00135116	1.92972858
P	46.3375356	31.4554732	41.274552	47.6066893	48.0041482	39.4597347	4.06751081

Figure 4.9 is a disintegration of Figure 4.8 as it segregates the total food import into the different food classes. The segregation is done in order to perceive a more accurate image of which type of food is imported more than the other from 2008 to 2014. The study categorizes all the food imported according to three major classes of carbohydrates (C), fruits and vegetables (FV), and protein food (P) which are the main food classes consumed by a majority of the population in Solomon Islands. Generally, the food type having the highest percentage of all imported foods into the Solomon Islands is carbohydrates, followed by protein then fruits and vegetables. However, the volume of carbohydrates and protein food imported do not display much variance; But, displaying almost similar percentage of quantities being imported, compared to the percentage of imported fruits and vegetables which is constantly low at an average rate of 8.9% of all imported foods. Figure 4.9 above, illustrates a trend which shows that the variation between the three different food classes imported between 2008 and 2014 is rather constant irrespective of the quantity imported. However, this trend discontinued in 2014 when almost 94% percentage of the total volume of food imported was carbohydrate alone. Protein food types and fruits and vegetables imported

into the country decreased significantly; 4% for proteins and only 2% of imports were fruits and vegetables.

The decline in import of protein and fruit indicated that there is an increase in local production of fruits and vegetable. The increase in local production of protein and fruits or vegetables influences the population to depend more on local protein and fruit or vegetable which influence the decline in imports of these classes of food.

4.7. Ten major food producing countries exporting to Solomon Islands

From the records collected from Solomon Islands Customs, Table 4.6:1 below exhibits the major food producing countries that export food to the Solomon Islands between 2008 and 2014.

Table 4.7:1. Top 10 major food producers to Solomon Islands

	Country	Percentage
1	Malaysia	50.17
2	Australian	37.68
3	China	2.93
4	Fiji	1.09
5	New Zealand	1.22
6	Papua New Guinea	0.96
7	Hong Kong	0.58
8	Philippines	0.55
9	Thailand	0.38
10	United States	0.34

Table 4.7:2 shows that Solomon Islands is highly dependent on imported food produced in Malaysia and Australia. Malaysia alone contributes up to 50.17 percent of food imported into Solomon Islands since 2008 while Australia contributes 27.68 percent. All the other countries that produce imported food into Solomon Island contributed to only less than 3 percent of food imported.

Figure 4.10 Major food producer to Solomon Islands

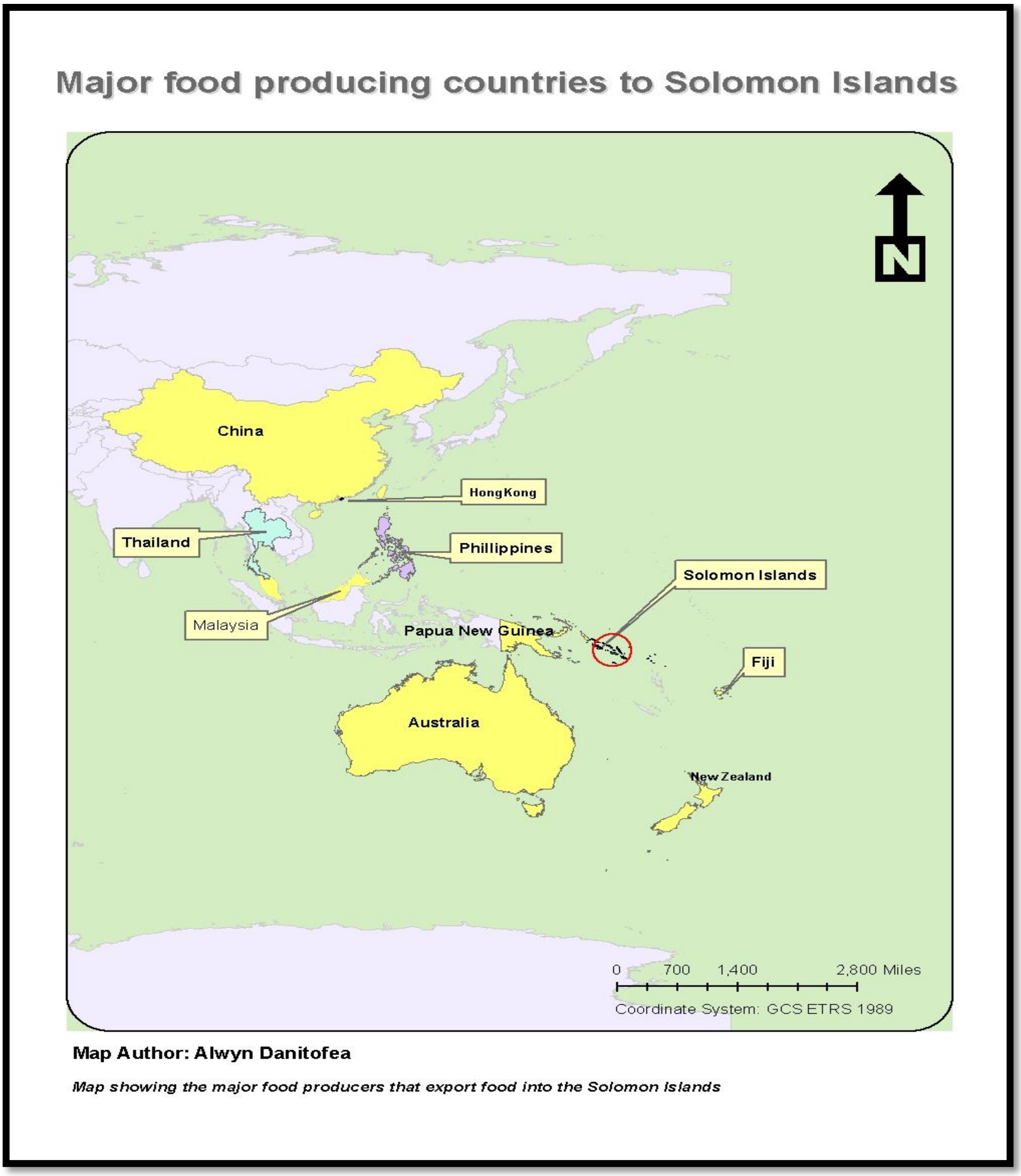


Figure 4.10 is a map showing Solomon Islands in the red circle and the 9 major food producers that export food products to Solomon Islands since 2009. As confirmed on the map, China is the farthest Asian country lying north east of Solomon Islands which produces

and exports food into the Solomon Islands. On the contrary, New Zealand is the farthest country down south that exports food to Solomon Islands.

4.7.1. Distance from Solomon Islands to ten major food producing countries

There is a great variation in the distance that different food travels to reach the Solomon Islands. These distances have a great impact on the cost of food which indirectly correlates to the affordability and accessibility to imported food.

Table 4.7:3 Food producers and their distance from Solomon Islands

	Country	Percentage	Distance from Solomon Islands (miles)		Distance food ratio index
1	Malaysia (MY)	50.17	3549.86		4.5028
2	Australia (AU)	37.68	2016.16		2.6694
3	China (CN)	2.93	4771.89		0.0147
4	Fiji (FJ)	1.09	1380.75		0.0023
5	New Zealand (NZ)	1.22	2377.93		0.0028
6	Papua New Guinea (PG)	0.96	998.47		0.0018
7	Hong Kong (HK)	0.58	4770		0.0006
8	Philippines (PH)	0.55	2897.60		0.0006
9	Thailand (TH)	0.38	4341.89		0.0003
10	United States (US)	0.34	6531.49		0.0002
		Total Distance	33636.40	**Distance percentage ratio**	7.20

According to Table 4.7:4, the furthest food producing country that export to the Solomon Islands is located 6531.49 miles away from Solomon Islands. Papua New Guinea on the other hand is the closest food producing country that exports to the Solomon Islands. The distance from Papua New Guinea to the Solomon Islands is 998.47 miles. On average, approximately 60 percent of the countries that export food to the Solomon Islands are located between 1 to 3 thousand miles away from Solomon Islands.

The food distance ratio exhibited in Table 4.7:5 present various impacts which distance has on food that is produced from overseas countries on the local food system. Out of the top ten food producing countries that export to Solomon Islands, the results show that Malaysia and Australia has scored the highest index of 4.5 and 2.7. Most of the other countries' scores fall below zero which will have a very minimal impact on the food security of the Solomon Islands.

The distance food ratio shows that impact of the distance ratio on food produced in Malaysia and imported into the Solomon Islands is fairly significant. The reason being is that food has a long distance to reach the Solomon Islands. Moreover, the contribution that Malaysia made to the imported food consumed in Solomon Islands is large. These two significant factors have resulted in high distance food ratio. Similarly, the distance food ratio index of Australia is fairly significant due to Australia's huge contribution to imported food into Solomon Islands despite its geographical closeness.

4.7.2. Major countries that contribute to carbohydrate, protein and fruits/vegetables import

Table 4.7:3 presents the major contributors of carbohydrates, proteins and fruits/vegetables into the Solomon Islands. Each of the initials used in the table represents the countries that export various types of food classes into Solomon Islands. Furthermore, the percentage is a representation of each country's contribution to each food class imported since 2008 to 2014.

Table 4.7:6 Top ten food class producers that produce and export Solomon Islands

Carbohydrate			Protein			Fruit or Vegetable		
Country	Percent contribute to import	Distance travel (miles)	Country	Percent contribute to import	Distance travel (miles)	Country	Percent contribute to import	Distance travel (miles)
AU	47.42	2016.16	MY	62.94	3549.86	MY	67.56	3549.86
MY	40.77	3549.86	AU	25.26	2016.16	AU	23.82	2016.16
CN	4.68	4771.89	NZ	1.24	2377.93	NZ	5.14	2377.93
PG	1.47	998.47	CN	0.93	4771.89	CN	0.92	4771.89
FJ	1.18	1380.75	PG	0.62	998.47	US	0.75	
PH	1.04	2897.60	TH	0.46		HK	0.65	4770
HK	0.61	4770	VU	0.39		SG	0.36	
VN	0.57		FJ	0.27	1380.75	JP	0.13	
NZ	0.41	2377.93	PH	0.22	2897.60	FJ	0.12	1380.75
ID	0.40		HS	0.20				

According to Table 4.7:3, Malaysia is confirmed to be the major producers of protein food such as chicken, beef, pork and beans. Most of the fruits/vegetables which are imported into the Solomon Islands since 2008 from Malaysia include vegetables such as Chinese cabbage and onion. Malaysia produced 62.94 percent of all protein imported since 2008, 67.56 percent of all fruits or vegetables imported since 2008 and second biggest producer of carbohydrate producing 40.77 percent of all carbohydrate food imported since 2014. The biggest percent of imported carbohydrate from Malaysia to the Solomon Islands includes rice and noodles.

Australia is the second biggest food producing country for the Solomon Islands; Australia produces the largest volume of carbohydrate food imported to the Solomon Islands. Australia alone contributed 47.42 percent of carbohydrate food imported since 2008.Most of the carbohydrate imported to the Solomon Islands includes rice and wheat. Australia is also the second biggest producer of protein such as beef and chicken, fruit/vegetable imported to the Solomon Islands including apples, pear, broccoli, and orange. Australia produces 25.26 percent of protein imported and 23.82 percent of fruit and vegetable imported to the Solomon Islands.

Table 4.7:3 also shows that all the other food producing countries that export food to the Solomon Islands only contributed up to 6 percent to the total food imported into 2008.

In relation to the distance that each class of food has to travel, 90 percent of food classes travelled in and around the Asia Pacific region. China is the furthest country that food had to travel from to reach Solomon Islands and is 4771.89 miles away from Solomon Islands. Papua New Guinea is the nearest country that produces carbohydrate and protein food imported into Solomon Islands. The distance from Papua New Guinea to Solomon Islands is 998.47 miles away from Solomon Islands. In relation to fruit or vegetable class, the result shows that Fiji is the closest country that produces fruits or vegetables that is imported and consumed in households in the Solomon Islands. Geographically, Fiji is situated 1380.75 miles away from Solomon Islands.

4.8. Food security index

The food security index presented in Table 4.8:1 represents the impact of imported food on food security in various urban and rural households in Malaita Province, Western Province and Honiara. The result further generalizes households into two major residential categories: rural category and urban category.

From Table 4.8:1, the food security index calculated from the Solomon Islands Customs data and data obtained from questionnaires has shown that food security scores ranges between 0.28 - 0.65. Rural households in Malaita province have the most secured food system with a food secured index of 0.65, while Honiara households have the most unsecure food system with a 0.25 food security index.

Table: 4.8:1 Food security and distance matrix for sample areas in the Solomon Islands

Residential class	Per-capita food supply in percentage of total food consumed	Per-capita demand	Food self-sufficiency index	Food dependency ratio	FSindex	FSindex with distance
Auki (Urban)	72	100	0.718	0.28	2.55	0.35
Malaita rural area	82.9	100	0.825	0.18	4.71	0.65
Malaita Province	76.31	100	0.76	0.24	3.17	0.44
Gizo urban	69.14	100	0.691	0.31	2.24	0.31
Gizo rural	78.6	100	0.79	0.21	3.76	0.52
Gizo (Western Province)	68.79	100	0.73	0.27	2.70	0.38
Honiara	67.98	100	0.68	0.32	2.13	0.30
Solomon Islands urban area	61.5	100	0.67	0.33	2.03	0.28
Solomon Islands rural	80.4	100	0.80	0.20	4.00	0.56
Solomon Islands	72.2	100	0.721	0.28	2.58	0.36

When assessing food security according to urban and rural areas in Table 4.8:1, the result shows that rural households are more food secure, having 0.56 in its index value while urban households scored an index of only 0.28. As we narrow down into urban households and rural households in different provinces, the results show that there are similar index scores in rural and urban households in the Provinces. Rural households in Malaita Province are the most food secured with an index score of 0.65 and Western Province having an index score of 0.52. According to Table 4.8:1, there is less variation in index scores of urban households in various provinces. The urban households in Auki, Gizo and Honiara are within the same range of food security index ranging from 0.35 in Auki, 0.31 in Gizo and 0.30 in Honiara Township. In a national context, the food security index of Solomon Islands is 0.36.

5. Discussion

This chapter will be divided into 4 parts which includes: a discussion of the results of food intake in rural areas, discussion of the food intake in urban areas, discussion on major food exporters to the Solomon Islands, discussion of the methodology used including food security in areas studied and the projections of climate change impact on food security in the Solomon Islands. By using the results of food intake in the studied areas, a generalised conclusion could be drawn on the food security in rural areas, urban areas and generally in the Solomon Islands.

5.1. Discussion of food intake results in rural areas

From the results of food intake in rural areas, it is evident that the population residing in the rural areas are highly self-sufficient in food. The sample population from rural households shows that 80.23 percent of the food consumed is produced locally in the Solomon Islands, which leaves, 19.77 percent of the food consumed in the rural areas to be imported. The result, however, shows that Malaita Province is more self-sufficient in food compared to Western Province. The result of food intake in households of rural areas in Malaita Province shows that local food consumed constitutes of 82.51 percent of total food consumed in households, while the local food consumed in Western Province constitutes of 78.67 percent of the total food consumed.

In a detailed assessment of the classes of food intake in rural areas, the result shows that the majority of imported food consumed in rural areas is of the carbohydrate food class including rice, flour and noodles. Imported carbohydrate alone constitutes of 15.41 percent of the total food consumed in rural households. The results, therefore, shows that imported carbohydrate makes up 50 percent of carbohydrate food consumed in the rural households. On the contrary, rural households are more self-sufficient on protein and fruit/vegetable food class. Approximately 22 percent of the total percent of food consumed is local protein and mostly fish, 35.73 percent of the total food consumed was locally produced fruit/vegetable including local cabbage, pineapple, melon, cucumber and tomatoes. Inversely, the imported protein and imported fruit/vegetable constitutes to 3.84 percent and 0.53 percent respectively of total food consumed in rural areas.

The households in rural areas of Western Province are more dependent on cash to acquire food compared to rural households in Malaita. In the rural areas of Western Province, 31.7 percent of food consumed in households is purchased at local markets or shops while the rural households in Malaita only purchase 26.65 percent of the total food consumed. These results show that households in rural area of Malaita province are more dependent on subsistence activities to obtain food compared to households in Gizo, Western province.

Despite having results that confirms self-sufficiency in food for rural households, this study has not explored the effort needed to obtain food from subsistence activities. As in the case of rural areas, it is worth carrying a study that determines the distance people had to travel to obtain food by means of subsistence farming or subsistence agriculture.

5.2. Discussion of food intake results in urban areas

The results of food intake in the sampled urban areas indicated that urban households are fairly food self-sufficient, 66.6 percent of the total food intake in rural households is local and 33.40 percent of food consumed in urban households is imported. When comparing the food intake in the three sampled urban areas, it is evident that Malaita Province is most self-sufficient with 71.79 percent of its total food intake locally produced. Both urban households in Gizo and Honiara consumed less than 70 percent of locally produced food.

Detail assessment on the classes of food intake in urban areas confirmed that rural households are fairly self-sufficient in protein food, highly self-sufficient in fruit/vegetable and import dependent on carbohydrate. 68.65 percent of protein consumed in the sampled urban areas is local and 90.54 percent of all fruit/vegetable consumed is locally produced. On the contrary, imported carbohydrate constitutes 51.75 percent of the total carbohydrates consumed in urban households. The three most common imported carbohydrate consumed in urban areas are rice, flour and noodles.

By assessing and comparing the sampled urban areas, the result shows that all households in the three sampled areas are highly depend on cash to acquire food for consumption. Honiara households are the most cash dependent urban area with 95.96 percent of food consumed in Honiara households being bought in shops or at the market place. In Gizo, 85.58 percent of food consumed is purchased while 79.41 percent of all food consumed in Auki town is bought in shops or at the market place. The result had shown that despite food self-sufficiency in urban areas, accessibility to food is highly dependent on cash except for few households that are involved in subsistence activities as alternative food sources.

5.3. Major producers exporting to the Solomon Islands

The results from the customs data on imported food shows that the ten major food producing countries that export food products to Solomon Islands are from Asia and Pacific region. Malaysia alone is the largest food producer to the Solomon Islands that produces 50.17 percent of imported food consumed in the Solomon Islands. Australia is the second largest food producer to the Solomon Islands that produces 37.68 percent of imported food into Solomon Islands. It is therefore evident that food imports for the Solomon Islands are highly dependent on Malaysia and Australia who mutually contributed to approximately 90 percent of imported food consumed in households of Solomon Islands.

When dissecting major food producers from the customs data according to the different food classes, it can be clearly established that Australia is the major importer of carbohydrate foods to the Solomon Islands. The data also shows that the three other countries that highly contribute to the export of carbohydrate into Solomon Islands are Malaysia, China and Papua New Guinea. However, the major exporter of protein food, fruits and vegetables into Solomon Islands is Malaysia followed by Australia, New Zealand and China respectively for both food classes.

5.4. Discussion on methodology

The methodology developed in this study is based on the existing studies on countries' food security that is founded upon a country's food self-sufficiency and dependency on GFS. The method in this case does not accommodate for nutrition input into the methodology used. The methodology enables incorporation of significant aspect of food security such as availability of food represented as imported or local food products and accessibility to food determined by distance the food had travelled to reach Solomon Islands.

The availability of food in the case of this methodology is categorised into two categories including imported food and locally produced food. Locally produced food includes food obtained from subsistence activities and local food purchased in market place or shops. Accessibility in this case is determined by the distance the food had travelled to reach the Solomon Islands.

The methodology in this case makes it easier for national country planers and decision makers to understand the significance of distance that food travels around the globe to be available to households. Furthermore, the distance that food travels has a direct relationship to access to food and the food security of a country. It is important for national planners to consider the variation in distance travelled by food, and the percentage of the total food available to households is local and imported.

By acknowledging the different distances that food had travelled, we could eliminate the potential error of generalisation and project the possible negative impact a country will experience if the GFS is infringed by issues such as climate change. Besides, make a near to truth estimation of food security of a country.

5.4.1. Discussion on food self-sufficiencies in urban and rural areas

For the purpose of this study, the food self-sufficiency of urban and rural areas represents the level of dependency that households have on locally produced food. Level of food self-sufficiency in the case of this study is represented as a percentage of the total food consumed; and is the sum of food gathered from subsistence activities and locally produced food purchase in shops or local markets.

Data obtained from the questionnaire carried out in urban and rural areas were used to obtain the level of food self-sufficiency for rural and urban areas. Using households as the most basic unit in residential areas, the questionnaire captures food intake in households which is processed to attain the quantity of imported food and local food consumed in households. A cumulative total of all imported and local food consumed in households are added together to reach the total food consumed in households. Self-sufficiency of each residential category is calculated by dividing the sum of local food by the total food consumed multiplied by one hundred.

The households' self-sufficiency that has been calculated will be used to determine the level of independence a specific residential category is. Henceforth, this index will be incorporated into used to calculate the food dependency ratio that was used to calculate the impact of imported food on the food security.

The food self-sufficiency is a major indicator that determines the level of dependency that each residential categories have on imported and local food. The score below fifty indicates high dependency on imported food and the score above fifty signifies a residential category that consumed food gathered from subsistence activities and locally produced food purchased in shops or the local markets.

Urban area's food self-sufficiency

The percentage of food self-sufficiency in urban areas revealed in Table 4.8:1 was 71.8 percent. The percentage of food self-sufficiency has established that urban areas are highly dependent on local food for consumption and are less dependent on imported food for household food intake. With the high percentage of food self-sufficiency, the result indicates that changes in the GFS will have a minimal impact on food intake in urban areas.

In a detailed assessment of specific food dependencies in Honiara, Gizo and Auki, the result shows that Auki is the most independent with 71.79 percent self-sufficient. Gizo is the second most independent with 69.14 percent and Honiara is the least food self-sufficient scoring 61.5 percent. The percentage of food self-sufficiency has shown that, Honiara will be the most affected urban area should there be a disaster hitting the GFS. Gizo and Auki will be the least affected.

Rural area food self-sufficiency

Rural areas are more food self-sufficient compared to Urban areas. According to the results in Table 4.8.1, the percentage of food self-sufficiency was 80.2 percent. This shows that most of the households in rural areas are highly dependent on local food that is mostly obtained from subsistence activities and only 20 percent of the food intake will be affected if there is global issue affecting the GFS.

A more detailed assessment of the results of rural areas in Table 4.8.1 shows that households in the rural areas in Malaita are the most self-sufficient, with 82.5 percent self-sufficient compared to Gizo with 78.67 percent self-sufficient. The result shows that households in rural areas in Malaita will be less affected compared to Gizo if there is disaster affecting the GFS.

5.4.2. Food demand of rural and urban areas

Specifically for this study, food demand is assumed to be equivalent to 100 percent of the food consumed in each household. The assumption made on household's food demand is founded on the notion that food consumed in households is equivalent to the minimal food intake needed for daily survival. To holistically capture household's food demand, both the local and imported food consumed in households is totalled to fully represent food demand in various residential areas in the study areas.

5.4.3. Travelling distance of food

Transportation of food from its place of production to households for consumption has various direct and indirect influences on food accessibility. Prices of imported food products are commonly influenced by transportation cost that result in elevation of goods price to accommodate for transportation cost. As a result of the elevation of the prices of goods, accessibility to food varies across the population due to lack of uniformity in the economic status of households within the provinces.

From Table 4.7:1 in the result section, approximately 95 percent of imported food consumed in households is produced in the Asia Pacific region. Other regions that contributed to imported food include the United States and other European countries that produce cereals. From the Asia sub region, Malaysia is the highest producer of food to the Solomon Islands and other Asian countries that produce food consumed in the Solomon Islands includes:

China, Hong Kong, Philippines and Thailand. Alongside Asia region, other pacific neighbours of Solomon Islands also contribute massively to the imported food consumed locally. Australia is the second biggest producer of food consumed in Solomon Islands, producing 37.68 percent and other pacific island countries includes: New Zealand, Fiji and Papua New Guinea.

The distance from Malaysia to the Solomon Islands and Solomon Islands to Australia is significant ... to the prices of imported goods and the food security of the Solomon Islands. Due to the high dependency on imported food from Malaysia and Australia, the cost associated with transportation of food products and the route taken for food to reach the Solomon Islands from these two countries are correlated to both the price and food intake in the Solomon Islands.

According to the results, a significant change in route for food transportation from Australia and Malaysia will affect 87 percent of imported food consumed in Solomon Islands. Approximately 87 percent of imported carbohydrate, 88 percent of imported protein and 90 percent of imported fruits or vegetables consumed in households will be infringed. This would result in major issues, affecting 17.4 percent of food consumed in all households in the Solomon Islands.

5.4.4. Food distance ratio

Food distance ratio is a measure of the impact of distance on the volume of imported food consumed in local households. The intensity of the impact is reflected in the ratio; the greater the ratio, the higher the impact will be.

Malaysia scores the highest ratio due to its large contribution to food that is consumed in Solomon Islands, and the fact that the distance that food travelled to reach Solomon Islands is quite far. On that understanding, Malaysia has a great impact on the final outcome on the food security in the Solomon Islands. Similarly, Australia is the second highest due its high contribution to Solomon Islands food security.

The food-distance ratio shows that the final outcome of food security of the Solomon Islands is mostly a reflection of the distance that food had to travel to reach Solomon Islands. Additionally, Australia and Malaysia are the most two important countries in Solomon Islands food security. A change in the route to reach Solomon Islands from Malaysia and Australia could heavily affect the food security in the Solomon Islands. Therefore, to maintain food security in the Solomon Islands, food travelling from Malaysia and Australia to Solomon Islands has to take the shortest route possible to maintain the availability of food and reduce cost to transport food into the country.

5.4.5. Food security index

Food security index is used as a measuring indicator to gauge the level of impact that imported food and distance have on food security in residential areas, provinces and Solomon Islands at large. According to the methodology used, a local food system is most secure from international disaster when 100 percent of food consumed in a country is locally produced. Such scenario is achieved when the food security index of a country closest to 1. The further the index from 1, the less secure the food system is.

Table 5.4:1 Food security index

Residential class	FSindex with distance
Auki (Urban)	0.35
Malaita rural area	0.65
Malaita Province	0.44
Gizo urban	0.31
Gizo rural	0.52
Gizo (Western Province)	0.38
Honiara	0.30
Solomon Islands urban area	0.28

Solomon Islands rural	0.56
Solomon Islands	0.36

Urban area food security

According to the results, food security in urban areas is lower compared to rural areas. The food security index for urban areas is 0.28 which is quite low compared to the 0.56 for the rural areas. As we closely compare the rural areas and urban areas in Malaita and Western Province, the result continues to exhibit the same trend that rural areas are more food secure compared to urban areas.

By assessing the results, it is evident that households in urban areas consumed more imported food products compared to rural areas. The level of dependency on imported food products has directly influenced the food security in urban areas. Moreover, the income survey of communities in Section 4.4 shows that urban population earn more monthly income than rural dwellers. Having access to more income could also influence the buying pattern of household. People who have access to more money will tend to buy imported products which tend to be more expensive in the Solomon Islands.

Other peripheral factors that may affect food security in urban areas is the availability of land to practice subsistence activities in order to produce food for households, and also time constraints. Most of the households are situated in very small areas and lack sufficient land mass to be involved in urban agriculture. Additionally, people who are living in urban areas are so occupied with white collar jobs to get better income and do not have sufficient free time to involve in subsistence agriculture or subsistence fisheries.

As a result urban dwellers rely more on imported food products bought in shops or the public market place and have less dependency on local food. Urban households food supply becomes more susceptible to a disaster negatively impacting the GFS compared to rural residents who are more dependent on local food supply.

Rural areas' food security

From the results of rural households' results in section 4.7, the result confirms that rural households are more food secure compared to urban areas. The overall food security index of rural areas is 5.6 which is twice the index of urban areas which is 2.8. It is certain from the result that food intake in rural households are more dependent on local food produce. The positive dependency on local food results in the less negative impact of imported food and the distance food travelled on the food security index.

The results show a high dependency on local food in rural households of the Solomon Islands has mainly resulted from the massive involvement in subsistence activities. Most of the rural households are involved in basic subsistence agriculture for the main source of carbohydrate (Sweet Potatoes, Yam, Taro, Banana and Cassava) and fruit or vegetable. Subsistence fisheries are also the main source of protein. People living in rural areas fish, collect shells and harvest other sea food from the sea to obtain protein for daily diets.

Other peripheral factors that contributed to high dependence on local food are limited financial capacity to obtain costly imported food products, available land to farm and sufficient free time. According to Table 4.4:1 in the result section, 95.12 percent of households in rural areas earn between 1 – 1000 dollars monthly. Earning such minimal income will not cater for all basic needs and will lead to heavy involvement in subsistence activities for food to cater for daily food intake. In addition to income, there is a lot of available land and time to involve in subsistence activities. Land is customary owned and is always freely available for subsistence agriculture for households in rural areas. Unlike people in urban areas, time is the most available resource that they do not have. Most people in rural areas are not involved in formal employment, therefore, can expend more time to make farms and fish for daily consumption. These facts about the rural areas has significantly influence their food intake and food security.

5.5. Impact of climate change on food security

Climate change continues to be a major threat to the GFS and the level of impact experienced by each country. Countries such as the Solomon Islands with a smaller land mass and weaker economy will definitely experience negative impacts on the country's food security. Additionally, food products that are imported may also decline due to the negative impacts on GFS.

5.5.1. Discussion on the impact of climate change on imported food

The food system in the Solomon Islands consists of approximately 28 percent imported food. Beside the imported food produces, local food produced and consumed in households consists of approximately 72 percent of total food consumed in households. A negative impact on the global food network may result in constraint to the 28 percent food import.

From the global food network, the Asia and Pacific region contributed massively to the food import into Solomon Islands. Approximately 54 percent of food imported into Solomon Islands is from Asia region and a climatic disaster reducing food production in Asia will directly affect the food security of Solomon Islands. Relatively, the Pacific Island countries including Australia and New Zealand contribute to approximately 41 percent of Solomon Islands' food import. Some of these Pacific Islands are quite small in geographical size and are very susceptible to climate change, especially to sea level rise, increase sea acidity and extreme weather patterns.

According to the 2014 report on climate change in Asia produced by IPCC, there will be general decline in food production in Asia, but with diverse possible outcomes (medium confidence). For example, most simulation models show that higher temperatures will lead to lower rice yields as a result of a shorter growing period. An Asia-wide study revealed that climate change scenarios (using 18 GCMs for A1B, 14 GCMs for A2, and 17 GCMs for B1) would reduce rice yield over a large portion of the continent. The scenario that climate change reduces food production in Asia, approximately 28 percent of food intake in all households in Solomon Islands will be affected due heavy reliance on rice. Such decline in the availability of food will directly affect the population that depends massively on food produced in Asia.

In the case of food produced in the Pacific region including Australia and New Zealand that is imported into Solomon Islands. Australia is the biggest food producer that is the is the origin of approximately 38 percent of imported food consumed locally. A climate change impact that may deplete the volume of food produced in Australia may result in an impact on 14.3 percent of food consumed in all households.

According to IPCC's report on the impact of climate change on food production at the Australian national level, the net effect of a 3°C temperature increase (from a 1980–1999 baseline) is expected to be a 4% reduction in gross value of the beef, sheep, and wool sector. Dairy productivity is projected to decline in all regions of Australia other than Tasmania under a mid-range (A1B) climate scenario by 2050.

In the scenario as described above, the volume of imported protein available in the Solomon Islands may reduce by 4 percent. In the case when there is decline of protein available, the price of protein may elevate due to scarcity in market and high demand which may lead to decline in food security in households.

Despite assessing the possible impact of climate change on the food system, this study does not quantitatively calculate the precise volume to import which will be affected.

5.5.2. Discussion on impacts of climate change on urban food security

If climate change reduces food production in Asia, urban areas in the studied area will experience change in the amount of food available. The current imported food consumed within the studied urban areas makes up 33.4 percent of food consumed. Specifically for Honiara, imported food constitutes 32 percent of total food consumed in households. In Gizo of the Western province, 30.87 percent of food consumed is imported and 28.2 percent of food consumed in Auki Township is imported.

Using the scenarios discussed in Section 5.5.1, urban areas would be the most affected in situation when food productivity in Asia and Australasia is negatively impacted by climate change. The claim made is due to urban areas high dependency on food imported from Asia and Australia. Therefore a decline in food production in these regions due to climate change could reduce a food that is available in urban households up 33.4 percent.

Certain variation will be experienced in the three different study areas that were studied including Honiara, Auki and Gizo urban area. These variations are due to different levels of dependency that each urban area has on imported food products.

Amongst the three urban areas studied, Honiara is the most dependent on imported food with a food dependency index of 0.32 which is equivalent to 32 percent of all food consumed in households. The ratio indicates that 1/3 of food consumed in Honiara households is imported from Asia or Australia and the climate impact on food may reduce up to 32 percent of food consumed in all households in Honiara.

In Gizo, 31 percent of food consumed in households is imported. The result shows that 31 percent of food consumed in Gizo urban area is imported. The result also shows that decline of food production from Asia, Australia and the Pacific may reduce up to 31 percent of food available in households for daily consumption. It is, therefore, evident that a negative impact of climate change on Asia, Australia or Pacific will result in food shortages in Gizo.

Auki in Malaita Province is the most food self-sufficient urban area out of the three urban areas studied. Only 27 percent of the foods consumed in households are imported, indicating a high food self-sufficient urban area. However, in situation as described in section 5.5.1, food available in Auki may even decline up to 27 percent, which can give rise to food insecurity in Auki urban area.

5.5.3. Discussion on impacts of climate change on rural areas' food security

From the results on food intake in rural areas, it is evident that rural areas are more food self-sufficient and food secure compared to urban areas. In the rural areas, approximately 80 percent of food intake in households is locally produced and only 20 percent is produced overseas and imported into Solomon Islands.

Specifically in the case of rural areas in Malaita and Western Province, rural areas in Malaita are more food secure compared to Western Province. The food security index for rural areas in Malaita Province is 0.65 and that of the rural areas in Western Province is 0.52. The result shows that rural areas in Malaita Province are more dependent on food produced locally compared to Western Province.

In a situation that climate change is projected to negatively impact production of food in Asia and Australia, it is very likely that up to a maximum of 20 percent of food available in rural areas will be affected.

A decline of food production as described by IPCC reports in Asia may result in decline of up to 10.03 percent of all imported food consumed in rural areas. Specifically for rural areas in Malaita, a decline in food production in Malaysia may negatively affect up 9 percent of food which is available and consumed in households. On the other hand, a decline in food production in Australia may influence up to 7.5 percent of imported food consumed in rural households in Malaita province.

For households in rural areas in Gizo, the total amount of imported food consumed in households of Gizo makes up to 21 percent of total food consumed. Approximately 10.5 percent of the imported food consumed is produced in Malaysia and 7.9 percent are products of Australia.

In relation to the volume of food imported from the specific countries identified. A climate change impact that depletes food production in Malaysia may reduce up to 10.5 percent of food available in Gizo rural areas. Similar to Malaysia, the climate change impact on food system in Australia may impact up to 7.9 percent of all imported food products available in rural areas in Gizo.

After assessing the possible impact of climate change on imported food consumed in households. Rural households in Solomon Islands are massively reliant on subsistence activity to obtain food. Noting that fact, later studies need to assess possible impact which could affect the locally produced food and do projection on the availability and accessibility of food in Solomon Islands. Moreover, further studies needs to quantitatively assess the food security in relation to changing weather pattern, extreme weather events, sea level rise and increasing sea acidity.

6. Limitation to methods

This chapter of the research highlights limitation in this study and methodology which gives room for improvement. Additionally, this section also highlights some of the essential factors that contribute to food security which could not be accounted for in this study. These limitations include inter-country distance, intra-country distance and soil fertility depletion.

6.1. Distance travelled using country centroid

Using the formula to calculate the food security of Solomon Islands, a possible source of limitation is the distance from Solomon Islands to the centroid of other countries. Centroids of these countries that trade with Solomon Islands is generally the geographical centre of these countries including both the land and sea areas. The centroid therefore is not the true representation of the port of departure that food originated from.

Australia, the United States of America and the Republic of China that have larger political boundaries, using the centroid of these countries may exaggerate the distance to Solomon Islands. The exaggeration is a result of the centroid in the middle of these land areas that is far from port of departures. These exaggerations may possibly elevate food security or food insecurity in the Solomon Islands. However, this study focus more on the national productions of the countries that exports to the Solomon Islands, and not on the specific sites of productions or port of departure.

A future research could improve on this issue by specifically identifying port of departure for all imported food that is consumed in Solomon Islands. By precisely locating the port of departure of the imported food into Solomon Islands, enables a precise calculation of the distance that food had travelled to reach Solomon Islands from countries of origin.

6.2. Local food system resilience

Another limitation to the methodology deployed in this study includes its inadequacy to scrutinise the Solomon Islands' domestic food system. The methodology used in this study does not account for the distance that food travelled domestically to consumers. Lacking to account for the domestic travelling distance may cause under estimation in the impact of distance on food security in rural areas.

A future study could improve from this limitation by accounting for the distance from Honiara to all the provincial centres. Having that improvement will accommodate for the domestic distance and adding it to intercountry distance, enables a more accurate distance that could be used to calculate for residential category food security.

6.3. Soil fertility depletion in Solomon Islands

Acknowledging the sizes of the islands in Solomon Islands, depletion of soil fertility is a major contributing factor to food availability that is not discussed in this study. Due to continue cultivation of same areas will result in massively depletion of crop yielding. The phenomenon of land usage and soil productivity is not reviewed in this study. It is fitting that such phenomenon be studied in a separate paper to understand the implication of soil to food production in the Solomon Islands and natural disaster such as storms and cyclone.

6.4. Assumptions done with methodology

One of the short coming of the methodology is the lack of support to the assumptions made and outlined in section 4.3.3. The assumptions are basically made from my knowledge as a local of Solomon Islands. Moreover, these assumptions are made to ensure that the formula used is practical with limited data that is available. These assumptions can be a used as basis for future studies in the case of Solomon Islands.

7. Recommendations

This chapter of the thesis will focus on options which the Solomon Islands could consider and practice in order to be more food secure. These options include various farming methods that will encourage local food production in order to reduce of food imports of items that can be produced locally in the Solomon Islands. Additionally, these recommended alternatives will cater for the negative impact of climate change on the GFS. The recommendations that will be discussed include: subsistence farming, commercial farming, urban farming and climate change resilient crop farming.

7.1. Increase involvement in subsistence farming

Subsistence farming in this case refers to the mode of farming where the majority of foods produced are purposely for household consumption. Subsistence farming is highly recommended due to the availability of free land in the customary lands in Solomon Islands. Approximately 80 percent of the population in Solomon Islands have access to customary land; these lands can be used to make vegetable farms, fish farms, piggery, and cattle that can be used for household consumption.

When households are involved in subsistence activities, it increases the availability of carbohydrate food, protein and fruit or vegetable. Increasing the availability of these foods will indirectly reduce the need to import food from other countries and also increase food security due to availability of balance diet in all households. Furthermore, having high food self-sufficiency reduces the possible of catastrophic shock on local food system in situation of a major disaster affecting the GFS

7.2. Increase urban farming

From the results, it is evident that urban areas are more dependent on imported food. Most of the urban dwellers could utilise urban farming to reduce over reliance on imported food. Households situated in urban areas can utilise free spaces surrounding their homes to make vegetable gardens in order to avoid buying of imported vegetables or fruits from shops and market place.

A major advantage of utilising free space in urban areas to plant vegetable farms is reducing the over dependency on imported fruits or vegetable. Most of the imported crops are seasonal and can cause a massive disadvantage if there is shift or change in seasons due to climate change. Most of the vegetables that can grow in the tropics could be planted throughout the year. Such crop type is therefore more resilient to climate changes compared to the seasonal crops imported.

Commercial farming

Commercial farming is also another method of farming that needs to be encouraged in the Solomon Islands. Such form of farming must be encouraged to assist people who are busy and do not have sufficient time to involve in urban or subsistence farming. With commercial farming, production of food in the country will be more consistent and enough to meet the national food demand. More importantly, increasing the quantity of food produced locally reduces the need to import food.

Most of the food imported to the Solomon Islands could be farmed locally. Food such as rice, beef, pork, vegetables and fruits can be farmed locally to change the food import matrix to a more food self-sufficient state. This approach reduces the distance that food travels in order to reach Solomon Islands and so increases the food security of Solomon Islands due to high food self-sufficiency and availability of food locally.

8. Conclusion

Food security at a country level is increasingly important worldwide, especially with the increasing reliance on the GFS. GFS refers to the global network of food from country of production to final consumers. Due to increasing reliance on food that had travelled across the globe to reach consumers, it is significantly important to understand the impact that distance has on a country's food security.

Recent studies have focused on the availability of food in various countries worldwide and its impact on food security at national level. Other studies have also focused at possible influence that distance have on food security both globally and at national level. The present study focus on the availability of food from both imported and local sources that households can have access to; and the impacts on households' food security relating to the distance that food travelled to reach Solomon Islands, especially with the fact that accessibility to food from the GFS is becoming fundamental to households' food security.

The methodology developed in this thesis allows for understanding a countries' dependency on imported and locally produced food. The level of dependence on imported food was obtained and the total distance that food travelled was used to calculate the total impact of households' food security. Moreover, households were aggregated into residential categories including urban and rural by which these residential categories' food security was determined; finally it allows for a determination of national food security.

The results of this study shows that responses from the questionnaire on food intake in households could be complemented with Solomon Islands Customs data on food import to calculate food security both at household level and national level. Calculate food security using these data sources, certain generalisation and assumption has to be made on demand and availability of food in households.

The case studies of urban areas and rural areas in Honiara, Gizo and Malaita province demonstrates that the food system in the Solomon Islands includes imported and locally produced food. The case study shows that urban areas are more dependent on imported food compared to rural areas. Only 20 percent of food consumed in rural areas is imported while 33 percent of food consumed in urban areas is imported. By focusing on the provincial level, it is evident that Malaita is the most food self-reliant province with 76.31 percent food self-sufficient, Gizo (western province) 68.79 percent food self-sufficient and Honiara with 67.98 self-sufficient.

The result also correlates to the food self-sufficiency ratio in the case that rural areas are more food secure compared to urban areas. The food security index for urban areas is 0.28 and the food security index for rural areas is 0.56. The higher score for rural areas shows that food supply in rural areas are more secure compared to urban areas.

To improve on this study, a more detailed consideration should be done to the locally produced food that has been consumed in households. Some households do rely heavily on cash to obtain local food. More detail on the distance that food travels domestically could enhance an understanding on the impact that distance has on food security.

The methodology developed in this thesis is adaptable, and can be used to model the potential effects of different climatic scenarios for different countries especially in considering the possibility that issues such as climate change could influence a local food system. The result could be used for agricultural planners and decision-makers to make decisions about which residential category that needs attention to improve local food improvement. Moreover, derive strategies on how to reduce food imports to increase food security.

9. References

Barnett, J. (2010). Dangerous climate change in the Pacific Islands: Food and food security. *Regional Environ Change, 11*(2011), 229-237.

Burt, B. (1994). Land in Kwarae and Development in Solomon Islands. *Oceania, 6*(4), 317-335.

Bell, D., Kronen, M., Vunisea, A., Nash, WJ., Keeble, G., Demmke, A., Pontifex, S., & Andrefouet, S. (2009). Planning the use of fish for food security in the Pacific. *Marine Policy, 33*(2009), 64–76.

Bell, D. J., Reid, C., Batty, J. M., Lehodey, P., Rodwell. L., Hobday, A., & Demmke, A. (2013). Effects of climate change on oceanic fisheries in the tropical Pacific: implications for economic development and food security. *Climatic Change, 119*, 199-212.

Berg, A., Noblet-Docoudre, De. N., Sultan, B., Lengaigne, M., & Guimberteau, M. (2012). Projection on climate change impacts on potential C4 crop productivity over tropical region. *Agriculture and Forest Meterology, 1* (2012), 1-14.

Bevier, G. (2012). Global food systems: Feeding the world. *Reproduction in Domestic Animal, 47*(4), 77-79.

Birk, T. (2014). Accessing vulnerability to climate change and socio economic stressors in the Reef Islands group, Solomon Islands. *Journal of Geography, 114*(1), 59-75.

Birk, T., & Rasmussen, K. (2014). Migration from atolls as climate change adaptation: Current practices, barriers and options in the Solomon Islands. *Natural Resource Forum, 38*,1-13.

Bryant, M., & Stevens, J. (2006). Measuring of food availability in the home. *Nutrition Review, 64*(2), 67-76.

CGIAR. (2012). *CGIAR Research Program on Aquatic Agricultural Systems: Food and nutrition security in Solomon Islands.* Retrieved (2015, May 15) from http://www.aas.cgiar.org/publications/food-and-nutrition-security-solomon-islands

Chen, S., Florax, R., & Snyder,S. (2013). Obesity and fast food in urban markets: a new approach using geo-referenced micro data. *Health economics, 22*, 835–856.

Chakraborty, S., & Newton, A. (2011). Climate change, plant diseases and food security: an overview. *Plant Pathology, 60* (1), 2-14.

CIA. (2013). *CIA World Factbook*. (2013). Retrieved (2015, June 15). from http://www.isilo.com/download/CIAWFB13.htm

Dimitri, C., & Rogus, S. (2014). Food choice, Food Security, and Food policy. *Journal of International Affairs*, *67*(2), 21-31.

Dix, C. (2011). Balancing climate change and development initiative in a small island developing state. St. *Mary's university. 1-16.*

Engler-Stringer, R., Stringer, B., & Haines, T. (2011) Complexity of Food Preparation and Food Security Status In Low-income Young Women. *Canadian Journal of Dietetic Practice and Research*, *72*(3), 133-137.

FAO (Food and Agriculture Organisation of the United Nations). (2001).*The World Food Summit Goal and the Millennium Development Goals.* Retrieved (2015, May 10). from http://www.fao.org/docrep/MEETING/003/Y0688E.HTM#P28_624

FAO (Food and Agriculture Organisation of the United Nations). (2003). *Rome Declaration on World Food Security.* Retrieved (2015, June 1). from http://www.fao.org/docrep/003/w3613e/w3613e00.HTM.

FAO (Food and Agriculture Organisation of the United Nations). (2008). *Basic Concepts of Food Security.* Retrieved (2015, June 1). from http://www.fao.org/docrep/

Food and Agriculture Organization of the United Nations Statistics Division. (2015). *Solomon Islands*. Retrieved (2015, May 20). from http://faostat3.fao.org/browse/rankings/countries_by_commodity/E

Foalea, S., Adhurib, D., Aliñoc, P., Allisond, H. E.,Andrewe, N., Cohena. P., & Weeratungee, N. (2013). Food security and the Coral Triangle Initiative. *Marine Policy, 38*, 174-183.

Ford, J. (2008). Vulnerability of Inuit food system to food insecurity as a consequence of climate change: *A case study from Igloolik. Nunavut. Regional Environmental Change, 9*, 83-100.

Friel, S., & Ford. L. (2015). Systems, food security and human health. *Food security, 7*, 437-451.

Hughes, G. R., & Lawrence, A. M. (2005). Globalisation, food and health in the Pacific Island countries. *Asia Pacific J Clinical Nutrition, 14*(4), 298-306.

International Panel on Climate Change (IPCC). (2014). *Climate Change 2014 Synthesis Report*. Retrieved (2015, May 12). from http://www.ipcc.ch/publications_and_data/publications_and_data_reports.shtml.

Ivanic, M., & Martin, W. (2008). Implications of higher global food prices for poverty in low-income countries. *Agricultural Economics, 39*, 405–416.

Knox, J., Hess, T., Daccache, A., & Wheeler, T. (2012). Climate change impact on crop productivity in Africa and South Asia. *Environment reach Letters, 7*, 1-8.

Lake, I., Hooper. L., Abdelhamid, A., Benham, G., Boxall, A., Draper, A., & Waldron, W. (2012). Climate change and food security: Health impact in developing countries. *Environment health perspectives, 102*(11), 1520-1526.

Lebot, V. (2013). Coping with insularity: the need for crop genetic improvement to strengthen adaptation to climate change and food security in the pacific region. *Environment, Development Sustaiablen, 15,* 1405-1423.

Lehodey, P., Senina, I., Calmettes, B., Hampton, J., & Nicol, S. (2013). Modelling the impact of climate change on Pacific skipjack tuna population and fisheries. *Climatic change, 119*, 95-109.

Li, X., Takahashi, T., Suzuki, N., & Kaiser.M. H. (2010). The impact of climate change on maize yields in the United States and China. *Agricultural Systems, 104*, 348-353.

Losasso, C., Cibin,V., Cappa, V., Roccato, A., Vanzo, A., Andrighetto, I., & Ricci, A. (2012). Food safety and nutrition: Improving consumer behaviour. *Food control, 26*, 252-258.

Lytle, L. (2009). Measuring the food environment. *American Journal of Preventive Medicine, 36*(4S), S134-S144.

McCathy, M. (2013). Social sciences for food and health research. *Genes Nutrition, 8,* 435–437.

McIver, L., Woodward, A., Davies, S., Tibwe, T., & Iddings, S. (2014). Assessment of health impact of climate change in Kiribati. *International Journal of Environment research and health, 11,* 5224-5240.

Oexle, N., Barnes, T., Blake, C., Bell, B., & Liese, A. (2015). Neighbourhood fast food availability and fast food consumption. *Appetite,* 92, 227-232.

Odoms-Young, A., Zenk, S., & Mason, M. (2009). Measuring Food availability and access in African-American Communities implication for intervention and policing. *American Journal for Preventive Medicine, 36*(4S), S145-S150.

Pickels, R., Thornton, D., Feldman, R., Marques, A., & Murray, D. (2013). Predicting change in parasite distribution with climate change: A multi-tropic level approach. *Global Change Biology, 19*, 2645-2654.

Popkin, BM. (2013). Nutrition, agriculture and the global food system in low and middle income countries. Food Policy, 47(2014), 91-96.

Puma, M., Bose, S., Chon, Y. S., & Cook, I. B. (2015). Assessing the evolving fragility of the global food system. *Environmental Research Letters, 10*, 1-15.

Qureshi, M., Hanjra, M., & Ward, J. (2012). Impact of water scarcity in Australia on global food security in an era of climate change. *Food policy, 8, 136-145.*

Rhodes, C. (2014). Soil Erosion, Climate change and global food security: *Challenge and Strategies. Science Progress, 97* (2), 97-153.

Roberts, C., & Barnard, R. (2005). Effects of exercise and diet on chronic disease. *Journal of Applied Physiology*, *98*, 3–30.

Sadler, R., Gilliland, J., & Arku, D. (2011). An application of the edge effect in measuring accessibility to multiple food retailer types in Southwestern Ontario, *Canada. International Journal of Health Geographics, 10*(34), 1-14.

Solomon Islands Government. (2009). *Report on 2009 population & housing census.* Retrieved (2015, May 9). from http://www.mof.gov.sb/Homepage.aspx.

Soliah, L., Walter, J., & Jones, S. (2012). Benefits and Barriers to Healthful Eating: What Are the Consequences of Decreased Food Preparation Ability? *American Journal of Lifestyle Medicine*, *6*(2), 152-158.

Su, Y., Weng, Y., & Chiu, Y. (2009). Climate change and food security in East Asia. *Asia Pacific Journal of Clinical Nutrition, 18(4),* 674-678.

Tan, G., & Shibasaki, R. (2003). Global estimation of crop productivity and the impacts of global warming by GIS and Epic integration. *Ecological Modelling*, *168*, 357-370.

Tirado, M.C., Hunnes, D., Cohen, J. M., & Lartey, A. (2015). Climate change and nutrition in Africa. *Journal of Hunger and Environmental Nutrition*, *10*(1), 22-46.

Vermeulen, S., Aggarwal, P., Cambell, B., Davey, E., Jones. E., & Yao. X. (2014). Climate change, food security and small-scale producers, Climate change. *Agriculture and Food Security*, 1, 1-9.

Widener, M., Farber, S., Neutens, T., & Horner, M. (2013). Using urban data to calculate a spatiotemporal accessibility measure for food environment studies. *Health and place, 21*, 1-7.

Wheeler, T., & Broun, V.J. (2013). Climate change and impact on global food security. *Natural system in changing climate*, *341*(2013), 508-513.

World Health Organisation (WHO). (2015). *Solomon Islands.* Retrieved (2015, May 5) from http://www.who.int/countries/slb/en/

Wyett, K. (2014). Escaping a rising tide: Sea level rise and migration in Kiribati. *Asia and the pacific Politicy studies. 1*(1), 171-185.

Ye, L., Xiong, W., Li, z., Yang1, P., Wu, W., Yang2, G., Fu, Y., Zou, J., Chen, z., Ranst, V. E., & Tang, H. (2012). Climate change impact on China food security in 2050. *Agronomy Sustainable development , 33*, 363-374.

10. Appendices

10.1. Research Questionnaire

(Next page)

Imported and locally produced food in the Solomon Islands Survey:

Questionnaire

Thank you very much for your assistance in participating in this Survey. The objective of this questionnaire is to collect information on the diet of Solomon Islanders' diet pattern in different provinces in the country.

This questionnaire is conducted as part of my data collection for my Master's thesis at the University of Canterbury, New Zealand. All responses and answers given to this questionnaire are voluntary. All individuals participating in this questionnaire will remain anonymous and all data collected will be strictly used for statistical purpose only. Information relating to this questionnaire will not be divulged under any circumstances.

If you have questions about your rights as a participant in this survey, or are dissatisfied at any time with any aspect of the survey, you may contact me at [apd51@uclive.ac.nz /a_danitofea@yahoo.com].

Questionnaire Number	

Questions

This section of the Questionnaire is aimed at gathering information concerning geographical location of each family being interviewed in the Solomon Islands.

1. What Province is your resident located in? (*Please tick the appropriate space provided*)

1. Malaita 1... [ ] ii. Guadalcanal 2... [ ] iii. Makira 3... [ ] iv. Renbel 4... [ ] v. Central 5... [ ]

vi. Western 6 ... [ ] vii. Honiara 7 ... [ ] viii. Choiseul 8... [ ]. Temotu 9... [ ]

2. What is the name of your residential area: [ ]

3. Where is this village located? (*Please tick appropriate box*)

i. Urban area 1... [ ] ii. Coastal 2... [ ] iii. Highlands 3... [ ] iv. Low Lying Island 4... [ ]

5. Others.... ________________________

4. Village coordinate: [ ]

Family's economic capacity

1. What is your total fortnightly income for the household? (please take note of the range of income, and tick the most appropriate income)

1. $1.00 - $500.00 1.... [ ]
2. $501.00- $1000.00 2.... [ ]
3. $1001.00 - $ 1500.00 3.... [ ]
4. $1501.00 - $ 2000.00 4.... [ ]

5. $2001.00 -$ 2500.00 5.... [ ]

6. $2501.00 -$ 3000.00 6.... [ ]

7. Above $3000.00 7.... [ ]

8. What is the total Monthly household income? (please take note of the range of income and tick the most appropriate income)

9. $1.00 - $1000.00 1.... [ ]

10. $1001.00- $2000.00 2.... [ ]

11. $2001.00 - $ 3000.00 3.... [ ]

12. $3001.00 - $ 4000.00 4.... [ ]

13. $4001.00 -$ 6000.00 5.... [ ]

14. $6001.00 -$ 7000.00 6.... [ ]

15. Above $7,000.00 7.... [ ]

Confidential

Family Food Expenditure

This section of the questionnaire is aimed at obtaining information regarding household expenditure on food. It also tries to capture the amount of food consumed by a household per day.

1. How many meals do you have in 1 day? (*Please Tick the most appropriate box*)

   i. One 1.... [ ], ii. Two 2.... [ ], iii. Three times 3.... [ ]

   iv. More than 3 times 4.... [ ]

Imported/Locally produced food

This section is aimed at obtaining information on imported and locally produced food consumed.

Hence, it also tries to capture cost of purchasing imported and local produced food consumed.

Starchy Food source

1. Please fill in the details of starch food consumed and purchased for each food type.

Starch Food Source Type	Amount consumed daily (%)	Quantity of food (kg)	Amount of food purchased that is locally produced (%)	Amount of food locally harvested (%)	Amount of food purchased that is imported (%)
Cassava					
Sweet Potatoes					
Taro					
Yam					
Bread Fruit					
Banana					
Rice					
Bread					
Cake					
Biscuit					
Cereals					
Noodles					
Others					

Protein food source

1. Please fill in the details for each protein food type.

Protein Food Source Type	Amount consumed daily (%)	Quantity of food (kg)	Amount of food purchased that is locally produced (%)	Amount of food locally harvested (%)	Amount of food purchased that is imported (%)
Fish					
Chicken					
Beef					
Pig					
Shell/crustaceans					
Egg					
Fish					
Others					

Vegetable and Fruits

1. Please list and fill in the types of vegetable consumed and purchased from local Markets and shops.

Vegetables/Fruits Food source Type	Amount consumed daily (%)	Quantity of food (kg)	Amount of food purchased that is locally produced (%)	Amount of food locally harvested (%)	Amount of food purchased that is imported (%)

The End

Confidential

We have come to the end of the Questionnaire. I would like to personally thank you so much for the support you have given in assisting me with my research.

Alwyn Danitofea

10.2. Approval letter from Solomon Islands government to get data

THE RESEARCH ACT 1982
(No. 9 of 1982)

RESEARCH PERMIT

Permission is hereby given to:

1. Name: Alwyn Danitofea
2. Country: Solomon Islands
3. Research subject areas: Climate Change and its impacts on food security in the Solomon Islands.
4. Ward (s): Auki, Gizo/Munda, Honiara
5. Province: Malaita, Western, Guadalcanal
6. Conditions:

   a. To undertake research only in subject areas specified in 3 above.
   b. To undertake research only in the ward (s) and Province (s) specified in 4 and 5 above.
   c. To observe with respect at all times local customs and the way of life of people in the area in which the research is carried out.
   d. Not to take part at any time in any political or missionary activities or local disputes.
   e. To leave four (4) copies of your final research report in English with the Solomon islands Government Ministry responsible for research at your own expense.
   f. A research fee of SBD500.00 and deposit sum of SBD200.00 must be paid in full or the Research Permit will be cancelled. (See sec. 3 subject 7 of the Research Act).
   g. This permit is valid until **31st July 2015** provided all conditions are adhered to.
   h. No live species of plants and animals to be taken out of the country without approval from relevant authorities.
   i. A failure to observe the above conditions will result in automatic cancellation of this permit and the forfeit of your deposit.

Signed: ....

Minister of Education and Human Resources Development

Date: 08/06/15

10.3. Approval from Human Ethics Committee for questionnaire

UNIVERSITY OF CANTERBURY
Te Whare Wānanga o Waitaha
CHRISTCHURCH NEW ZEALAND

HUMAN ETHICS COMMITTEE

Secretary, Lynda Griffioen
Email: human-ethics@canterbury.ac.nz

Ref: HEC 2015/22/LR

13 May 2015

Alwyn Danitofea
Department of Geography
UNIVERSITY OF CANTERBURY

Dear Alwyn

Thank you for forwarding your Human Ethics Committee Low Risk application for your research proposal “Climate change and the future of Solomon Islands' food security”.

I am pleased to advise that this application has been reviewed and I confirm support of the Department’s approval for this project.

Please note that this approval is subject to the incorporation of the amendments you have provided in your email of 8 May 2015.

With best wishes for your project.

Yours sincerely

Lindsey MacDonald
Chair, Human Ethics Committee

University of Canterbury Private Bag 4800, Christchurch 8140, New Zealand. www.canterbury.ac.nz

F E S