How Does Climate Change Affect Agricultural Stability in Southeast Unguja? An Assessment of the Threats to Agriculture and Food Security From Rising Temperature and Changes in Predictability and Intensity of Rainy Seasons.

Eloise Reid
*SIT Study Abroad*

Follow this and additional works at: [https://digitalcollections.sit.edu/isp_collection](https://digitalcollections.sit.edu/isp_collection)

Part of the Agricultural and Resource Economics Commons, Agriculture Commons, Environmental Policy Commons, Growth and Development Commons, Natural Resources Management and Policy Commons, and the Sustainability Commons

**Recommended Citation**
[https://digitalcollections.sit.edu/isp_collection/1278](https://digitalcollections.sit.edu/isp_collection/1278)

This Unpublished Paper is brought to you for free and open access by the SIT Study Abroad at SIT Digital Collections. It has been accepted for inclusion in Independent Study Project (ISP) Collection by an authorized administrator of SIT Digital Collections. For more information, please contact digitalcollections@sit.edu.
How does climate change affect agricultural stability in Southeast Unguja?  
An assessment of the threats to agriculture and food security from rising temperature and changes in predictability and intensity of rainy seasons.

Eloise Reid  
Oberlin College  
Advisor: Mzee Mohammed Mzee  
School for International Training; Zanzibar  
Coastal Ecology and Natural Resource Management  
Academic Director: Helen Peeks  
Spring, 2012
Table of Contents

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acknowledgements</td>
<td>3</td>
</tr>
<tr>
<td>Abstract</td>
<td>4</td>
</tr>
<tr>
<td>Introduction</td>
<td>5</td>
</tr>
<tr>
<td>Study Area</td>
<td>9</td>
</tr>
<tr>
<td>Methodology</td>
<td>13</td>
</tr>
<tr>
<td>Results</td>
<td>17</td>
</tr>
<tr>
<td>Discussion</td>
<td>30</td>
</tr>
<tr>
<td>Conclusion</td>
<td>33</td>
</tr>
<tr>
<td>Recommendations</td>
<td>36</td>
</tr>
<tr>
<td>References</td>
<td>38</td>
</tr>
<tr>
<td>Appendices</td>
<td>39</td>
</tr>
</tbody>
</table>
Acknowledgements

I am incredibly grateful for a multitude of people who gave me all the tools I needed to succeed during this study. Mzee Mohammed Mzee, my cheerful and supportive advisor, thank you for your time, enthusiasm and expertise which allowed me to delve deep into the issues of climate change and food security. Thank you to Hamza Rijaal and Mansura Mame, who were both helpful and informative contacts dedicated to their work and to helping others. To Paul Watkiss for providing me with much needed graphs, figures, and support, as well as the professionals at SMOLE who still made time, despite busy schedules to meet and help me narrow the scope of the study, thank you all so much.

Thank you to the Kiswahili teachers who gave me the most important gift of language, and with it, connections, insight and understanding. Asante sana to Mwalimu Said and Bi Helen for all of your wisdom, laughter, encouragement, and smiles. Okala, thank you for translating, for rice and fish, for engaging and challenging me to push myself harder and for providing substance and history to a study so rooted in the island. Lastly, thank you to the women, men and children of Bwejuu, Paje, and Jambiani who were open, honest, welcoming and warm; endelea regardless.
Abstract

The relationship between climate change, agriculture, and food security on the island of Unguja was studied. Informal interviews were carried out in the south-eastern coastal communities of Bwejuu, Paje, and Jambiani in order to gain perspective and awareness of local knowledge concerning changes in climate and its affects on crop production. Formal interviews were conducted in Stone Town with the Ministry of Agriculture, the Department of Environment, the Sustainable Management of Land and the Environment office, private climate change experts and environmental consultants, and local NGO's to gain insight on what aspects of climate change are most detrimental in the agricultural successes and failures in Zanzibar. Both sets of interviews also addressed future perceptions of the island in terms of agricultural vulnerability and villagers' awareness levels concerning the concepts of global and local climate change. Field observations were conducted on each available farmers land, and general crop health and soil quality was recorded.

Analysis of this information is presented in the following paper as a synthesized document written in order to fully understand how vulnerable the agriculture sector of coastal south-eastern Zanzibar is to the changing climate. The data collected is regarded as a key insight into the relationship between climate change and subsistence agriculture and the change in this union over the last twenty years. Lastly, recommendations are given for a more resilient and self-sufficient Zanzibar as well as further climate change related projects that could complement this exploration.
**Introduction:**

Global environmental climate change is a growing concern for coastal communities and island nations in particular. One region of the world where the effects of climate change are being felt particularly hard is southeast and equatorial Africa. Because of inadequate economic, development, and institutional capacity, countries in this region are more likely to be vulnerable to the impacts of climate change according to the International Panel on Climate Change (IPPC). Climate change impacts have the potential to undermine and even undo progress made in improving the socio-economic well being of Zanzibari people. The negative impacts associated with climate change are also compounded by many factors, including widespread poverty, human diseases, and high population density, which could be exacerbated by migration of poor farmers from Tanzania mainland to Zanzibar in search of new livelihood as droughts erase farms from the arid land.¹ The indications of a changing climate range anywhere from increased and prolonged droughts, amplified intensity of tropical storms or hurricanes, to warming sea and air temperatures and a change in rainfall, leading to flash floods. Increase in sea level is also a major concern for islands such as the Zanzibar archipelago because of increased coastal erosion and salt-water intrusion on crop fields.

Climate change poses a range of challenges for people and sustainable development, with the coastal zones being a focus for impacts and adaptation needs. Coastal zones and islands in particular contain valuable ecosystems with high ecological value and economic importance². Sea-level rise and extreme water levels represent important components of climate change for islands, and have significant implications to coastal environments and ecosystems including low-lying coastal plains, beaches, mangroves, corals, coastal wetlands, estuaries, etc. The potential

---

impacts are likely to affect the most vulnerable, where populations and associated economic activities are highly concentrated. The IPCC Fourth Assessment Report published in early 2007 published the fact that global climate change is occurring right now. The paper investigated marginalized communities and families who depend directly upon natural resources for their livelihoods are almost certainly the most vulnerable population group susceptible to climate change. As indigenous and traditional human beings are being forced out of their former homes by factors such as population growth and modern technologies, they are moving to "the least fertile and most fragile lands as a consequence of historical, social, political and economic exclusion are among those who are at greatest risk." Global and regional assessments have identified East Africa as one of the most threatened coastal regions in Africa and globally. This area is typically undergoing rapid and unplanned growth, urbanization, and island migration, and has high population densities and overburdened infrastructure. These factors will increase the vulnerability and exposure level to climate change in general. However, despite all these threats, few high population islands have been assessed in detail in terms of possible agricultural impacts. When examining the effects climate change has on coastal, subsistence agriculture towns on the island of Unguja, this study will focus on two of the indicators of climate change; specifically change in rainfall and the causation of drought, which indicates a change in seasons, and relates to the challenge of securing food security for a rapidly expanding population. This report is a case study examining prolonged droughts, fluctuating seasonal temperatures and rainfall, and other related effects on crop production.

In Zanzibar, the importance of agriculture not only presents itself as a way towards self-sustainability and food security, but also as a cultural and historical way of life for the people of

---

3 Macchi, Mirjam and other contributing authors. Indigenous and Traditional Peoples and Climate Change. IUCN, March 2008.
the island. If the practice of subsistence agriculture is dramatically affected by the stress of climate change, citizens of Zanzibar will be left extremely vulnerable and without many other options to turn towards. The agriculture sector is a mainstay of Zanzibar’s economy, as well as having a key role in sustaining livelihoods on the islands. It is also a very climate-sensitive sector. Recent climate variability, notably the poor and erratic rains in 2007, significantly reduced agricultural production and also led to widespread malnutrition the following season. This report and others state that greater unreliability of the rains is affecting farmers. The current production risks in agriculture could be exacerbated from changes in temperature, rainfall trends or from the greater extremes of climate variability and has the potential to be increased by climate change in the future. However, there are potentially positive as well as negative effects, and the changes vary strongly with individual crops and locations.4

While negative impacts on temperature sensitive crops such as maize are projected in the longer term, there is only relatively low production of this crop on the island. Changes in rainfall have implications for other rain fed crops, and there are risks from salt water intrusion for some coastal (rice) fields. High value exports, notably cloves, are vulnerable to increased storm and high winds. Agriculture is clearly a key priority for adaptation, especially in relation to existing climate variability. It is widely accepted that poor, natural-resource dependent communities in the developing world are especially vulnerable to climate change, especially those living in high-risk areas such as small islands or low lying coastal areas5. In every map depicting vulnerability from climate change, Zanzibar is located in one of the most troublesome zones, by being both a low-lying island nation and in the Western Indian Ocean, off the coast of East Africa. Therefore,

with the added fact that the majority of its citizens are farmers and are extremely dependent upon
the land, these same citizens are also overly exposed to severe impacts of climate change.

Rural Zanzibari people have preserved traditional knowledge about agriculture, raising
livestock, fishing, forestry and the use of medicinal plants. In the past many of these
communities have been exposed to different kinds of environmental changes and have developed
coping strategies to face these phenomena. These peoples may therefore have to offer valuable
knowledge to learn from for future adaptation to and mitigation of climate change. However,
while there is a growing knowledge about the impacts of climate change on species and
ecosystems, the understanding about the potential impacts of climate change on livelihoods and
cultures of indigenous and traditional communities is fragmented. Furthermore, there is a lack of
recognition of the importance, which traditional people may play in their own future adaptation
to climate change. Given these issues, the general objective of this report is to: improve
understanding of the potential impacts of climate change on the traditional, vulnerable
communities and cultures of Zanzibari farmers and their interactions with the land as agriculture
stewards, and to identify further research and knowledge required to contribute to risk reduction
and appropriate adaptation strategies that could be beneficial in both the short and long term. The
report particularly focuses on the southeast of Zanzibar because this area has been acknowledged
to be one of the most vulnerable places on the island in terms of agriculture stability, with high
risk and potentially high socio-cultural impacts. The specific objectives of this report are to: 1)
identify the most vulnerable groups of people in these areas 2) analyze potential impacts of
climate change on the livelihoods of farmers in this area and the effects on agricultural stability
and food security and 3) identify past, current and future coping strategies and education
developed by these communities in order to adapt to agricultural instability and food security in
relation to climate change.
Study Area

Off the coast of Tanzania Mainland in Eastern Africa, lies the Zanzibar Archipelago, a previously independent island nation made up of two large islands and a smattering of smaller islets along the periphery. Zanzibar itself consists of Unguja to the south and Pemba Island neighbouring her at the north. South of the equator by a few degrees, between latitudes 5 and 7, and about 30 kilometres off the coast, Zanzibar is cradled by the Western Indian Ocean and experiences a warm temperate climate relatively year round. In 1964 the mainland of Tanganyika and the islands of Zanzibar joined together to form a union that holds the record for longest unified country in all of Eastern Africa; the United Republic of Tanzania.

The tropical climate of Zanzibar is accustomed to warm daily temperatures and a mean of over 1000 mm/year of rainfall. Zanzibar's typical yearly climate is driven by two monsoon seasons, which are caused by alternating prevailing trade winds. Kaskazi is the northeastern monsoon that starts during November and ends in the beginning weeks of March whereas Kusi, the second monsoon, comes from roughly June to September. The two wind-conducted monsoon

---

6 Watkiss, Paul, Interview
8 Watkiss, Paul, Interview
seasons dictate the fluctuations in temperature, rainfall and storm frequency and generally decide the patterns of seasons throughout the year as well.

During the transitional period from northeasterly Kaskazi changing to south-easterly Kusi, a rainy season occurs that is known as Masika. The second transition, back from the south-eastern winds to the north-eastern Kaskazi, the second rainy season occurs, which is locally called Vuli. Masika occurs from March to June and is generally regarded to be the longer, heavier rainy season. Vuli, the shorter rain season, comes from September to November in a normal year. Rainfall is variable and can greatly depend on micro-climate differences, such as a change in geography and vegetation in different parts of the island. The last two seasons that complete the four of Zanzibar are Kipupwe or Mcho, which is cold and dry from June to August, and the hot season, also known as Kaskazi, comes from December to March. Although there are two wet seasons, there are other times in which most locations in Unguja and Pemba receive off-season rains as well. Like many other tropical areas, Zanzibar has a minuscule temperature variation, with yearly changes ranging from only around 3°C to 4°C. When examining rainfall, there is a wider range of amount per both month and year. In the rainy seasons especially, there is a difference between the 10th and 90th percentiles, with a difference as high as 250mm/month.

The south-eastern coastal communities of Bwejuu, Paje, and Jambiani are strongly affected and dependent on the rainfall of both Masika and Vuli for water resources, as they are also characteristically built on coral rag soil and have a much sandier base than that of the western side of the island, which is home to a deeper, more fertile, agriculture-friendly soil. Sandy soil is known for its limited capacity to store water and retain nutrients, which is the

---

9 Mohamed, Mzee. Interview, March 12, 2012
10 Watkiss, Paul. Interview, April 4, 2012
reason why most farming in this part of the island is subsistence only and not for profit. Due to an increase in deforestation on the eastern side of the island as well as the higher prevalence and intensity of winds from the exposed coast to the Western Indian Ocean, these three coastal villages are subjected to less rainfall during Masika and even the occasional complete abstention of Vuli season altogether.

Paje, Bwejuu and Jambiani are all tourist destinations as well as home to subsistence farmers and fishermen and all vary differently in the amount that tourism has affected each of the town's village life and relationship to the land, agriculture, and the community. Bwejuu is 4km north of Paje and has a population of just over 5,000 residents; some of whom work in the tourism industry, while the remainder are comprised of fishermen, farmers, rope makers and seaweed farmers, among other subsistence professions. The community is made up of towering palm trees, dusty sandy roads, and scattered houses and is currently experiencing a very high population growth rate. The farmland is located further inland on the peninsula and consists of coral rag soil with low shrubbery and a few tall palms.

To the south is the village of Paje, a smaller town that has experienced the most growth from the tourist industry and is significantly more covered in hotels and with tourists during the high season than its counterparts to the north and south. Paje has a population of about 3,000, making it the smallest of the communities yet it represents a high level of English speakers, tourism jobs, and even the Seaweed Center which is a small collective of women who are employed through both seaweed farming and entrepreneurship as well. Paje's traditional subsistence farmers and fishermen are still abounding, yet seem less frequent amongst the throngs of the tourism industry.

Lastly, the most southern town that was included in the study was the village of Jambiani. A very traditional yet incorporated village with the biggest population of any three studied; a
hefty 6,000 permanent residents. With less tourism and a seemingly more conscious crowd of guests who do visit the town, there are many institutions for higher education funded by some of the hotels, clinics and schools in the area. There is a push for sustainability from two environmental NGO's founded by local Zanzibari's, and still a significant portion of the population that support themselves through subsistence agriculture and fishing as well as seaweed farming and handicrafts. Jambiani has a unique situation on the east coast, yet each town is very significant, different and important to the study of south-eastern coastal towns and their relationship to climate change.

These three towns were a useful and beneficial study site due to the variety of answers and livelihoods experienced in each separate place, while each town, at the same time maintained a similar geographic and geologic composition. With coral rag, sandy soil and much subsistence farming, a dry area that depends upon agriculture is easily one of the most vulnerable places on the island, yet the added factor of tourism could either add to or detract from the resilience of the area studied. These interesting considerations, diverse opinions and wealth of answers from the semi-structured interviews serve as a very helpful and useful tool, while also allowing each placed studied to maintain autonomy. Paje, Bwejuu and Jambiani represent a similar geography, yet due to industry and tourism, each village is different and therefore provides an interesting study area. The results from the study are published below, but they would not have been as accurate or interesting without the choice of these three villages as the areas chosen to carry out research concerning vulnerability and resilience in agriculture as it relates to climate change.

---

Methodology

Interviews

Formal interviews were conducted in the first week of the study with knowledgeable individuals who held office in government or with non-profit organizations. Secretaries from both the Department of Environment and the Office of Food Security were interviewed on their positions and on their connections with climate change work in the government and within the agriculture sector of the island. The head of the Department of Agriculture was also interviewed for preliminary research and networking possibilities and a very fruitful interview was recorded from the private climate change consultant from the UK, which provided many forms of data for this report. These interviews were based on the premise that the informant was aware of the science behind and explaining climate change and that they were all aware of the relationship between Zanzibar, agriculture, and climate change vulnerability.

The village fieldwork for this study was based upon a series of semi-structured interviews carried out with the residents of Jambiani, Paje, and Bwejuu (for questionnaire see appendices). Interviews were conducted with individuals as well as with pairs and in groups of three. Appropriate informants were chosen based on occupation, gender, and age. In order to ensure a basis for comparison of past and present trends, older members of these communities were often the subjects of the interviews, though a diversity of answers were provided by interviewing younger generations as well. Given the prevalence and importance of farming and land-based subsistence agriculture for the relevance of the study, farmers were the most practical and targeted sources for interviews. Although substantially less women were interviewed, the importance of equal representation was felt in the equally shared tasks of women and men in the profession of farming. This allowed for a greater representation of both genders rather than if the
study was primarily based within the agriculture of seaweed farming, considered a woman's profession; or the industry of fishing, which is predominately done by men.

In all villages the use of a local translator was necessary for accurate results; therefore the majority of interviews were done in Kiswahili, with a few exceptions in the methodology if the interviewee was sufficient and comfortable in English and could follow the interview closely and with precision. The use of a semi-structured questionnaire sheet was implemented in a majority of the conversations in order to ensure quantifiable results, but not every question was asked or understood in 100% of the interviews. In a few cases with the group or pair interviews, the conversation would take on a new angle and the questionnaire would ultimately be dropped from discussion, which turned out to be a helpful and interesting tool and provided a more natural observation type of interaction. During these interviews, the translator and interviewer would translate and record the conversations in order to get further information that possibly would have been omitted if the interview had been overly-structured and dissuaded tangents.

The calendar and interactive assessment sheet were also used as tools during a percentage of the interviews. They allowed the interviewee to demonstrate, using stones, sticks or lines in the sand, the change in weather patterns and crop productivity without having to explain quantifiable data using only words. This methodology was helpful at times, whereas other times it was more challenging than beneficial. Informants were able to physically represent the differences in the past versus the present, yet were dissuaded by the time commitment and therefore, less than preferred were involved in these two types of assessments.

Lastly, as an interview tool, a tape recorder was used and highly regarded as an efficient device that works well for the majority of interviews. Not only does it provide first class data collection, but it also works well to convey a message of reality when presenting later on the topic studied. The tape recorder was always asked about at the beginning of the interview and
was only used if the informant said it was okay, so the success rate of recorded interviews was about 55%. This tool also worked well if it happened that an opportunity for interview arose without the presence of a translator, which happened frequently and often unexpectedly due to the willingness of informant to share stories and overwhelming presence of farmers in most places on the east coast of Unguja. The tape recorder allowed the interview to be analyzed at a further time and was crucial to have in order to translate and comprehend a Swahili based interview.

Field Observations

The second part of the methodology used in the data collection for this study was done in the field and the shamba farms in the three villages of choice. Not all farmers were interviewed in their farms, as some were in town or in their homes during the times that the conversations were had. When the farmers were open to the idea, field observations were made when allowed in the plots of land outside of the villages. Other times the interviews were done in the shambas and the farmers were working while answering questions. These interviews were prosperous due to the fact that field observations were able to be made while asking questions simultaneously. The informants were also willing to perform a show and tell act while explaining their answers, which allowed for the conversation to be interactive as well as informative.

During these field observations, crops and soil notes were taken and comparisons were made in order for a fuller scope of results to be calculated later on. The soil was qualified by amount of water and type of substrate. The crops were qualified by appearance and quantified by number of both unhealthy and healthy plants. Amount of crops species were examined and counted and remarked upon according to health or disease prevalence. This was not done during the first few interviews but only after many of the informants let on that there were diseases and

---

13 Shamba is a traditional Kiswahili word meaning farmland. Generally it can mean countryside or rural land, and specifically it means an individual's privately owned land, usually with crops.
pests prevalent in some of the crops and in their shambas in general. The general quality and type of soil was recorded as well in the farm land when visited in Paje, Jambiani and Bwejuu. This was done by observing and examining the soil by both touch and sight. The methods of these field observations were primarily about the main subsistence crops that almost 100% of informants grew; cassava and yams. The results are published in the following section of this report.

**Academic Research**

To present the most accurate and complete report of climate change and agriculture security, general background information was needed to ensure the legitimacy of the paper. The most relevant sources came from a formal interview and were presented in online and hard copy formats. Methods to incorporate the academic research were very traditional and consisted mostly of note-taking, fact-checking, and referencing during all stages of the study. Interviews, field observations and writing were all supported by the use of general academic research. Before going into the field, it was necessary to obtain general knowledge on the causes of climate change and the biggest affects of this anthropogenic crisis in Zanzibar. Necessary statistical and reference data was also obtained through academic research.
Results

**Formal Interviews**

Four formal interviews were done with the directors of both The Ministry of Food Security and The Department of Environment, as well as an associate and private climate change consultant of the office of Sustainable Management of Land and the Environment, and lastly the director of The Ministry of Agriculture. These results are tabulated in the following table and represent the views of informed and knowledgeable government employees and a private environmental consultant. These results were used as a precursor to the farmer interviews, the study area decision and to the methodology chosen for the study. A general trend in each question is very noticeable and can be traced through the following chart.

<table>
<thead>
<tr>
<th></th>
<th>Paul Watkiss</th>
<th>Hamza Rijaal</th>
<th>Mansura Kassim</th>
<th>Mzee Mohamed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Involvement</td>
<td>Private assessment on CC in almost all East African countries, Zanzibar 2</td>
<td>Sensitize the public to understand C.C. and it's impacts, also how to overcome CC</td>
<td>Director of Food Security - plans to get involved in future with Climate Change</td>
<td>Part of Rapid Vulnerability Assessment, held &amp; attended workshop</td>
</tr>
<tr>
<td>Biggest Threat to Zanzibar from Climate Change</td>
<td>Economic Impacts are all encompassing: 1) Agriculture 2) Tourism 3) Fishing Livelihood</td>
<td>1) Salt Water Intrusion 2) Over-fishing 3) Drought 4) Low Awareness Levels on CC</td>
<td>1) Irregular Rainfall Patterns 2) Salt Water Intrusion</td>
<td>1) Sea level rise 2) Food Security 3) Increase in wind intensity/speed 4) Fish catch decreasing</td>
</tr>
<tr>
<td>Is agriculture threatened by Climate Change?</td>
<td>Of course, agriculture is very climate sensitive for export &amp; food source</td>
<td>Obviously, long droughts and less rain makes Zanzibar more vulnerable</td>
<td>Absolutely yes, rainfall driven agriculture</td>
<td>Yes, unpredictable rains and very long dry periods affect food production</td>
</tr>
<tr>
<td>Local environmental issues</td>
<td>1) Deforestation in vulnerable areas 2) Increase in charcoal production 3) Natural gas found</td>
<td>1) Salt water in rice farms 2) Native and non-native plant species competing for space</td>
<td>1) High rate of deforestation 2) Increase in natural resource use</td>
<td>1) Nitrogen Evaporation from soil with too much sun 2) Deforestation 3) Rivers drying up</td>
</tr>
<tr>
<td>High Risk Areas in Zanzibar?</td>
<td>1) Southeast Unguja 2) Northeast Pemba 3) Everywhere from sea-level rise/size</td>
<td>Micheweni in Pemba</td>
<td>1) Southern parts of Unguja 2) Northern parts of Pemba</td>
<td>East coast of both Unguja and Pemba because they are coral rag areas</td>
</tr>
</tbody>
</table>
Farmer Interviews

In the appendix B, one will find the questionnaire that was the key in generating these results. The results in this section are organized based on question asked in numerical order, and then formed into comprehensive and detailed charts, tables, images, and graphs. Demographic data is presented first in the results so the reader is able to grasp the full picture of the farmer interviews detailed below. 68 farmers were interviewed and all were residents in the towns of Bwejuu, Paje, and Jambiani. 22 of the informants were women, whereas 48 farmers were male. The ages of the interviewees spanned from 18 to 87 with the youngest woman at the age of 18 and the oldest at 87. The youngest man was 19 years old and 86 was the age of the most elderly man. The average age for females was 45 whereas for males it was 51 years. The mean age was similar, with women at 42 years of age and men at 45. The general trend was that the men interviewed were older than the women interviewed, even though the oldest participant in the study was a woman. The pie chart inserted above shows the percentage of men.
(68%) and women (32%) spoken with out of the total interviews conducted.

The next question on the survey was in regards to the size of the shamba that the interviewee had to work with. There were 11 farmers out of 68 that owned two pieces of land, usually one in the town that they lived in and the other in a part of the island that was more inland, central or western than the three villages that were studied. These farmers either had inherited the land from their families, or in some cases had two wives and therefore, two pieces of land. The farmers who were able to afford two pieces of shamba were counted as business owners in the alternative livelihood pie chart because the majority sold and ate their crops and did not use agriculture for pure subsistence living only. These farmers implemented agriculture into their lifestyles as a career and business venture and not just a source of day-to-day food. In the acres of farmland pie chart below, each piece of land that the farmers owned were counted as separate land masses and then added together, for example if “Hassan” had a farm in Paje that was 1 acre and a farm in Kitogani\(^{14}\) that was 2 acres, he would be counted as having three acres of land. The other farmers were counted only as owning one piece of land in one location.

The chart below demonstrates the frequency of acreage that the farmers interviewed owned and worked on. It shows us that 6 farmers have ½ acre, 19 farmers have 1 acre, 12 farmers farm 1 ½ acres of land, another 12 have 2 acres of land, only 4 have 2 ½ acres, 11 farmers own 3

\(^{14}\) An agricultural community inland in south-eastern Unguja between Stone Town and Paje
acres of shamba, 3 have 3 ½ acres and just one farmer was working 4 acres of land. The average size of shamba according to these calculations was 1.7 acres. These results are significant because it shows the trend of the area and relates to the vulnerability of each farmer according to their size of land. More will be discussed on the relationship between vulnerability and the plot size of each farmer in the following section of the report.

The table below correlates to questions 3, 4, 5, and 6 in Appendix B. The first column lists all the crops that were mentioned during the entirety of the interviews; from the most prevalent crop – cassava, a root vegetable that is high in carbohydrates but low in nutrients and vitamins\(^\text{15}\) to pineapple – which was grown by one farmer who sells them in the market as a lucrative, cash crop. Cassava was grown by 100% of the people interviewed and is the most prevalent crop eaten and grown by Zanzibaris all across the two islands\(^\text{16}\). This season, there were reports in the interviews of many of the cassava crops experiencing both an increase of pests and an increase of disease, yet cassava is also listed as a drought-resistant crop and is supposedly mostly unaffected by a lack of water.\(^\text{17}\) The discussion section of this paper will go more into the importance of drought resistant crops in Zanzibar when assessing vulnerability, and the correlation between pests, disease and drought in tropical environments. The changes in crop production from the past 5, 10 and 20 years is a very varied mixture of trends and numbers and also represents a change in vulnerability and resilience that will receive more detail in further discussion.

<table>
<thead>
<tr>
<th>Crops Grown</th>
<th>Number of People who grow them (68 Total Interviewed)</th>
<th>Changes in crop production from the past (5,10,20 years)</th>
<th>% Of crops with Disease Prevalent</th>
<th>% Of crops With Pests Prevalent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mohogo, Cassava</td>
<td>68</td>
<td>32 Less 36 More</td>
<td>33%</td>
<td>50%</td>
</tr>
</tbody>
</table>

\(^\text{15}\) Lotschert, pg. 219  
\(^\text{16}\) Rapid Vulnerability Assessment (RVA) of the Effect of Prolonged Dry Spell on Agriculture, Livestock Production and Environment in Zanzibar during the Agricultural Season 2005/06. MALE. Zanzibar, March 2006.  
\(^\text{17}\) Mohammed, Mzee. Interview
<table>
<thead>
<tr>
<th>Crop</th>
<th>Field</th>
<th>Healthy</th>
<th>Disease</th>
<th>Pests</th>
<th>Soil Quality</th>
</tr>
</thead>
<tbody>
<tr>
<td>Banana</td>
<td>64</td>
<td>56</td>
<td>8</td>
<td>10%</td>
<td>33%</td>
</tr>
<tr>
<td>Corn</td>
<td>39</td>
<td>27</td>
<td>12</td>
<td>20%</td>
<td>15%</td>
</tr>
<tr>
<td>Rice</td>
<td>3</td>
<td>0</td>
<td>3</td>
<td>10%</td>
<td>20%</td>
</tr>
<tr>
<td>Beans</td>
<td>25</td>
<td>13</td>
<td>12</td>
<td>20%</td>
<td>0%</td>
</tr>
<tr>
<td>Eggplant</td>
<td>29</td>
<td>12</td>
<td>17</td>
<td>15%</td>
<td>10%</td>
</tr>
<tr>
<td>Tomatoes</td>
<td>19</td>
<td>14</td>
<td>5</td>
<td>10%</td>
<td>0%</td>
</tr>
<tr>
<td>Oranges</td>
<td>33</td>
<td>3</td>
<td>30</td>
<td>20%</td>
<td>0%</td>
</tr>
<tr>
<td>Grapefruit</td>
<td>10</td>
<td>4</td>
<td>6</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>Peppers, Green</td>
<td>36</td>
<td>18</td>
<td>18</td>
<td>15%</td>
<td>0%</td>
</tr>
<tr>
<td>Peppers, Hot</td>
<td>6</td>
<td>2</td>
<td>4</td>
<td>10%</td>
<td>0%</td>
</tr>
<tr>
<td>Mango</td>
<td>7</td>
<td>4</td>
<td>3</td>
<td>0%</td>
<td>10%</td>
</tr>
<tr>
<td>Pineapple</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>10%</td>
<td>20%</td>
</tr>
<tr>
<td>Lime</td>
<td>24</td>
<td>14</td>
<td>10</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>Jackfruit</td>
<td>3</td>
<td>1</td>
<td>2</td>
<td>10%</td>
<td>0%</td>
</tr>
<tr>
<td>Pumpkin</td>
<td>41</td>
<td>29</td>
<td>12</td>
<td>0%</td>
<td>10%</td>
</tr>
<tr>
<td>Papaya</td>
<td>53</td>
<td>25</td>
<td>27</td>
<td>15%</td>
<td>0%</td>
</tr>
<tr>
<td>Mbazi (no translation)</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>10%</td>
<td>0%</td>
</tr>
<tr>
<td>Feewee Beans</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td>0%</td>
<td>15%</td>
</tr>
<tr>
<td>Lettuce</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>10%</td>
<td>0%</td>
</tr>
<tr>
<td>Spinach</td>
<td>27</td>
<td>20</td>
<td>7</td>
<td>0%</td>
<td>10%</td>
</tr>
<tr>
<td>Lemon</td>
<td>12</td>
<td>3</td>
<td>9</td>
<td>20%</td>
<td>0%</td>
</tr>
<tr>
<td>Majimbi (no translation)</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>Millet</td>
<td>5</td>
<td>3</td>
<td>2</td>
<td>10%</td>
<td>0%</td>
</tr>
<tr>
<td>Garlic</td>
<td>3</td>
<td>3</td>
<td>0</td>
<td>15%</td>
<td>0%</td>
</tr>
<tr>
<td>Onion</td>
<td>16</td>
<td>12</td>
<td>4</td>
<td>0%</td>
<td>20%</td>
</tr>
<tr>
<td>Ginger</td>
<td>4</td>
<td>2</td>
<td>2</td>
<td>15%</td>
<td>0%</td>
</tr>
</tbody>
</table>

Figure 5. Table of Crops, Disease, and Pests

The field observation data is better suited as a part of the interview results and process as it relates directly to questions 3 – 6 in the Appendix B. The table of field observations below explains the health of the crops in accordance to the pests, disease and soil quality of 8 farms visited. In relation to the interview questions concerning these categories, the field observation data matches its counterpart at least 60% of the time. Out of 8 farms; 4 seemed healthy, 2 were not as healthy, and 2 were very poor-off. The soil type usually had a direct relationship with the
health of the crops and the prevalence of disease and pests. Most healthy farms had moist and/or coral rag soil and usually the two were not mutually exclusive. The coral rag soil was very rocky but when it was pure soil it also did well holding the moisture within its body. These field observations are only a small percentage of all farmers interviewed but formulate a more concise representation of the interactions between crops, soil quality, pests and disease.

<table>
<thead>
<tr>
<th>Farms</th>
<th>Crops</th>
<th>Pests</th>
<th>Disease</th>
<th>Soil</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Healthy</td>
<td>None</td>
<td>Some</td>
<td>Coral Rag</td>
</tr>
<tr>
<td>2</td>
<td>Suffering</td>
<td>Some</td>
<td>Some</td>
<td>Coral Rag</td>
</tr>
<tr>
<td>3</td>
<td>Suffering</td>
<td>Many</td>
<td>None</td>
<td>Dry</td>
</tr>
<tr>
<td>4</td>
<td>Healthy</td>
<td>None</td>
<td>None</td>
<td>Moist</td>
</tr>
<tr>
<td>5</td>
<td>Healthy</td>
<td>Few</td>
<td>None</td>
<td>Sandy</td>
</tr>
<tr>
<td>6</td>
<td>Getting by</td>
<td>Some</td>
<td>Some</td>
<td>Coral Rag</td>
</tr>
<tr>
<td>7</td>
<td>Getting by</td>
<td>Few</td>
<td>Few</td>
<td>Dry</td>
</tr>
<tr>
<td>8</td>
<td>Healthy</td>
<td>None</td>
<td>Some</td>
<td>Moist</td>
</tr>
</tbody>
</table>

Figure 7. Table representing Field Observations

Questions 7, 8 and 9 in Appendix B are answered in the following chart. When respondents were asked whether or not they believed that the weather was changing, they were given three separate categories to classify the changes in relation specifically to agriculture. Rainfall, temperature, and wind/storm intensity or severity was considered and the results are published below. The chart signifies a very large decrease in rainfall, an increase in warm temperatures, and primarily no change in the intensity of wind and/or storm frequency. These results would be more accurate with a larger sample size and could be more easily represented through scientific data rather than through an anthropological study. The Economics of Climate Change report put together by Paul Watkiss and UKAid include much of the necessary scientific data and are also included in this report in Appendix E. Scientific data is collected by the Tanzanian Meteorological Weather Station and when considering Zanzibar, provides data from the last forty years until the present. The data is on patterns in rainfall, temperature, and
seasonality regularities. The graph below represents 68 farmers’ views on the change in these three categories.

![Graph showing changes in weather patterns](image)

Figure 8. A bar graph representing the interview results on changes in weather patterns.

The graph below represents the answers to question 10 in the survey, and like the previous chart would be more accurately represented when looking at the changes through a scientific lens, over a long period of time. What this graph shows us is that the farmers of Jambiani, Paje and Bwejuu most certainly notice a change in the regularity of seasons and are able to back up the science that is saying that Vuli is disappearing and that Masika is less frequent, intense, and on time with their words, stories and personal experience.
Question 11, “Do you know what climate change is? Can you define it?” is answered and depicted in the pie chart below. The answers to this question during all 68 interviews were primarily vague and unaware, yet there were a few farmers who also had other careers as teachers or government officials who were able to provide vaguely to very scientific answers to the question asked. One of the most common answers given was basically a restatement of the question asked. This proved that people had heard of climate change in the past, (from organizations like JAMABECO or REDD or HIMA\textsuperscript{18}) but had not truly been able to comprehend and make the definition their own. These people said they attended a few information meetings concerning environmental matters but were still primarily unaware of the anthropogenic reasons behind the cause of climate change. Scientific answers consisted of people answering in a range from understanding about emissions from industry in developed countries to understanding that cutting and burning trees and trash added smoke to the air and therefore changed the climate. Many people said they had no answer and moved on to the next question.

\textsuperscript{18} JAMABECO – Jambiani Marine and Beach Conservation Organization
REDD – Reducing Emissions from Deforestation in Developing Countries
HIMA – Hifadhi Ya Misitu Ya Asili, a branch of CARE Tanzania
The question number 12 is answered in the graph above and proved to be one of the most interesting questions to ask and received the most diverse answers. The level of knowledge on climate change is represented in Figure 9 but when the people who answered wanted to go into Figure 10. is a bar graph showing the different answers to the question, “what causes climate change?”

The question number 12 is answered in the graph above and proved to be one of the most interesting questions to ask and received the most diverse answers. The level of knowledge on climate change is represented in Figure 9 but when the people who answered wanted to go into
more detail on what is the cause of climate change, many different answers were given. Deforestation, by far, was the most prominent answer in all the towns, followed by international pollution, then overpopulation and lastly local industries. Awareness levels were extremely influenced by town, giving the impression that even in one small corner of an island the size of Zanzibar, education on the environment is lacking and varied.

The chart to the right represents the attitudes of farmers responding to climate change and is the visual representation to the question number 13 in Appendix B. The majority of the interviewees said they are worried about climate change, and many paired this emotion with the want for education in order to learn about different ways to cope with climate change and how to readjust their lives using both local and international tools and information. The desire for education was a widely given answer regarding all questions asked but became very noticeable when specifically addressing the attitudes and feelings the farmers experienced when thinking about the uncertainty of their future. The next widely represented feeling was a basic apathetic emotion where many of the people interviewed believed they had no control over their future and that it was in the hands of God or in their fate to have the climate changing and environment shifting around them. Respondents stated that their beliefs in the coming of the end of the world contributed to the apathy, or could also be from a lack of empowerment and encouragement from the surrounding community. More will be written on this topic in the following section. The

Figure 11 shows a variety of attitudes toward climate change
other emotion expressed was a feeling of calm and relaxation about the situation, and the final option was that the interviewee didn't answer the question.

Next in the results is the chart above that represents question 14 in the farmer survey. These answers are shown in the bar graph above and represent different types of agricultural adaptations that the farmers have gone through already or plan to do in the future. Many farmers opt for the decision to plant different types of crops or they had already started planting them before the interview took place. The crops that were chosen were drought resistant or more accepting of dry conditions. Another time where the planted crops were varied was at the request of the government, which some farmers said that they had been selected to test new crops out at the request of the Ministry of Agriculture. These projects were specifically targeting a new type of rice crop, which required less water. This was only the first season for planting so they did not have results yet on whether or not the crops were able to flourish in Zanzibar. The farmers chosen seemed to be very knowledgeable about the project and about farming in Zanzibar in general. They were able to pick up on many of the changes in the weather quickly and then reference the disappearance of Vuli as a part of climate change. One farmer in particular said that...
there were many local indicators that the 2012 Masika season was already finished (the interview was conducted mid April, which is supposed to be the middle of the long rainy season). The farmer said that when they heard a certain song bird and saw the blossom of a type of yellow flower called “manatari” in Swahili, it meant that the rains had stopped coming and that the season was over. These farmers were very knowledgeable and were aware that they needed to implement new technologies in order for their farms to continue producing a profitable amount of crops. In agreement with the passive attitude of the majority of interviewees when asked their feelings on the changing climate, the majority of farmers in this question were also not motivated or informed enough in order to make changes in their agricultural decisions to better prepare for the future.

The last question is answered in the chart above that represents the alternative livelihoods that each interviewee admitted to pursuing in addition to using farming as a tool for subsistence living. This area was inquired upon in consideration with the ability to assess vulnerability of the persons interviewed. The majority of people interviewed were farmers only, followed by the fishermen / farmer combination of a traditional Zanzibari livelihood. The next most popular

![Alternative Livelihoods](image)

Figure 13. This pie chart presents the different types of livelihoods pursued by farmers in addition to their agriculture career
profession was specific to women only and was the work of producing artisan crafts or clothing. Many of these women made kofias\textsuperscript{19}, coconut-fibre ropes, or pursued basketry as a form of making an extra income in addition to farming. Women in these coastal areas were also able to invest their energy in seaweed farming and supported themselves primarily with this profession and had the shamba plot for food production only. In addition to farming, a few men and women both owned small stores or small businesses that usually meant a produce stand in the village or in Stone Town. Few people interviewed were teachers, students, and government officials, but this minority was noticeably more educated and aware of the issues involving climate change in Zanzibar and worldwide.

The tourism sector in Jambiani, Paje and Bwejuu is also a form of income for some of the respondents interviewed. A few of the respondents worked in hotels as either chefs, waiters, or dishwashers, and others used the tourism industry to their benefit by offering snorkelling tours, henna, massages or any other sort of small business operation. Tourism on the southeast coast seems prominent with the number of hotels built on the beach\textsuperscript{20} yet more low-key than places like Nungwi or Matemwe, two tourist destinations on the north coast. The costs and benefits of tourism to an agricultural village can be spoken about at length and were a subject of conversation in many of the interviews. The intersection of tourism, the environment, food and water security and climate change is very complex and needs to be explained in depth, yet from interviews with elderly farmers it was clear that there was a negative attitude towards tourism. A handful of older farmers remarked that the younger generations did not go to the farmland and rural areas as much as in the past due to the increase in hotel work and also tourism activities, which they referred to as the use of alcohol and drugs, in Paje especially, the most developed.

\textsuperscript{19} A Kofia is a hat worn by many Muslim men in Zanzibar and worldwide. They are traditionally hand-stitched and sewn.

\textsuperscript{20} Eaton, Laura. Appendix B
Discussion

The island of Unguja is already being affected by climate change based on the results gathered from the formal and informal interviews, academic research, and field observations. When examining the biggest problems that Zanzibar faces from the looming aspects of climate change, one can see that lack of rainfall, increase in temperature and change in regularity of arrival of the seasons are all extremely detrimental to the survival of agriculture success on the island. Zanzibari climate change experts and farmers alike understand the shift in continuity and time period of rainfall, and the severity of temperature fluctuations, as well as the implications that these changes have had on successful crop production throughout the years. A reoccurring question that appeared multiple times throughout the interviews was if the farmers knew about the differences were between micro-climate change and global climate change and which one seem to be more problematic on the island. Many people said that they thought local deforestation was the main source of decrease in rainfall, change in wind patterns, and decrease in soil fertility as well. The study did not even include a question concerning deforestation, yet it was brought up in many of the interviews that were conducted. The three educated people who were more familiar with the concept of climate change either from education outreach programs or governmental knowledge base gave more traditional answers that focused on both the deforestation issue as well as the other concerns involving global CO2 emissions. This lead to the question; how are micro and macro climate change taking their toll on the island of Unguja, specifically the southeast section, and how are these two related to the concept of food insecurity.

It can be noted that seasons are getting less and less predictable, for example; rainfall during Masika and Vuli has shifted intensity or quantities and in some places on the island, the Vuli season has completely disappeared. The cold season is much less cold; for example no one
needs to make fires in the morning or evenings anymore while they used to make fires 20 years ago to keep warm during Mcho. Many farmers related the change to deforestation and micro-climate change and were aware of a connection between lack of trees and soil fertility and erosion of soil. All of these compounded factors affect the amount of crops during a season by generally producing less than they remember in the past five, ten, or twenty years ago. The crops are also more affected by diseases and bugs than they have been in the past, and farmers drew connections between warmer seasons and increase in pests. Also noted was that, while each year fluctuates, 2008 seemed to be a very intense year in terms of freak weather patterns, as almost all farmers mentioned it to be one of the worst for crop productivity. 2010 was a relatively good year that most farmers mentioned when reflecting on the past twenty years, but it may have also been just a regular year in terms of rainfall and temperature seeming much more profitable because it was surrounded by such low productivity in the years of 2008, 2009 and 2011. Extreme weather events were mentioned although they were not the prevalent in most conversations, but are related to climate change and should be looked into further when considering vulnerability.

One subject that was spoken of at length was the relationship between vulnerability and the plot size of each farmer. If the farmer had a smaller plot of land, he or she was more likely to be more vulnerable to climate change because of the lack of food available if something were to go wrong during the season. The farmers previously mentioned in the results section of the paper who had the most land by owning two plots of land in different are mostly likely to remain adaptable and resilient to the affects of climate change. These farmers are diversifying their productivity yet are still able to maintain the same livelihood which they are the most knowledgable about. These farmers also have land in a more fertile part of the island as well as in the coastal areas and therefore are able to make adjustments to both types of farms, plant
different types of crops and implement new techniques in two types of soil; sandy and coral-rag, and inland and water soluble.

Another way to improve adaptability and resilience is to apply new types of drought resistant crops and crops that require less water, can grow in sandier soils, or are able to cope with a changing climate. The importance of planting drought resistant crops in Zanzibar when assessing vulnerability is critical for farmers to improve their trade. Some drought resistant crops are cassava, certain types of rice and corn, potatoes, carrots, and other types of root and leafy vegetables. The correlation between pests, disease and drought in tropical environments is also important to discuss because when the climate is changing, the temperature and rainfall are affected and have dramatic affects on pest and disease increase. If less rain falls per season, even if the crop is able to thrive in drier soil, the chance that pests will affect the plant is high because there is no way to remove the bugs quickly and efficiently. Most of the farmers spoken to were not using any sort of pesticide, although one farmer was buying an organic pesticide made from herbs and spices that he said removed the bugs, during his interview. As listed in the Figure 5, cassava was experiencing both pests and disease this season according to almost half the farmers. Because cassava can basically be harvested year round and is a primary source of starch for the people of Zanzibar, the increase in disease and pests is a primary concern when addressing food security. The farmers were experiencing a blue rotted inside of the cassava in otherwise normal crops. They speculated this was from the lack of rain that the plant was receiving. This is a specific example of weather patterns changing the resilience of farmers in southeastern Zanzibar. The changes in crop production from the past 5, 10 and 20 years is a very varied mixture of trends and numbers and also represents a change in vulnerability and resilience that affects Zanzibari farmers throughout the island.

---

Conclusion

A combination of micro climate change and global climate change has affected the entirety of Zanzibar. Southeast Unguja is particularly vulnerable to droughts and decreased crop production, leading to decreased food security, due to the vast amount of deforestation and saltwater intrusion affecting this area. Farmers seem to be more aware of micro climate change than global climate change, therefore education is needed to inform Zanzibar of the global problems facing many parts of the world. When examining climate change on the island of Unguja, it is prominent that food security is incredibly affected by almost all aspects of climate change. In order to combat climate change, a shift on all levels needs to occur simultaneously, from policy to mindset altering on both local and global scales. It is clear from this study and also from living in Zanzibar for roughly two months that carbon emissions from industry and vehicles are not necessarily a pressing issue facing the island, yet the amount of CO2 emissions globally is the biggest driving factor of climate change today. As stated in the introduction, poor and developing countries, like eastern Africa, are baring the majority of the affects of climate change, while remaining the most innocent in carbon emissions production.

Traditional practices of farming and the culture of the rural people of Zanzibar are going to be particularly burdened by the costs of climate change impacts and show evidence that the dangers of climate change are already threatening the traditional way of life. The degree of vulnerability varies from one town to another and can even be unevenly distributed across and within communities. Although women are expected to be particularly affected by the effects of global warming\textsuperscript{22}, it seems like the women living in coastal communities are able to thrive due to women’s farming cooperatives, the seaweed farming industry, and their ability to diversify their livelihoods through handicrafts such as basketry and kofia-making. In other case studies

\textsuperscript{22} Macchi, Mijam, pg. 43
referenced, it is noted that there is already a long record of adaptations to climate variability practiced by traditional peoples, which may ultimately enhance their resilience. Examples of such traditional and innovative adaptation practices include: shoreline reinforcement, improved building technologies, increased water quality testing, rainwater harvesting, supplementary irrigation, traditional farming techniques to protect watersheds, changing hunting and gathering periods and habits, crop and livelihood diversification, use of new materials, seasonal climate forecasting, community-based disaster risk reduction and so on. While this may be true in other studies, this study found only a few of these techniques being applied in Zanzibar today.

The capacity to adapt to climate change can be asymmetrically distributed within a community (depending on age, social status or sex) and may change over time. Adaptive capacity depends on a range of factors, such as social capital, social networks, values, perceptions, customs, traditions, and levels of cognition. Additionally, the capacity to adapt is also affected by external factors including the spread of infectious diseases and population migration. However, even if the capacity to adapt is given within a society, successful adaptation may not occur. In the case of indigenous and traditional peoples, social and cultural barriers, insecurity of rights and loss of traditional knowledge may hold back adaptation as well. These factors need to be considered further in the case of Zanzibari farmers and also could be related to other aspects of the culture that have yet to be examined.

Limitations of the study include; lack of time, inconsistency of questions asked per interview, changes in translations between each village among others. Because some of the interviews were done in groups, (which was both positive and negative, as it encouraged farmers to talk amongst themselves as well as answer the questions) there were times when the results were skewed due to translation, pressure from other individuals or deliverance of question asked.

23 Maachi, Mirjam. Pg. 46
In conclusion, increased education and increased support to REDD and JAMABECO are needed, which are organizations that are already in place to work on reducing emissions and educating people about climate change. Implementations of new farming techniques and drought resistant crops that can either provide cash or nutritional sustenance are recommended. Ultimately, government reform and cooperation for local problems such as deforestation and hotel-induced erosion on coasts is recommended. Increasing the strength of Zanzibar’s ties with other small countries experiencing similar issues with climate change would be beneficial in order to increase pressure on the countries emitting the majority of carbon dioxide; like the USA, China and India. Finally, because all humans need to work together to live at the earth’s pace, sustainable and slowed development for Zanzibar is recommended with increased considerations to solar and wind powered electricity.

Zanzibari farmers are owed the chance to continue a lifestyle that is barely threatening the environment around them, much less the entire globe. While extracting a study such as this, and considering the wealth of results that were collected, it truly makes one re-examine their energy intensive, environmentally damaging, and carbon spewing lifestyles. If all people were living in the way that the majority of Zanzibari people lived, working and subsisting off the land and off the ocean, there would certainly be less harm done to the atmosphere and the environment in general, as opposed to the industry filled countries of the developed world. The desire for development in countries such as the United Republic of Tanzania needs to be examined as well and questioned further as to who is encouraging development of these nations and for what monetary gain. Change needs to start individually and within the country one calls home, yet simultaneously adaptations and resilience needs to be improved worldwide and in Zanzibar as well.
Recommendations

While more studies are needed and more scientific research will always be necessary in order to gain a very full and complete understanding of the vulnerability and resilience of the agriculture sector of the island, the move towards action is also crucial and necessary in increasing the resilience of the people who are dependent on the land for their livelihood. Action can come in the form of education, it can come in the form of policy, it can even manifest itself through community organizing and youth empowerment. To increase the resilience of a group of people, one needs to work within the community to create substantial change from the inside out. Action needs to happen simultaneously with the scientific research and will be the most important next step for an improvement in the livelihoods of the farmers studied in Paje, Bwejuu and Jambiani; but also on the entire island of Zanzibar. In all of the literature published today on climate change adaptations and vulnerabilities, each paper lists Eastern Africa and island nations as two areas where climate change will disproportionately affect the citizens of these regions. Instead of allowing this statement to come true in the very near future, why not instead create a rooted and deep change within a very vulnerable location as well as one of the most climate change threatened places in the globe?

For further studies I recommend familiarizing oneself with the literature already in place online and published in numerous papers and then researching pre-existing organizations in developed or developing countries that work to combat the affects of climate change. These organizations can provide support for research and individual studies but are also excellent launching pads for action-based projects that can be implemented in a short time but are effective for many years. Agriculture in Zanzibar is reliant on climate, but there are many ways that the availability of food and farms could be improved by implementing such techniques such as simple drip irrigation or rain-water catchment systems. By taking action locally, one can
empower the surrounding community and start creating a change *pole pole*\(^{24}\) until it grows wider
and wider and changes the path of our interconnected future.

**Recommended Techniques for Agricultural Resilience**

- **Water Conservation and Sustainable use**
  - Rainwater Catchment Systems
  - Drip Irrigation Techniques
  - Timing of watering throughout day; least evaporation
  - Planting drought resistant crops and shade resistant crops

- **Practices which maintain top soil and nutrient availability**
  - Crop rotation with crops families and different nutrient receptors/givers
  - Lasagne Composting
  - Implement Agro-forestry techniques instead of clearing the forest for agriculture
  - Planting perennial crops instead of annual crops
  - Companion Planting, for example; planting beans, corn and squash together because they benefit from growing together

In Appendix C there is a list of environmental NGOs in Zanzibar and abroad that focus on environmental justice, agricultural stability, and food security. There are possibilities that funding is available for action-based projects for the short and long term.

\(^{24}\) "Pole pole" means slowly in Kiswahili
References


5) Department of Geography (University of Turku) and the Department of Commercial Crops, Fruits and Forestry (Zanzibar). *Practical Measures to tackle climate change: Coastal forest buffer zones and shoreline change in Zanzibar, Tanzania.* 2009. Date Accessed; March 7, 2012


Appendices:

Appendix A: Interview Questions for Formal Interviews

1) What is the title of your position?
2) Can you explain your involvement with climate change research and studying on the island of Zanzibar?
3) What is the biggest threat from climate change to Zanzibar?
4) Do you think that Zanzibar's agriculture is threatened by global climate change?
5) What are some of the local threats to the environment that could also be threatening Zanzibar agriculture?
6) Are there any particular areas geographically that are more vulnerable in terms of drought and agriculture?
7) Are there any techniques in place to improve agriculture resilience threatened by climate change?
8) Lastly, what do you see as a connection between "God willing", as in it is in the hands of God, and climate change? Are these attitudes prevalent in Zanzibari farmers?

Appendix B: Interview Questions for Informal Interviews

1) What is your name and age?
2) How many acres is your farm?
3) What types of crops do you grow?
4) Have you noticed any changes in crop production this year? Five years ago? Ten? Twenty?
5) Have you noticed any changes in pests increase or decrease recently?
6) Have you noticed any changes in disease increase or decrease recently?
7) Can you explain any changes you have noticed in rain? • Wind/Storms? • Temperature?
8) Can you explain any changes you have noticed in start and end dates in the rainy/wet seasons?
9) Do you know what climate change is? Can you explain it?
10) What are the reasons climate change occurs? From what?
11) Do these changes worry you? How do you feel about these changes?
12) Will you do anything differently in terms of adaptations to agriculture in the future?
13) Do you have another job? An alternative livelihood?
Appendix C: List of Non-governmental Organizations for further studies and contact

JAMABECO – Jambiani Marine and Beach Conservation Organization

Pamoja Zanzibar – Water resources and conservation in Stone Town

African Development Foundation - Tanzania

Carym - Mijarc

Church of the Province of Tanzania

Community Development Trust Fund of Tanzania

DWT Development Centre

Family Planning Association of Tanzania

Food Development Association

Integrated National "Best Practice Forums"

Journalists Environmental Association of Tanzania

Ngara District Development Organization

Ruvuma Women Development Trust Fund

Soil Conservation and Agro-Forestry Project, Arusha

Tanzania Young Farmers' Club

The Equal Opportunities for All Trust Fund

The Steering Committee for NGO Policy Formulation

Ukimwi Orphans Assistance

African Medical and Research Foundation

African Services Committee, Inc.

Baha'i International Community

Cofina RK Inc.

Grassroots Organizations Operating Together in Sisterhood
Appendix D: Crop Family Genus and Species Names

<table>
<thead>
<tr>
<th>English Name</th>
<th>Latin Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>Zanzibari Spinach</td>
<td>Amaranthaceae</td>
</tr>
<tr>
<td>Lentil</td>
<td>Fabaceae</td>
</tr>
<tr>
<td>Cassava</td>
<td>Euphorbiaceae</td>
</tr>
<tr>
<td>Tomato, Potato, Eggplant, Pepper</td>
<td>Solanaceae</td>
</tr>
<tr>
<td>Carrot</td>
<td>Apiaceae</td>
</tr>
<tr>
<td>Onion and Garlic</td>
<td>Amaryllidaceae</td>
</tr>
<tr>
<td>Grapefruit, oranges, all citrus</td>
<td>Rutaceae</td>
</tr>
<tr>
<td>Mango</td>
<td>Anacardiaceae</td>
</tr>
<tr>
<td>Banana</td>
<td>Musaceae</td>
</tr>
<tr>
<td>Ginger</td>
<td>Zingiberaceae</td>
</tr>
<tr>
<td>Sweet potato</td>
<td>Convovulaceae</td>
</tr>
<tr>
<td>Yam</td>
<td>Dioscoreaceae</td>
</tr>
<tr>
<td>Corn</td>
<td>Crambidae</td>
</tr>
<tr>
<td>Lettuce</td>
<td>Asteraceae</td>
</tr>
<tr>
<td>Beans</td>
<td>Fabaceae</td>
</tr>
<tr>
<td>Rice</td>
<td>Poaceae</td>
</tr>
</tbody>
</table>

Mohogo (Cassava) affected by pests and disease.