

Adaptation strategies of small-scale agriculture production to climate change impacts in Micheweni, Tanzania

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Abstract. Bakari MS, Abdallah JM, Hella JP. 2018. *Adaptation strategies of small-scale agriculture production to climate change impacts in Micheweni, Tanzania. Trop Drylands 3: 60-75.* The impacts of climate change in the form of prolonged drought, low rainfall, increasing temperature and sea level rise are predicted to affect developing nations especially in the dryland region such as in Africa. This study was conducted in three Shehias within Micheweni district, Pemba, Tanzania to assess the extent of climate change impacts and crop yields. Specifically, the study aimed to identify and assess climate change impacts to small scale farmers, assess the link between precipitation, temperature, sea-level rise, crop/fish production, identify and assess climate change adaptation strategies by small-scale farmers in the District. Primary data were obtained through focus group discussions, key informants, and households. Household questionnaires and checklists were used to collect both qualitative and quantitative data to obtain information from respondents. In each Shehia, a sample of 30 households was randomly selected from the register for household interviews. Climate data were obtained from Pemba Meteorological Headquarter at Chake Chake Airport and the Matangatuani station. Secondary data were extracted from literature review. Data analysis was done using Excel (to get descriptive statistics), Statistical Package for Social Sciences (SPSS), correlation analysis and content analysis methods. The trend of climate measured for the last 30 years showed decreasing precipitation and increased temperatures. The highest annual average rainfall was 196.2 mm (1986) and the lowest 72.5 mm (2001) measured at the Matangatuani Meteorological station. Crop failure, low crop production, soil infertility, crop pests/diseases and seawater intrusion were major climate change impacts. Results indicated annual decrease in crop production in the past 10 years, with pests and diseases, uneven distributed low rainfall and extended drought periods. Crop rotation, use of improved seeds and new crop varieties, fertilizer application, irrigation, mixed cropping, and adjusting sowing dates were some of adaptation strategies. Seawater rise and intrusion constrained paddy farm production where fish and salt farming contributed to environmental degradation in farming areas. The decrease in crop production resulted mostly from climate variations; hence community should establish short-term and drought-resistant crops.

Keywords: Adaptation strategies, climate change, small scale farming

INTRODUCTION

Climate change is a global problem; although the associated impacts and adaptation strategies vary across the world (Ehrhart and Twena 2006; New et al. 2006). Developing countries are expected to be severely affected by climate change (Kurukulasuriya and Mendelsohn 2008). These countries, especially in Africa, are reported to be more vulnerable to climate change impacts because majority of the population depends on rain-fed agriculture for food and livelihoods at large (Boko et al. 2007; IPCC 2007; Morton 2007). Climate variability has a direct adverse influence on agricultural production in Africa because nearly 80% of agricultural production in these countries is rainfall and temperature-dependent (Thornton 2011).

Over the past few decades, the continent has experienced increased number of warm days and decreased number of extremely cold days (New et al. 2006). Spatial and temporal variability of rainfall and temperature, more intense and widespread droughts and aggravated floods have been common during the period (Deressa and Hassan 2009). These changes alter the type of agricultural crops, cropping patterns and lead to emergence of crop diseases

(Bosire 2009). For poor rain-fed agriculture-dependent communities, change in rainfall and temperature patterns compound existing vulnerabilities. Heavy dependence on natural climate places livelihoods at risk of climate parameters (i.e. in situ rainfall and temperature) as the stability of the trends of these climatic parameters declines, so does the security of their livelihoods (Suryavanshi et al. 2012).

Limited resources and capacities to respond to stresses (floods, drought and emergence of crop diseases) caused by instability of these climatic parameters constrain the ability to meet basic needs and move out of poverty. In recent years, Tanzania has experienced crop failure due to low rainfall and emerging crop diseases in many parts (Mtalo et al. 2005). Likewise, in other developing countries the climate change impacts have been unavoidable and can lead to widespread poverty if community has not been prepared to adapt to the situation. Currently, this climate is found to be highly variable and unpredictable and the country is prone to extreme weather conditions, including droughts and floods (Agrawala et al. 2003).

Recent data shows that temperature has increased and precipitation decreased in many areas of Tanzania. The average annual temperature is projected to increase by

2.2°C and rainfall to decrease by 100 mm by year 2100 (Houghton et al. 2001; Agrawala et al. 2003; URT 2003, 2007). In this country, where irrigation is very limited and almost the production of all food and cash crops depends on rainfall, changes in climatic parameters are expected to severely have affected crops and cropping pattern. However, little attention has been paid to relate climatic parameters variation with changes in type of crops and emergence of crop diseases.

The objectives of the study were: (i) To identify and assess climate change impacts on small-scale farmers in Micheweni District, Tanzania. (ii) To assess the link between precipitation, temperature, sea level rise and crop/fish production in the District. (iii) To identify and assess climate change adaptation strategies undertaken by small-scale farmers in Micheweni District.

MATERIALS AND METHODS

Study area

Location and climate

This study was conducted in Micheweni Constituency which is comprised of three Shehias/villages: Mjini wingwi, Majenzi and Micheweni (Figure 1). Micheweni District is located in the North-Eastern part of Pemba Island comprising of 27 administrative Shehias. Pemba Island is part of Zanzibar archipelago along with the other sister island of Unguja and numerous small islands and islets. Pemba is located in the Indian ocean about 60 km East of Tanzania mainland and lies between longitude 39° and 40° East and between latitude 4°50' and 6°30'South, covering 920 km² (Figure 1).

Temperature ranges between 21°C at the coolest and 34°C at the warmest. Traditionally, two rain seasons occur in the area: long rains between March and May and short rains between November and December. The mean annual rainfall is about 1860 mm; the long rains averaged 363 mm per month and short rains averaged 175 mm per month.

Population

According to the 2012 Census report, Micheweni District has a population of 103,816 inhabitants with an average household size of 5.3, women making up 51% of the population (URT (2013)). The study area population is 13 088 inhabitants, women making 49.5% of the population (URT (2013) (Table 1).

Culture

The culture of Micheweni people is almost the same as that of all parts of Zanzibar. Being Muslims, they wear pleasant dresses that identify and differentiate them from other foreign cultures. They live cooperatively in their daily life and this is easily recognized during traditional, wedding and funeral ceremonies. *Khanga* and headscarf (kilemba) are the most conspicuous, enjoyable and appreciated dress for women and dishdasha (*Kanzu*) with sewn caps for men. On all occasions, it is very rare to see the naked head of a mature woman. Apart from being sent to school for basic education, *Madras* and Islamic education is a necessity for children. Dances and drama are

normal performances during weddings, public, religious holidays and political ceremonies. The long-time hospitality of the people is still recognized and valued. Men mostly appear to be household heads performing large parts of the daily work particularly farming and fishing activities while women engage in paddy farming, house chores handicrafts, and child caring.

Economic activities

According to ZBS (2010) report, Micheweni people depend mostly on subsistence agriculture as the major income-generating activity for their livelihoods. Other economic activities of the District include fishing, livestock and poultry farming, sea-weed farming, small business enterprises and lime making. Most of the land is coral rag supporting the growth of shallow-rooted cereal crops such as millet, sorghum, maize, finger millet, cassava, bananas among others. Tree planting for household consumption and sale, stone and brick mining are other socio-economic activities of the population. Paddy farming, which is highly affected by seawater intrusion, is also a common practice in lowlands. Information from DADO office shows that for 2013, Micheweni comprised 2317 farmers practicing subsistence farming in various areas.

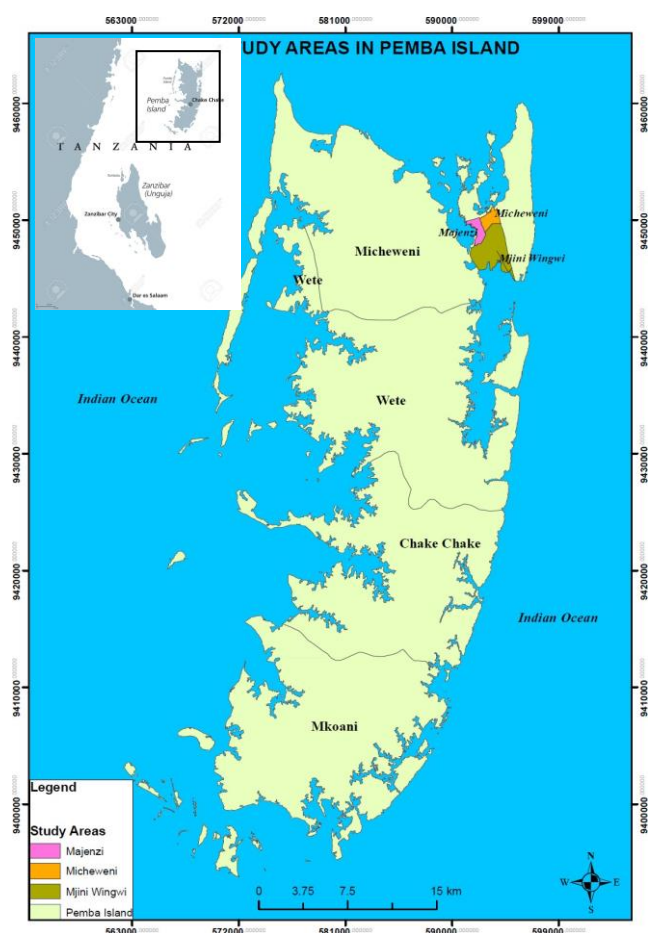


Figure 1. Map of Pemba Island, Tanzania showing study areas in Micheweni District

Fishing

Fishing which is mainly practiced by men is the second income-generating activity of Micheweni people after agriculture. Fish constitutes the most important source of protein in Zanzibar, and fisheries are an important economic sector on the island as well as sustaining many livelihoods. The impacts of climate change on fisheries potentially include shifts in species, food chain effects, diseases, and increased ocean acidity. Fish production is so far fluctuating at times, showing increasing and decreasing rates on a monthly and annual basis. Harvesting of fish is permissible to almost all species at maturity although this differs from species to species. The only restricted fish types to harvest are the known endangered and threatened species including dolphins (*Pomboo*), turtles (*Kasa*), etc. According to Hassan (2010), the fisheries activities were found to be affected by severe wind change to the extent that fishermen have to shift from normal fishing grounds instead to deep-sea though they face acute gear problems.

Justification of the study area

Micheweni is the poorest District in Zanzibar with most of the population living at a minimum income of less than 1 US\$ per day per household (ZBS 2010). Due to its poor economic condition, the District has been identified as the only Millennium village/District in Zanzibar among other villages in Tanzania. Most economic donations and aids are regularly year after year directed towards this District to combat their livelihood problems believed to be caused by climate variations. Apart from supporting different types of staple and cash crops, the eastern part of Micheweni, where this study was conducted, does not support the growth of Zanzibar's main cash crop (cloves); the highly dependent Zanzibar crop for foreign exchange earnings, economic growth and community livelihoods.

Research design

The study used cross-sectional design. Creasey (2006) and Miller (2006) recommended the use of this design because of its high degree of accuracy and precision in social science research. A cross-sectional research design allows the researcher to effectively describe change over time and to identify the various mechanisms associated with those changes. This design allows for relative quick and easy collection of variables only at once.

Sampling methods

Purposive sampling was employed to select farmers of both sexes and age not less than 45 years. Higher age group respondents are thought to provide valuable information taking into consideration that climate change data variation needs long periods of time. Respondents included in the study were drawn from three villages divided into strata depending on their level of income; high income (>3000 TZS per day), middle income (1000 to 3000 TZS per day), and low income (<1000 TZS per day). Random sampling was used to select members from each level, thus allowing for equal chances of members participation. Also, the key informants were selected to gather more information with regard to changes in climate change patterns. This included District Agricultural Development Officer, Subject Matter Specialists (Environment and Agriculture) and Village

Government leaders representing all the three villages in the area.

Sample size

According to information from DADO, Micheweni is comprised of 2317 farmers and it was expected that only 25% of all farmers were at the age of >45 years which is approximately 579 farmers. Matata et al. (2010) argue that a sample size ranging from 80 to 120 is adequate for most of social-economic studies in Sub-Saharan Africa, hence a sample size for this study was 90 respondents representing 30 members from each of the three villages of Micheweni, Mjini wingwi and Majenzi.

According to the District administration plan, each Shehia (Shehia leader) has got ten assistants each representing one of the villages forming the Shehia. In the selection of these 30 members from each Shehia, three members were randomly selected from each village, making a total of 90 members for all three Shehias of the study (Table 1).

Data collection methods and analysis

Identification and assessment of climate change impacts

Primary data were collected through Questionnaires and Focus group discussions (FGD). Questionnaires were administered to the randomly selected households within each level of income. Both close-ended and open-ended questions were prepared to allow for better responses from the selected respondents. The collected data included identified climate change impacts for the entire period of 30 years and the assessment of the climate change production results per hectare today compared to the past (30) years production data. These data were then analyzed using Statistical Package for Social Sciences (SPSS) to generate descriptive statistics like frequency, mean, percentage and standard deviation while correlation and multiple linear regression analysis were used to test the magnitude of the relationship and influence among dependent variables (crops) and independent variables (climate variables). Qualitative data were analyzed by involving the communities through group discussions where immediate feedback was produced.

In FGD with farmers and Key informants, interview checklists were used to collect information. Key informants included 15 members in each village. The checklists aimed to collect data on the types of climate change impacts they faced with regard to their daily crop production. The impacts were then assessed to check their relation to small scale farming in the District.

Table 1. Demographic characteristics in Micheweni District, Pemba Island, Tanzania and sample were drawn

Shehia	Population				Sampled h/h
	Male	Female	Total	Households	
Micheweni	3134	3063	6197	1127	30
Mjini wingwi	2305	2216	4521	853	30
Majenzi	1166	1204	2370	423	30
Total	6605	6483	13088	2403	90

Source: URT (2013)

Link between climate variables and products in the district

Secondary data were obtained from literature reviews and other secondary sources to supplement the primary information. Data on temperature and rainfall were collected from the Micheweni District Meteorological Station at Matangatuani while data on sea-level rise were collected from the TMA headquarters at the Chake Chake airport-Pemba. Production data of four crops (i.e., cassava, banana, millet and rice) was collected from District Agricultural Development Office (DADO) while data on fish production were collected from the District Fisheries Office. All information collected on temperature, rainfall, sea-level rise, fish and crop production reflected a period of 30 years back.

Data on temperature, rainfall and sea-level rise were analyzed using Trend analysis method to present patterns and trends of climate in the form of graphs and showing time series on the data collected. Collected information at district level on crops and fish production was analyzed using Statistical Package for Social Sciences (SPSS), while data on the relationship between temperature, rainfall, sea-level rise, and changes in crop production in the district were analyzed using Correlation analysis method.

Correlation analysis method:

$$r = \frac{\sum (X-X)(Y-Y)}{\sqrt{\sum (X-X)^2 \sum (Y-Y)^2}}$$

Where,

r : Correlation coefficient

X : Independent variables (Temperature, rainfall and sea-level rise)

Y : Dependent variables (Crop yield)

Assessment of climate change adaptation strategies

The unit of analysis for this objective was households at Shehia, Ward, District and Region. Households were stratified and within each stratum, a sample of households was selected randomly. Data on identified adaptation practices against climate change impacts were collected from households and assessment was done to check their performance in the last 30 years using household questionnaires.

In-depth interview was done with relevant authorities from Shehia, Ward, District and Region to provide information on adaptation strategies using a checklist (Appendix 3). The required information included the short and long term analysis undertaken by small scale farmers on the use of improved seed varieties (maize, rice, millet, sorghum, etc.) enduring different soil and salt characteristics, drought and unexpected climate regimes. Analysis was also carried out on changes of farming practices and timing of farm operations, increased use of manure and fertilizer, use of cropping mixes, better use of management tools including climate information, use of agriculture extension activities and education on climate change, awareness creation on climate change and adaptation strategies and changes in governmental and institutional policies and programs.

At all administration levels, information was collected on how responsible officers effectively communicate with the Tanzania Meteorological Agency on any early warning systems and issues related to changes in climate patterns and how TMA communicates to regional and lower-level authorities on providing such information to farming communities for implementation. Analysis of these data was done using Content Analysis method.

RESULTS AND DISCUSSION

Household Socio-Economic Profile

This entails socio-economic characteristics of the respondents in the study area. It involves respondents' age, education level, sex and marital status, household dependents and income of respondents, type of agricultural crops, land ownership and size of land used for production. These factors are considered to be important when assessing the impacts of climate change and adaptation strategies at household level.

Demographic characteristics

The study indicated that 53% of the respondents' age ranged from 45 to 55 years old. This age range is considered to be an effective human capital age as opposed to 2% aged above 76 years (Table 2).

Majority of the sample households were male-headed (73%) the rest were headed by females (27%). About (70%) of the sample households had a primary level of education. The higher number of households with primary education is attributed to a slight increase in the number of educational facilities countrywide. Households with no formal education were about 23% where Mjini wingwi ranked higher for people with no formal education (30%) than other villages in the area, where only (7%) of the respondents had secondary education attainment. This situation automatically brings negative implications towards future development of the District as a whole. The lower the level of education households possess in the area the higher the negative impacts to climate change as far as experiences and skills on adjustment are concerned.

About 78% of the respondents were married compared to only 2% singles with more couples found in Micheweni village (36%). More males were reported in Micheweni village (35%) as compared to more females in Mjini wingwi (38%) and more divorcees were recorded in Micheweni and Majenzi than Mjini wingwi where the highest level of widowed respondents was found in Mjini wingwi village (Table 2). Indications of more divorces in former villages were a result of being closer to district headquarter as compared to Mjini wingwi which is a bit far from the district. This shows the strictness of community in rural villages in preserving their marriage ties than in the urban villages.

Household incomes

The study revealed that of the 532 household members from the total surveyed households (90), 442 members were dependants who are almost 83% of the total household members. There were more female dependants

(54%) against 46% of male dependants in the area. More male dependants were observed in Majenzi (35%) compared to more female dependants (37%) in Mjini wingwi (Table 3).

Furthermore, Table 3 shows that most of the income of the respondents was earned from crops production (41%) followed by fishing (20%) and formal employed sector by 18% (Table 3). Agriculture is still the main income-generating activity (IGA) in this District followed by other important IGAs including petty business, seaweed farming, tree planting, stone/bricks mining, salt farming and lime making. Results indicate that Mjini wingwi earn more in crops farming (36%) as compared to Micheweni and Majenzi (33% and 31% respectively), whereas Micheweni earnings are more directed from fishing (40%) and formal employed sector (58%) than Mjini wingwi and Majenzi villages (Table 3).

Similar results were reported by Kangalawe et al. (2009) on climate change and variability impacts, vulnerability and adaptive capacity in Kasulu indicating that majority of the respondents (96.6%) accrued their income from crop cultivation as their main occupation but followed by livestock keeping. Petty business and self-employment were also dominant practices in Micheweni village while in Mjini wingwi income sources were also from bricks mining, beekeeping, and sale of lime and building poles from woodlots for building purposes. The average income per household per day was TZS 1 579 equivalent to 0.71 United States Dollar (Table 3).

Land ownership and size

There was a negligible difference between size of land owned and used by community for crop production, where 37% of all respondents were found to own 1 ha of land for cultivation. Community in Micheweni District possesses just small portions of land for crop production due to land scarcity relative to population increase. Further, it was found that 92% of the respondents cultivated their farms twice a year compared to those who farm only once per year. Almost 42% of the respondents have been identified to cultivate on the same piece of land for a period of 21 to 30 years, whereas 27% and 15% were those respondents who cultivated their farms for a duration of 11 to 20 and 31 to 40 years respectively (Table 4).

Types of agricultural crops

Results identified millet and cassava as the main staple food crops accounting for almost 54% of all crops grown by households in these Shehias followed by cassava and bananas (13.3%). These crops are widely grown in the area due to the fact that the coral nature of the soil supports well the growth of these crops. Further, the area is semi-arid supporting drought-resistant crops grown at minimum and maximum rainfall and temperatures respectively. Other staple food crops grown at small scale in the District include maize and bananas, rice and millet, rice with bananas, rice and cassava, bananas and millet, millet with maize, cassava and maize and rice with maize (Figure 2). These crops are mostly grown for household consumption, although selling is sometimes also practiced.

Table 2. Respondents' characteristics in surveyed villages in Micheweni District, Pemba Island, Tanzania (n=90)

Socio-economic attributes	Category	Responses			
		Micheweni (n=30)	Mjini wingwi (n=30)	Majenzi (n=30)	Av. Total (n=90)
Age	45-55	18 (60)	16 (53)	14 (47)	48 (53)
	56-65	8 (27)	11 (37)	9 (30)	28 (31)
	66-75	3 (10)	2 (7)	7 (23)	12 (13)
	Above 76	1 (3)	1 (3)	0 (0)	2 (2)
Gender	Male	23 (77)	21 (70)	22 (73)	66 (73)
	Female	7 (23)	9 (30)	8 (27)	24 (27)
Education level	No formal	4 (13)	9 (30)	8 (27)	21 (23)
	Primary	23 (77)	19 (63)	21 (70)	63 (70)
	Secondary	3 (10)	2 (7)	1 (3)	6 (7)
Marital status	Single	0 (0)	1 (3)	1 (3)	2 (2)
	Married	25 (83)	22 (73)	23 (77)	70 (78)
	Divorced	2 (7)	1 (3)	2 (7)	5 (6)
	Widowed	3 (10)	6 (20)	4 (13)	13 (14)

Note: Numbers in parentheses indicate percentages

Table 3. Household incomes in Micheweni District, Pemba Island, Tanzania

Variables	Category	Responses			
		Micheweni (n=30)	Mjini wingwi (n=30)	Majenzi (n=30)	Av.Total (n=90)
Dependants	Male	68 (33)	65 (32)	72 (35)	205 (46)
	Female	79 (33)	88 (37)	70 (30)	237 (54)
Income (Tshs)	Crops	6862545 (33)	7531972 (36)	6669483 (31)	21064000 (41)
	Fishing	4235073 (40)	3190654 (31)	2961273 (29)	10387000 (20)
	Petty business	1523000 (36)	1368100 (32)	1359800 (32)	4250900 (8)
	Employment	5349250 (58)	1256380 (14)	2554370 (28)	9160000 (18)
	Others	1969741 (28)	2908750 (41)	2143509 (31)	7022000 (13)
	Total	19939609	16255856	156884355	1883900

Note: 1 US\$ = 2210 TZS; 1 Year = 365 days

Table 4. Land ownership and cropping in Micheweni District, Pemba Island, Tanzania

Variables	Category	Responses			
		Micheweni (n=30)	Mjini wingwi (n=30)	Majenzi (n=30)	Av.Total (n=90)
Farm area owned (ha)	0.5	11 (37)	12 (40)	9 (30)	32 (35)
	1	11 (37)	11 (37)	11 (37)	33 (37)
	>1	8 (27)	7 (23)	10 (33)	25 (28)
Cultivation seasons	Once	2 (7)	1 (3)	4 (13)	7 (8)
	Twice	28 (93)	29 (97)	26 (87)	83 (92)
Cropping duration (years)	1-10	2 (7)	3 (10)	3 (10)	8 (9)
	11-20	8 (27)	9 (30)	7 (23)	24 (27)
	21-30	15 (50)	12 (40)	11 (37)	38 (42)
	31-40	2 (7)	4 (13)	8 (27)	14 (15)
	41-50	2 (7)	2 (7)	1 (3)	5 (6)
	51-60	1 (3)	0 (0)	0 (0)	1 (1)

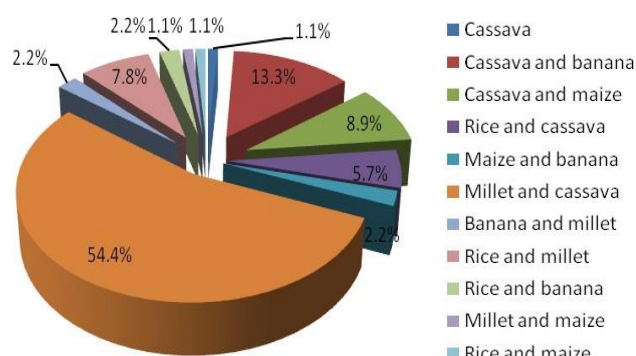


Figure 2. Types of agricultural crops grown in Micheweni District, Pemba Island, Tanzania

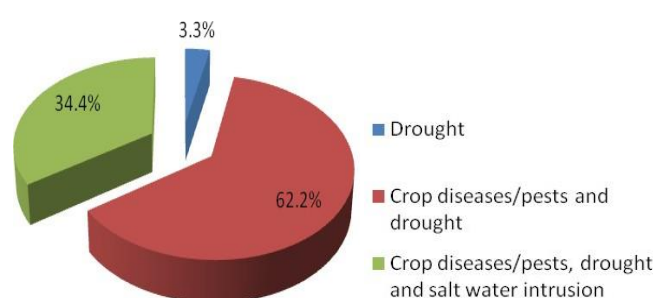


Figure 3. Reasons for decreasing crop production in Micheweni District, Pemba Island, Tanzania

Crop production improvement

Fertilizer application in respondents’ farms

Of the total respondents interviewed, more than half (57%) reported using fertilizer in their farms while 43% do not use any type of fertilizers. About 45% of those who use fertilizer were reported from Micheweni village against 46% who completely refused the use of any type of fertilizer in their farms reported from Majenzi. The most common fertilizer in use in the District is organic fertilizers (82%) (Table 5). This indicates that most farmers have

enough awareness and are oriented on the use of less costly livestock and poultry manure plus other important organic fertilizers locally available within their surroundings. The average crop production per year for those who applied fertilizers in their farms was found to be 1895.3 kg as opposed to 529.3 kg for non-fertilizer users indicating that fertility is a very important factor for high crop production.

Trends of crop production

Almost all respondents commented on the annual decreasing trend of crop production in the past 10 years, caused by various factors either under community controls or not. About 23% of the respondents reported crop pests and diseases as the major factors causing the decrease in crop production followed by land/soil infertility and low rainfall (21%), low rainfall per se (18%) and land/soil infertility associated with crop pests/diseases (18%).

Either, it was observed that 100% of all respondents interviewed face major problems in crop production leading to decreased food security in the district (Table 6). Specifically, 1987, 1994, 1998, 2000, 2004, 2009, and 2010 were reported by the community as years of high food decrease in the area.

Furthermore, all Shehias reported crop diseases/pests and drought (62.2%), and crop diseases/pests associated with drought and saltwater intrusion (34.4%) as among the major reasons for crop decreases (Figure 3).

Table 5. Type of fertilizer used by respondents in Micheweni District, Pemba Island, Tanzania

Variables	Category	Responses			
		Micheweni (n=30)	Mjini wingwi (n=30)	Majenzi (n=30)	Av.Total (n=90)
Fertilizer	Yes	23 (77)	16 (53)	12 (40)	51 (57)
	No	7 (23)	14 (47)	18 (60)	39 (43)
		(n=17)	(n=17)	(n=17)	(n=51)
Type	Inorganic	1 (6)	5 (29)	3 (18)	9 (18)
	Organic	16 (94)	12 (71)	14 (82)	42 (82)

Table 6. Production trend, causes and problems in crop production in Micheweni District, Pemba Island, Tanzania

Variables	Category	Micheweni (n=30)	Responses		
			Mjini wingwi (n=30)	Majenzi (n=30)	Av.Total (n=90)
Production	Increasing	0 (0)	0 (0)	0 (0)	0 (0)
	Decreasing	30 (33)	30 (33)	30 (33)	90 (100)
Causes	Land/Soil infertility	1 (1)	1 (1)	1 (1)	3 (3)
	Low rainfall	5 (17)	6 (20)	5 (17)	16 (18)
	Crop pests and diseases	9 (30)	5 (17)	7 (23)	21 (23)
	Land/soil infertility and low rainfall	4 (13)	8 (27)	7 (23)	19 (21)
	Drought	5 (17)	2 (7)	3 (10)	10 (11)
	Land/soil infertility and crop pests/diseases	3 (10)	7 (23)	6 (20)	16 (18)
	Land fragmentation	2 (7)	0 (0)	0 (0)	2 (2)
	Unavailability of improved seeds	0 (0)	1 (3)	0 (0)	1 (1)
	Sea level rise during high tides	1 (3)	0 (0)	1 (3)	2 (2)
Problems in production	Yes	30 (33)	30 (33)	30 (33)	90 (100)
	No	0 (0)	0 (0)	0 (0)	0 (0)

Solution to decreased crop production

With regard to finding best solutions against problems on decreased crop production more than two-thirds of the respondents (67%) were found to have no adopted solution with almost 38% from Mjini wingwi village. Solely use of improved seeds and use of improved seeds with fertilizer application were other suggested solutions for decreasing crop production at 19% and 6% respectively (Table 7). It was learned from this study that most of the households were still lacking appropriate agricultural extension awareness from extension officers at district level.

Climate trends

Rainfall. Figure 4 shows that there was a decrease in precipitation over the last 30 years. In 1986 the annual rainfall was about 196.2mm compared to 72.5mm in 2001 as recorded at Matangatuani Meteorological Station. In some seasons, rainfall starts earlier while in other seasons comes late and thus interferes with crop schedules and production.

Household surveys revealed the same phenomena. About 90% of the households reported that rainfall has shown a decreasing trend over the past 10 years. Almost, all Shehias (Micheweni, Mjini wingwi, and Majenzi) reported low annual rainfall intensity, unreliable, and uneven distribution during farming seasons (Table 8). All these phenomena contribute to the decrease in crop production (as observed in Section 4.2.2). Other factors believed to contribute to this decrease include loss of nutrient levels damage, use of unqualified seeds and salt intrusion due to pumpage of groundwater.

A study carried out by the University of Pretoria (Lina Häckner, 2009) that sampled 8000 farmers in 11 countries in Africa showed that half of the African farmers perceived a long term decline in precipitation. One-third of the respondents perceived a change in the timing of the rains, and one-sixth perceived droughts to be more frequent compared to the past. Likewise, Lina Häckner (2009) interviewed 9500 farmers in 10 countries in Africa and found that significant number of farmers reported decrease in precipitation. Both studies support the decrease of rainfall in Micheweni district for the past 30 years.

Temperature. The recorded temperature for the last 30 years at Matangatuani Meteorological Station varies across the period. In the first half of the period, the trend presented relatively uniform average minimum temperatures. In 1997 the mean temperature dropped to 19.2°C with an abrupt increase to 20.7°C in 1998, while in the second half of the period (1999-2012) the trend of the mean temperature presents a gradual increase of up to 24.4°C in 2012. Figure 5 shows these mean temperatures.

The temperature records were in line with responses from the sampled households where 97% of the respondents reported increase in temperature over the period of the last 10 years (Table 9). Extended periods of temperatures, crop pests, and diseases, soil infertility and decreased rainfall in Micheweni District is the main cause of diminishing crop production (Table 9). The situation has either caused prolonged drought periods leading to death or failure of most crops depended by the community for their livelihood.

Table 7. Solution to crop production problems in Micheweni District, Pemba Island, Tanzania

Variables category	Responses			
	Micheweni (n=30)	Mjini wingwi (n=30)	Majenzi (n=30)	Av.Total (n=90)
Adoption of new farming technology	0 (0)	0 (0)	1 (3)	1 (1)
Use of improved seeds and fertilizers	2 (7)	1 (3)	2 (7)	5 (6)
Solely application of fertilizers	1 (3)	1 (3)	1 (3)	3 (3)
Use of improved seeds	8 (27)	3 (10)	6 (20)	17 (19)
Applying mixed cropping system	0 (0)	1 (3)	1 (3)	2 (2)
Improved seeds and crop rotation	1 (3)	1 (3)	0 (0)	2 (2)
No suggested solution	18 (60)	23 (77)	19 (63)	60 (67)

Table 8. Response on rainfall characteristics in Micheweni District, Pemba Island, Tanzania (n=90)

Rainfall	Category	Responses			
		Micheweni (n=30)	Mjini wingwi (n=30)	Majenzi (n=30)	Av.Total (n=90)
Trend	Increase	0 (0)	0 (0)	1 (3)	1 (1)
	Decrease	30 (100)	30 (100)	29 (97)	89 (99)
Intensity	High rain and for a long time	0 (0)	1 (3)	0 (0)	1 (1)
	High rain and for a very short time	26 (87)	24 (80)	26 (87)	76 (84)
	Low rain and for a long time	1 (3)	1 (3)	0 (0)	2 (2)
	Low rain and for a very short time	3 (10)	4 (13)	4 (13)	11 (12)
Distribution	Even distribution	0 (0)	1 (3)	1 (3)	2 (2)
	Uneven distribution	27 (90)	26 (87)	26 (87)	79 (88)
	No change	3 (10)	3 (10)	3 (10)	9 (10)

Table 9. Temperature trend and effects to agricultural crops in Micheweni District, Pemba Island, Tanzania (n=90)

Temperature	Category	Responses			
		Micheweni (n=30)	Mjini wingwi (n=30)	Majenzi (n=30)	Av. total (n=90)
Trend	Increase	29 (97)	29 (97)	29 (97)	87 (97)
	Decrease	0 (0)	1 (3)	1 (3)	2 (2)
	No change	1 (3)	0 (0)	0 (0)	1 (1)
Effects	High temperatures	14 (47)	8 (27)	7 (23)	29 (32)
	Death of crops	0 (0)	2 (7)	1 (3)	3 (3)
	Crop pests and diseases	6 (20)	11 (37)	9 (30)	26 (29)
	Low rainfalls	4 (13)	5 (17)	5 (17)	14 (16)
	Sea water rise	0 (0)	0 (0)	1 (3)	1 (1)
	Infertile land	5 (17)	4 (13)	6 (20)	15 (17)
	No effects	1 (3)	0 (0)	1 (3)	2 (2)

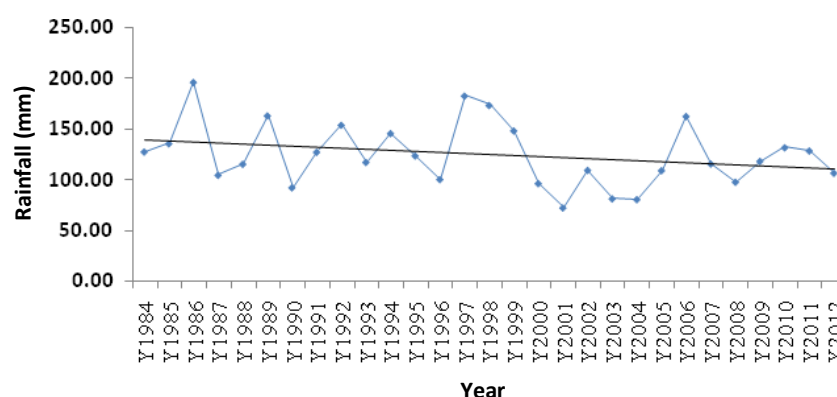


Figure 4. Mean annual rainfall (1984-2012) Matangatuani, Micheweni District, Pemba Island, Tanzania (TMA 2014)

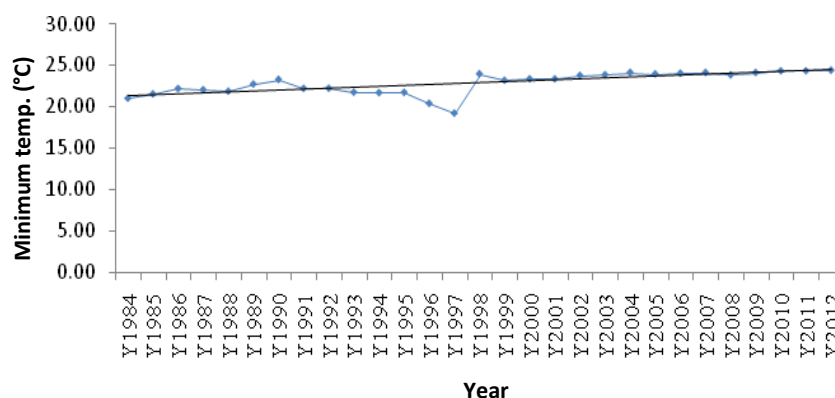


Figure 5. Mean annual minimum temperature (1984-2012) Matangatuani, Micheweni District, Pemba Island, Tanzania (TMA 2014)

Results from the temperature measurements reported the increase of mean annual maximum temperatures from 29.5°C in 1984 to 30.2°C in 1987 followed by a quick temperature decrease of up to 29.2°C recorded in 1989. The mean annual temperature increasing trend reached to maximum in 1992 recording a peak of 31.4°C. This increasing trend of temperatures stipulates signs of crop failure and/or low crop production in the district (section 4.2.2). Figure 6 indicates that although there were relative increasing and decreasing trends of temperatures, the last 18 years up to 2012 recorded almost a regular temperature increasing trend. Results show maximum temperatures

with significant correlation to cassava and millet production indicating that whenever there is an increase in maximum temperatures, there is a decrease in crops production. The crops are the two most common food crops in the community. Also, there was a decrease in banana production though it was insignificantly correlated to temperature (Table 10). For the other food crops, for instance, rice and fish products, there was no observed significance between the maximum temperatures and productions. This may be caused by other variable factors like soil infertility, timing of planting, etc.; factors that were not put into considerations.

Sea level rise. During the initial years (1985-1997), there was a periodic decrease and increasing rise of sea level followed by an abrupt decreasing and increasing rate between 1997 and 2001 before recording the increasing trend between 2001 and 2011 (Figure 7). Results showed the highest annual average sea level rise of 2110 mm reported in 2010 whereas the lowest was 1980 mm recorded in 2001 with an average increase of 5mm/year (Figure 7). The rise in sea level affected mostly paddy farming in lowland areas as compared to other crops grown in different areas resulting in decrease in rice production. However, for the last 30 years results (Table 10) indicated that fish catch was found to have a significant correlation to sea rise showing the actual decrease in production. In contrast, the highest fish catch (11,400 tons) recorded in 2012 was not reported on the same year of minimum sea-level rise and as well the lowest catch was not observed in maximum sea level season, hence contradicting. In addition to climatic variables collected, the implication of this scenario might be a result of some other variables not put into considerations during data collection. The provision of various advanced fishing gears to fishing community and rise in price of fish products within the internal and external markets could have contributed to this insignificance.

Comparison of monthly mean sea level height

For the period of 26 years, Zanzibar experienced a rising trend of sea-level rise which affected most of the paddy farms. The trend shows a slight variation between the long term monthly mean sea level at 20 years and the 2003 monthly mean sea level rise (Figure 8). There was a decrease of long term monthly mean sea level against 2003 means sea level. As well, Figure 9 depicts a big variation between the long term and 2001 monthly mean sea level rise where the long term monthly mean sea level was higher than 2001 mean sea-level records.

Table 10. Relationship between climate and agriculture/fish production

Agricultural produces	Sea level	Rainfall	Max. temp	Min. temp
Cassava	-0.214	0.123	-0.441*	-0.409*
Banana	0.007	0.144	-0.245	-0.248
Millet	0.083	0.176	-0.401*	-0.364
Rice	-0.016	0.225	-0.238	-0.432*
Fish	0.426*	-0.086	0.005	0.157

Note: *. Correlation is significant at the 0.05 level

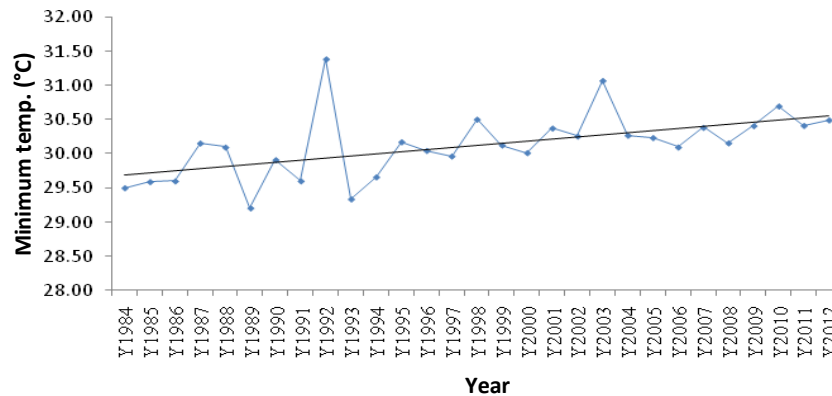


Figure 6. Mean annual maximum temperature (1984-2012) Matangatuani Micheweni District, Pemba Island, Tanzania (TMA 2014)

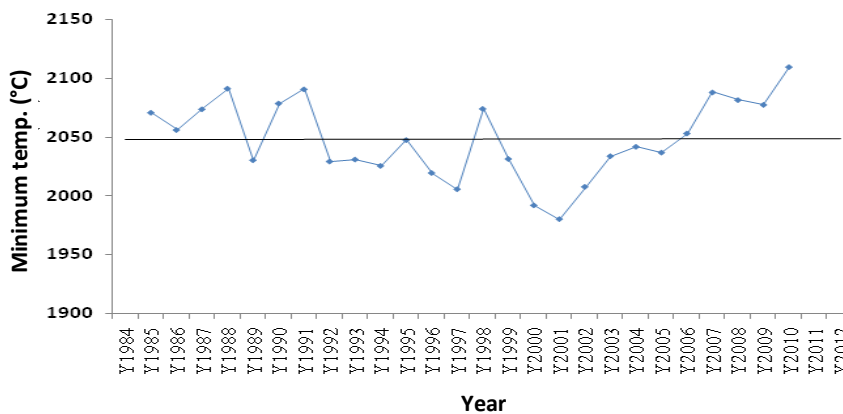


Figure 7. Mean annual sea level (1985-2010) Chake Chake Airport, Pemba Island, Tanzania (TMA 2014)

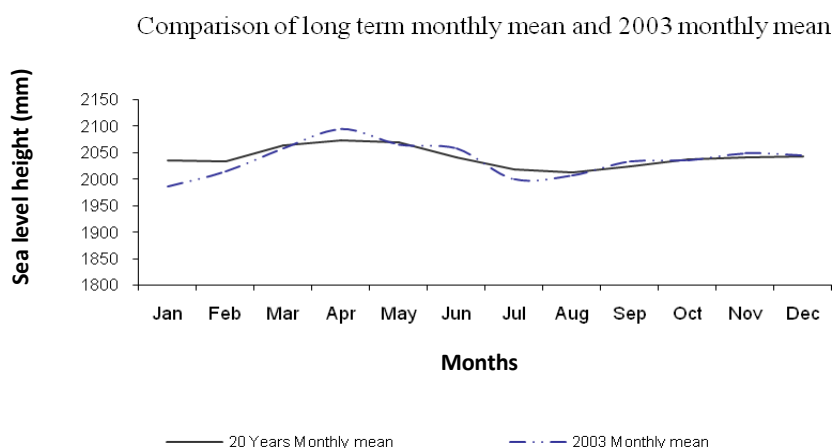


Figure 8. Comparison of long term and 2003 monthly mean sea level

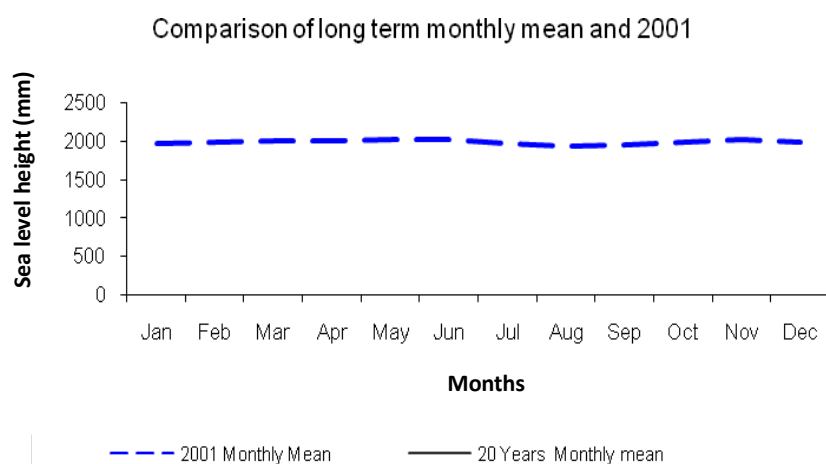


Figure 9. Comparison of long term and 2001 monthly mean sea level

Effects of climate change on crops

Crops disappearance, affected crops and causes

Survey findings showed that 99% of all respondents from the study area agreed on the disappearance of some important food crops being grown before by farmers in the District and so far the community has lost interest to continue raising these crops (Table 11). The crops have been found to cost farmers in terms of time, energy and financial resources. The most affected crops include pumpkins, pigeon peas, cassava and green grams as well as banana and millet varieties (Table 11). In the past, these crop varieties were found to be plenty in the District as their growth was well supported in semi-arid climates and coral rag areas. Community used to depend on these crops as the most staple food varieties and sometimes sold for cash income, but as time went on they slowly started to disappear in the vicinity, believed to be as a result of climate change. This is supported by Sanga et al. (2013) in small-scale farmers' adaptation to climate change effects in Pangani river basin and Pemba where 72.8% of farmers asked to report on the changes happening in their respective areas and what they think could be the reason. The farmers believe that the disappearance of crops that

used to be produced in their areas is a result of climate change.

Table 11. Crop disappearance and effects in Micheweni District, Pemba Island, Tanzania (n=90)

Variables	Category	Responses			
		Micheweni (n=30)	Mjini wingwi (n=30)	Majenzi (n=30)	Av. total (n=90)
Crops affection	Yes	30 (100)	30 (100)	29 (97)	89 (99)
	No	0 (0)	0 (0)	1 (3)	1 (1)
Affected crops	Cow peas	1 (3)	0 (0)	0 (0)	1 (1)
	Banana	3 (10)	5 (17)	3 (10)	11 (12)
	Green grams	4 (13)	4 (13)	4 (13)	12 (13)
	Pineapple	2 (7)	2 (7)	1 (3)	5 (6)
	Millet	3 (10)	3 (10)	5 (17)	11 (12)
	Sweet potatoes	2 (7)	2 (7)	2 (7)	6 (7)
	Cassava	4 (13)	5 (17)	3 (10)	12 (13)
	Pumpkins	5 (17)	5 (17)	5 (17)	15 (17)
	Sorghum	1 (3)	1 (3)	0 (0)	2 (2)
	Cocoyam	0 (0)	0 (0)	1 (3)	1 (1)
Pigeon peas	5 (17)	3 (10)	6 (20)	14 (16)	

Among the reasons for crop disappearance reported by farmers include low rainfall by 34.4% of the respondents, 23.3% crop pests/diseases and 22.2% extended drought periods. Other reasons mentioned in the District were land infertility, high temperatures, and the use of unimproved seeds that are not capable of growing (Figure 10).

Climate change impacts and disasters to crop farming in the district

Climate change awareness and impacts

Results from the study observed that 96% of all respondents were knowledgeable and aware of the term climate change through long period experiences with 100% from Mjini wingwi agreeing and 75% from Majenzi disagreeing on the term. Similar results were reported by Nyanga et al. (2011), Rao et al. (2011) and Osbahr et al. (2011) on studies assessing farmer perceptions in semi-arid environments of Africa. Almost 100% of the respondents agreed that their farming activities have been affected by change in climate year after year. Community cropping is still being seriously impacted by change in climate leaving farmers with less or no access to food for their livelihood.

Respondents also concluded on the results of these impacts being contributed entirely by low rainfall trend (Majenzi), high temperature (Mjini wingwi), sea-level rise (Micheweni) and drought claimed by all of the respondents (Table 12). Juana et al. (2013) also mentioned the climate change impacts being low rainfall patterns, high temperatures and drought affecting most of the Sub Sahara African countries. However, Hassan (2010) reported the available land for agriculture as increasingly in short supply due to salinity as a result of climate change and sea-level rise where people now experience low yield of agricultural crops accompanied by unpredictable flowering and fruiting.

Seawater intrusion in Micheweni District has also shown a big threat to agricultural production especially in rice fields where during high tides sea water enters into farms and forces farmers to vacate the area until situation prevails (Figure 13). Of the most known severe climate change effects noticed by respondents in the last 10 years

were the low level of crop production, crop/seed death, and soil infertility reported by Micheweni, Mjini wingwi, and Majenzi community respectively (Figure 11).

Figure 12 depicts that almost 70% of all surveyed households reported the duration of these climate change effects occurring more than three times in 10 years of cropping period and thus cause decreasing production rate of food crops in the District.

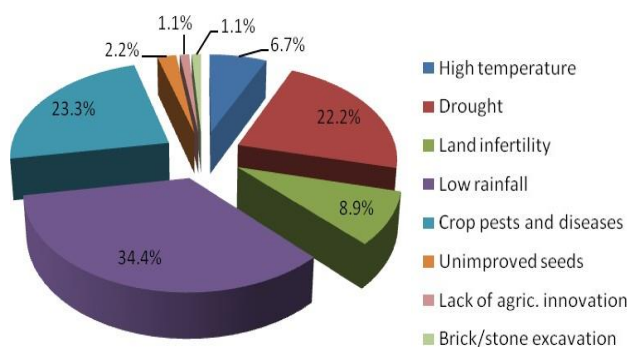


Figure 10. Reasons for crop disappearance

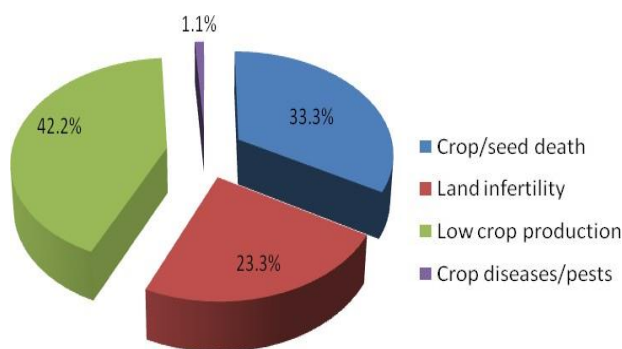


Figure 11. Climate change effects in Micheweni District, Pemba Island, Tanzania

Table 12. Climate change impacts on crop production in Micheweni District, Pemba Island, Tanzania (n=90)

Variables	Category	Responses			Av. total (n=90)
		Micheweni (n=30)	Mjini wingwi (n=30)	Majenzi (n=30)	
Awareness on CC	Yes	29 (97)	30 (100)	27 (90)	86 (96)
	No	1 (3)	0 (0)	3 (10)	4 (4)
Effects of CC	Yes	30 (100)	30 (100)	30 (100)	90 (100)
	No	0 (0)	0 (0)	0 (0)	0 (0)
Effect of CC impacts	Low crop production	7 (23)	8 (27)	13 (43)	28 (31)
	Crop pests/diseases	12 (40)	9 (30)	6 (20)	27 (30)
	Soil infertility	7 (23)	11 (37)	9 (30)	27 (30)
	Seawater intrusion	4 (13)	2 (7)	2 (7)	8 (9)
Contributing factors of CC	Low rainfall	7 (23)	9 (30)	12 (40)	28 (31)
	High temperature	9 (30)	11 (37)	7 (23)	27 (30)
	Sea level rise	6 (20)	2 (7)	3 (10)	11 (12)
	Drought	8 (27)	8 (27)	8 (27)	24 (27)

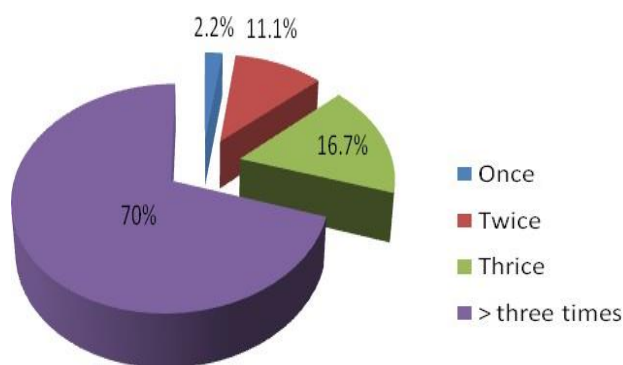


Figure 12. Duration of climate change effects in Micheweni District, Pemba Island, Tanzania

Information sharing on climate change impacts in the district

Most of the interviewed respondents reported that for the last 10 years, the District did not formulate any information network among Shehia leaders, agricultural extension officers and district officials to convey alert messages whenever climate change impacts and disaster reports were revealed from Tanzania Meteorological Authority (TMA). This lack of reliable information systems and networks created ill coordination among officials and farmers as they were unable to gain the required information in time and hence farmers invested energy to prepare their fields for cropping for nothing. Table 13 shows that about 83.3% of the surveyed respondents commented on the poor information system that existed in the District with 35% support from Majenzi community and therefore exposing community agricultural activities open to climate change impacts. Besides the problem of community missing timely and reliable climate change information, no injuries and /or deaths were reported during the past El Niño and tsunami disasters (Table 13).

Seawater rise and intrusion into community farms in the district

Findings of the study show that about 56% of the surveyed respondents in the area responded negatively against 44% who agreed on problems they face associated with seawater rise in their farms (Table 14). Rise in seawater has affected mostly the rice farms which are in lowland areas practiced by a few farmers compared to farmers of other crops whose farms are less affected by seawater. Repercussion of seawater rise was the increased salinity to rice farms, therefore, vacating the area for long time until the coming rainfall seasons to dilute excessive salts. The effect of seawater intrusion into farmers’ fields (rice) was claimed by 100% of the surveyed respondents as being source of decreasing yield in the crop production for years (Table 14).

Climate change adaptation strategies in Micheweni district

Strategies and limiting factors to adaptation

Climate change in Micheweni poses a lot of negative impacts to general agricultural production, contributing to decrease in crop production and threatening food security of the people. Prior to this situation, the community has

managed to apply reliable and sound strategies to overcome the problem. According to this study, various adaptation strategies were recommended by respondents aimed at eliminating or otherwise reducing the impacts to the extent that crop production in the District would be otherwise enhanced. About 20% of the respondents recommended the use of improved seeds as the most adaptation strategy followed by crop rotation/diversification (18%), the use of new crop varieties (18%), the adjustment of sowing dates (14%), fertilizer application (11%) and the use of mixed cropping (10%) among others.

In addition to adaptation strategies undertaken to combat climate change impacts, there were some limitations that hindered implementation of the steps taken by the community in the study area. These limitations include low-income levels of the community, fish/salt farming in mangroves, lack of appropriate skills and technology among farmers and lack of improved seed varieties (Table 15). Otherwise, government policy reforms could be given special considerations to climate change adaptation. Juana et al. (2013) on the other hand indicated barriers to climate change adaptations as being high cost of adaptation measures and population growth among Africa countries.

Another important adaptation strategy commonly and widely used by the community in the area involves planting of mangroves along farm banks to reduce impacts and speed of seawater to enter the rice farms during high tides (Figure 14).

In supporting the community efforts to combat impacts of climate change, the Revolutionary Government of Zanzibar (RGoZ) through Tanzania Social Action Fund (TASAF) supported the construction of 800 m long ridge at Ukele paddy farms as an adaptation strategy. This construction saved 49 hectares of paddy farms in the area costing 269 988 560 TZS; 150 000 000 TZS from TASAF and 119 988 560 TZS from RGoZ (Figure 15).

Table 13. Responses on information sharing in Micheweni District, Pemba Island, Tanzania (n=90)

Variables	Category	Responses			Av.Total (n=90)
		Micheweni (n=30)	Mjini wingwi (n=30)	Majenzi (n=30)	
Information sharing	Yes	5 (17)	6 (20)	4 (13)	15 (17)
	No	25 (83)	24 (80)	26 (87)	75 (83)

Table 14. Effects of seawater rise and intrusion in Micheweni District, Pemba Island, Tanzania (n=90)

Variables	Response Category	Responses			Av. Total (n=90)
		Micheweni (n=30)	Mjini wingwi (n=30)	Majenzi (n=30)	
Sea water rise	Yes	16 (53)	13 (43)	11 (37)	40 (44)
	No	14 (47)	17 (57)	19 (63)	50 (56)
Seawater intrusion yield	Increase	0 (0)	0 (0)	0 (0)	0 (0)
	Decreased yield	30 (100)	30 (100)	30 (100)	90 (100)

Table 15. Respondents views on climate change impacts and adaptation in Micheweni District, Pemba Island, Tanzania (n=90)

Variables	Response category	Responses			
		Micheweni (n=30)	Mjiniwingwi (n=30)	Majenzi (n=30)	Av.Total (n=90)
Adaptation Strategy	Crop rotation/diversification	8 (27)	3 (10)	5 (17)	16 (18)
	Use of improved seeds	3 (10)	8 (27)	7 (23)	18 (20)
	Fertilizer application	4 (13)	3 (10)	3 (10)	10 (11)
	Irrigation/community migration	3 (10)	2 (7)	2 (7)	7 (8)
	Use of indigenous crop species	0 (0)	1 (3)	0 (0)	1 (1)
	Adjustment of sowing dates	4 (13)	5 (17)	4 (13)	13 (14)
	Employing mixed cropping	3 (10)	3 (10)	3 (10)	9 (10)
	Use of new crop varieties	5 (17)	5 (17)	6 (20)	16 (18)
Limitation factors	Human population increase/growth	0 (0)	1 (3)	1 (3)	2 (2)
	Low income levels	10 (33)	8 (27)	7 (23)	25 (28)
	Lack of adequate arable land	1 (3)	2 (7)	1 (3)	4 (4)
	Cultural/traditional backgrounds	1 (3)	3 (10)	2 (7)	6 (7)
	Lack of appropriate skills and technology	3 (10)	5 (17)	5 (17)	13 (14)
	Lack of improved seed varieties	3 (10)	4 (13)	4 (13)	11 (12)
	Lack of alternative support	2 (7)	2 (7)	2 (7)	6 (7)
	Frequencies of crop disease outbreaks and pest Infestations	1 (3)	1 (3)	2 (7)	4 (4)
	Fish and salt farming	9 (30)	4 (13)	6 (20)	19 (21)

Low income level of the community is one of the big challenges towards climate change adaptation strategies in the district where people rush to engage themselves in non-environmental friendly activities. Illegal tree felling/fishing, charcoal and lime making are among the most IGAs practiced by the community to increase household incomes but, so far are exposed to environmental degradation. Although seaweed, fish and salt farming are legally permitted by the government for improvement of livelihoods, they are not friendly to environment. Fish and salt farming practices are characterized by clear-felling of several mangroves resulting in land left bare and exposed to severe environmental impacts (Figure 16).



Figure 14. Adaptation strategies of seawater rising through mangrove planting



Figure 13. Paddy plot vacated by farmers due to seawater intrusion



Figure 15. Adaptation strategy of climate change through ridge construction at Ukele, Micheweni District, Pemba Island, Tanzania



Figure 16. Salt farms contribute severe cutting of mangroves in Micheweni District, Pemba Island, Tanzania

Adjustments against climate change adaptation barriers

To employ proper adjustments against climate change adaptation barriers, 30% of respondents’ suggestions were directed towards construction of dikes (ridging) along farm boundaries, 27% establishment of tree-planting programs, 18% employed awareness and sensitization programs, and 11% adjusted planting times plus protection of existing community and natural forests (Table 16). Tree planting programs are expected to reduce community future firewood and building poles shortages while awareness and

sensitization programs could raise community understanding on climate change education (Table 16).

Nevertheless, these adjustment efforts were constrained by a number of factors as reported by the respondents. Most of the constraints claimed by all respondents in the area involved inadequate working facilities, human population growth and lack of cohesion and unity among community members. Other constraints to adaptation involved inadequate cropping/environmental skills and illiteracy (Majenzi), deliberate uprooting of transplants and absence of strong by-laws within the community (Mjini wingwi), and low income levels and unavailability of improved seeds among farmers as reported by Micheweni village (Table 17).

Assisting institutions to climate change victims

Results from this survey showed that for the last 10 years in the district the community has suffered a lot from various impacts, especially those associated with climate change. Nonetheless, no reliable contributions towards the impacts were provided to help the affected families. Only 36% of respondents responded to have been provided with sorts of assistance as compared to 64% who completely denied receiving any type of assistance during climate change impact occurrences (Table 18). Mostly, the types of assistance provided were in the form of funds by 57%, foodstuff (23%), seeds (17%), and inorganic fertilizers (3%) originating mainly from relatives, government institutions, and NGOs/CBOs (Table 18).

Table 16. Adjustment responses on climate change adaptation barriers in Micheweni District, Pemba Island, Tanzania (n=90)

Variables	Category	Responses			
		Micheweni (n=30)	Mjini wingwi (n=30)	Majenzi (n=30)	Av. total (n=90)
Adjustments	Change of the cropping pattern	0 (0)	2 (7)	0 (0)	2 (2)
	Ridging	15 (50)	7 (23)	5 (17)	27 (30)
	Tree planting programs	5 (17)	8 (27)	11 (37)	24 (27)
	Use of organic fertilizers	0 (0)	0 (0)	1 (3)	1 (1)
	Awareness and sensitization programs	5 (17)	7 (23)	4 (13)	16 (18)
	Protection of existing forests	2 (7)	2 (7)	0 (0)	4 (4)
	Use of different sectoral laws enforcement	1 (3)	3 (10)	2 (7)	6 (7)
	Adjusting planting times	2 (7)	1 (3)	7 (23)	10 (11)

Table 17. Constraining factors to climate change adaptations in Micheweni District, Pemba Island, Tanzania (n=90)

Variables	Response factors	Responses			
		Micheweni (n=30)	Mjini wingwi (n=30)	Majenzi (n=30)	Av. total (n=90)
Constraints	Inadequate cropping/environmental skills	5 (17)	8 (27)	12 (40)	25 (28)
	Inadequate working facilities	7 (23)	7 (23)	7 (23)	21 (23)
	Deliberate uprooting of transplants	1 (3)	3 (10)	1 (3)	5 (6)
	Human population growth	1 (3)	1 (3)	1 (3)	3 (3)
	Lack of cohesion and unity among community members	2 (7)	2 (7)	2 (7)	6 (7)
	Low-income levels	8 (27)	6 (20)	2 (7)	16 (18)
	Absence of by-laws	1 (3)	1 (3)	0 (0)	2 (2)
	Illiteracy	1 (3)	2 (7)	3 (10)	6 (7)
	Unavailability of improved seeds	4 (13)	0 (0)	2 (7)	6 (7)

Table 18. Type and source of assistance to households in Micheweni District, Pemba Island, Tanzania (n=90)

Variables	Category	Responses			Av. total (n=90)
		Micheweni (n=30)	Mjini wingwi (n=30)	Majenzi (n=30)	
Assistance	Yes	14 (47)	7 (23)	11 (37)	32 (36)
	No	16 (53)	23 (77)	19 (63)	58 (64)
Type	Funds	23 (77)	16 (53)	12 (40)	51 (57)
	Food	7 (23)	7 (23)	7 (23)	21 (23)
	Seeds	0 (0)	7 (23)	8 (27)	15 (17)
Origin	Inorganic fertilizers	0 (0)	0 (0)	3 (10)	3 (3)
	Not applicable	18 (60)	15 (50)	13 (43)	46 (51)
	Government	3 (10)	3 (10)	9 (30)	15 (17)
	NGOs/CBOs	3 (10)	0 (0)	1 (3)	4 (4)
	Relatives	6 (20)	12 (40)	7 (23)	25 (28)

Table 19. Food shortages in Micheweni District, Pemba Island, Tanzania (n=90)

Variables	Category	Responses			Av. total (n=90)
		Micheweni (n=30)	Mjini wingwi (n=30)	Majenzi (n=30)	
Relationship	Increase	0 (0)	0 (0)	0 (0)	0 (0)
	Decrease	30 (100)	30 (100)	30 (100)	90 (100)
Food shortage status	Yes	28 (93)	30 (100)	30 (100)	88 (98)
	No	2 (7)	0 (0)	0 (0)	2 (2)
Shortages factor	Drought	8 (27)	9 (30)	14 (47)	31 (34)
	Low rainfall	11 (37)	9 (30)	7 (23)	27 (30)
	High temperatures	9 (30)	11 (37)	8 (27)	28 (31)
	Others	2 (7)	1 (3)	1 (3)	4 (4)

Climate change impacts crop production and food shortages

The findings show that 100% and 98% of all respondents claim decrease in crop production and food shortages for the last 10 years respectively (Table 19). According to the respondents, the causes of this food shortage in the District are mostly drought, high temperatures and low rainfall. Other causes mentioned include lack of agricultural inputs, technology and improved seed (Table 19).

Focus Group Discussions (FGD) and Key Informants

Information from these groups was gathered through formal and informal discussions using a checklist (Appendix 2 and 3) involved District extension officers (environment, fisheries and agriculture), village government leaders (Shehas), conservation clubs and some village influential people. Reports from group discussions showed that all members have lived in the area for more than 45 years with long experiences on climate change and its impacts where 100% of the respondents reported the decrease of agricultural crop production for the last 10 years in the District. With regard to climate change impacts, it was observed that 98% and 96% of the respondents admitted the presence of low rainfall and high-temperature trends respectively, while 98% of the respondents claimed food production decrease.

Furthermore, the results indicated that 80% and 100% of the FGD respondents reported decrease in rainfall and increase in temperature respectively, associated with

prolonged drought periods and food shortages for the last 10 years in the District. To solve the problem of food shortages, 93% of the respondents proposed fertilizer application as the best option against the use of disease-resistant seeds, use of crop rotation and use of crop mixes.

As it was shown in the discussion in the case of food shortages, for those who were given such assistance, 91% of them admitted to get assistance from government sources and their relatives. It was found that all of the respondents were, in one way or another affected by climate change in crop production and 56% highlighted tree planting as a means to overcome the impact followed by ridge/wall construction around seashores or cropping sites bordered by sea. With respect to early warning alerts during climate change disasters, 51% of the respondents admitted to get reliable information from the media as opposed to 49% who completely refused to get any early warning information and from nowhere. Those who acknowledged getting such information on climate disasters realized their roles of reporting such information to their village leaders and agricultural officers and sharing the knowledge and experiences among others for further considerations.

Conclusion

Extended periods of high temperatures and low rainfall were found to cause major climate impacts to crop production in Micheweni District resulting into food insecurity. Drought periods associated with crop pests and diseases, land infertility, uneven rainfall distribution and

seawater intrusion in farmers' plots were claimed as major causes of decreasing food production, disappearance and death of some important food crops in the District.

There is no strong correlation between climate factors and crop production in the District and this can be due to other factors that were not considered during data collection. Factors like higher price of fish catch and provision of improved fishing gears could have increased fish production without considering impacts of sea waves and high currents as a result of changing climate.

Apart from being limited by other factors, various climate change adaptation strategies were suggested by community to minimize and/or otherwise eliminate climate change impacts to the extent that crop production in the District would be enhanced. The use of improved seeds and new crop varieties, crop rotation practice and diversification, adjustment of sowing dates, mixed cropping and fertilizer application were a priority. However, these communities are lacking a strong organization to distribute climate change information to them when need occurs. Community initiatives through government support so far have been directed toward ridge construction and mobilizing community through tree planting among the strategies, though fish and salt farming constrain the adaptation efforts.

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