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RESEARCH ARTICLE

SOCIAL VULNERABILITY OF CLOVE FARMERS TO IMPACTS OF CLIMATE CHANGE AND VARIABILITYIN PEMBA ISLAND, ZANZIBAR, TANZANIA

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ABSTRACT

Clove industry supports significantly Zanzibar economy and leading sector for foreign exchange earning in Zanzibar. The objective of this study was to examine social vulnerability (exposure, sensitivity, and adaptive capacity) of the clove farmers in Pemba Island to the impacts of climate change and variability. The study covered four districts of Pemba Island (Mkoani, Chakechake, Wete and Micheweni). The livelihood vulnerability index (LVI) and LVI-IPCC scores were used to assess components of vulnerability of the households. A total of 360 households were surveyed during this study. The main assessed parameters were socio-demographics profile, livelihoods, social networks, health, food and water security, natural disasters and climate variability and energy resources. The overall LVI index for Mkoani, Micheweni, Wete and Chake chake were 0.5261, 0.5148, 0.5061, and 0.5016 respectively. Likewise, LVI-IPCC scores were 0.0770, 0.0729, 0.0602 and 0.0269 for Micheweni, Mkoani, Chake chake and Wete districts, respectively. The results showed the sources of vulnerability differed within and between the four districts. The overall LVI-IPCC scores indicate that the level of vulnerability varies the sampled districts based on the degree of the dependence of clove industry for their socioeconomic activities.

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INTRODUCTION

Agriculture accounts for almost 30% of Zanzibar gross domestic product (GDP), provides 70 % of all exports and saves as a livelihood to over 70 percent of the total population. The country depends on limited agricultural commodities such as spices, seaweed and cloves for export (ZRA, 2015). Clove industry is the major source of foreign exchange in Zanzibar. It contributes over $11million annually to Zanzibar's economy (ZSTC, 2011). Nevertheless, in the past four-decade, they have been a steady decline in clove production from 16,000 tons in 1970's to about 3500 tons in the 2010s (Ali *et al*., 2011). Diseases and climate change and variability are considered as major sources of clove production decline in Zanzibar (Dabek, and Martin, 1987). Climate change poses a major threat to sustainable development because adverse effects are likely to be directed particularly at poor population (Sheikh *et al.,* 2011). The impact of climate change such as heat waves, floods and drought, increased surface temperatures may have potential consequences on agricultural production such as clove plantation ecosystems (Olesen and Bindi, 2002).

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There are also concerns that flooding, drought and environmental degradation associated with climate change may lead to population displacement and more environmental refugees (Haines *et al*., 2006). In addition, Climate change is also likely to affect biodiversity and the ecosystem goods and services that we rely on for our daily living (Haines *et al*., 2006). However, farmers can reduce the potential damage and risk brought about by climate change through tactical responses to these changes (Hassan and Nhemachena, 2008). The adaptation strategies taken by clover farmers, researchers and government include: irrigation varying clove plantation from lowland to the valley; shading and shelter young clove trees, and prohibit the cutting clove trees. The main question remained how stakeholders of the clove industry will adapt to climate change impacts. Despite, many researches on social vulnerability to disasters, global environmental change, famine, and poverty have been conducted; few studies have examined the social vulnerability in the context of climate changes specific to agricultural ecosystems (Adger *et al*., 2003). Vulnerability is the degree to which a system is susceptible to, and unable to cope with, the adverse effects of a chronic or stochastic disturbance (IPCC, 2007). Hence, vulnerability to environmental change across spatial and temporal scales for different people within society, do affects more poor and

migrants (Bene, 2009). In the context of agricultural-dependent societies, understanding the potential impacts of climate change and society's capacity to adapt changes requires analysis on combination of conditions (economic, environmental and social). That contributes to vulnerability, and characterizing locations and segments of society that are most vulnerable (Hahn *et al.,* 2006).

Moreover, several research frameworks have been developed to examine how vulnerable societies to environmental change. The three main components of vulnerability are; (1) exposure; (2) sensitivity; and (3) adaptive capacity (IPCC, 2007). Exposure can be defined as the direct danger/stressor, where the nature and extent of changes to a region's climate is due to variation of temperature, precipitation, and extreme weather events (Adger, 2006). Sensitivity, in the context of environmental change, is the state of susceptibility to harm from perturbations or long-term trends (Adger, 2006). While, Adaptive capacity is described as a latent characteristic that reflects peoples' ability to anticipate and respond to changes, to minimize, to adopt, and recover from the consequences of change (Adger *et al*., 2005). It is quietly known that people with low adaptive capacity, such as low income, uneducated and environmental migrant are found to be difficult to adapt to changes brought about by climate alterations, thus unwilling to take advantage of the opportunities created by change (Adger, 2000). There is very limited information regarding to the social vulnerability regarding to the impacts of climate change in agricultural systems including the clove industry. The objective of this study therefore was to examine vulnerability (exposure, sensitivity, and adaptive capacity) of clove farmers in Pemba Island to the impacts of climate change and variability and recommend ways to mitigate the effects of climate change on clove farmers. The study was mainly focus on how clove growers, government, researchers, donors, and policy makers and those consider policy actions at different horizontal and vertical dimensions to reduce different aspects of the vulnerability of clove famers to key impacts of climate change on clove industry context.

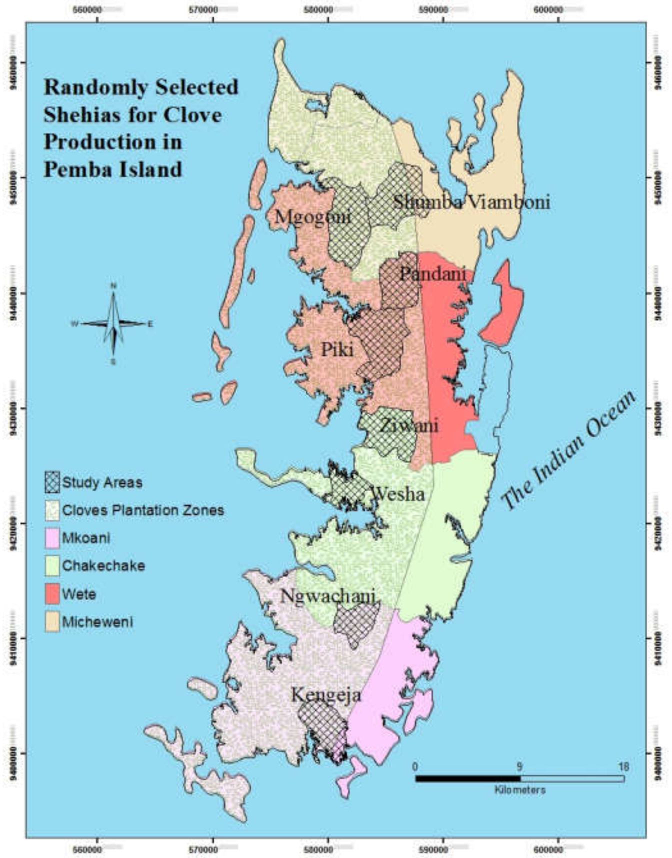
MATERIALS AND METHODS

Study area

The study was conducted in selected Shehia in the four main districts of Pemba Island (Mkoani, Chakechake, Wete and Micheweni) as shown in Figure 1.

Data collation and analysis

Socioeconomic data were collected from eight Clove zone communities, which were derived from four districts (Micheweni, Wete, Chake Chake and Mkoani) in Pemba Island (Fig. 1). Sites were selected within districts in random sampling on the based on Clove plantation zone. This type of purposive sampling of communities is an appropriate strategy for exploratory studies (Agrawal, 2001). For each village we obtained data on: (1) exposure, (2) sensitivity; and (3) adaptive capacity, based on socioeconomic surveys as conducted. Beside, the Livelihood Vulnerability Index (LVI) and LVI-IPCC scores were used to assess components of vulnerability of the households. The components were categorized into eight (8) different major components; Socio demographic (DS), livelihood strategies (LS), social network (SN), food (F), health (H), water (W), natural disaster and climate variability (NDCV), and energy resource (E).



To collect comprehensive information on vulnerability several sub-components were used as indicators under each major component. The LVI index was calculated by using a balanced, weighted average approach, each sub-component contributes equally to the overall index though each major component. Each sub-component was measured on different scale and standardized as index using equation.

$$index_{sd} = \frac{Sd - Smin}{Smax - Smin} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots.(1)$$

Where, Sd is the original sub-component, *S* min and *S* max are the minimum and maximum values, respectively, for each sub-component.

The livelihood vulnerability (LVI) was calculated using the equation below:-

$$LVI_s = \frac{\sum_{i-1}^{8} W_{M}{}_i M_{si}}{\sum_{i-1}^{8} W_{Mi}} \quad \text{--}(2)$$

Where, LVIs is the Livelihood Vulnerability Index for household and equals the weighted average of the eight major components; *Wmi*, are the weights of each major component, determined by the number of sub-components, *Msi*, that make up each major component were included to ensure that all sub-components contribute equally to the overall LVI (Hahn *et al*., 2009).

LVI can also be calculated using equation below:-

$$LVI = \frac{WsdpSDPs + WlsLSb + WsnSNb + WhHb + WwWb + WncWb + WnbWb}{Wsdp + Wls + Wsn + Wh + Wf + Ww + Wnc + Wnd} \ldots 3$$

According to Sullivan, (2002) the LVI is scaled from 0 (least vulnerable) to +1 (most vulnerable).

On the other hand, the LVI- IPCC was calculated as follows:-

$$CF_s = \frac{\sum_{i=1}^{n} W_{mi}\, M_{di}}{\sum_{i=_1}^{n} W_{mi}} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (4)$$

Where, CFs is the IPCC-defined contributing factor (exposure, sensitivity, or adaptive capacity) for each district, Mdi are the major components for a districts' s indexed by i, *Wmi* is the weight of each major component, and n is the number of major components in each contributing factor. Once exposure, sensitivity, and adaptive capacity were calculated, the three contributing factors were combined using the following equation:

LVI-IPCC = (ES-AS)*SS……..... (5)

or

LVI-IPCC = (Exposure – Adaptive capacity)*Sensitivity.

Where, LVI–IPCCS is the LVI for a district expressed using the IPCC vulnerability framework. Es, is the calculated exposure score for districts (equivalent to the natural disasters that have occurred in the past 6 years, while climate variability is measured by the average standard deviation of the maximum and minimum monthly temperatures and monthly precipitation over a 6-year period. and energy resources major components As, is the calculated adaptive capacity score for district (weighted average of the socio-demographic profile (e.g., percent of female-headed households), livelihood strategies (e.g., predominately agricultural, or also collect natural resources to sell in the market),, and social networks major components(e.g., percent of residents assisting neighbors with chores), and SS, Sensitivity score for districts is the calculated, weighted average of the heath, food, and water major components. The used scale were the LVI–IPCC from -1 (least vulnerable) (most vulnerable) (Hahn *et al*., 2009).

RESULTS AND DISCUSSION

The results and analysis assessment of vulnerability of households involved in clove production and the spatial variations of the districts in term of vulnerability were analyzed and presented in this paper.

Livelihood vulnerability index (LVI) and LVI-IPCC Scores.

The Livelihood vulnerability index (LVI) and LVI-IPCC for Micheweni**,** Wete, Chakechake and Mkoani districts are shown in Table1 below:-

Comparison of LVI between Micheweni, Wete, Chake Chake and Mkoani

Household demographic information

The results of sub-components and major components are shown in (Table 1) for the SDP index, the result showed that Wete district had relatively high vulnerability (0.355) compared to other districts Mkoani (0.351), Chake chake (0.349) and Micheweni (0.310). On the other hand, the dependency ratio index, results showed Micheweni had a higher ratio (0.63) followed by Wete and Chake chake which had the same ratio (0.58), while Mkoani had 0.56. Furthermore, the index for female-headed households was lower in Mkoani (0.10) and slightly increased for Wete (0.15), Chake Chake (0.16), and Micheweni (0.20). The literacy level in the household was higher in Micheweni district (0.19) and lower in Wete (0.10), while Chake Chake Mkoani was 0.12, and 0.16 respectively. The results indicate that the households have less vulnerability in term of education. Similar study conducted by Moyo (2013) in Zanzibar found that Mtetema and Mahonda vulnerability index for rice farmers were 0.05 and 0.22, respectively. In addition, education level considered an important factor for the livelihood to adapt to the climate change variability. The present findings showed why household in Mkoani and Micheweni districts were more vulnerable than those in Wete and Chake Chake. Comparable findings were reported by Mhinte (2000) that education increases working efficiency and productivity and making households with more educated to benefit in terms of food and income.

Livelihood strategies

Various literature show that the livelihood strategies for the households vary greatly from place to place due to knowledge and experience adaptation to climate change impacts. The livelihood strategy include growing crops, raising animals, collecting natural resources such as timber and family member(s) migrate to another places. In this study, the results showed that the overall livelihood strategies component was high in Micheweni (0.40) or more vulnerable than other districts like Mkoani (0.18), Wete (0.16) and Chake Chake (0.15). Furthermore, significant portion of farmers in Micheweni and Mkoani districts highly depend only on agriculture such as food crops and clove production for their daily livelihood. The agriculture dependency ratio was 0.56, 0.11, 0.08 and 0.06 for Micheweni, Mkoani, Wete and Chake Chake, respectively. However, the average overall agricultural livelihood diversification index for both districts was the same 0.25. The findings revealed that both districts were less vulnerable to climate change in comparison to Zanzibar Stone Town, Kizingo and Buyu which had adaptive capacity of 0.43, 0.43 and 0.37 respectively (Cinner *et al*., 2011). The study also found the households depend on clove production were more affected than those produced food crops they have the extra advantage by earning money from selling other commodities such as coconuts, fruits and vegetables among other crops.

Social Network (SN)

The result of a SN indicator of the four districts is shown in (Table 1). The vulnerability index for SN was low in Micheweni (0.361) and gradual increased in Mkoani, Chake Chake chake and Wete 0.432, 0.451 and 0.590 respectively. The result also showed that over 90% of the households in all districts had not sought any assistance from their respective local governments in the past 12 months. This demonstrates that households in all districts were more vulnerable because they had not received any kind supports from their local government. Likewise, the study found few households were members of Saving and Credit Cooperative (SACCOS) in Chake Chake, Micheweni, and Mkoani 0.35, 0.37, and 0.38 respectively as compared to Wete which were most vulnerable of SACCOS members (0.77). Moreover, households in all districts reported receiving more in-kind assistance from family, friends and other relative who are living outside Zanzibar.

Table 1. Indexed of sub-components and major components for Micheweni, Wete, Chake Chake and Mkoani districts

	INDEX								
Sub components	DM	DW	DC	DMK	Major components	DM	DW	DC	DMK
Dependents ratio	0.63	0.58	0.58	0.56	Socio-demographic profile	0.310	0.355	0.349	0.351
Percent of female-headed households	0.20	0.15	0.16	0.10					
Average age of female head of household	0.26	0.60	0.56	0.55					
Percent of households where head of HH not attended to school	0.16	0.10	0.12	0.19					
Average Agricultural Livelihood Diversification Index (range: 0.20–1)a	0.25	0.25	0.25	0.25	Livelihood strategies	0.403	0.163	0.153	0.182
Percent of household depends only in agriculture	0.56	0.08	0.06	0.11					
Percent of households that have not gone to their local government for assistance in the past 12 months	0.93	0.97	0.95	0.95	Social network	0.361	0.590	0.451	0.432
Percent of households where not member of SACCOS/VIKOBA	0.37	0.77	0.35	0.38					
Percent of households receive support from relative out of Zanzibar	0.24	0.32	0.29	0.26					
Percent amount (Tsh.) earned from trades year 2011	0.13	0.68	0.48	0.44					
Percent amount (Tsh.) earned from other sources year 2011	0.15	0.22	0.20	0.15					
Average distance to health centre	0.67	0.11	0.30	0.40	Health	0.254	0.158	0.345	0.248
Percent of households with family member with chronic illness	0.25	0.24	0.20	0.16					
Percent of households where a family member had to miss work or school in the last 2 weeks due to illness	0.09	0.02	0.25	0.27					
Average malaria exposure*prevention index	0.02	0.27	0.33	0.17					
Average number of months households struggle to find food	0.75	0.83	0.85	0.80	Food	0.538	0.615	0.482	0.642
Percentage of households who save the money from clove	0.44	0.65	0.43	0.68					
percentage of households that most get money from clove	0.58	0.78	0.62	0.75					
Percentage of households that most get seed from government	0.18	0.25	0.17	0.20					
Percentage of family get most of its food from its own farm	0.75	0.57	0.35	0.80					
Average distance taken to water source	0.40	0.20	0.20	0.30	Water	0.377	0.249	0.386	0.377
Average number of liters of water stored per household	0.40	0.66	0.62	0.52					
Percentage of household do not have consistent water supply	0.87	0.14	0.80	0.88					
Percent of HHs that collect water directly from river, pond and streams	0.05	0.02	0.04	0.07					
Percent of households reporting water conflicts	0.17	0.24	0.28	0.13					
Average number of flood, drought, and events in the past 30 years	0.30	0.43	0.45	0.40	Natural disaster and climate variability	0.380	0.351	0.397	0.387
Percent of households that did not receive a warning about the pending natural disasters	0.81	0.46	0.81	0.76					
Percent of households injured during the recent climate disasters	0.03	0.03	0.02	0.02					
Percent of households reporting death during the recent climate disasters	0.01	0.02	0.01	0.01					
Percent of HHs reporting land degradation by climate related extremes during past 30 years	0.98	0.95	0.97	0.98					
Mean standard deviation of daily mean average maximum temperature by month	0.28	0.28	0.28	0.28					
Mean standard deviation of daily mean average minimum temperature by month	0.14	0.14	0.14	0.14					
Mean standard deviation of daily precipitation by month	0.49	0.49	0.49	0.49					
Percent of HHs using only Forest-based energy for cooking purpose	0.96	0.86	0.79	0.97	Energy resources	0.869	0.871	0.759	0.810
Average distance/time to fetch firewood	0.90	0.75	0.45	0.50					
Percent of HHs reporting that firewood is being scarce now in comparison to 30 years back	0.65	0.71	0.83	0.78					
Percent of HHs using traditional cooking stoves	0.97	0.91	0.94	0.95					

Table 2. Overall LVI index for four main districts

District	LVI
Micheweni	0.5148
Wete	0.5061
Chake chake	0.5016
Mkoani	0.5262

Table 3. LVI–IPCC contributing factors calculation for Micheweni, Wete, Chake Chake and Mkoani Districts, Pemba Island (IPCC, 2001)

PCC contributing factors to vulnerability	Micheweni	Wete	Chake	Mkoani
Exposure	0.5432	0.5032	0.5151	0.5248
Adaptive	0.3502	0.4272	0.3595	0.3571
Sensitivity	0.3992	0.3537	0.3869	0.4347
LVI-IPCC	0.0770	0.0269	0.0602	0.0729

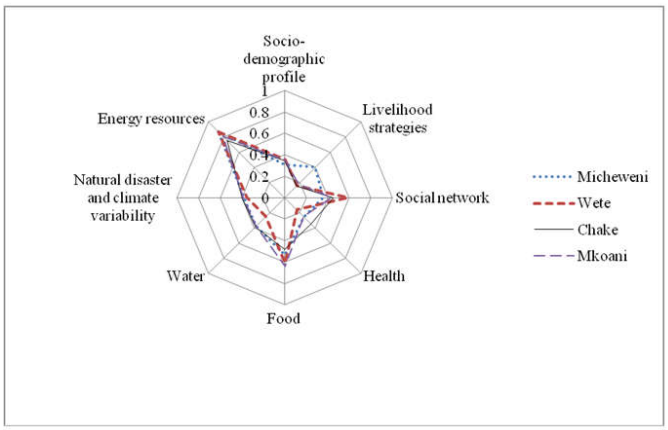


Figure 2. Vulnerability spider diagram of the major components of the livelihood vulnerability index for districts (Micheweni, Wete, Chake Chake and Mkoani)

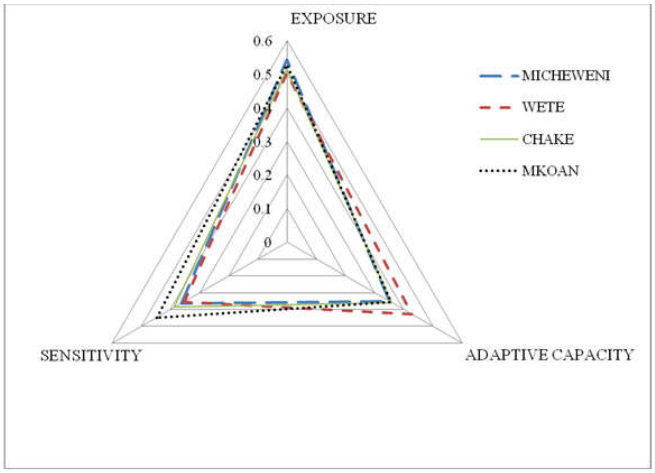


Figure 3. Triangle diagram show exposure, adaptive and sensitivity for Micheweni, Wete, Chake chake and Mkoani districts

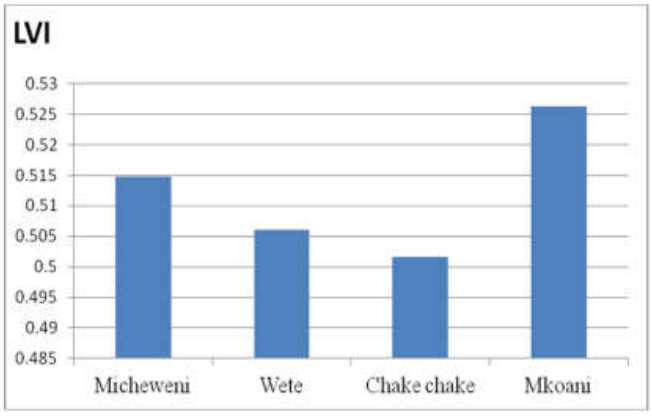


Figure 3. The graph show the overall LVI index of four districts

The study found that households in Wete were slightly better (0.32) than other districts Chake Chake (0.29), Mkoani (0.26), Micheweni (0.24). As found by Hahn *et al*. (2008) that the socio-network activities borrowing money and receiving assistance, seeking assistance from government are good indicators to measure of the degree to which households rely on family and friends for financial assistance. Furthermore, the result showed that the average amount of income in Wete households earned from other sources were more than other districts. This might contributed by many households in Wete have other income generating activities such as small-scale industry and small business activities.

Accessibility of health services and health assessment

For the health care services, the result showed that Micheweni households travel an average of 1.5km (VI= 0.67) for health service centers, while Mkoani, Chake Chake, and Wete are 0.9km (VI=0.40), 0.8km (VI=0.30), 0.2km (VI=0.11), respectively. Likewise, the result showed that Micheweni and Wete have higher vulnerability indexes (0.25) and (0.24) in terms of chronic diseases, respectively, whilst slightl lower in Chake Chake (0.16) and Mkoani (0.20). The study found higher vulnerability index for off-sick households in Mkoani (0.27) and Chake Chake (0.25) and relatively low for Wete (0.02) and Micheweni (0.09). The results suggest that the households of Chake Chake, and Mkoani were more vulnerable than those of Micheweni and Wete. In addition, the results of malaria prevalence showed that the vulnerability index was higher in Chake Chake (0.33) followed by Wete (0.27), Mkoani (0.17) and Micheweni (0.02). Also, the result showed that the overall health vulnerability score were 0.158, 0.248, 0.254 and 0.345 for Wete, Mkoani, Chake Chake, and Micheweni, respectively. These findings suggest that diseases prevalence for example malaria may have a negative impact on social income. Also, the distance from households to health centre facilities might be additional reason for vulnerability. For instance, the higher health vulnerability index for Micheweni is related to relative long distance covered by households to receive health services. This is concurred with the study of Mtei and Borghi (2010) who reported that the poorest segment of the population received less health care benefits relative to their need, whereas other population segments receive a greater share of benefit relative to their needs.

Food

The study found that the vulnerability index of households to find adequate food for their families was very high in Chake Chake (0.85) and Mkoani (0.80) compared to Micheweni (0.75) and Wete (0.83). The result also showed that 68% and 65% of the households in Mkoani and Wete, respectively saved their money from clove and spent food compared to 44% in Micheweni and 43% in Chake Chake. In addition, the percentage of households solely relying on their farm for food consumption were 80 % for Mkoani, 75% for Micheweni, 57% for Wete and 35% for Chake Chake. Furthermore, the result indicated that 75% of households in Wete did not get clove seedling from the government compared to Micheweni (82%), Chake Chake (83%) and Mkoani (80%). The overall food vulnerability score for Mkoani and Wete districts were very high (0.642), and (0.615) compared to Micheweni (0.538) and Chake Chake (0.482), respectively. In addition, insufficient rainfall for planting Clove trees in both districts caused people

to move from the upland area to the valley in order to follow the water resources and some of them relied on others social economic activities such as agricultural activities like food crops and vegetables production. These were mitigating strategies for the effect of climate change and variability in these districts. According to Benjamin *et al*. (2012) achieving food security requires that the aggregate availability of physical supplies of food is sufficient, that households have access to those food supplies through their own production. Also, through the markets or through other sources and that the utilization of those food supplies is appropriate to meet the specific dietary needs of individuals in their households.

Water resources

The results showed that the overall vulnerability scores for water component was low in Wete (0.249) compared to Chake Chake (0.386), Micheweni (0.377) and Mkoani (0.377). Likewise, the result also showed that over 86% of the households surveyed in Wete reported to have a consistent public water supply. On the other hand, 87 % of household in Micheweni, 80% in Chake Chake and 88% in Mkoani had reported unreliable water supply from the public water Authority. The main waters sources were shallow ponds, community owned wells or boreholes. As adaptation strategy, Wete district households stored of water on average 155.5 L compared to Chake Chake, Mkoani and Micheweni districts who stored on average 148.5L,132.5L and 113.5L, respectively. Similarly, the study found a large portion of population had no puplic water access,while others walk relatively long distance to receive public waters services. For instance, household walk on average of 0.9 km and 0.8km for Micheweni and Mkoani districts, respectivelywhile for for Wete and Chake chake the distance is approximately 0.7 k m.

Natural disasters and climate variability

Natural disaster and climate variability is the major component of vulnerability. This includes several sub-components as shown in Table 1.The result showed that, the percentage of households who did not receive warnings about the pending natural disasters vary greatly from district to district. Micheweni and Chake Chake had the same percentage on not receiving climate related warnings (81%). However, lower percentage was reported for Mkoani and Wete, 76% and 46% respectively. In terms of Vulnerability Index the values were 0.81, 0.76, 0.81 and 0.46 for Micheweni, Wete, Chake Chake and Mkoani, respectively. However, the number of households reported a disaster-related injury or death was relatively very low. According to Hahn *et al*. (2008) the early warning systems and community preparedness plans may help communities to prepare for extreme weather events. Similarly, seasonal weather forecasts may help farmers to time their plantings and prevent diversion of scarce water resources for irrigation as well as disaster preparedness (Hahn *et al*., 2009). The both districts havd higher vulnerability index 0.98, 0.98, 0.97 and 0.95 for Micheweni, Mkoani, Chake Chake and Wete, respectively. The higher vulnerability may be due to land degradation. According to Mudzonga (2011) if a farmer is exposed to information on climate change, then his/her probability of adaptation to climate change increases by about 44%. This implies that more climate change information dissemination through extension services, weather reports and other channels would increase the likelihood of farmers' adaptation to climate change (Komba and Muchapondwa, 2009). Likewise, Hassan and Nhemachena (2008) reported that information on climate change significantly influences farmers' adaptation choices. The present results showed no significant difference in the overall LVI index. The LVI index for Chake Chake, Mkoani, Micheweni and Wete were 0.397, 0.387, 0.380 and 0.351, respectively. This implied that all districts had relatively high vulnerability to climate change impacts and could contribute clove production decline in the districts.

Energy Resources (ER)

The overall LVI score for the energy resources component is shown in Table 1. The result shows ER for all districts were 0.869, 0.871, 0.810 and 0.759 for edicheweni, Wete, Mkoani and Chake Chake, respectively. This contributed to the fact that all households were totally depended on forest-based energy (firewood) as a source of energy for cooking. Mkoani and Micheweni were the highest with 97.3% and 96%, respectively. While Wete and Chake Chake were 85.5% and 78.5%, respectively. In addition, the result showed that Micheweni and Wete households walk long distance to fetch firewoods, an average distance of about 2.5 and 2 km, respectively. For Mkoani households walk about 1.5 km and 1.4 km for Chake Chake. These means communities in Micheweni and Wete were more vulnerable in terms of ER compared to Mkoani and Chake Chake. Furthermore, the study also found around 95% of households in all districts were using traditional stoves for cooking. However, most of the stoves were inefficient and stressed more pressure on forest and cutting down more trees for firewood. In the near future, unless the stringent alternative measures considered, most of the forests in the studied districts will be over threatened which likely may causeenergy crisis. The vast majority of rural people in the third world depend on traditional fuel such as wood, dung and crop residues, often using primitive and inefficient technologies (Masekoameng *et al.,* 2005). Hence, while energy is one of the basic requirements for human life, most of the rural people do not have enough access to efficient and affordable energy sources as reported by the (World Energy Council, 1999) and these remain as a main challenge of rural energy poverty in developing countries.

The LVI-IPCC scores range between -1 to +1. The -1 score indicated least vulnerable and +1 indicated the most vulnerable (Hahn *et al*., 2009). In other words, when LVI-IPCC has positive score, it means a household is more exposed to natural disaster and climate variability than the capacity to adapt or overcome these adverse situations. When the score of LVI-IPCC is negative, it means a household is less exposed to natural disaster and climate variability. Our results showed that the most vulnerable districts blocks were Micheweni (0.0770) and Mkoani (0.0729) because of more sensitivity and less adaptive capacity, compared to Chake Chake (0.0602) and Wete (0.0269) (see Table2). The overall LVI-IPCC scores indicate that households in Wete were less vulnerable than other districts because of better adaptive capacity (0.43) and less sensitivity (0.35).

Moreover, the study also found Wete district as the least vulnerable District despite being severely exposed to climate change stress in comparison to other Districts. The other Districts lack basic facilities and thus why were more vulnerable because they have less capability to recover. However, in all the Districts have comparable exposure; most of the households still depend on natural capital for their livelihood. It means that the livelihood of households living

below the poverty line is controlled and regulated by the nature. Infertility and dispossession of land as well as dependency on rain fed agriculture have made the situation to be worse. Furthermore, unskilled labors are left with no opportunities to earn, and hence, migrate to other areas. The outmigration of people in order to earn a wage helps them to sustain their livelihood. Social ties facilitate the process of migration (Bird and Deshingkar, 2006) but for the poor it is difficult to migrate without any network or support. Social capital plays an important role in migration and features in all Districts, which helps in recovery of households.

Conclusion

The study has assessed clove famers vulnerability to the effect of climate change and variability. The overall, livelihood vulnerability index indicated that household's vulnerability was attributed mainly by food insecurity and limited access to cooking energy. However, when a comparison is made on the vulnerability between Micheweni, Wete, Chake Chake and Mkoani households, Wete was found to be least vulnerable. The overall LVI-IPCC scores indicated that households in Wete are comparatively less vulnerable than other Districts because of better adaptive strategy and less sensitivity. When the climate change factor is brought into the equation, the social vulnerability of all households appears to be higher for Micheweni and Mkoani Districts. These findings suggest that, change of the rainfall pattern and increasing of surface temperature are a matter of concern especially in clove production in Zanzibar and that, most households in Pemba Islandi.e Micheweni, Wete, Chake Chake and Mkoani districts are highly vulnerable to the effect of climate change and variability. Serious mitigation and adaptation measures should be considered to rescue potential consequences of climate related disasters and crisis.

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